Optimizing workstation layout in final automotive assembly

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INFLUENCE PRODUCT DESIGN

• Manufacturing efficiency (cost)
• Packaging (supply chain) considerations
Supply Chain: Design for density

BEFORE

AFTER

Courtesy: Sergio Angotti
Feedback from manufacturing

→ VIRTUAL MANUFACTURING

ISSUES

• Disjoint organizations
• Disjoint IT systems
• Anecdotal knowledge
Final assembly

• Moving assembly line
• Mixed model assembly
Line Planning Process

• Process sheets (parts & tools, times needed for each task)

• Task allocation process (done at the assembly plants)

• Operator balance chart

• Standardized work chart
Task allocation and cell layout

- Line Balancing: allocating tasks to workcells
- Workcell layouts: arrangement of elements in workcells (bins, tools, etc)
e-Workcell

Michigan Truck
Model granularity

• Different levels of description
• Audience (plants vs. central office)
  ⇒ Appropriate visualization at all levels (VRML, X3D, PLM-XML)
• Worker participation (Toyota Production System)
Optimization problem

- WALKING TIME: Given the bins’ positions and the sequence of tasks, determine the time required to complete all tasks.

- BIN LOCATION: Given a sequence of tasks, determine the optimal location of part bins.

- SEQUENCE OF TASKS & BIN LOCATION: Given a set of tasks, determine optimal sequence of tasks and allocation of part bins.
Levels of complexity

• One operator per cell, sequence of tasks identical for all vehicles

• One operator per cell, different sequences for different vehicles

• Multiple operators, different sequences
  – Sequences of tasks involve coordination between different operators
  – In a mixed model line some vehicles may require involvement of only one operator
Optimization algorithms

- Minimize non-value added time
- Unconstrained optimization
- Constrained optimization (SQP, MINLP)
Applications

• Work Pattern Analysis for Moving Line
  – Heritage (New Dearborn Plant)

• Detailed vehicle mix studies
  – Kentucky Truck, Oakville

• Synchronization of Multiple Operators
  – Louisville, Chicago

• Aston Martin
Benefits

- Improve assembly efficiency/flexibility.
- Visual interface to central database (feedback into Product Development)
- Expanded user audience (line operators as well as engineers)
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Q & A