Digital Modeling of Reconfigurable Assembly Systems with Manual Workcells

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Ergonomics & Manual Assembly

• Majority of an assembly operations still cannot be automated.

• The productivity of a manual assembly system can be increased with better ergonomics.

• Production simulation and virtual manufacturing tools are valuable in reducing the time needed in the design steps.

Assembly Systems and a Human Factor

Reasons for reduction of automation

The key features of modern final assembly system technology are:

• Human friendly (ergonomics)
• Modular
• Rapid implementation, scaleable, adaptable to varying product life cycle volumes;
• Reusable, redeployable for different product models and families, product life-cycle, economics;
• Adaptable to individual customer needs, time-to-customer, mass customization;
• Reconfigurable, ability to arrange modules for different objectives;

• After concept of an Assembly System is completed,
  – Database with all standard and non standard modules is formed
  – Assembly layout is designed with a:
    ➢ **Base module**
      (Ergonomic table and a chair);
    ➢ **Linking modules**
      (Boxes, tools, gadgets, jigs, fixtures);
    ➢ **Material handling modules**
      (Boxes and palettes).
Base Modules

Ergonomic table and a chair

Designed workplaces should fit various people, in a range from the shortest woman to the tallest man.
Material handling modules

Fixture family

Fixtures could be designed by using a family designing option in CAD software

Imported in CATIA from Pro/ENGINEER
Material handling modules

Material Shuttles

Shelves

Containers & Covers

Retrieved from a BOSH Rexroth Web CAD parts catalogue (Pro/E)
MAS Catalogue

How to integrate: Pro/ENGINEER, Mechanical Desktop, and CATIA?

- IGES
- VDAIS and VDAFS
- DXF
- SET
- STEP
Material Handling Modules

- Shuttes
- Covers
- Holders
Base Modules

Tables

Linking modules

Chairs
Tools

Table Presses

Jigs and Fixtures
A Product – Cordless Drill
Assembly Process

Workplace 1
Housing gear assembly

Final assembly
Workplace 2
Housing motor assembly

Workplace 3

Control
Workplace 4

Repair
Workplace 5

Packaging
Workplace 6
Product

Mechanical Desktop Model
Ergonomic Analysis

• DELMIAV5 tools, integrated in CATIA V5R14:
  ➢ Human Builder,
  ➢ Human Posture Analysis,
  ➢ Human Measurements Editor
  ➢ Human Activity Analysis.
Human Builder

• Create virtual human model (manikin):
  gender, race, height and weight

A human body:
  ➢ 68 segments
  ➢ 6 hinge joints
Gear Subassembly Workstation
Human Posture Analysis

- Local and global postures analysis
- Predefined angles (total range is divided to a smaller angles and they are being quantified with a score)
- Posture optimization

Before predefined angle definition

After predefined angle definition
Human Activity Analysis

- Human Activity Analysis is being performed before the system actually exists.
- It determines human and workplace interaction.

- RULA analysis
- Lift / lowering analysis
- Push / pull analysis
- Carry analysis
RULA analysis Workstation 1

Rapid Upper Limb Assessment

RULA is a postural targeting method for estimating the risks of work-related upper limb disorders.

Before the change

After the change
Assembly System