eu Robotics Forum

5th Workshop on
Hybrid Production Systems

Flexible manipulation using dual arm robots

THOMAS EU Project

LMS
Laboratory for Manufacturing Systems & Automation

Dr. George Michalos

Laboratory for Manufacturing Systems and Automation (LMS)
University of Patras
www.lms.mech.upatras.gr
Tel.: +30 2610 91 01 60
E-Mail: michalos@lms.mech.upatras.gr

Motivation

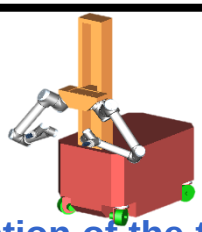
- Currently there are about 2.3 million industrial manufacturing SMEs in the EU (99% of all companies)
- Small scale production exhibits "one of a kind" product variability requiring production structure & process / equipment flexibility
- Strategies for reducing cell's maintenance and auxiliary systems cost & effort required will promote production automation
- Complex manual tasks cannot be fully automated with a good ration of cost vs robustness
- At least 85% of the production tasks in major industries are automatable through robotic applications

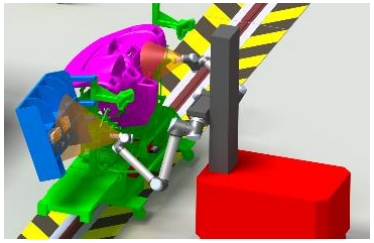
The vision is:

*"to create a **dynamically reconfigurable shopfloor** with **mobile dual arm** robots, able to **perceive their environment** and **cooperate with other robots** and **humans**"*

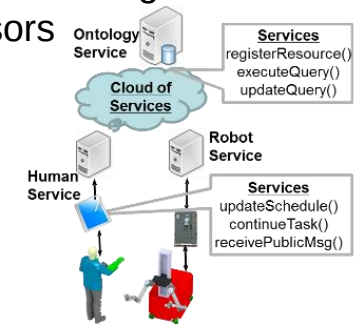
Objectives

- **O1. Enabling mobility on products and resources** by means of mobile resources able to navigate in the shop floor while utilizing dexterous tooling

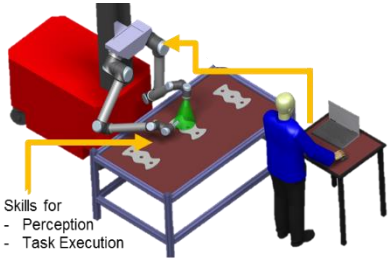




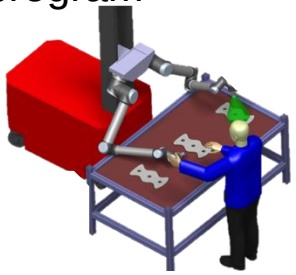
- **O2. Enabling perception of the task and the environment** using a) the individual resource's sensors and b) collaborative perception by combining sensors of multiple resources and shop floor sensors



- **O3. Dynamic balancing of workload and redirecting to stations** allowing the resources to communicate automatically adjust their behaviour

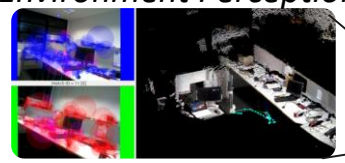


- **O4. Fast programming and automatic execution of multiple tasks**. By applying skills over the perceived environment and by automatically generating the robot program



- **O5. Safe collaboration between humans and robots** eliminating physical barriers (fences, etc.) by introducing cognitive capabilities allowing the robots to detect the human and its intentions

Concept

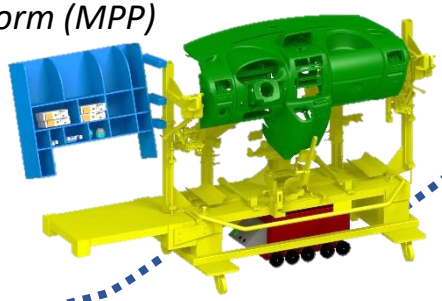


Environment Perception

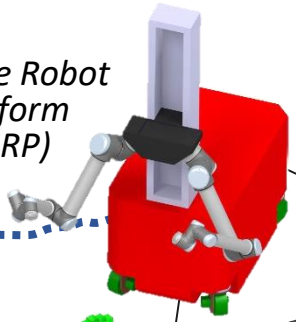
"Dynamic balancing and redirecting to stations"

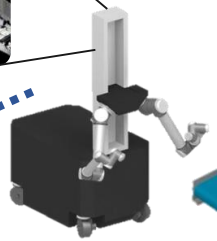
"Enabling mobility on products and resources"

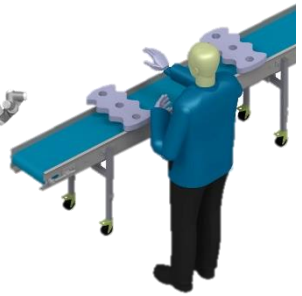
Mobile Product Platform (MPP)

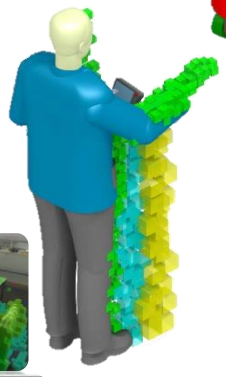


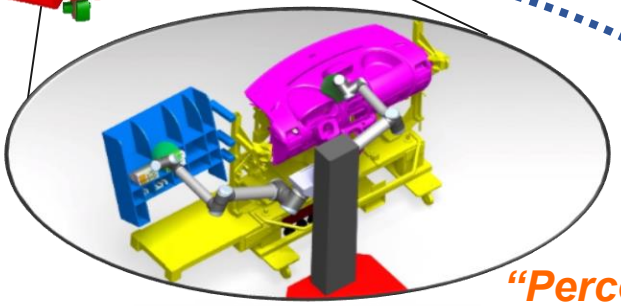
Mobile Robot Platform (MRP)

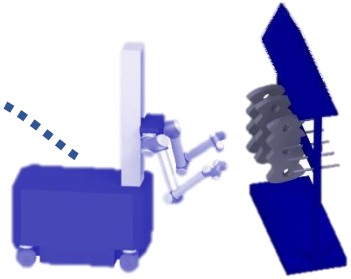




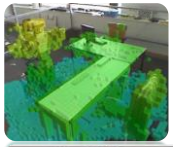


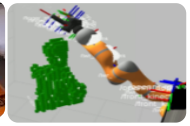






"Human-Robot and Robot-Robot collaboration in a safe way"





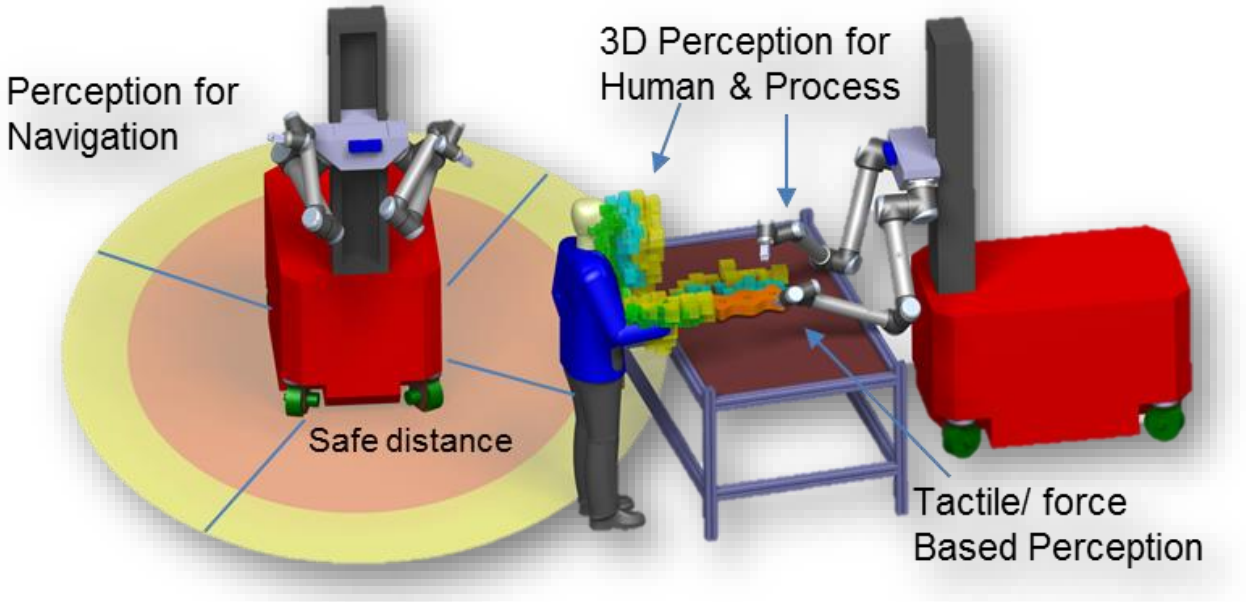
Human awareness

Product & Process Perception

"Perception & skills to automatically program and execute multiple tasks"

Environment & Process Perception

- ✓ **3D vision** enabled **process perception for manipulation**
- ✓ Process **context awareness** perception
- ✓ In cell & Cell to Cell navigation
- ✓ Multi sensors based **enhance safe navigation**



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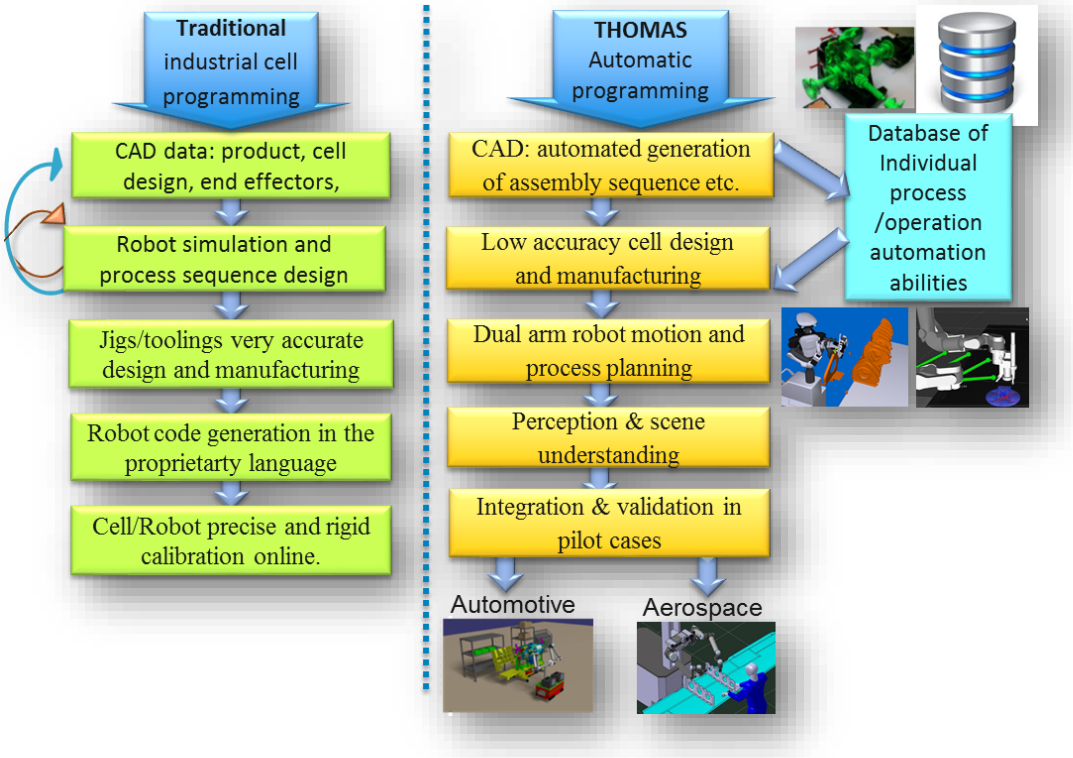
Autonomous Object detection & Motion generation

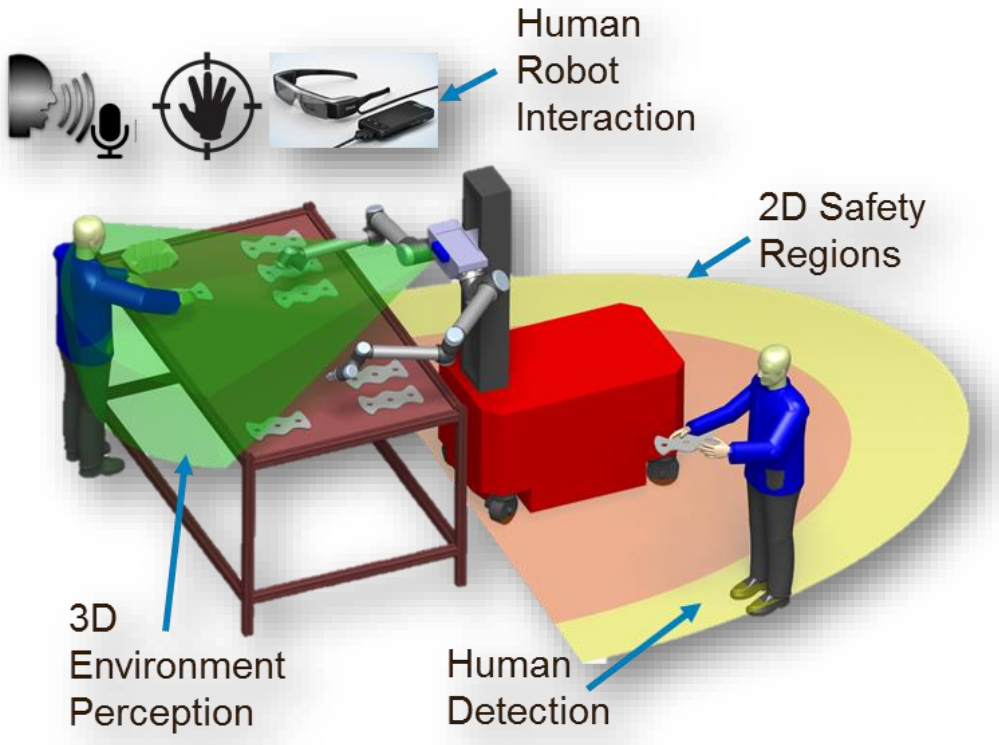
Automated programming & execution

- ✓ CAD based **autonomous program generation**
- ✓ Collision free **grasp, path & motion planning**
- ✓ Offline **robot skills composition**
- ✓ Online **skills refinement** based on sensor input



H-R and R-R Collaboration & Safety

- ✓ **Hybrid Safety** : fusing 2D – 3D sensor data
- ✓ **Direct** H-R **interaction**: (voice, gestures, wearables)
- ✓ **In – direct** H-R **interaction**: (human intention detection)
- ✓ Manipulator **End of Arm Safety**
- ✓ Human – Robot **workspace supervision**



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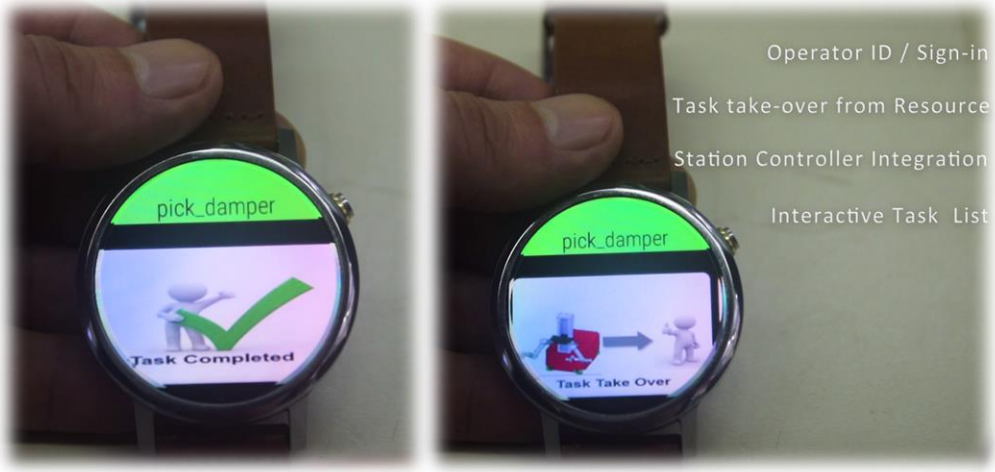
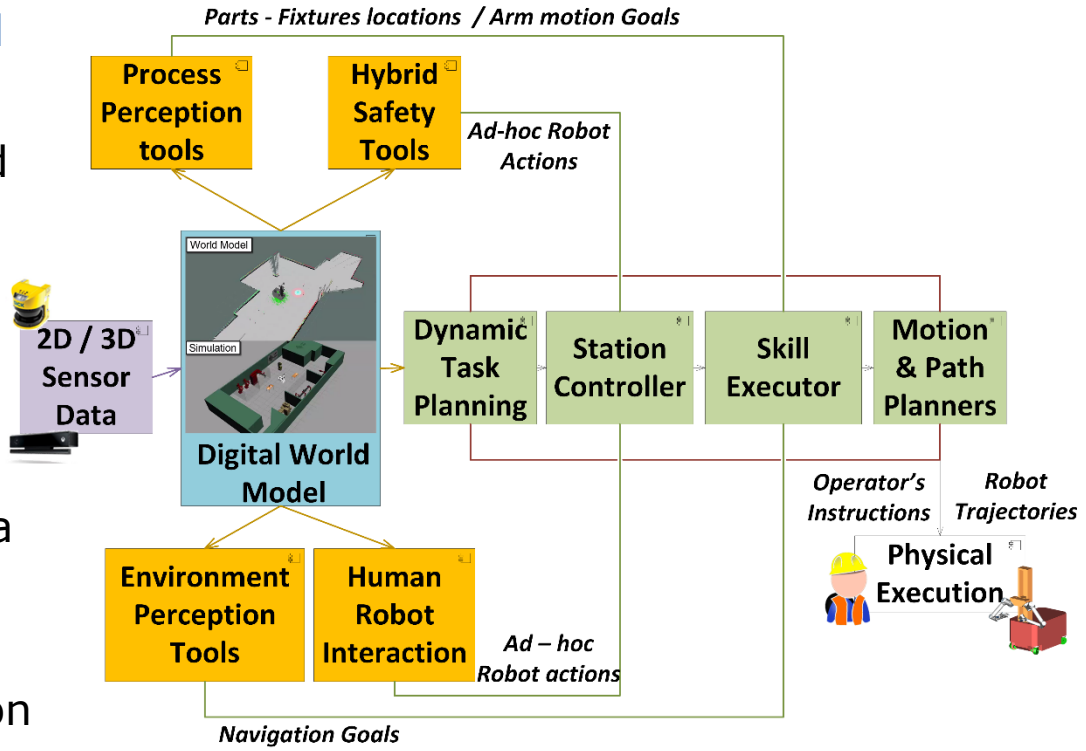
Interfaces on "Smart" wearables



Dynamic work re-organization architecture

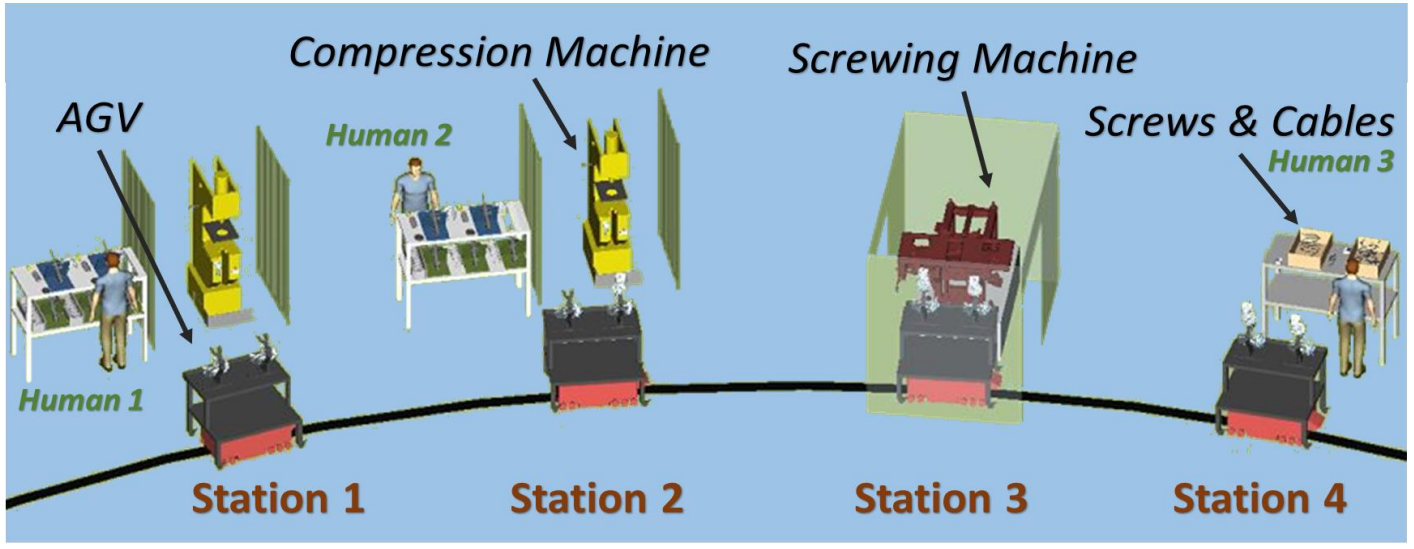
- ✓ Shopfloor **Digital World Model**
- ✓ **Real Time update** of the World based on sensors & data processing modules
- ✓ AI based **HR Task Planning**
- ✓ Service based integration & data flow
- ✓ **Station Controller** for execution coordination & monitoring



Automotive Case Study

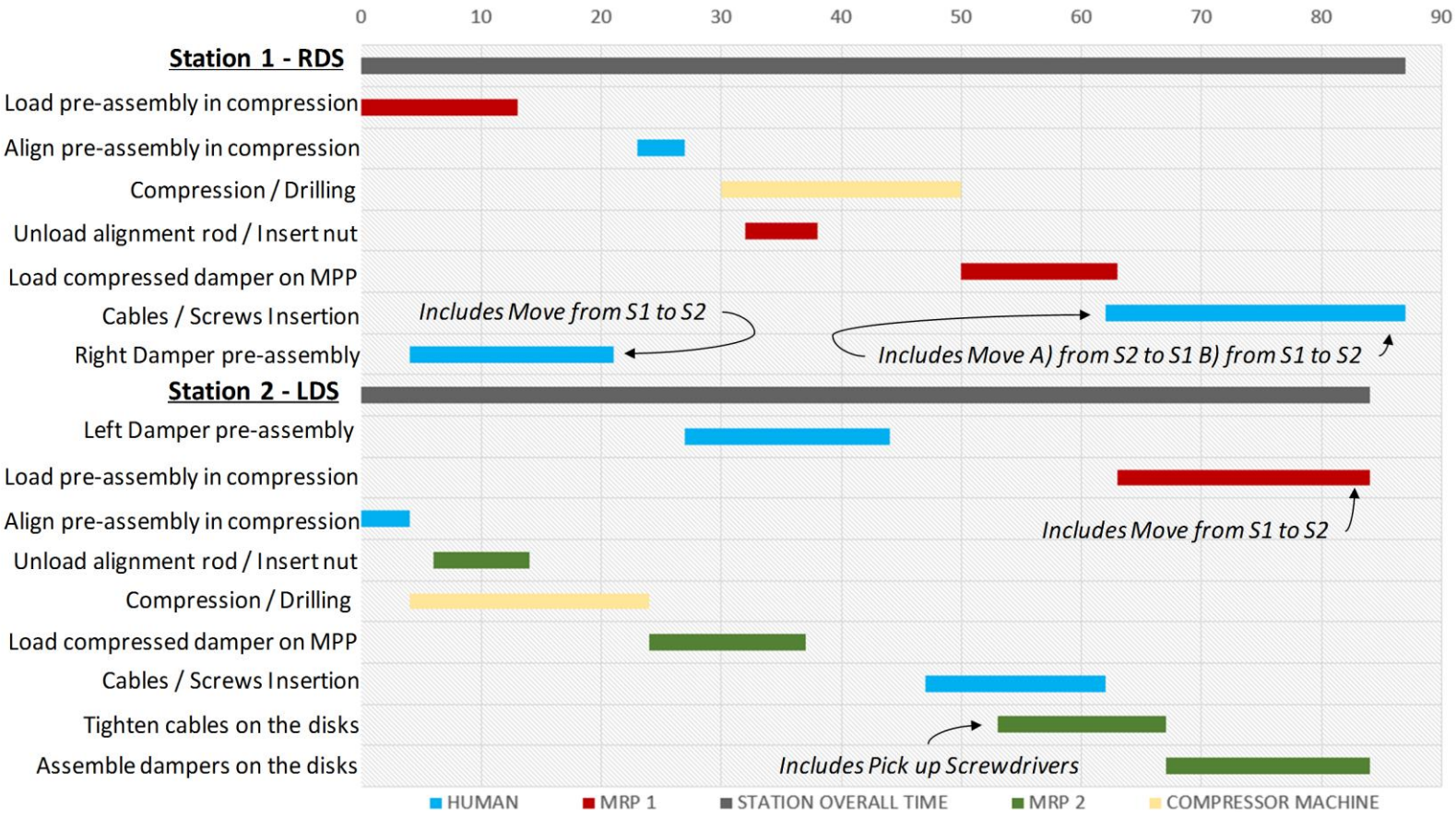
Front Axle Assembly Line – Current State

Station	Task	Resource	Duration
S1	Pre-assembly of right damper	Human	12 secs
S1	Load pre-assembled damper on the compression machine, compression of right damper and load compressed damper on the AGV	Human – Compression mach.	30 secs
S2	Pre-assembly of left damper	Human	12 secs
S2	Load pre-assembled damper on the compression machine, compression of left damper and load compressed damper on the AGV	Human – Compression mach.	30 secs
S3	Screwing machine connect each damper with one disk	Screwing machine	57 secs
S4	Cables / Screws Insertion	Human	50 secs



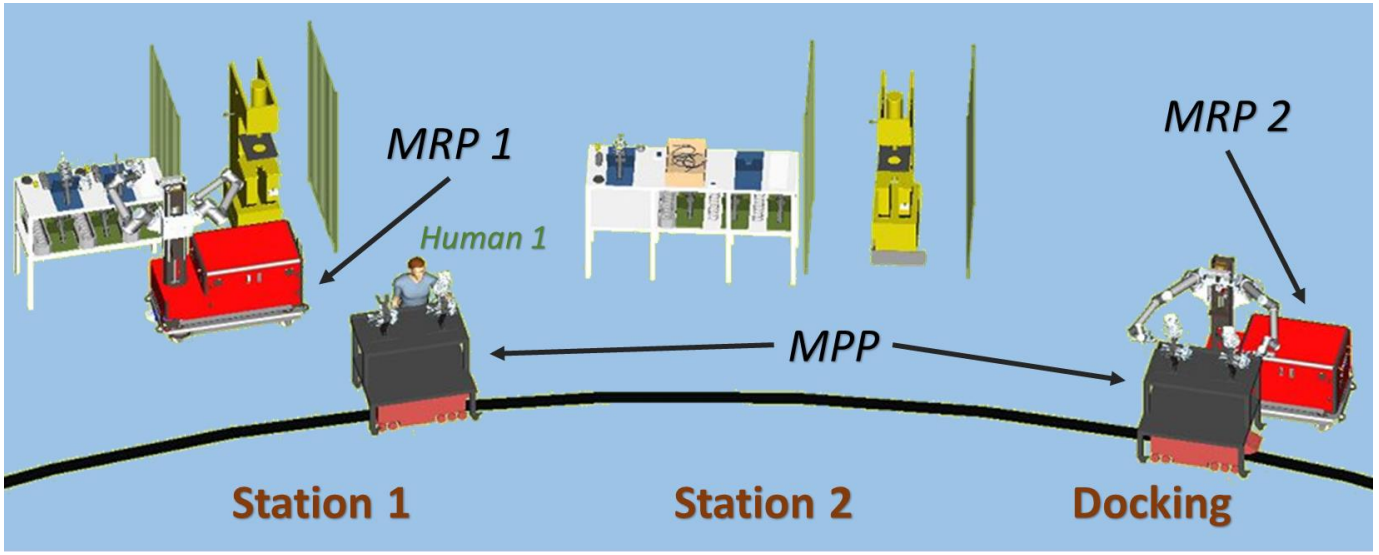
Automotive Case Study

Front Axle Assembly Line – Vision (1/2)



Automotive Case Study

Front Axle Assembly Line – Vision (2/2)



KPI	Current State	Hybrid Paradigm
Weight Handled by Operators (Kg)	6	0.5
No. of models	3	6
Operator Activity (%)	71.5	100
No. of Operators	3	1

Contact Information

Presenter & Project Coordinator
Dr. George Michalos
Laboratory for Manufacturing Systems and Automation (LMS)
University of Patras, Greece
Tel: +30-2610-910160
Fax: +30-2610-997314
E-Mail: michalos@lms.mech.upatras.gr

Thank you for your Attention!

Questions?

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For more information visit us at www.thomas-project.eu