Workshop on Product Intelligence (Concepts and Theory)

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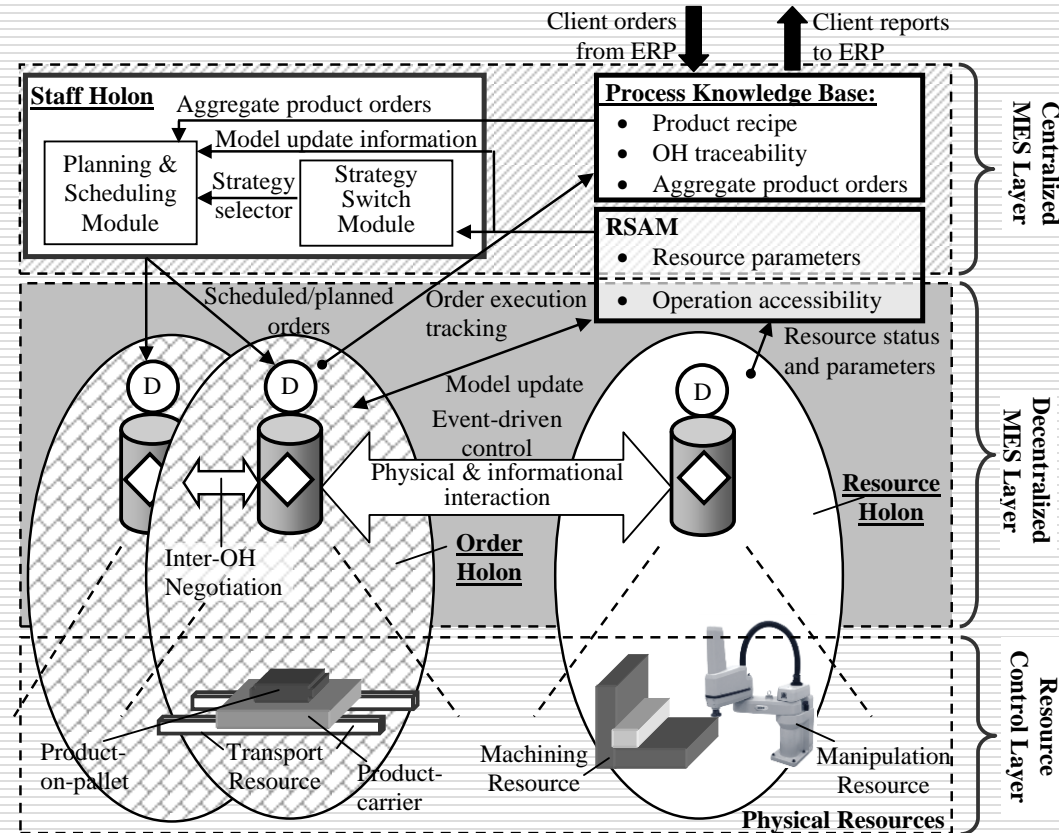
CIMR Centre, cimr@cimr.pub.ro , www.cimr.pub.ro

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CIMR

Supporting holonic control architecture for IP

Model composition:

1. **Staff Holon** : global production planning, scheduling, coordinator, GUI and production strategy decider;

2. **Order Holon**: an aggregate intelligent entity in charge of taking real-time decisions;

3. **Resource Holon**: physical resources together with the control counterpart;

4. **Product and Process Knowledge Database** (PPKB): stores the operations structure for the products;

5. **Resource Service Access Model** (RSAM): distributed autonomous entity in charge of collecting resource information and offering it in a concise manner.
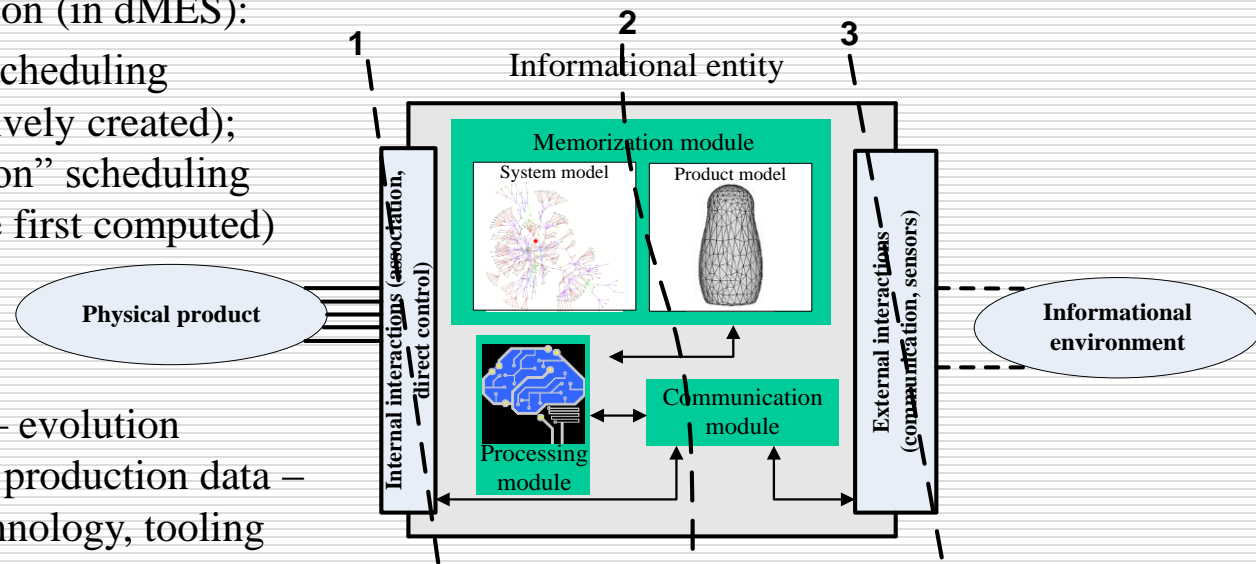
Client orders from ERP · Client reports to ERP

Staff Holon · Aggregate product orders · Model update information · Planning & Scheduling Module · Strategy selector · Strategy Switch Module

Process Knowledge Base:
- Product recipe
- OH traceability
- Aggregate product orders

RSAM
- Resource parameters
- Operation accessibility

Scheduled/planned orders · Order execution tracking · Model update · Event-driven control · Physical & informational interaction · Resource status and parameters

Resource Holon

Inter-OH Negotiation · **Order Holon**

Product-on-pallet · Transport Resource · Product-carrier · Machining Resource · Manipulation Resource

Physical Resources

Centralized MES Layer · Decentralized MES Layer · Resource Control Layer

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IP model

- *Embedded intelligence*, handles:
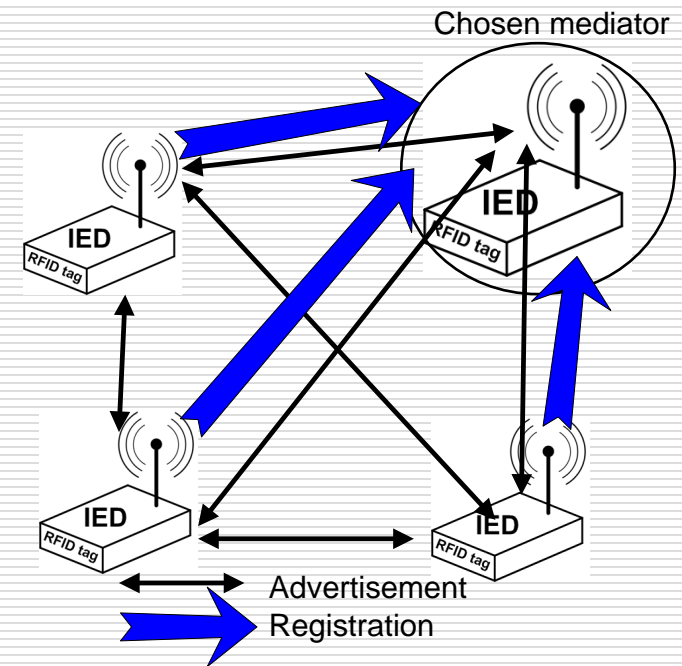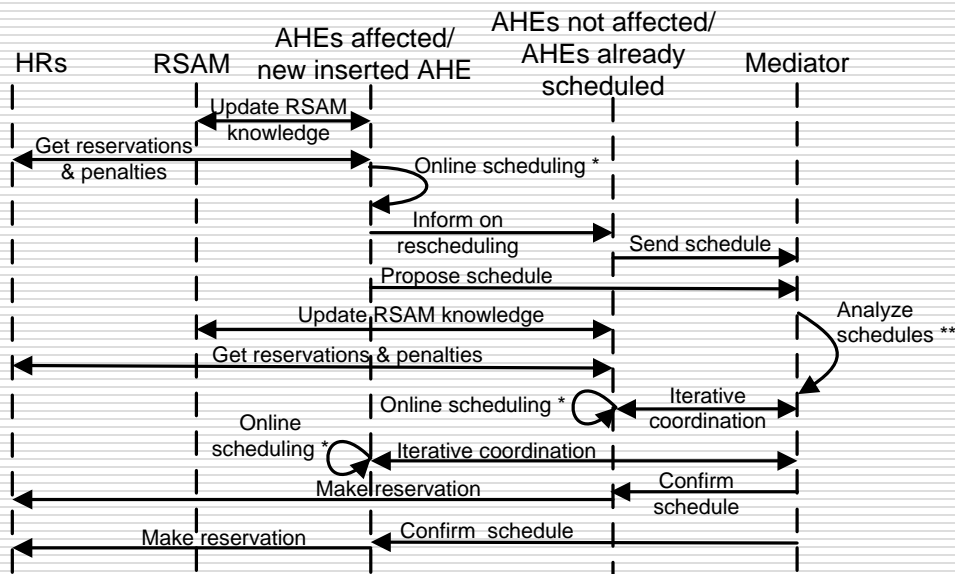
  ✓ the updated model of resource services
    access (RSAM);
  ✓ the product model;
  ✓ an inter-agent communication protocol;
  ✓ a set of resource allocation algorithms
    (real-time scheduling);
  ✓ product-driven automation (in dMES):

    - "Next-operation" scheduling
      (schedule progressively created);
    - "Packet optimization" scheduling
      (complete schedule first computed)

  ✓ *Location* of intelligence – evolution
  ✓ *Complexity* of product & production data –
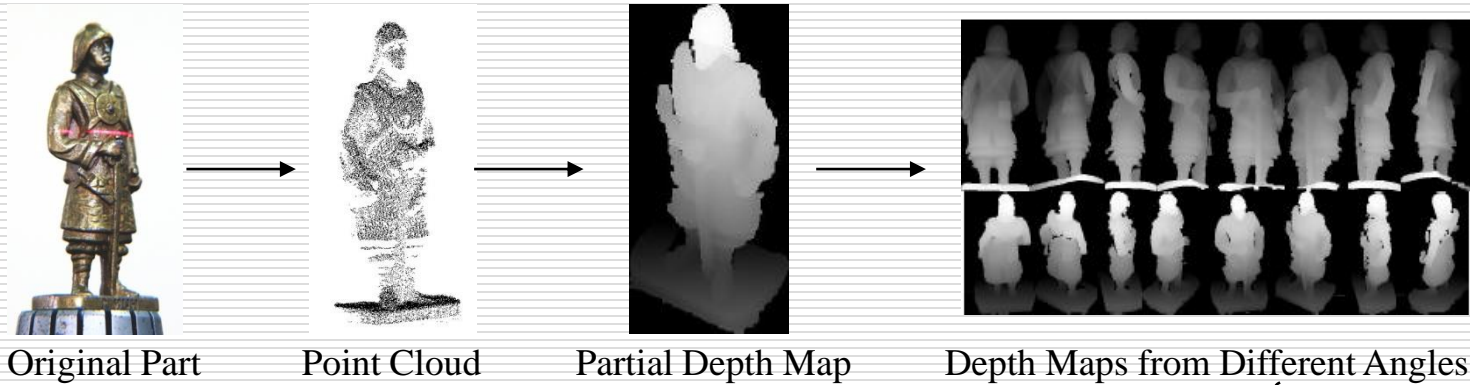 operations, precedence, technology, tooling

1   **2**   **3**

Informational entity

Memorization module

System model   Product model

Physical product

Internal interactions (association, direct control)

External interactions (communication, sensors)

Informational environment

Communication module

Processing module

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Product-driven automation in heterarchical manufacturing control

- ➢ **Dynamics of the control model: allocation process & Mediator**
- ➢ **Process objective:**
  - • **Makespan minimization and equal resource utilization**
  - • **Adaptability to perturbations**
- ➢ **Real-time decentralized resource allocation**

# IP - Digital representation of product [processing sequence]

Original Part   Point Cloud   Partial Depth Map   Depth Maps from Different Angles

3D Surface Model

front

back

Depth Maps for
CNC reproduction

Tool Offset
(morphological dilation)

CNC toolpaths

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CMR
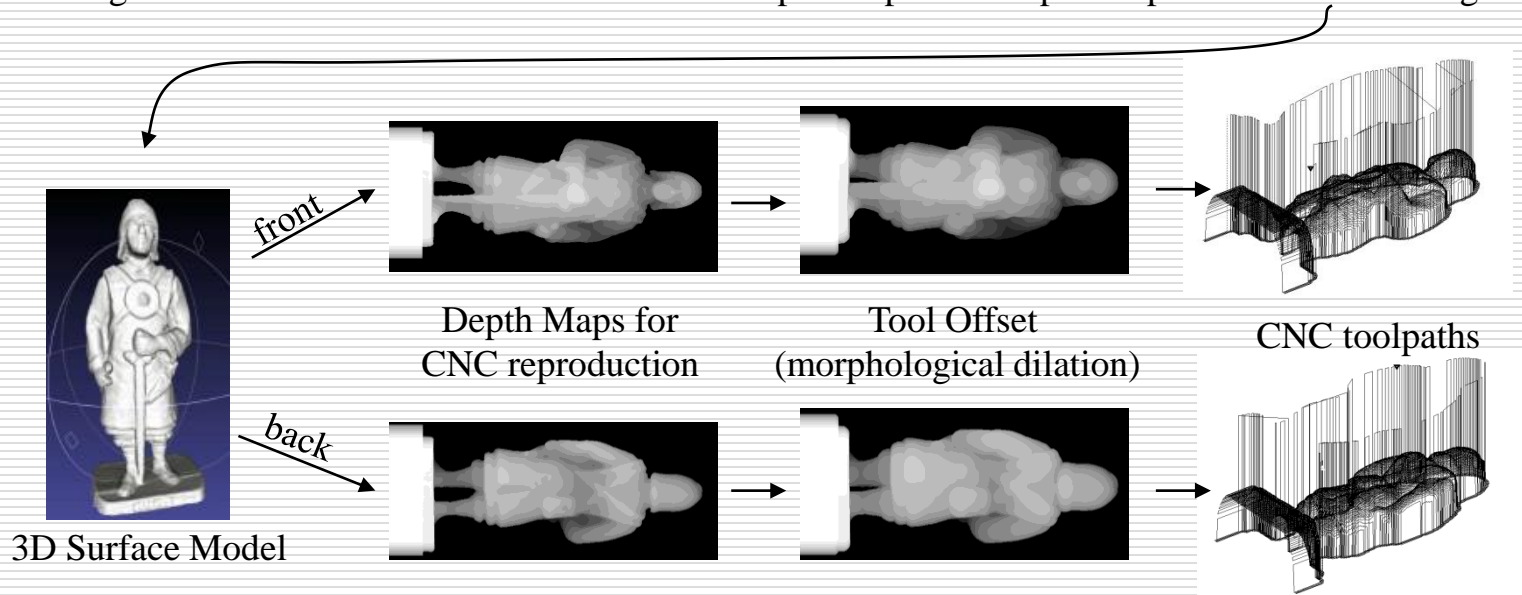
IP - Digital representation of product [tooling]

Robot-driven shape reconstruction for 4-dim. machining
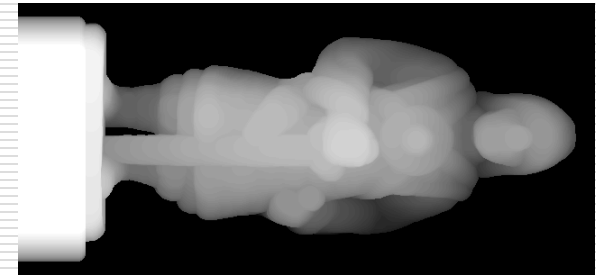
Compute 3D Tool Compensation from Image Processing

Milling Tool

Part Surface
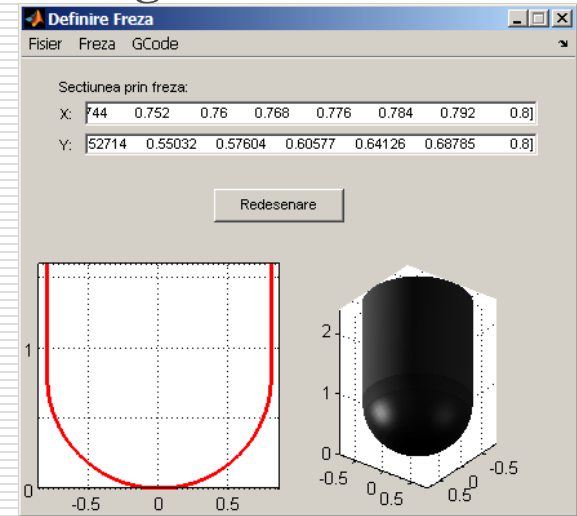
Milling Tool Tip

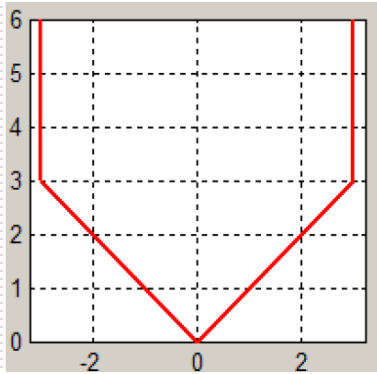Part surface (depth map)
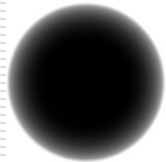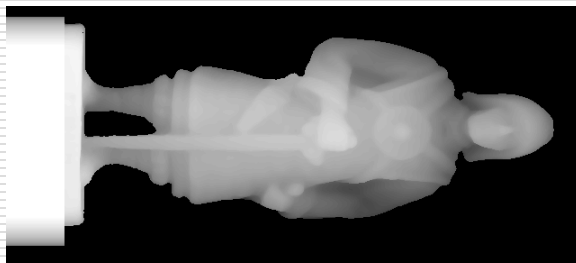
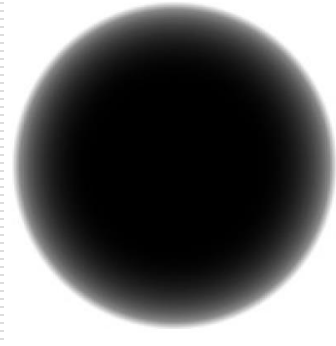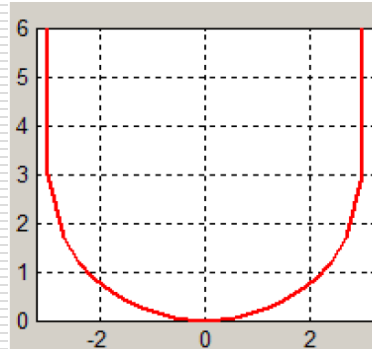Milling Tool Shape (depth map)

Morphological dilation

Milling Surface
The surface where the tip of the cutting tool can move
in order to be always tangent to the part surface
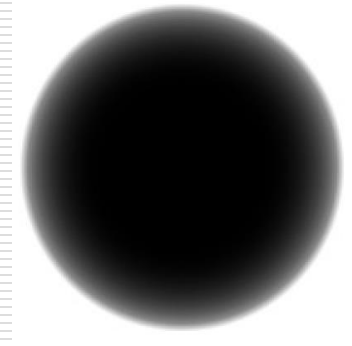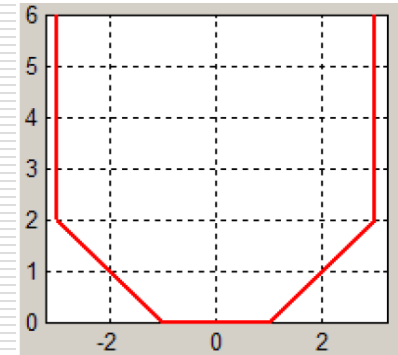
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Tool Shape Modelling
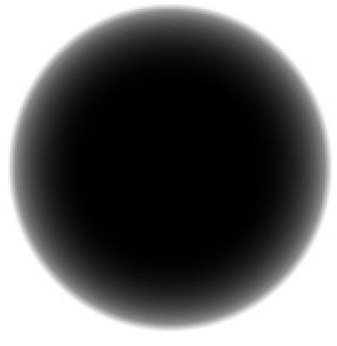
Conic Mill

Round End Mill

Bull End Mill