Digital Modeling of Reconfigurable Assembly Systems with Manual Workcells

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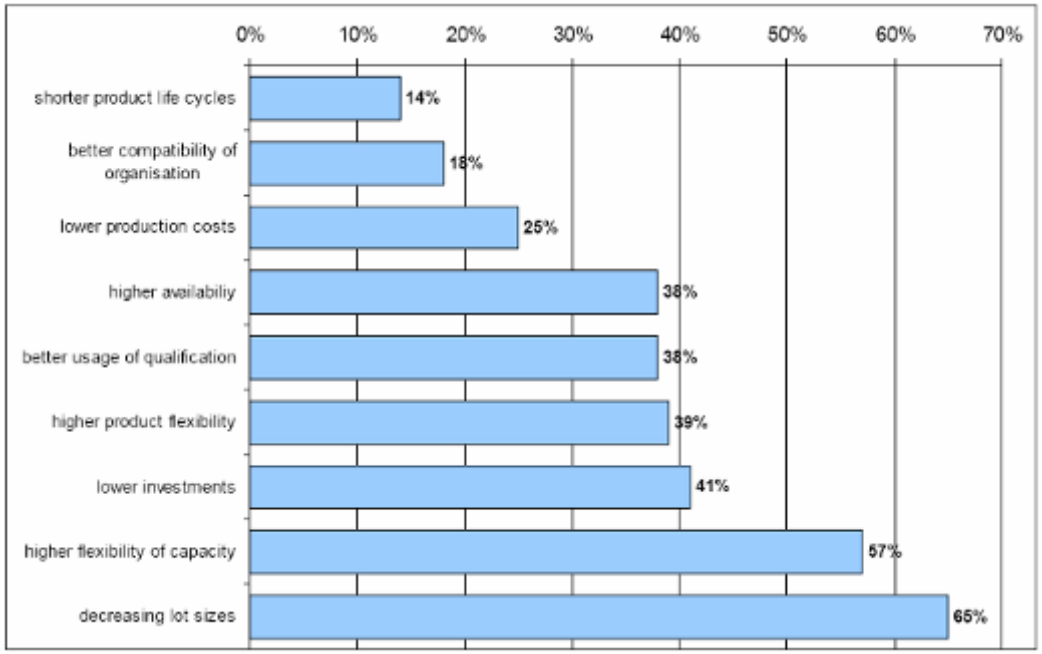
Ergonomics & Manual Assembly

- 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.

Heilala, J. and Voho, P. (1999), ``Semi-automatic modular final assembly systems for light assembly industry'', ICPR99, nternational Conference on Production Research, 9-13 August, Ireland.

Assembly Systems and a Human Factor



Reasons for reduction of automation

Lay G., & all 2001, Zurück zu neuen Ufern, in Zeitschrift für wirtschaftliche Fertigung ZWF, Jahrgang 96 (2001) 7- 8, Carl Hanser Verlag, München

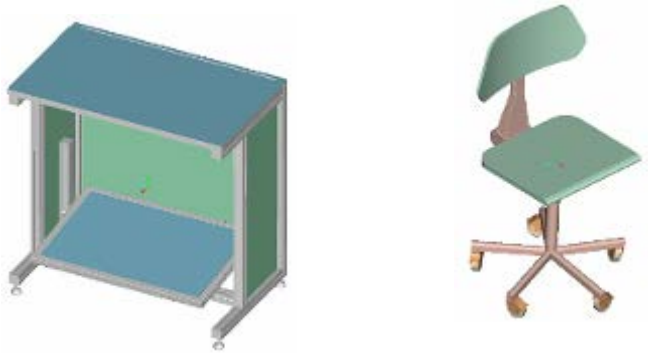
The key features of modern final assembly system technology are:

- 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;

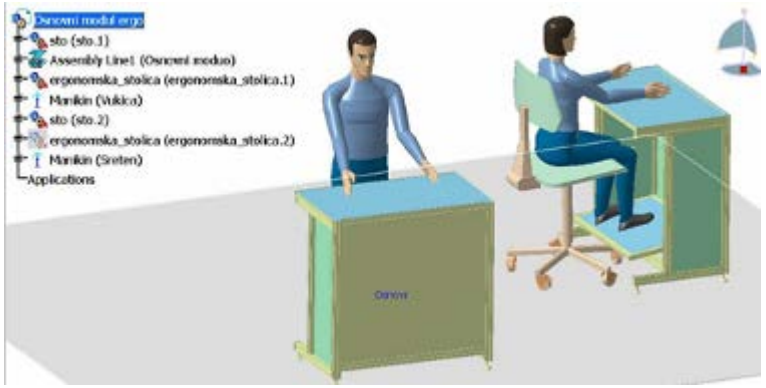
Heilala, J., Modular reconfigurable flexible final assembly systems, Assembly Automation Volume 21 . Number 1 . 2001 . 20-28

- 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

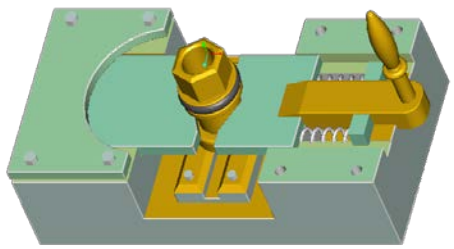


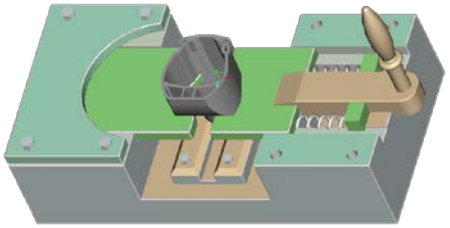
Ergonomic table and a chair



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

Material handling modules





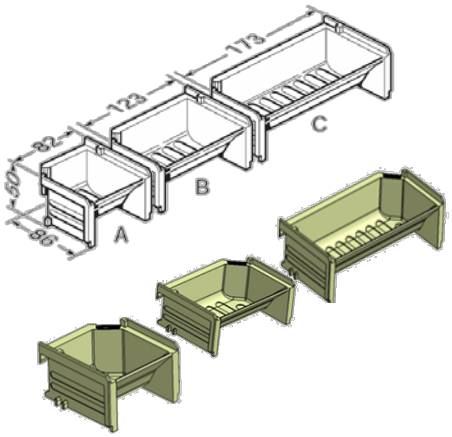
Fixture family

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

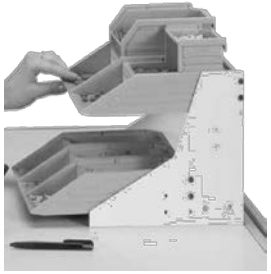
Imported in CATIA from Pro/ENGINEER

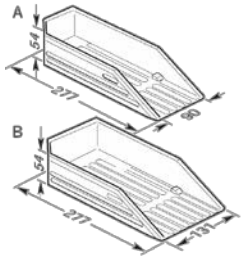
Material handling modules

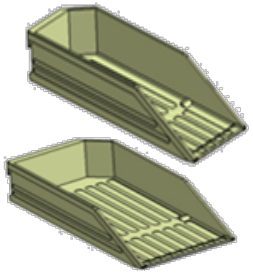
Material Shuttles



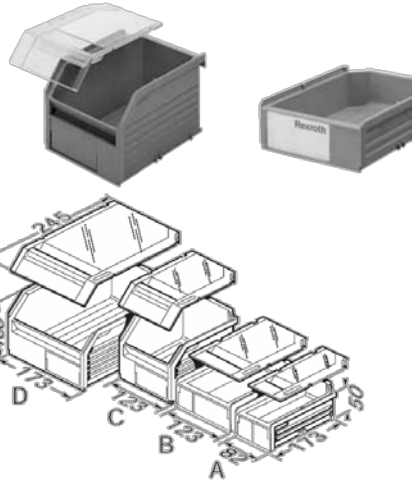
Shelves

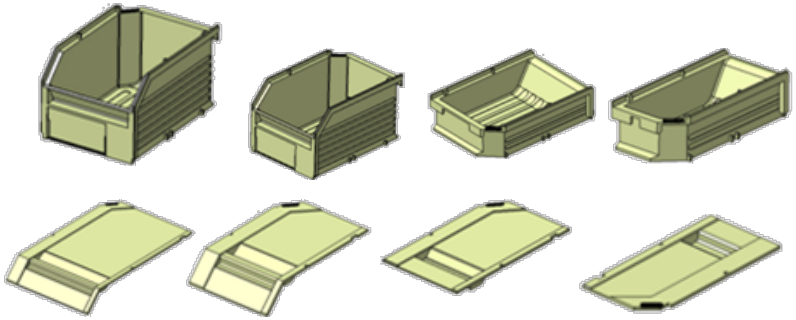






Containers & Covers



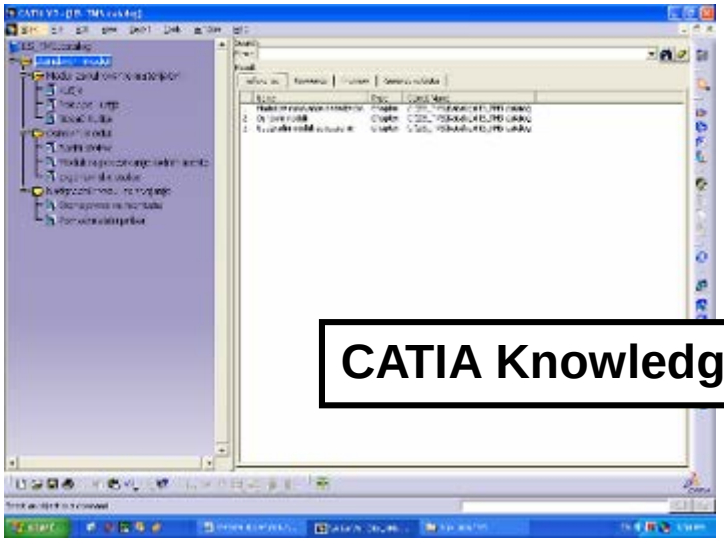


Retrieved from a BOSH Rexroth Web CAD parts catalogue (Pro/E)

MAS Catalogue

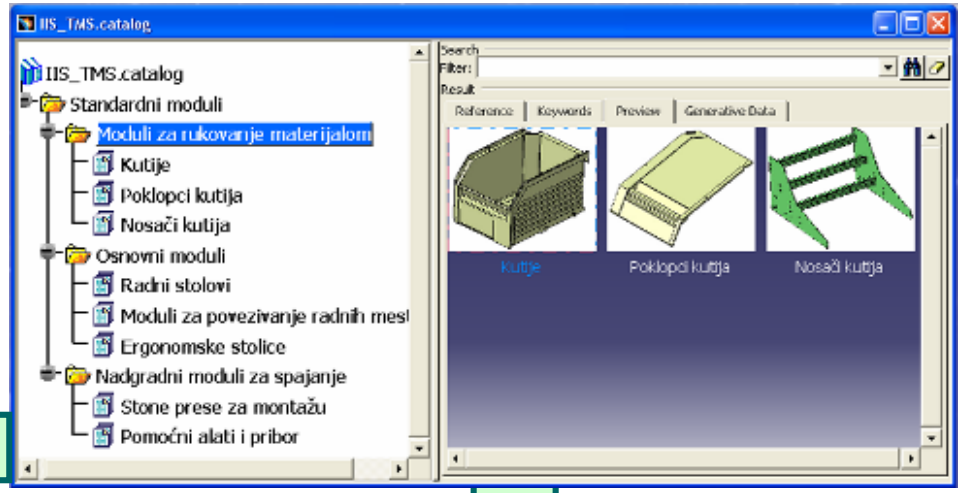
How to integrate: Pro/ENGINEER, Mechanical Desktop,and CATIA?

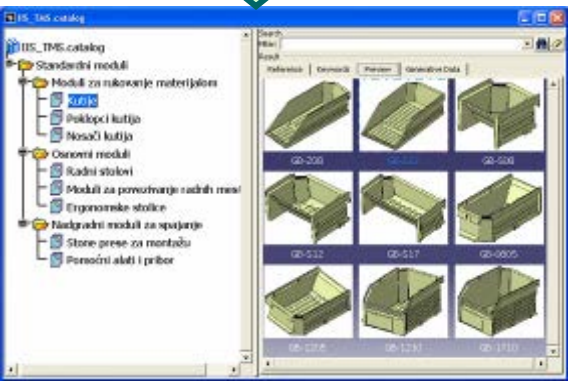
- IGES
- VDAIS and VDAFS
- DXF
- SET
- STEP

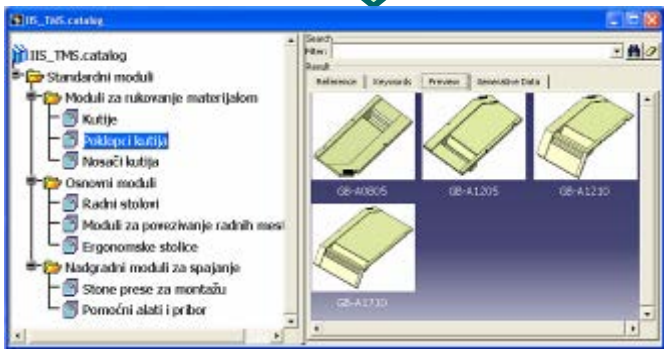


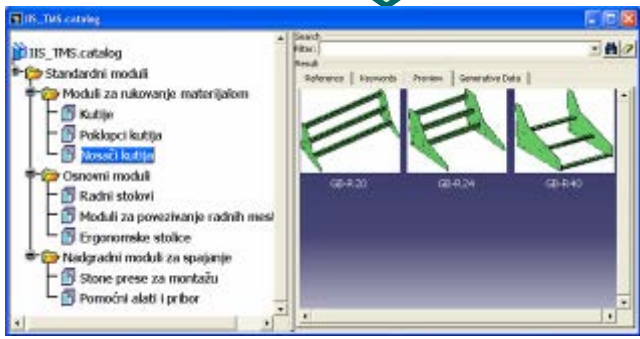
CATIA Knowledge Expert

Material Handling Modules







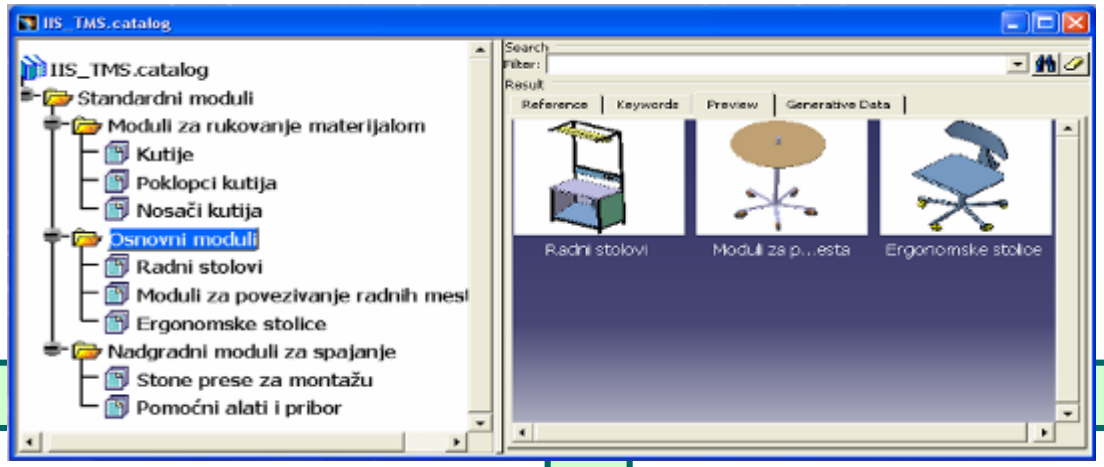


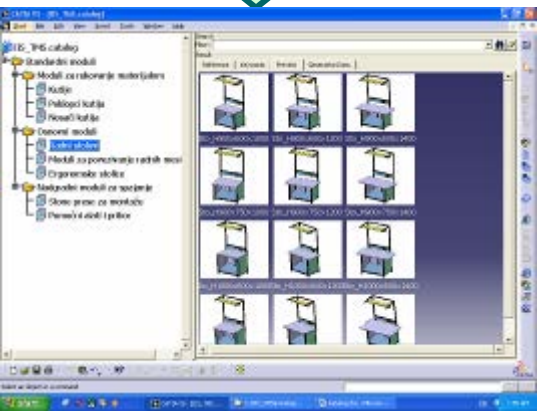
Shuttles

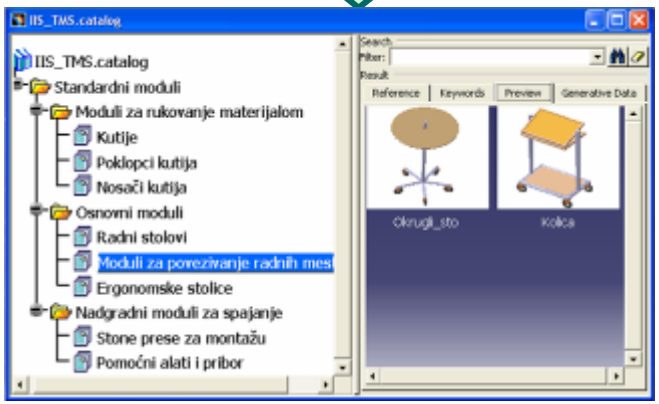
Covers

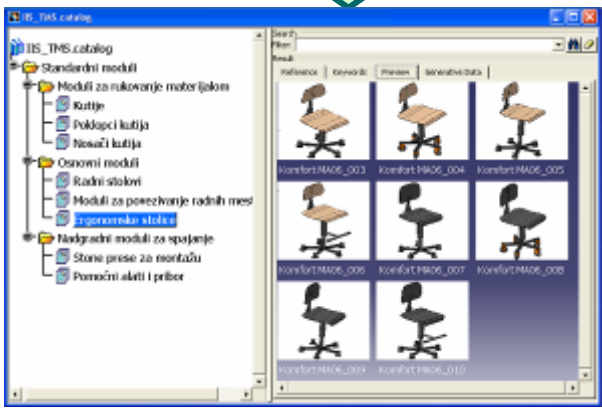
Holders

Base Modules









Tables

Linking modules

Chairs

Tools

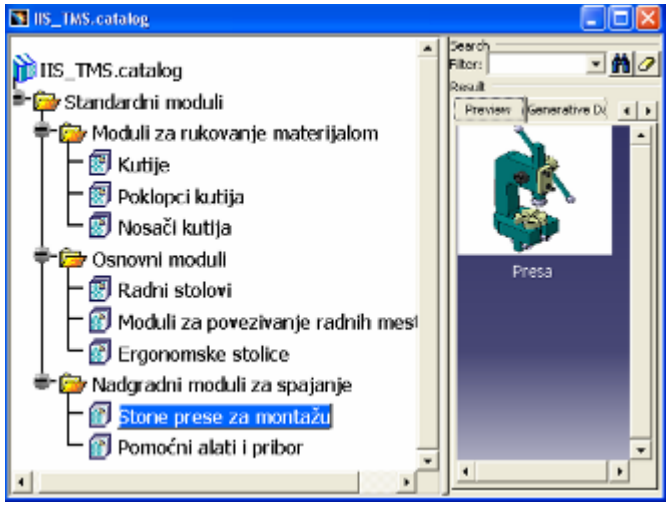
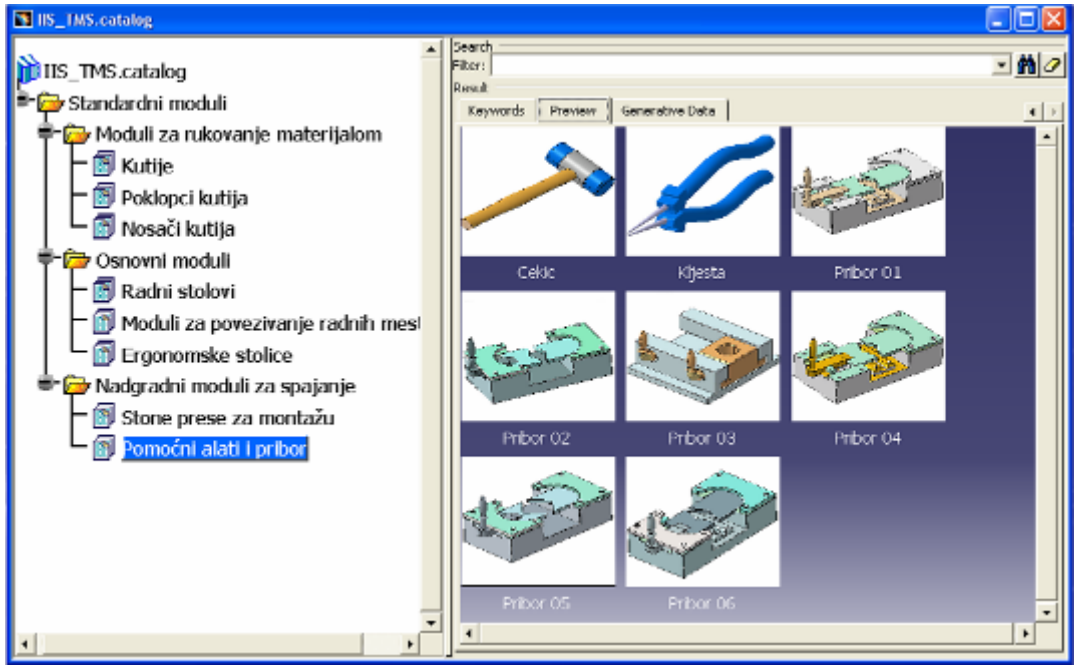
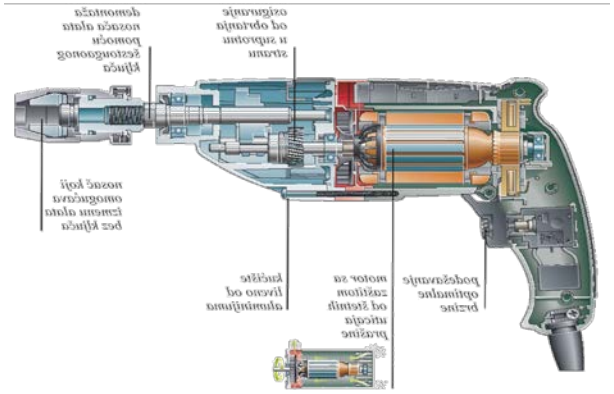


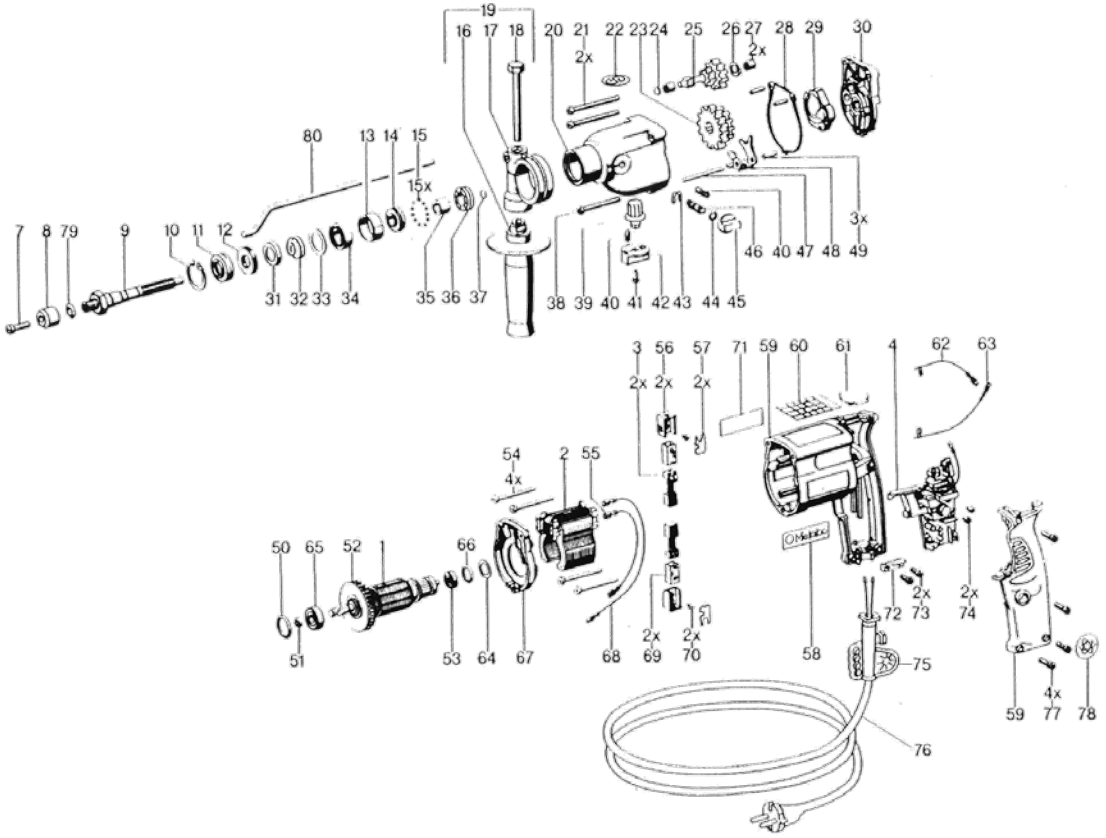
Table Presses



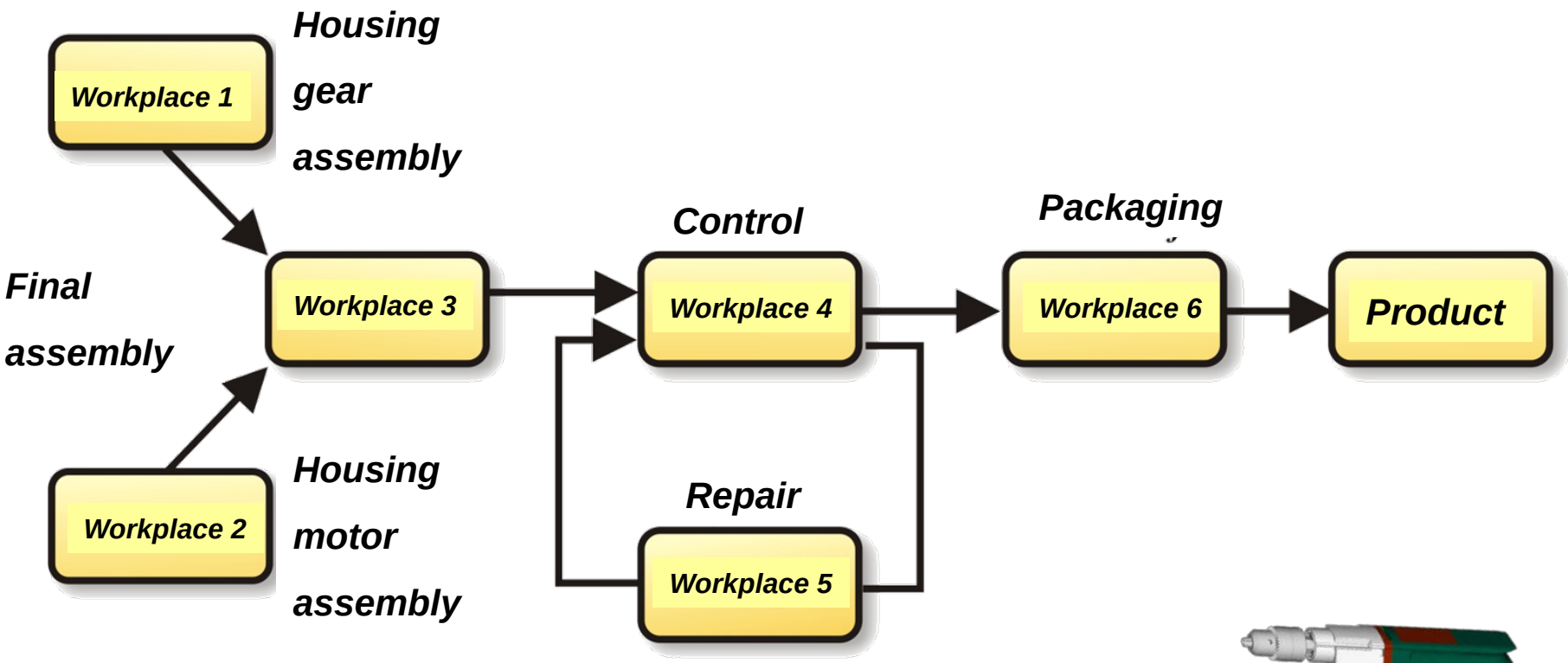
Jigs and Fixtures

A Product – Cordless Drill





Assembly Process



Mechanical Desktop Model

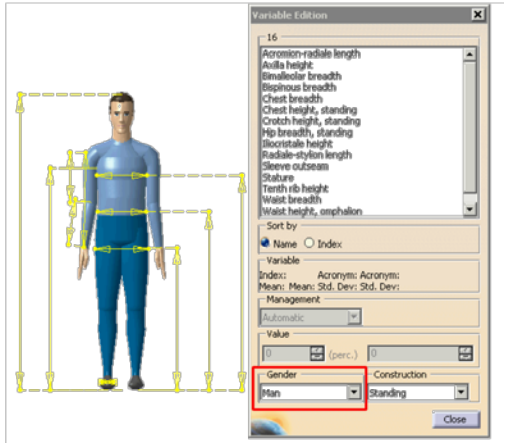
Ergonomic Analysis

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

Human Builder

- Create virtual human model (manikin):

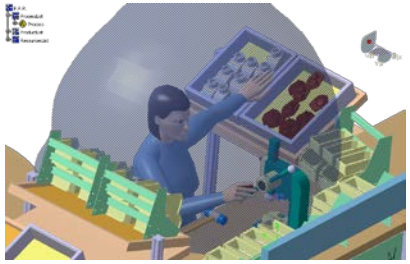
  gender, race, height and weight

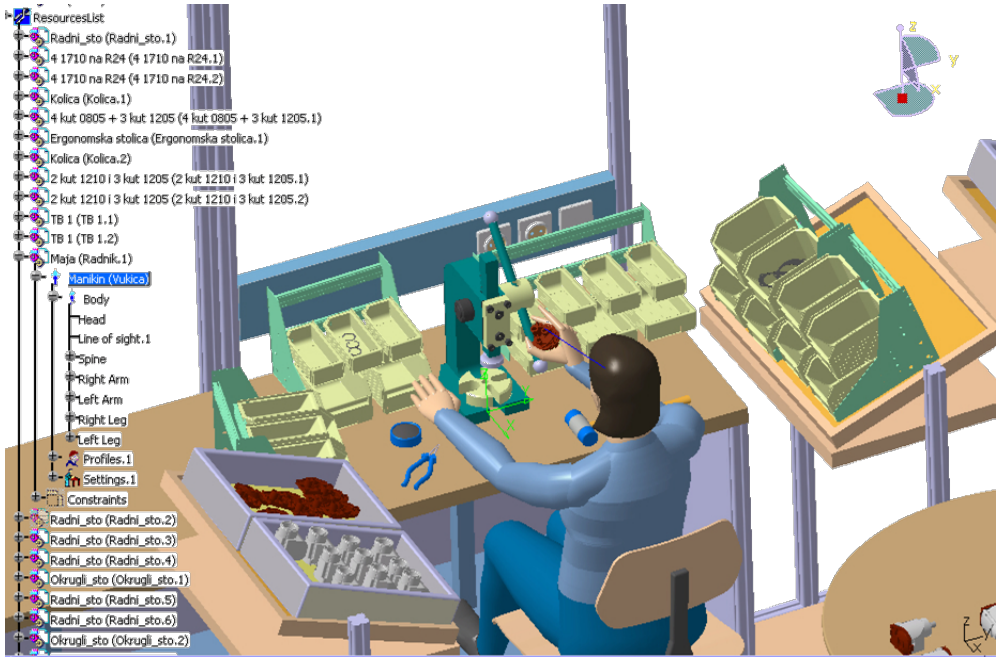


A human body:

- *68 segments*
- *6 hinge joints*

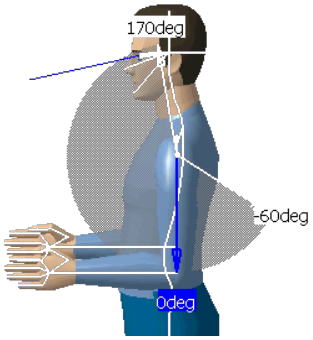
Gear Subassembly Workstation



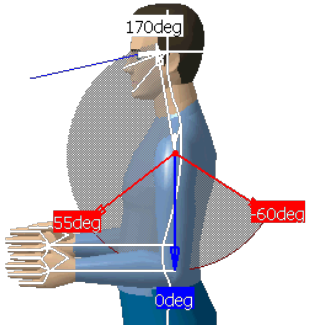


Human Posture Analysis

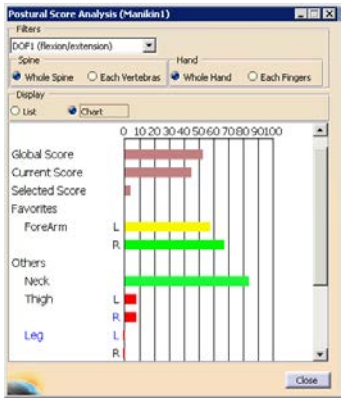
- Local and global postures analysis
- Predefined angles (total range is divided to a smaller angles and they are being quantified with a score)
- Posture optimization

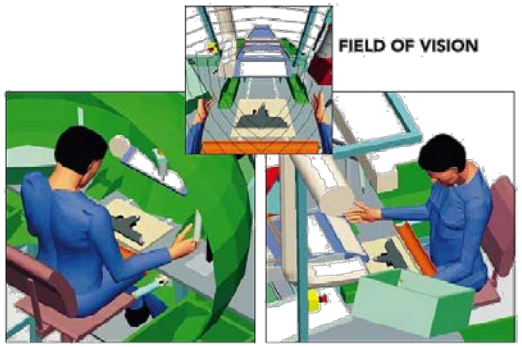


Before predefined angle definition



After predefined angle definition





Human Activity Analysis

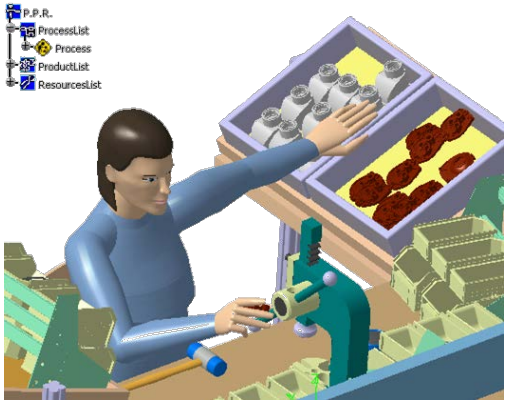
- Human Activity Analysis is being performed before the system actually exists.
- It determines human and workplace interaction.

  - *RULA analysis*
  - *Lift / lowering analysis*
  - *Push / pull analysis*
  - *Carry analysis*

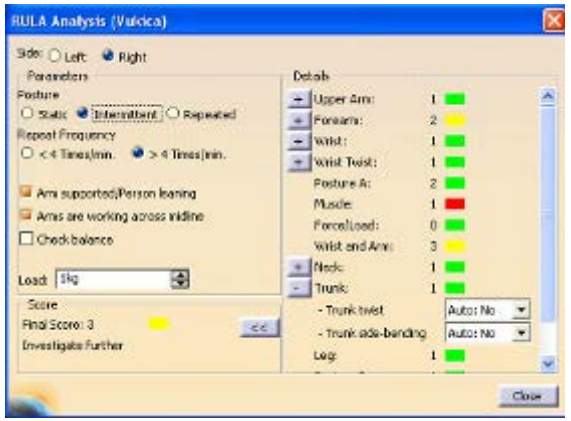
RULA analysis Workstation 1

Rapid Upper Limb Assessment

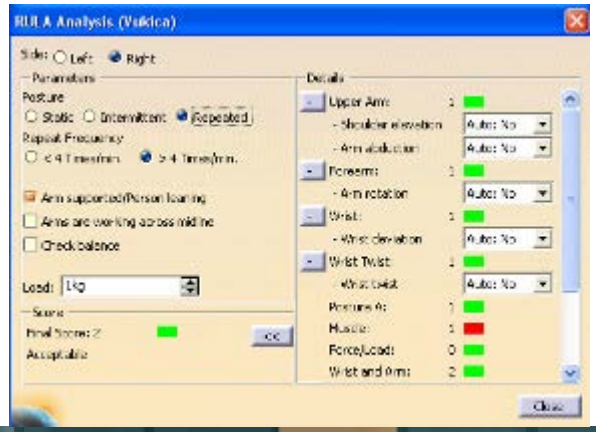
RULA is a postural targeting method for estimating the risks of work-related upper limb disorders.



Before the change



After the change



Assembly System