



DIGITAL MANUFACTURING

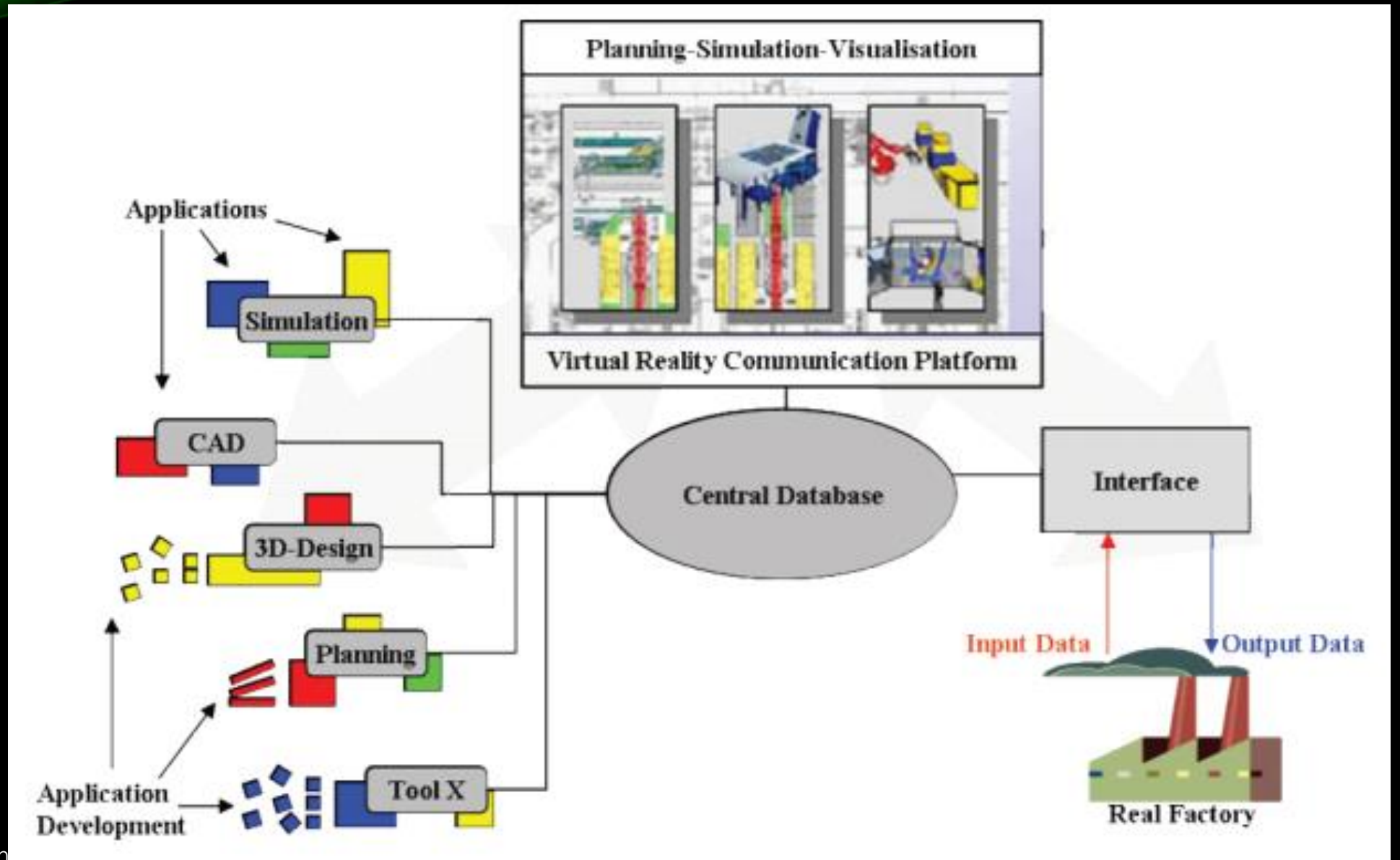
Digital Manufacturing allows for the.....

- Shortening of development time and cost
- Integration of knowledge coming from different manufacturing processes and departments
- Decentralized manufacturing of the increasing variety of parts and products in numerous production sites
- Focusing of manufacturing organizations on their core competences, working efficiently with other companies and suppliers, on the basis of effective IT-based cooperative engineering

BENEFITS OF DM

- Shortened product development
- Early validation of manufacturing processes
- Faster production ramp up
- Faster time to market
- Reduced manufacturing costs
- Improved product quality
- Enhanced product knowledge dissemination
- Reduction in errors
- Increase in flexibility

VISION OF THE DIGITAL FACTORY



- VIRTUAL REALITY
- COMPUTER NETWORK
- RAPID PROTOTYPING
- MULTI MEDIA

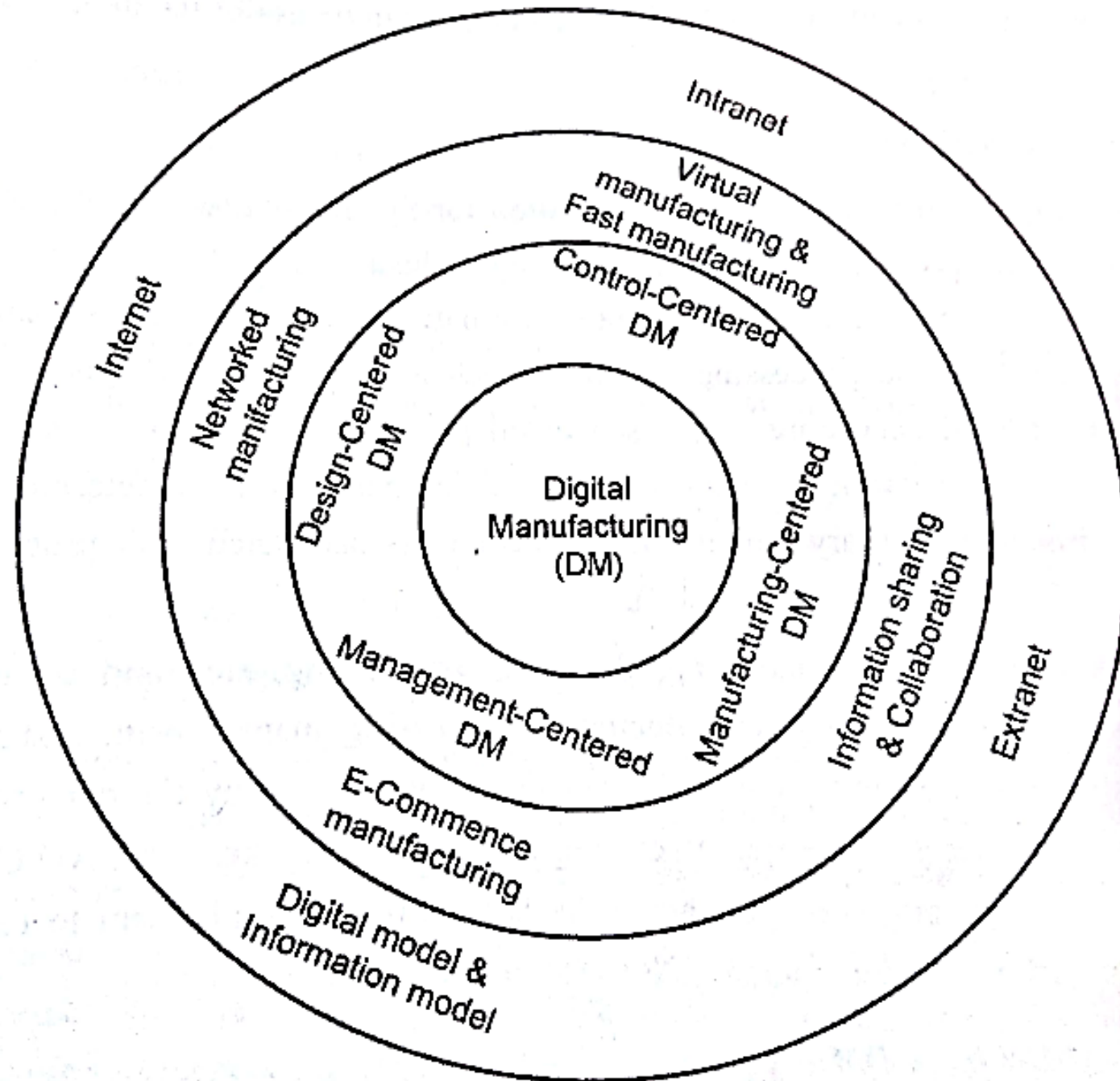
DM is the result of merging process of the following

- Digital Technology
- Network Information Technology
- Manufacturing Technology
- Digitizing process in manufacturing process in manufacturing enterprises, manufacturing systems and production systems

CONCEPT OF DIGITAL MANUFACTURING

- ✓ Control Centered DM
- ✓ Design Centered DM
- ✓ Management Centered DM
- ✓ Manufacturing Centered DM

CONCEPT OF DIGITAL MANUFACTURING



Control Centered DM

NC

CNC

DDC (Direct Digital Control)

FMS (Flexible Manufacturing Cell)

LAN

Design Centered DM

CAD

CAPP

CAM

Management Centered DM

- Evaluate the production and management of an enterprise
- Forecasts its future and operating conditions
- Devise an investment strategy
- Arrange the assignment of production

MIS (Management Information System)

ERP (Enterprise Requirement Planning)

PDM (Products Data Management)

Manufacturing Centered DM

- Virtual reality and virtual manufacturing
- Network manufacturing and E-manufacturing
- Rapid prototyping and rapid manufacturing

DEFINITIONS OF DIGITAL MANUFACTURING

Siemens: *“Digital Manufacturing is the use of an integrated, computer based system comprised of simulation, 3D visualization, analytics and collaboration tools to create product and manufacturing process definitions simultaneously”*

Wikipedia: *“Digital Manufacturing can be defined as an integrated approach to manufacturing that is centered around a computer system”*

University of Cambridge: *“The application of digital information (from multiple sources, formats, owners) for the enhancement of manufacturing processes, supply chains, products”*

Important features of DM

- When it is described and expressed, its digital expression has exclusive meaning and is reusable
- When it analyzes manufacturability and evaluates the performance of a product, it has the predictability of product development and product performance
- In the network environment, the manufacturing activities have independence in distance, time and location

DIGITAL EXPRESSIONS

Establishes a digital model of products and presenting the digital definition of the entire process of the product life cycle in such a way that the computer can understand

- | | | |
|---------------------|---|---|
| 1. GEOMETRIC MODELS | } | (Product design & Manufacturing) |
| 2. KNOWLEDGE MODEL | | |
| 3. PHYSICAL MODEL | } | (Product oriented performance analysis) |
| 4. PROTOTYPE MODEL | | |

MANUFACTURING IN NETWORK ENVIRONMENT

- Common digital manufacturing equipment used in the network
- Numerical Control (NC) and Computer Numerical Control (CNC) machine tools
- Automated welding machines
- Industrial robots
- Coordinate Measuring Machine (CMM)

THEORY SYSTEM OF DIGITAL MANUFACTURING SCIENCE

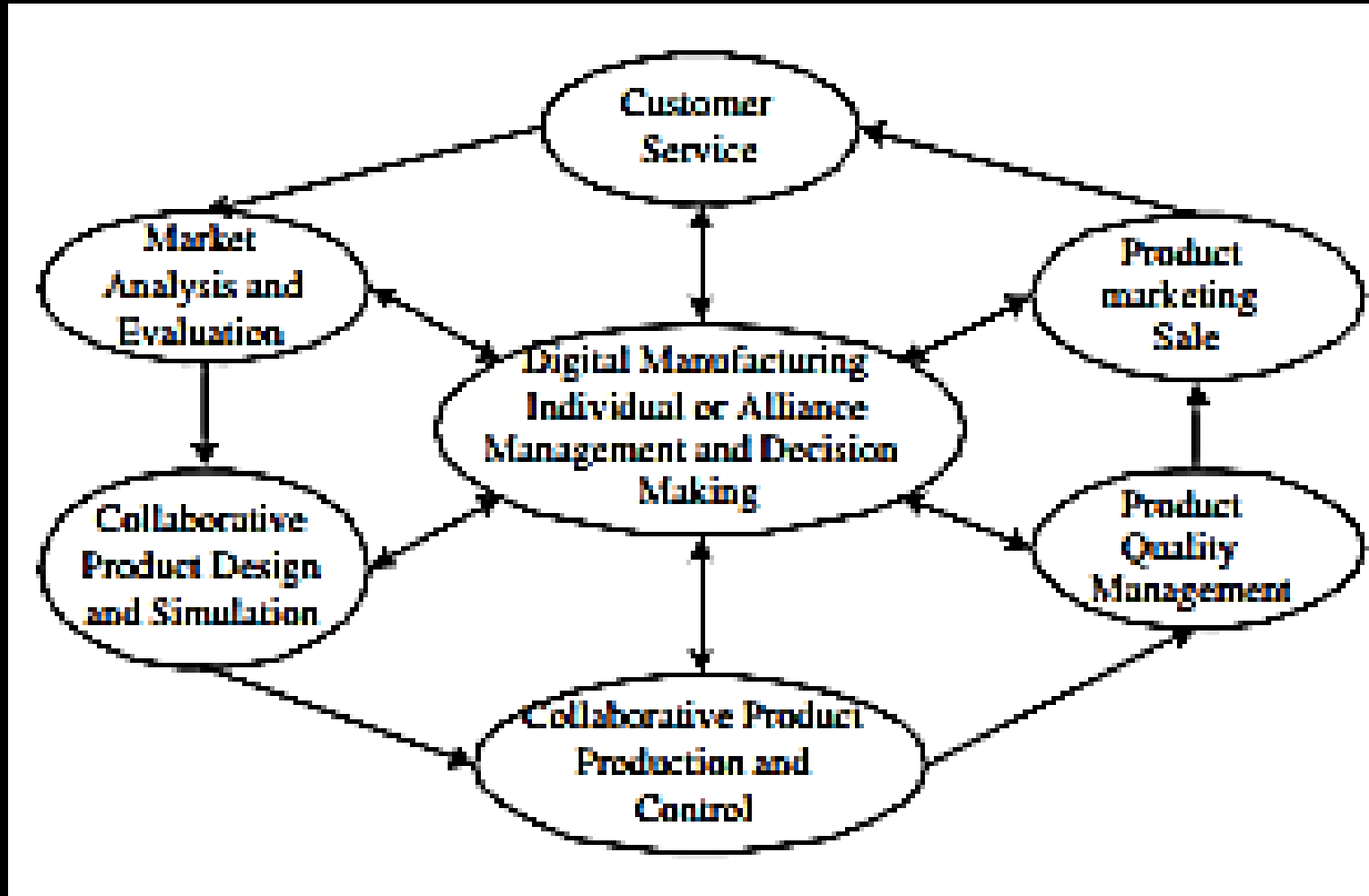
Digital manufacturing science is a science which deals the basic concepts and pivotal technologies, methods of informatics and system engineering with a target of optimal operation of the digital manufacturing system

Basic Mathematical Theories

- Product Demand
- Product design and simulation
- Management of manufacturing process
- Operational control of production equipment
- Management of product quality
- Product sales and maintenance and other aspects

Operation reference mode of digital manufacturing system

Design, simulation and production of a product are completed in a digital environment



OPERATION REFERENCE MODE DIGITAL MANUFACTURING SYSTEM

- Stages of Digital manufacturing system are as follows:
- Market Analysis and evaluation
- Product design and simulation
- Production and control
- Product quality management
- Marketing and sales
- Customer Services

ARCHITECTURE OF DM System includes

- Basic theories of DM science
- Key technology
- Network
- Application fields of DM

Key Technologies of DM include

- Product description technology
- Manufacturing process expression and control technology
- Manufacturing data acquisition
- Storage & processing technology
- Networks and grid technology
- Engineering database technology
- Virtual and simulation technology
- Metadata technology

Market Analysis and Evaluation system

Market Analysis Techniques

- Primary and Secondary research
- Surveys
- Focus groups
- Interviews
- Observations
- Experiments/Field trials

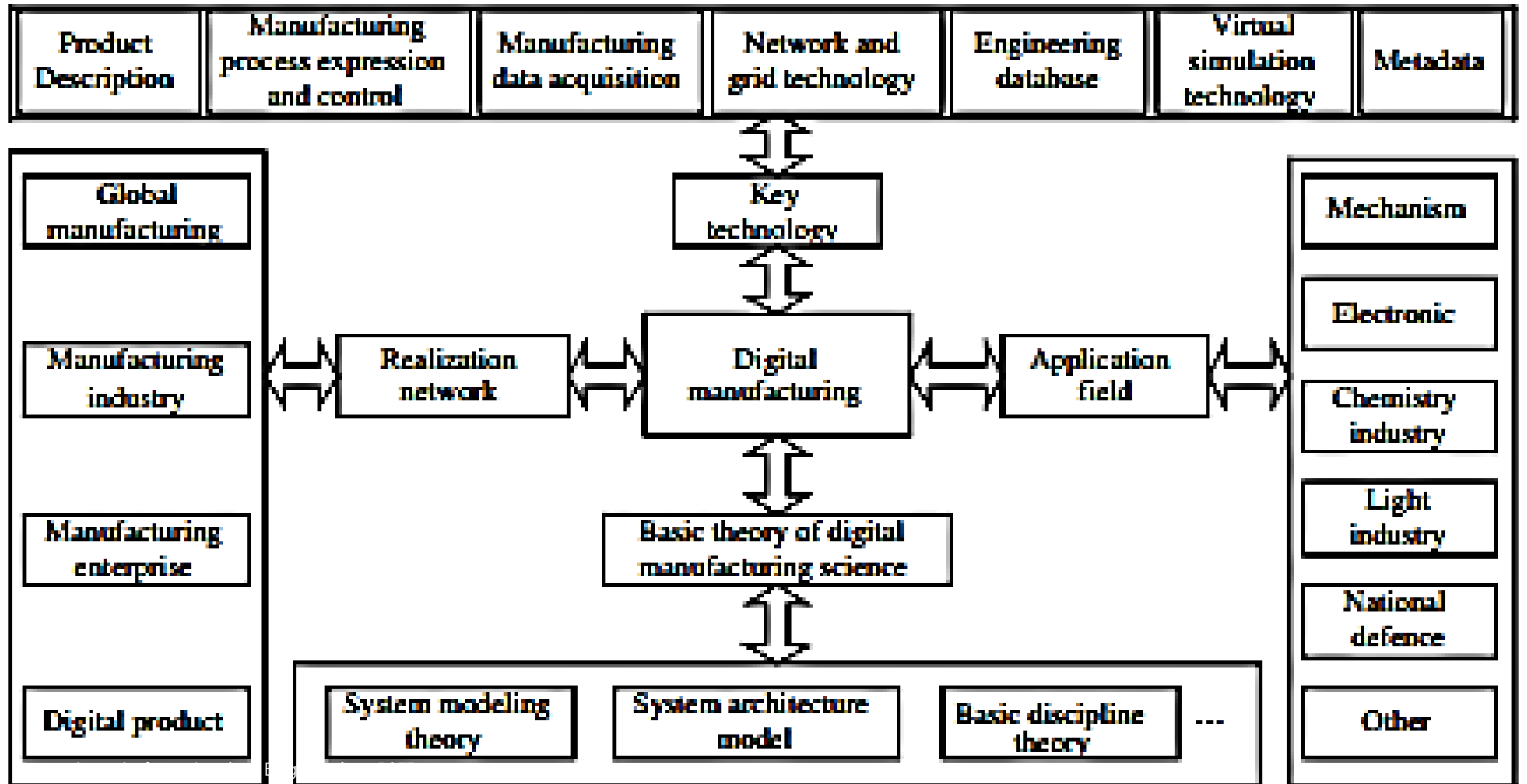
Production and control system

- Process control specifications
- Manufacturing Routing
- NC programs for CNC machines
- Plant Automation
- Material handling and storage facilities
- Inventory planning
- Master production schedule
- Materials requirement planning
- Production Scheduling

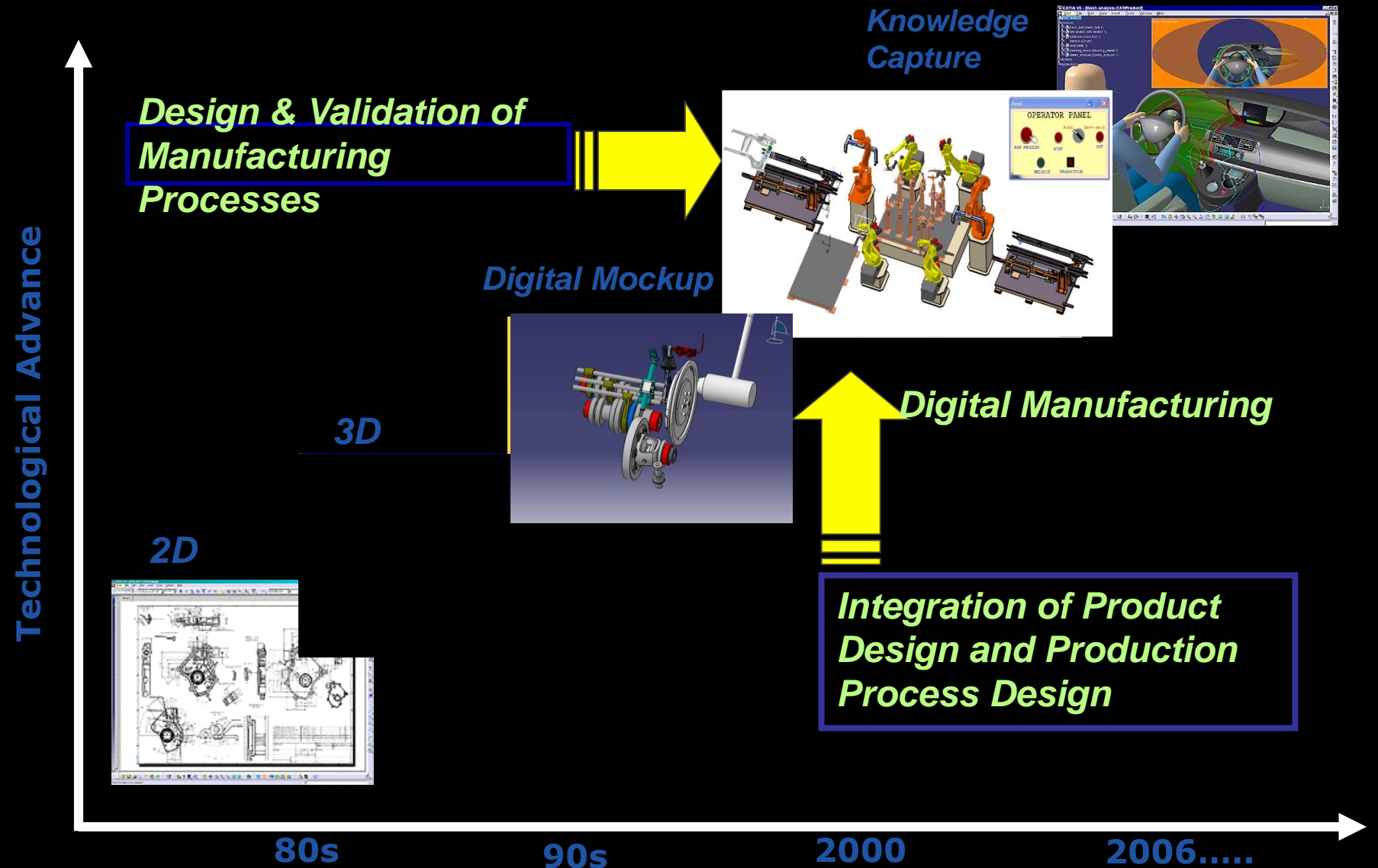
Digital equipment and facilities used for the optimized smooth flow of production are

- i. CAM software packages to generate NC programmings
- ii. Computer aided process planning packages
- iii. Layout optimization software
- iv. Flexible automation software
- v. Robots
- vi. Computer controlled Automated Guided Vehicles (AGVs)
- vii. Computerized automated material handling and storage facilities
- viii. Inventory planning and maintenance software packages
- ix. Material requirements planning (MRP) software packages
- x. Sequencing and Scheduling software packages

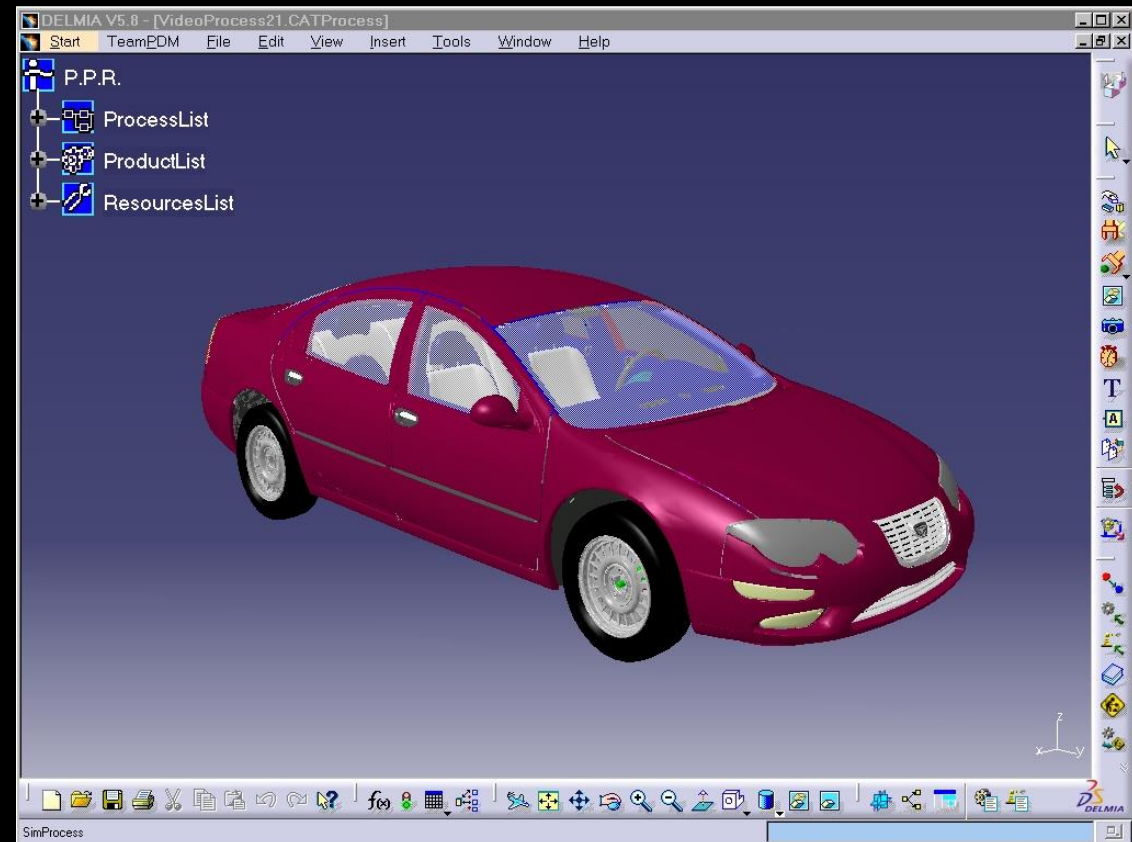
ARCHITECTURE OF DIGITAL MANUFACTURING SYSTEM



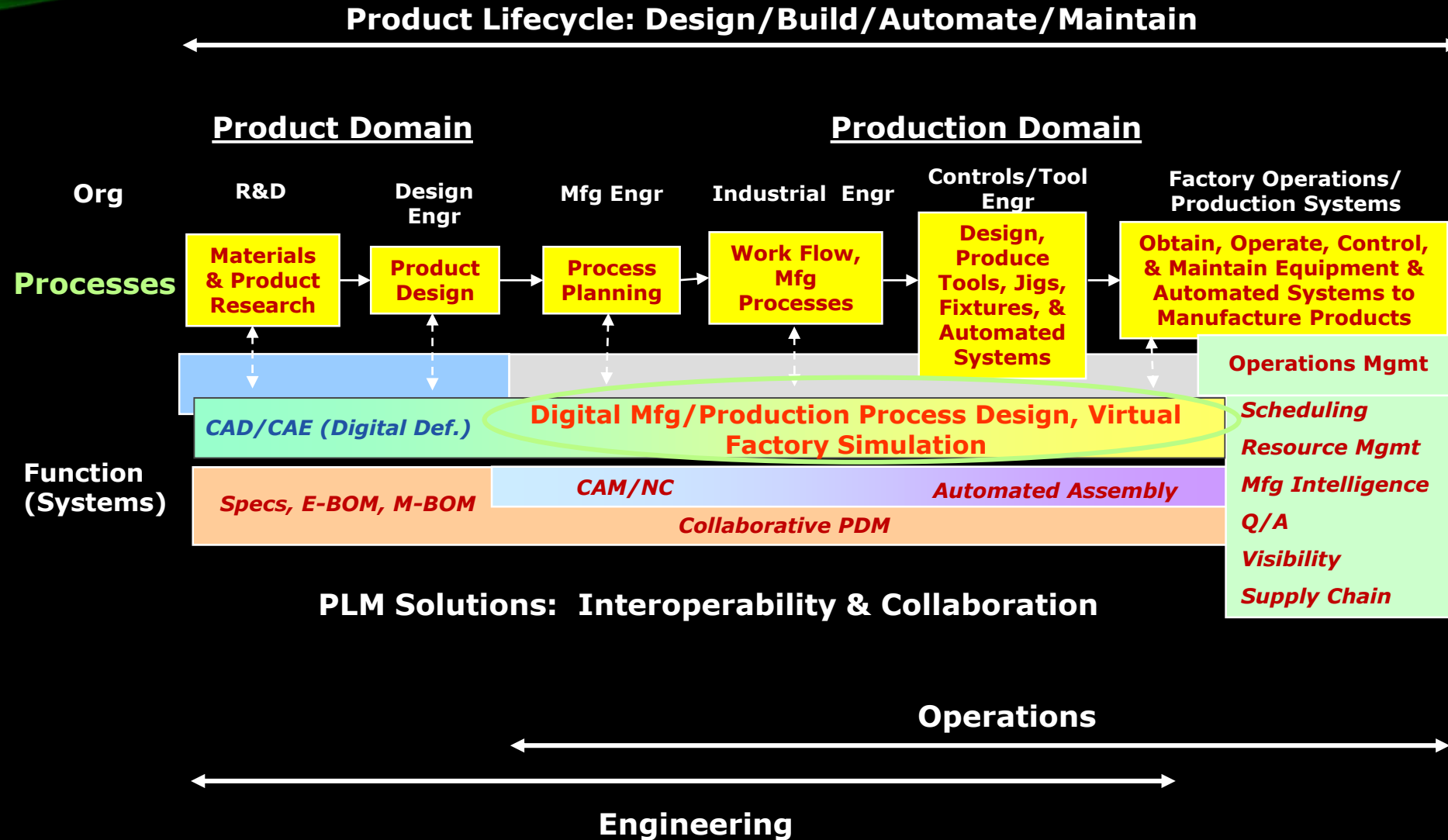
Evolution of the Design/Build Process



“Digital Manufacturing represents an integrated suite of PLM tools that supports manufacturing process design, tool design, plant layout, and visualization through powerful virtual simulation tools that allow the manufacturing engineer to validate and optimize the manufacturing processes. “

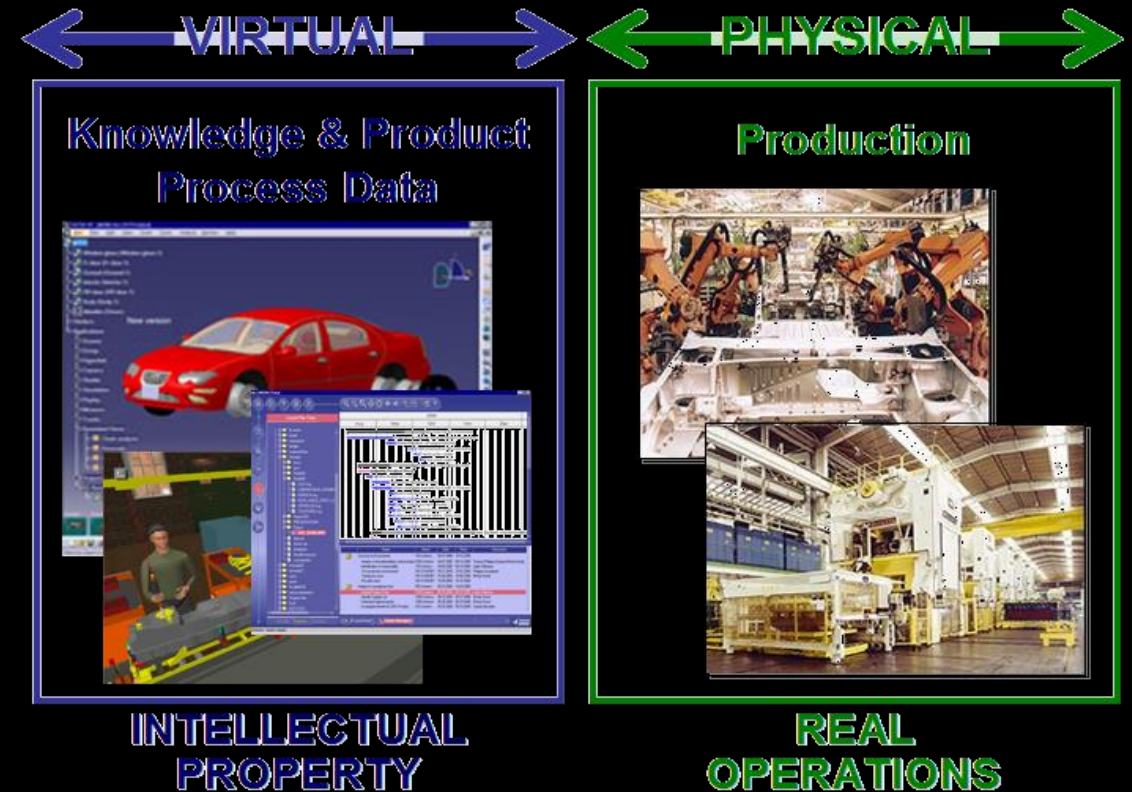


Where Does Digital Manufacturing Fit?



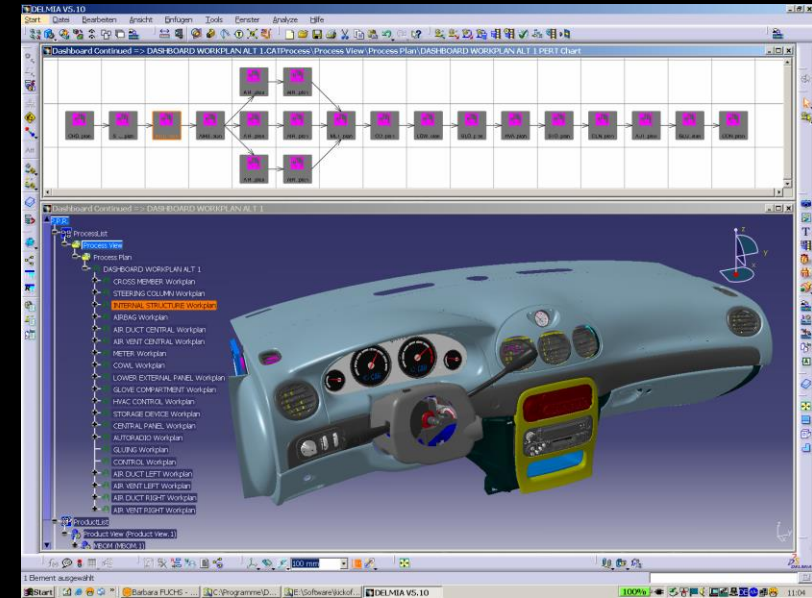
What Does Digital Manufacturing Do?

- ◆ Manufacturing Planning
 - Define High-Level Manufacturing Processes
 - Process Planning (Assembly & Installation)
 - Define Work Instructions & Work Flow
- ◆ Detailed Process Design & Analysis
 - Detailed Resource Modeling & Simulation
 - Process Definition and Validation
 - 3-D Factory Layout
 - Equipment, Tool & Fixture Simulation
 - Ergonomic Simulation
- ◆ Validation & Virtual Commissioning
 - Control Logic Validation
 - Kinematic (Robotic) Validation
 - Quality Assurance/Process Improvement Validation
 - Sensor/Metrology Placement Validation
 - Virtual Commissioning/Validation of Automation Systems
 - Knowing that the Production System Works Prior to Launch: Priceless.



Digital Manufacturing Redefines Concurrent Engineering

- Product Authoring (CAD) tools are employed to define “What” is to be built.
- Manufacturing Process Design tools are used to define “How” it is to be built.
- Integration of Product & Process Design directly supports the concept of Concurrent Engineering



Digital Manufacturing facilitates the Holistic view of Product and Process Design as integral components of the overall product life cycle

DIGITAL MANUFACTURING MODEL

Classifying by form,

- global structure model (such as the architecture of manufacturing system),
- the local structure model (such as the FMS model),
- the product structure model and
- the scheduling model of production planning

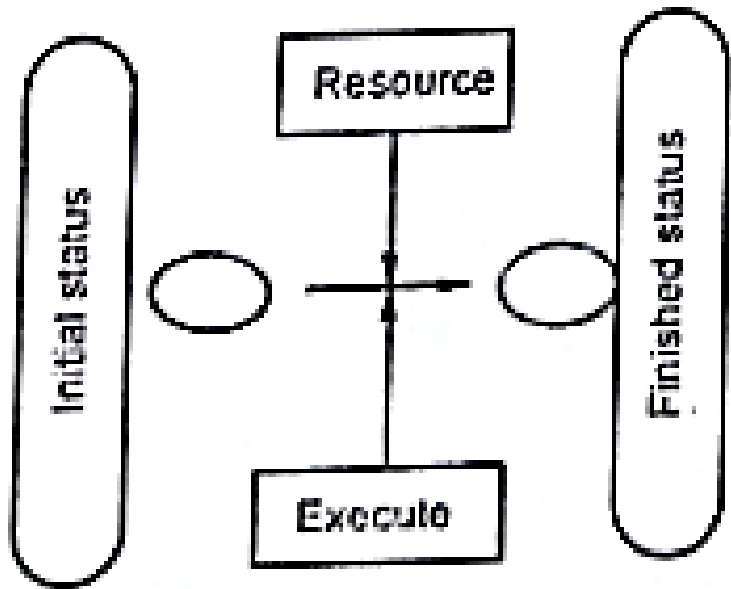
Classifying by modeling method,

- ❑ Mathematical analytical model (such as the state-space model),
- ❑ the graphic conceptual model (IDEF model) and
- ❑ the hybrid diagram–analysis model (such as the Petri net model)

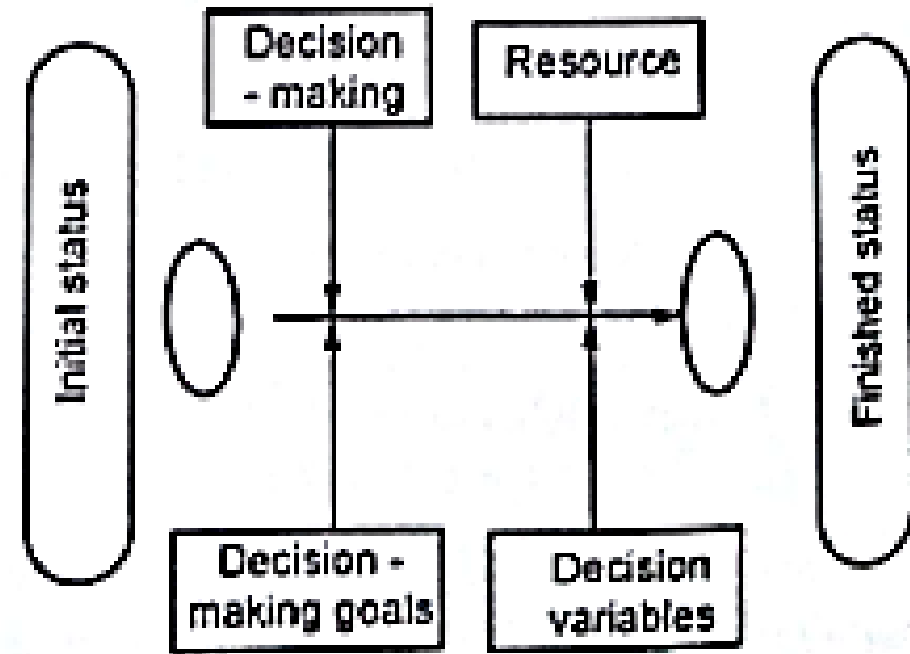
Classifying by function,

- Structure description model,
- the system analysis model,
- the system design and implementation model, and
- the system operation and management model.

GRAI Activities



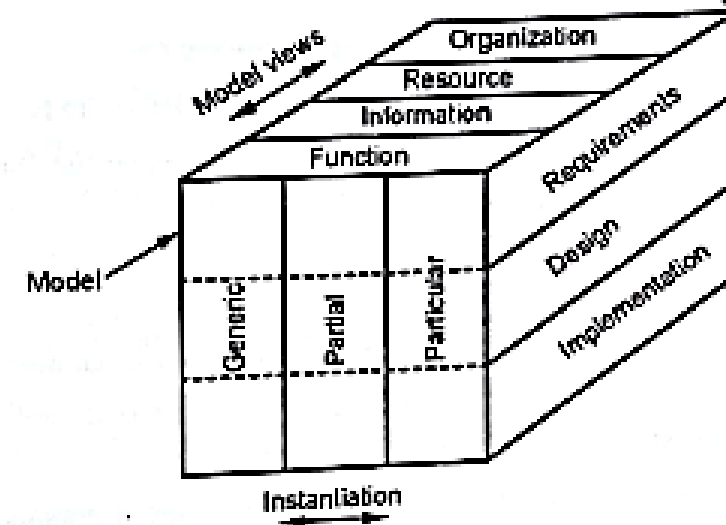
(a) Executive activities



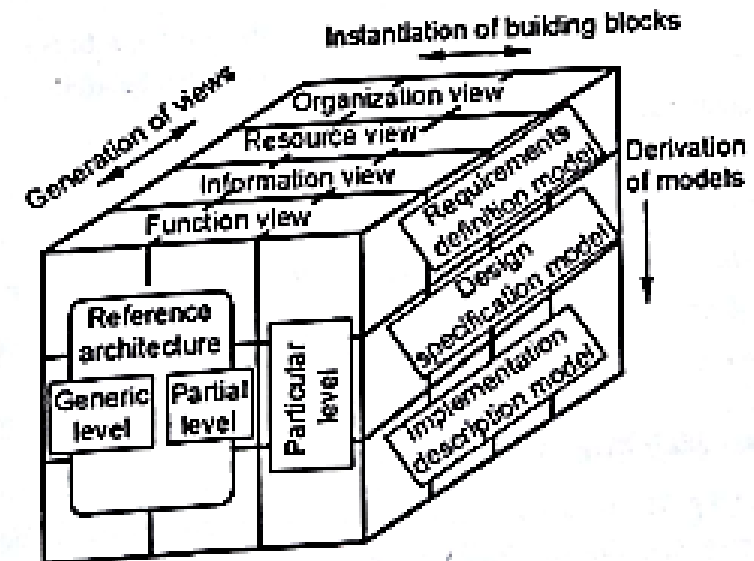
(b) Decision-making activities

GRAI activities

CIMOSA Architecture



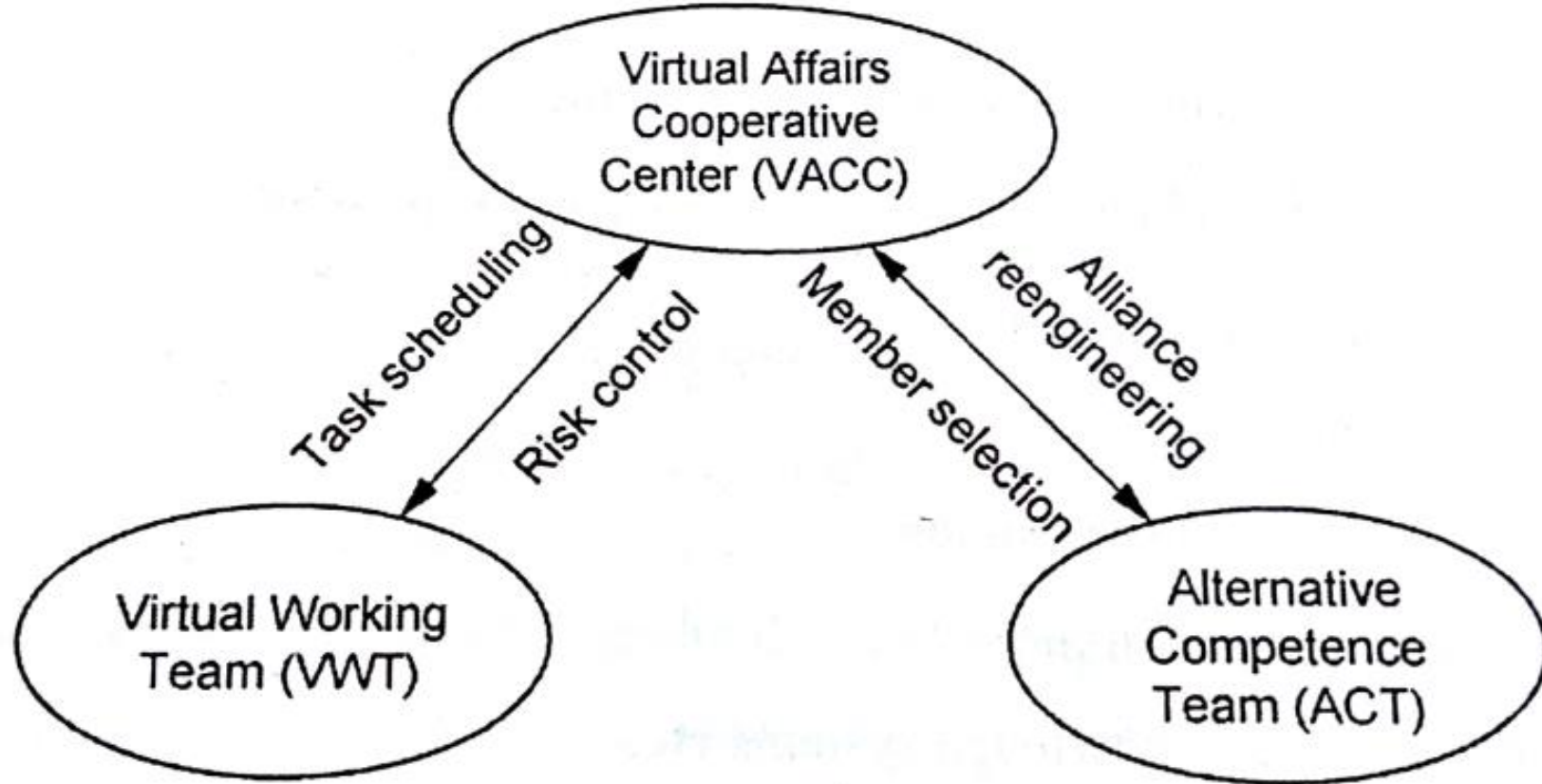
(a)



(b)

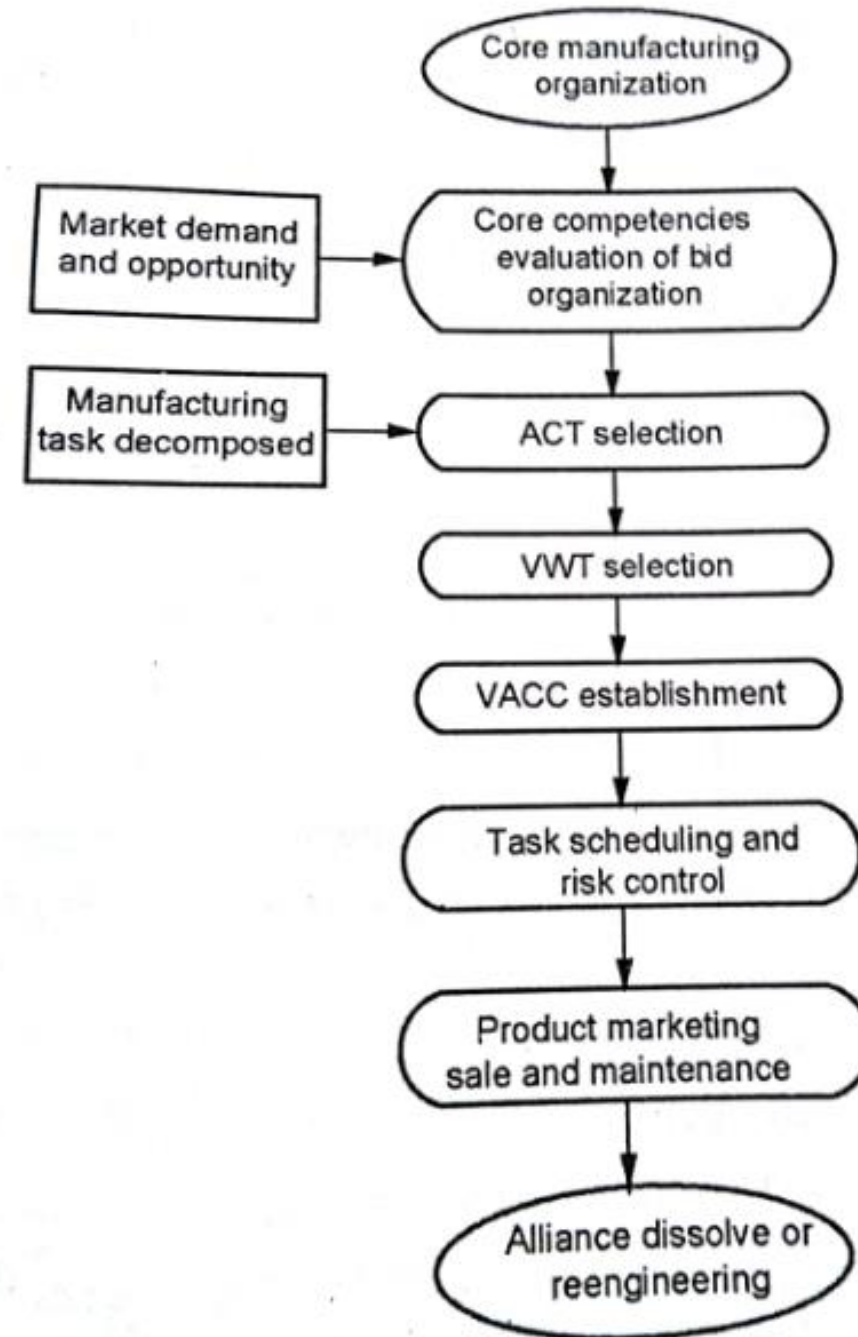
CIMOSA architecture

ORGANISATIONAL STRUCTURE MODEL

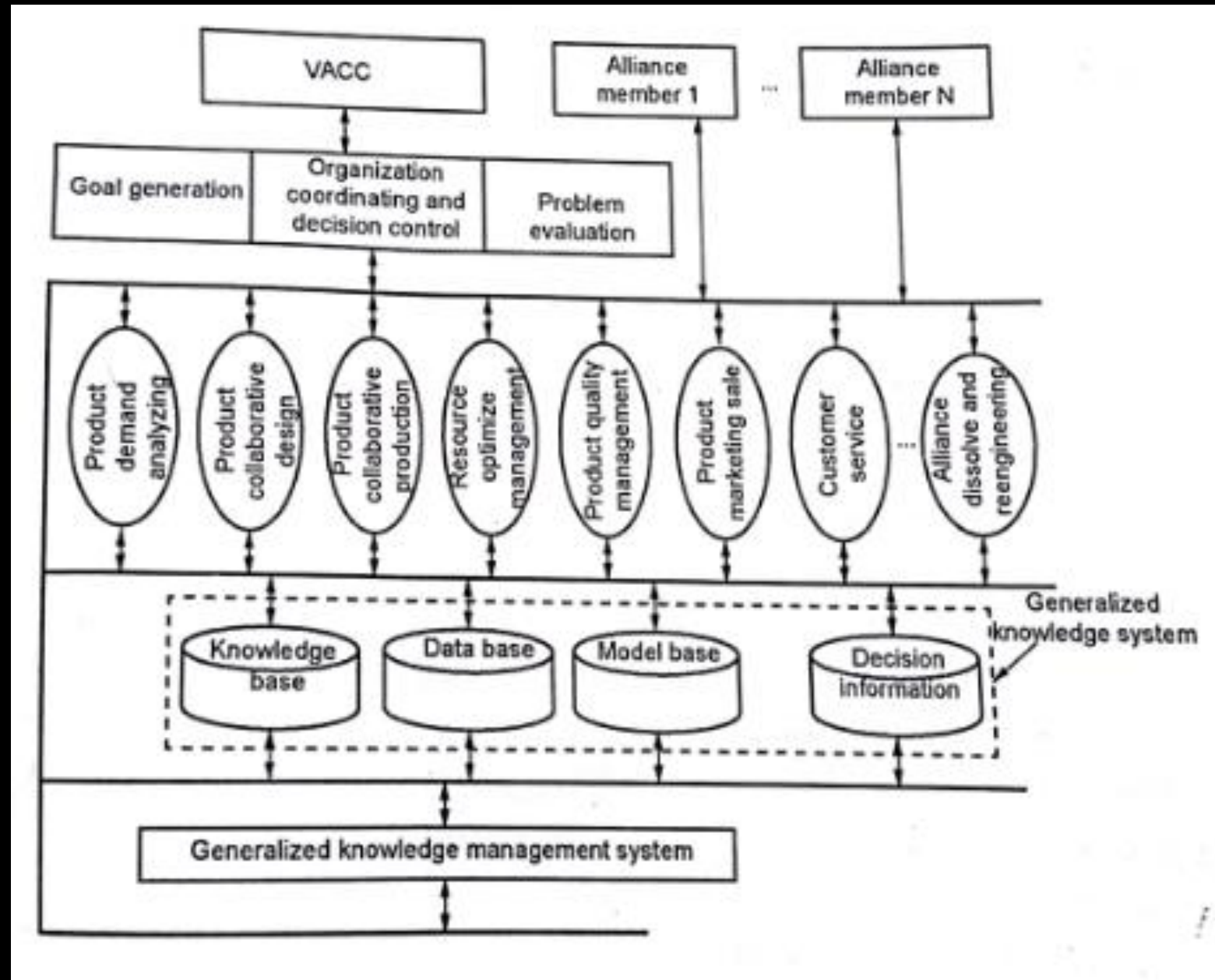


Organization structure model

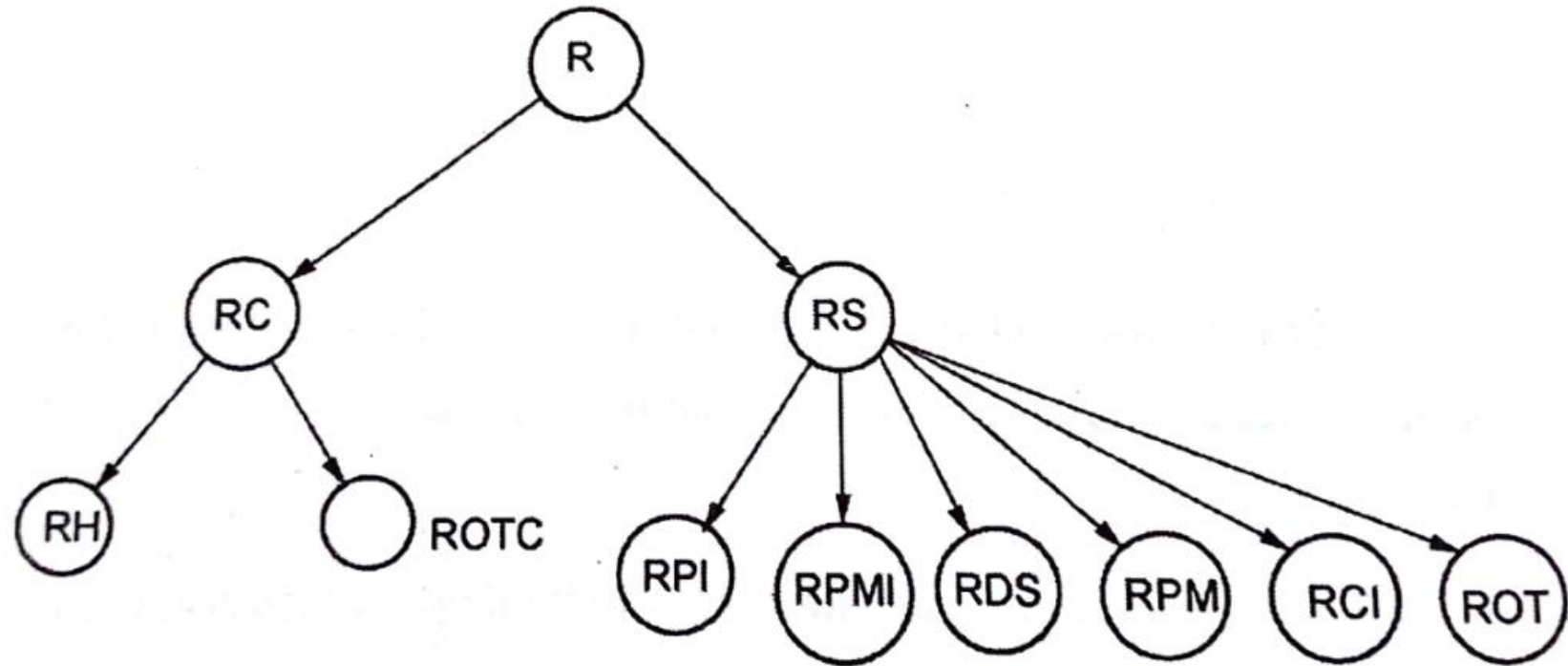
OPERATION PROCESS OF A VIRTUAL MANUFACTURING ALLIANCE



FUNCTION STRUCTURE MODEL OF THE DIGITAL MANUFACTURING SCIENCE




INFORMATION
MODEL OF
SYSTEM
MANUFACTURING
RESOURCE



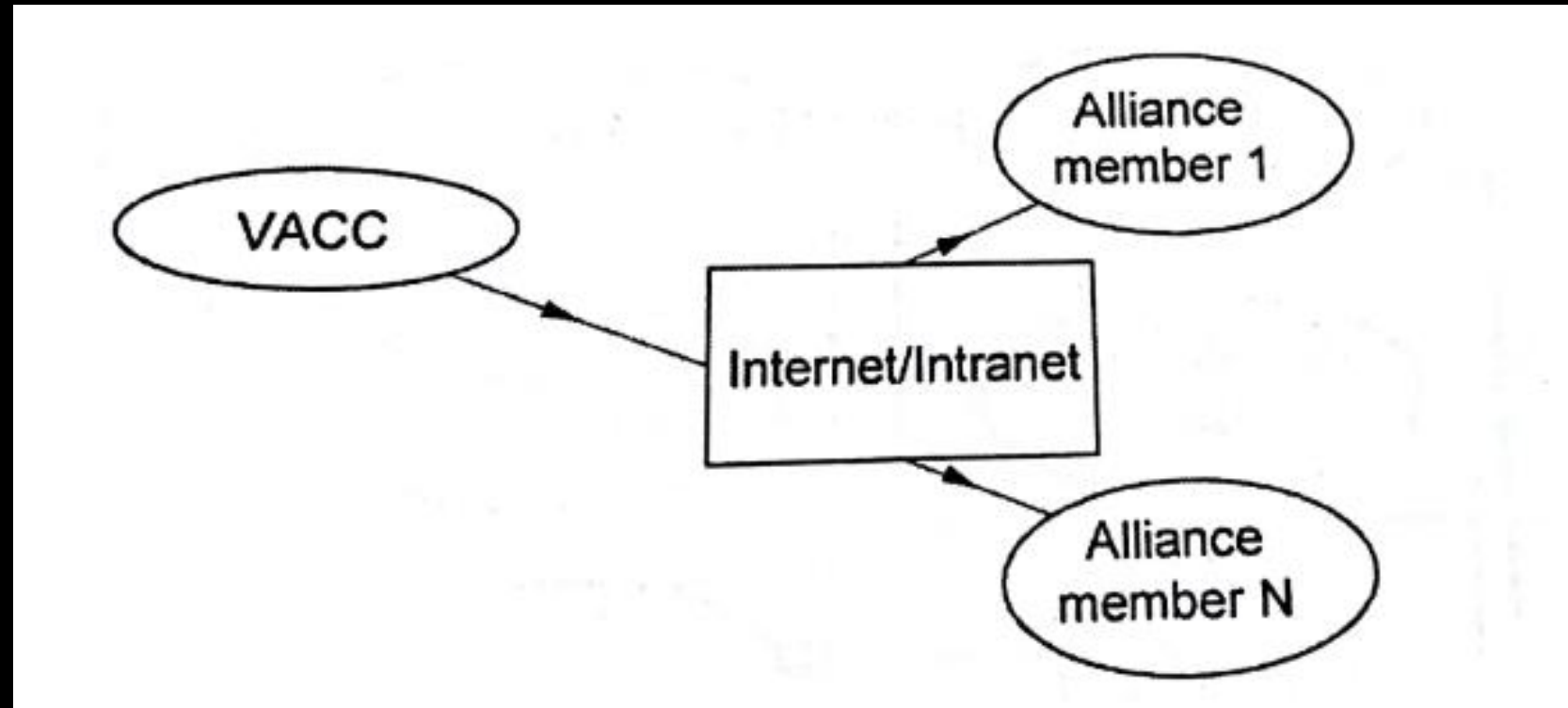
Information model of system manufacturing resource

R	⇒	System manufacturing resource
RC	⇒	Common resource
RS	⇒	Special resources
RH	⇒	Human resources
ROTC	⇒	Other common system resources
RPI	⇒	Product information resources
RPMI	⇒	Information resources of the potential alliance member
RDS	⇒	Design resources (Design software, drawings, documents)



RPM	⇒	Production manufacturing resources (Manufacturing equipment, material resources etc.)
RCI	⇒	Customer information resources
ROT	⇒	Other resources ROT

OPERATION AND CONTROL STRUCTURE
MODEL OF DIGITAL MANUFACTURING
SYSTEM



OPERATION AND CONTROL STRUCTURE OF AGENT BASED DIGITAL MANUFACTURING SYSTEM

