Planning of mobile assistant units in assembly lines for performing material supply operations

ERF 2016, March 21, 2016, Ljubljana

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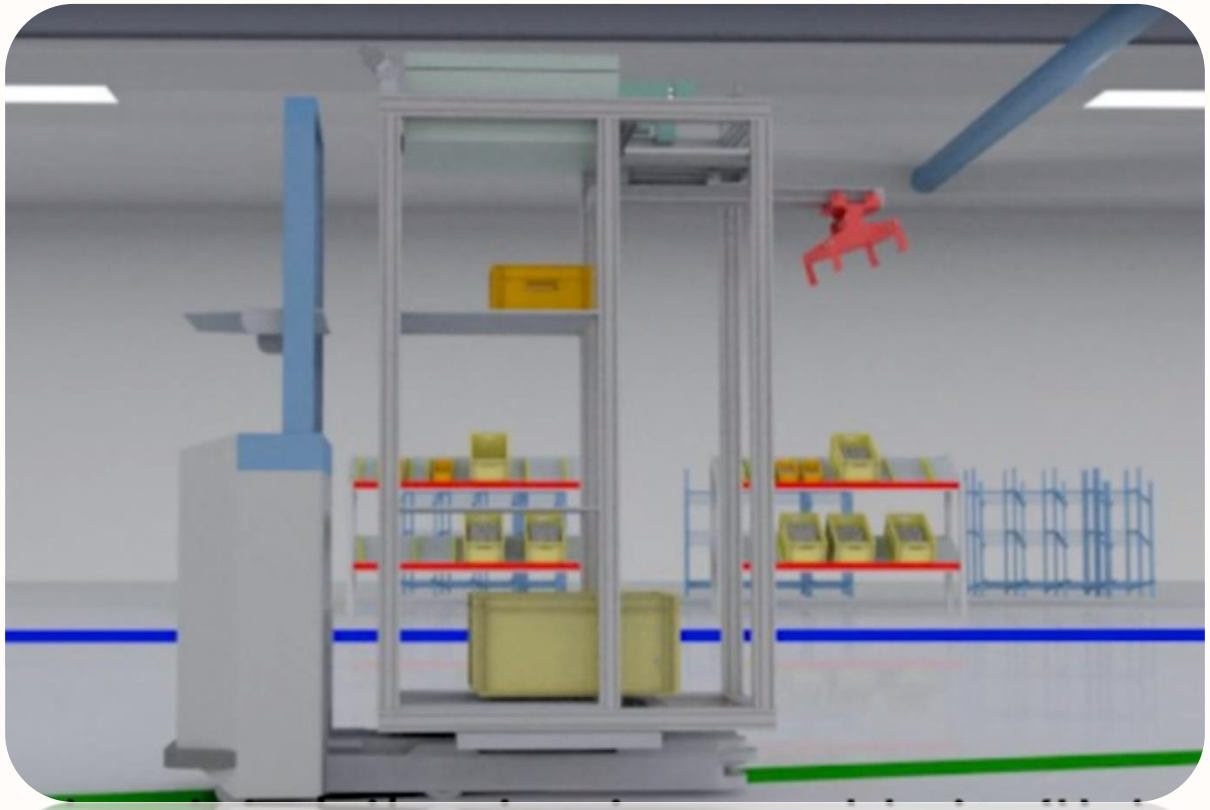
Intelligent Intralogistics Concept

- Intralogistics Mobile Assistant Units (IMAUs)



https://www.youtube.com/watch?v=Tkt11FZYH00

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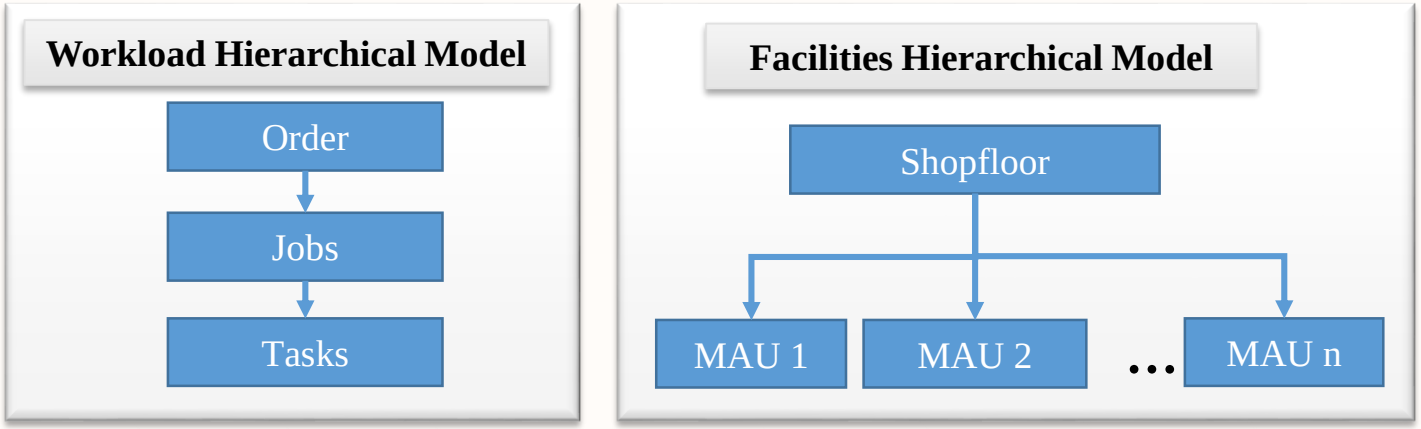
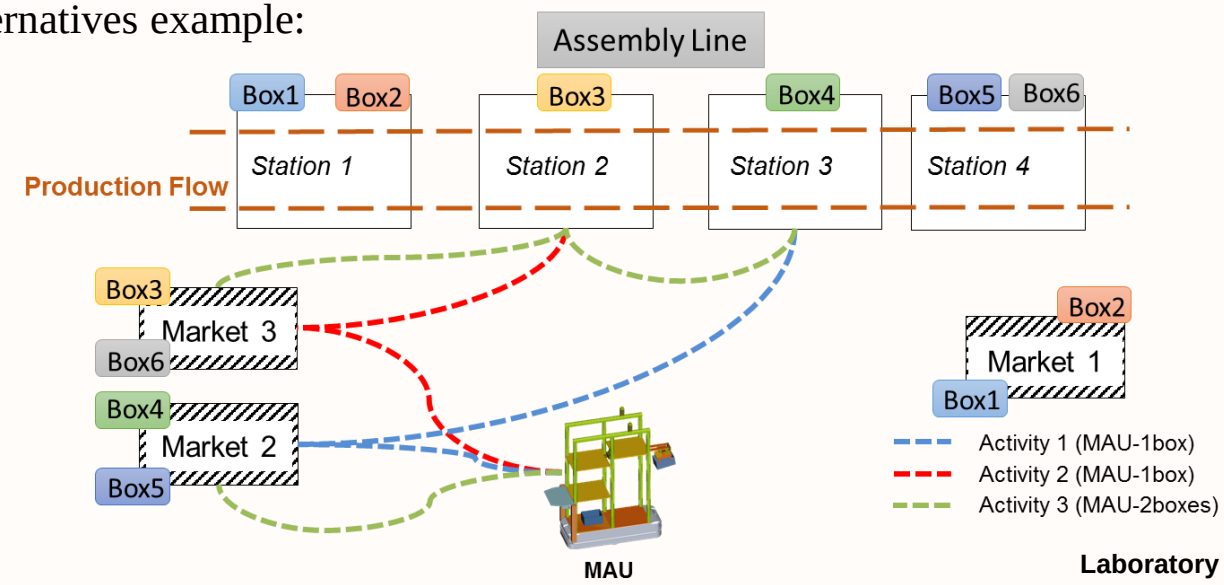
Planning of material supply operation

- Hierarchical Modelling



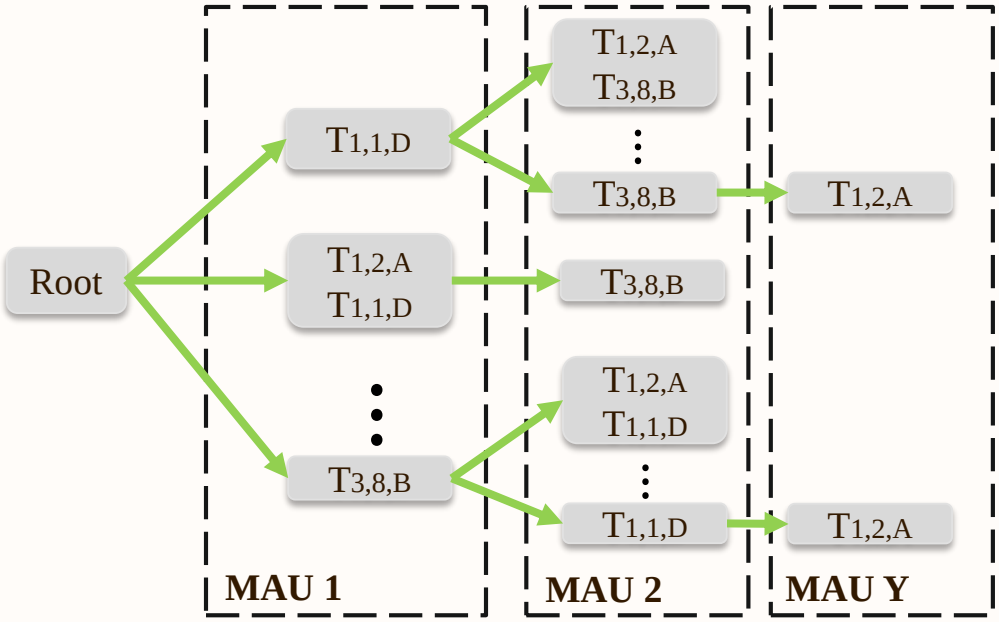
- Task alternatives example:



*G. Michalos, K. Kaltsoukalas, P. Aivaliotis, P. Sipsas, A. Sardelis, G. Chryssolouris, "Design and simulation of assembly systems with mobile robots", CIRP Annals-Manufacturing Technology, Available Online 2014

Formulation of search problem

- Boxes needing replacement = 3, Available MAUs in the shop floor is Y



$T_{i,j,k}$:
- i = destination station id
- j = consumable box id
- k = consumable box type

- Node of a tree ▸▸ Group of tasks to be performed by the MAU
- Branch of tree ▸▸ Complete schedule (tasks alternative)
- Operations precedence relations are satisfied
- MAUs suitability constraints define candidate resources for each task

*G. Michalos, P. Sipsas, S. Makris, G. Chryssolouris, "Decision making logic for flexible assembly lines reconfiguration", Robotics and Computer-Integrated Manufacturing, Available Online (2015)

**G. Michalos, S. Makris, D. Mourtzis, "An intelligent search algorithm-based method to derive assembly line design alternatives", International Journal of Computer Integrated Manufacturing, Volume 25, No.3, pp.211-229(2012)

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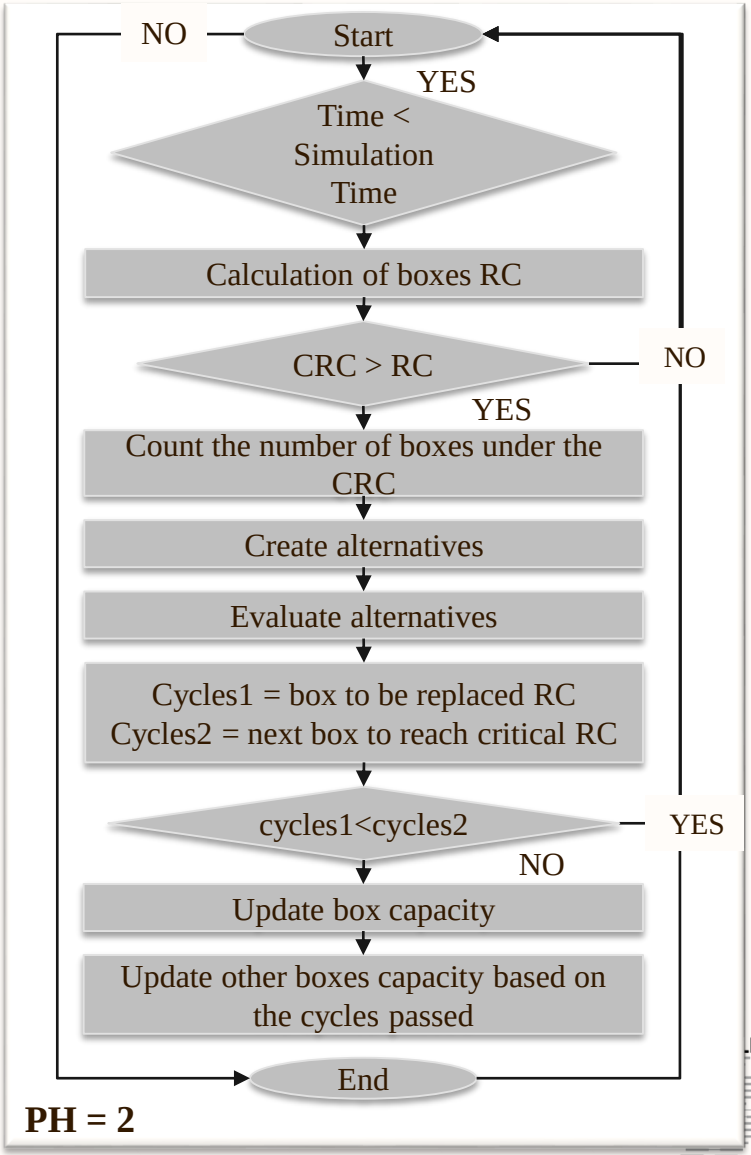
Planning Rules & Performance criteria

Planning rules:

- Remaining Cycles for part depletion (RC)
  - ✓ Represents the cycles that **each box can serve** before its depletion
  - ✓ Critical Remaining Cycles (CRC) - **threshold**
- Planning Horizon (PH)
  - ✓ Integer value – **1 to max number for boxes** that the MAU can carry simultaneously
  - ✓ Checks if the MAU should **wait** for the **next box** to get under the threshold

Performance criteria:

- Distance travelled from the MAU for each alternative
- Time Required for transportation (t_t)



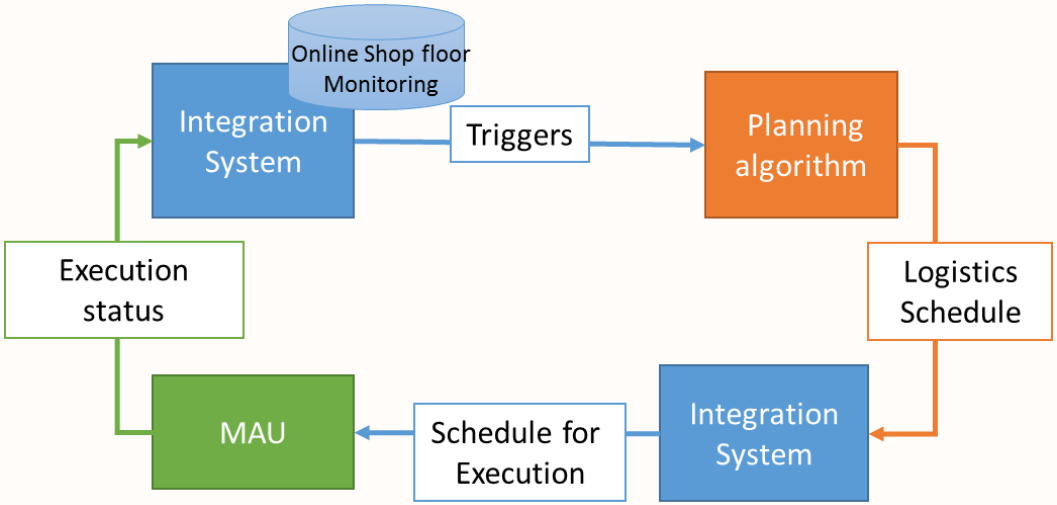
Case study

Rear wheel assembly line:

- 4 Product variants
- 4 Stations – 1.5 min cycle time / station
- 18 different consumable boxes
- 4 market areas

Rear Wheel group assembly line*

System Implementation Architecture:



Results:

PH	Parts entered	Production Volume	No of MAU transportation	No. of Rejections	Part depletion
PH = 1	1200	995	56	205	28
PH = 3	1200	1052	41	148	12

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*Source: http://www.nelman.es/servicios.html

Conclusions and Outlook

Conclusions:

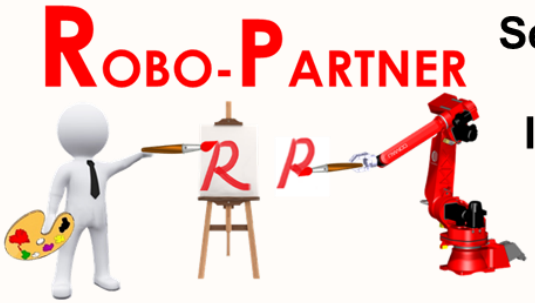
- Tailor the **characteristics of different MAUs** (number of shelves, dimensions) through the PH variable
- Adjust **the decision making process** in order for the multiple variants (e.g. number of boxes) to be considered by the PH variable
- Achieve a **higher production volume** of the system,
- **Reduce part depletion** occurrences and
- **Reduce the MAU's travelling distance**, leading to an increased utilization of these resources and to a reduction in the idle time.

Outlook:

- Implementation of **intelligent search algorithms**
- **Integration** of planning algorithm with **MAUs control** system
- **Connection** with **shop floor** monitoring systems

Niki Kousi, George Michalos, Sotiris Makris, George Chryssolouris, "Short – term planning for part supply in assembly lines using mobile robots", 6th CIRP Conference on Assembly Technologies and Systems (CATS) – Accepted for publication

Acknowledgements



Seamless Human-Robot Cooperation
for
Intelligent, Flexible and Safe Operations
in the
Assembly Factories of the Future

http://www.robo-partner.eu.eu/

This research has been partially supported by the research EU FP7 project "ROBO-PARTNER – Seamless Human-Robot Cooperation for Intelligent, Flexible and Safe Operations in the Assembly Factories of the Future" (Grant no. 608855) funded by the European Commission.

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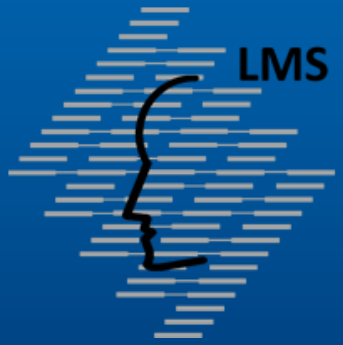

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