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

- Intralogistics Mobile Assistant Units (IMAUs)
Planning of material supply operation

- **Hierarchical Modelling**

- **Workload Hierarchical Model**
  - Order
  - Jobs
  - Tasks

- **Facilities Hierarchical Model**
  - Shopfloor
  - MAU 1
  - MAU 2
  - ... MAU n

- **Task alternatives example:**

Formulation of search problem

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

- 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

\[ T_{i,j,k} : \]
- \( i \) = destination station id
- \( j \) = consumable box id
- \( k \) = consumable box type


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)

Case study

Rear wheel assembly line:

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

Results:

<table>
<thead>
<tr>
<th>PH</th>
<th>Parts entered</th>
<th>Production Volume</th>
<th>No of MAU transportation</th>
<th>No. of Rejections</th>
<th>Part depletion</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH = 1</td>
<td>1200 1200</td>
<td>995</td>
<td>56</td>
<td>205</td>
<td>28</td>
</tr>
<tr>
<td>PH = 3</td>
<td>1052</td>
<td>41</td>
<td>148</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

*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, Spyridon Koukas, George Michalos, Sotiris Makris, George Chryssolouris, “Service oriented architecture for dynamic scheduling of mobile robots for material supply”, 5th CIRP Global Web Conference Research and Innovation for Future Production (CIRPe) 2016–Accepted for publication

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

http://www.robo-partner.eu.eu/
THANK YOU!

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