

Refrigeration and Cryogenics

Janusz Skrzypacz, PhD

Integrated Production Systems

Choose yourself and new technologies

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Integrated Production Systems

Lecture 1

Introduction to IMS

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9. Khan W. Raouf A. „*Standards for Engineering Design and Manufacturing*”, Taylor & Francis Group, LLC, London 2006.
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Course Agenda

- **Lecture 1** – An Introduction to Integrated Manufacturing Systems.
- **Lecture 2, 3** – Review of the Manufacturing Processes.
- **Lecture 4,5** – An introduction to CAD and CAE.
- **Lecture 6** – File Exchange Formats.
- **Lecture 7,8** – An Introduction to CAM and CNC





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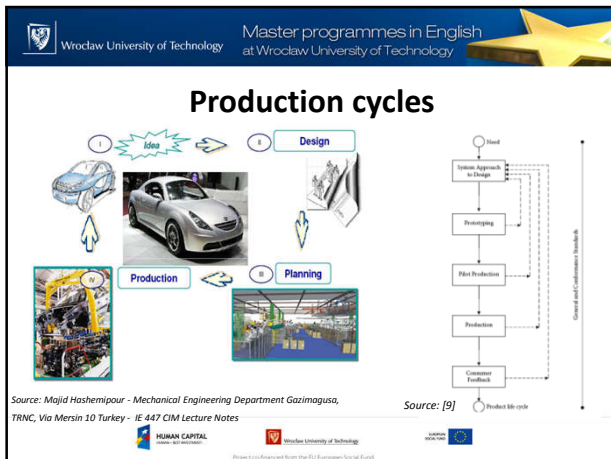
Course Agenda

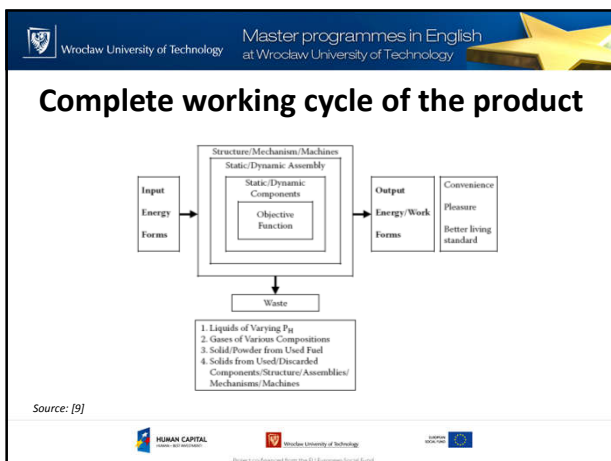
- **Lecture 9** – An introduction to CAPP
- **Lecture 10** – An Introduction to CIM
- **Lecture 11** - An Introduction to PDM and PLM
- **Lecture 12** - An Introduction to MRP and ERP
- **Lecture 13,14** - An Introduction to Rapid Prototyping Methods and Reverse Engineering
- **Lecture 15** - Credit

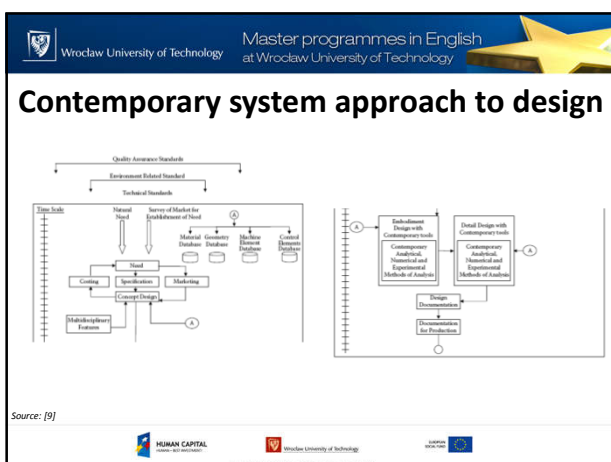


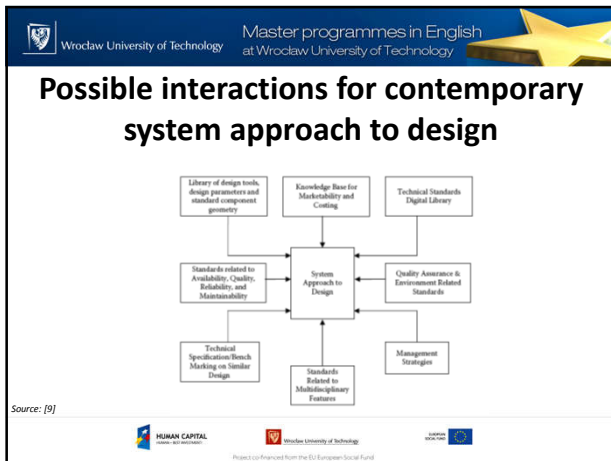


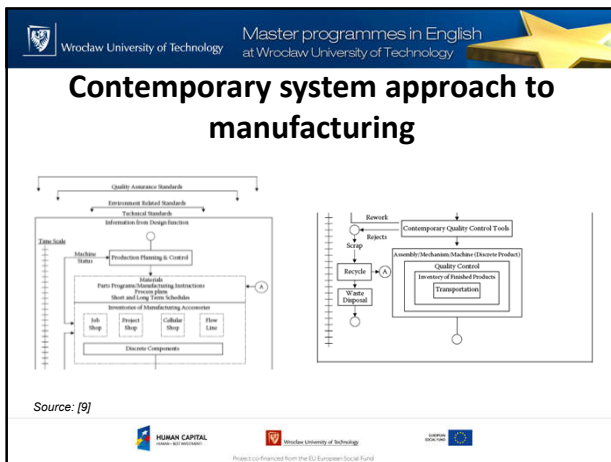
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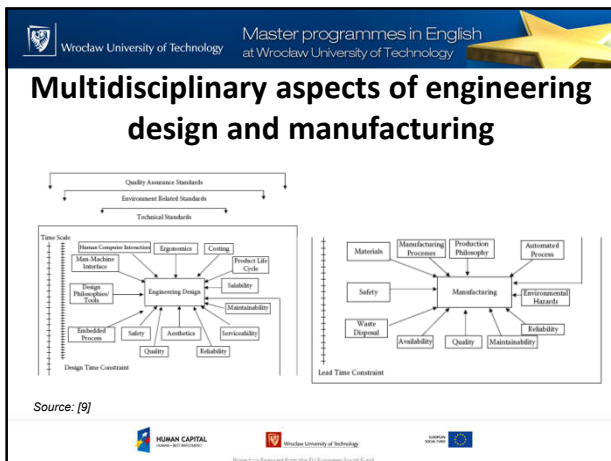












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What is Manufacturing?

- Manufacturing encompasses all those functions from the receipt of product definition to the satisfactory completion of an end item.
In other words, from a set of drawings and specifications (product design department) to a finished product (made by the factory) placed on the shipping platform.
- Industrial activity that changes the form of raw materials to create products.
- More simply, manufacturing is the transformation of (raw) materials into products that meet customers' demands.

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Definition: Manufacturing System

A manufacturing system is a collection of integrated equipment and human resources, whose function is to perform one or more processing and/or assembly operations on a starting raw material, part, or set of parts.

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Terminology

- **CAD** – Computer Aided Design
- **CAE** - Computer Aided Engineering
- **CAM** - Computer Aided Manufacturing
- **CAP** - Computer Aided Planning
- **CAPP** - Computer Aided Process Planning
- **CIM** – Computer Integrated Manufacturing
- **CNC** – Computerized Numerical Control
- **ERP** – Enterprise Resource Planning

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Terminology

- **IM** – Intelligent Manufacturing
- **JIT** – Just in Time
- **LP** – Lean Production
- **MRP** – Material Requirements Planning
- **MRP II** – Manufacturing Resource Planning
- **NC** – Numerical Control
- **PDM** – Product Documentations Management
- **PLM** – Product Lifecycle Management

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CAD Definition

Computer-aided design (CAD) is the use of computer technology for the design of objects, real or virtual. CAD often involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) objects.

Source: Wikipedia

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CAE Definition

Computer-aided engineering (CAE) is the broad usage of computer software to aid in engineering tasks. CAE areas covered include:

- Stress analysis on components and assemblies using FEA (Finite Element Analysis);
- Thermal and fluid flow analysis (CFD - Computational fluid dynamics);
- Kinematics;
- Mechanical event simulation (MES).
- Analysis tools for process simulation for operations such as casting, molding, and die press forming.
- Optimization of the product or process.

Source: Wikipedia

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CAM Definition

Computer-aided manufacturing (CAM) is the use of computer software to control machine tools and related machinery in the manufacturing of work pieces. Additionally, CAM has been considered as a numerical control (NC) programming tool, wherein two-dimensional (2-D) or three-dimensional (3-D) models of components generated in CAD software are used to generate G-code to drive computer numerically controlled (CNC) machine tools. Simple designs such as bolt circles or basic contours do not necessitate importing a CAD file.

As with other "Computer-Aided" technologies, CAM does not eliminate the need for skilled professionals such as manufacturing engineers, NC programmers, or machinists. CAM, in fact, leverages both the value of the most skilled manufacturing professionals through advanced productivity tools, while building the skills of new professionals through visualization, simulation and optimization tools.

Source: Wikipedia

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Definition of CIM

Computer Integrated Manufacturing

is the integration of the total manufacturing enterprise through the use of integrated systems and data communications coupled with new managerial philosophies that improve organizational and personnel efficiency.

Source: Wikipedia

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Definition of ERP

Enterprise resource planning (ERP) is an Integrated computer-based system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources. It is a software architecture whose purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders. Built on a centralized database and normally utilizing a common computing platform, ERP systems consolidate all business operations into a uniform and enterprise-wide system environment.

Source: Wikipedia

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Definition of PLM

Product Lifecycle Management (PLM) is the process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise. Within PLM there are five primary areas:

1. Systems Engineering (SE)
2. Product and Portfolio Management (PPM)
3. Product Design (CAx)
4. Manufacturing Process Management (MPM)
5. Product Data Management (PDM)

Source: Wikipedia

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Evolution in manufacturing technology

Year	Technology / Event
1997	Global manufacturing based on Virtual CIM
1990	Concept of Virtual CIM introduced
1990	Advanced systems in CAM, CAPP, CAQC, AS/RS, FMS etc. and CIM
1980	Developments in CAD, Application of CAM based systems and introduction of the concept of CIM
1970	Beginning of CAD and development in NC, such as CNC, DNC
1955	Early developments in NC for Automation
1950	Very large Mass production systems
1930	Mass production systems
1900	Mechanization and early factory systems
1750	Craftsman
1600	Manual and animal labor

Source: Tariq Masood, Iqbal Khan „Productivity Improvement through Computer Integrated Manufacturing in Post WTO Scenario“, National Conference on Emerging Technologies 2004

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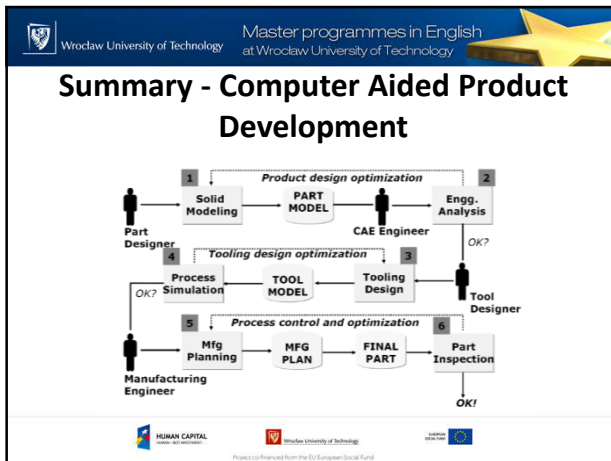
Evolution of manufacturing system integration towards CIM

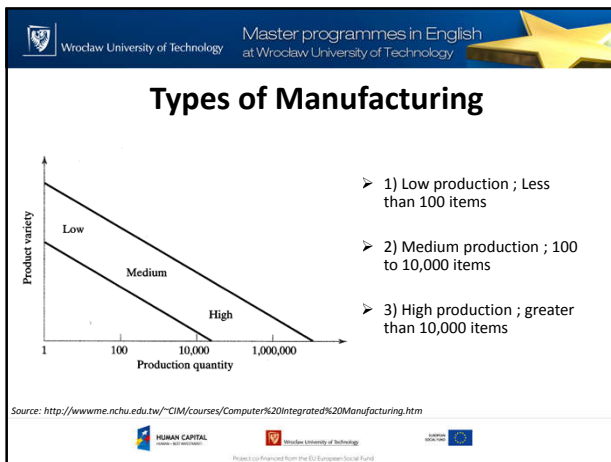
The diagram illustrates the evolution of manufacturing system integration towards CIM (Computer Integrated Manufacturing) from 1970 to 2010. It shows four main integration areas converging towards a central CIM Evolution path:

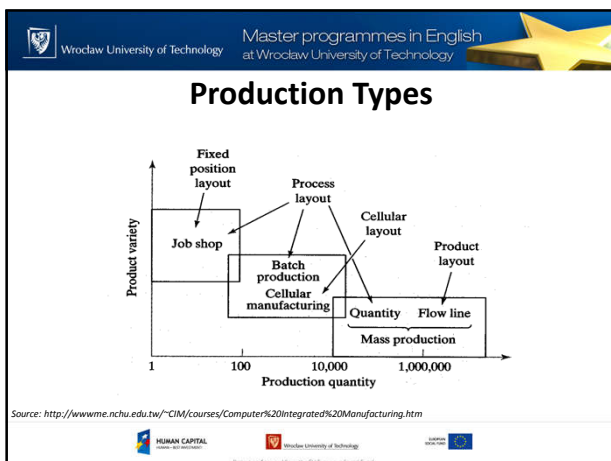
- Integration of Physical Systems (1970-1980):**
 - Inter-system communications
 - Network configuration management
 - Data exchange rules and conversion
 - Inter-connection of physical systems
- Integration of Business Processes (1980-1990):**
 - Knowledge based decision support
 - Knowledge based business systems and controls
 - Extension to business processes such as e-commerce, global supply chains etc.
 - Automatic monitoring of business processes
 - Simulation in design, process, product, and testing
- Integration of Applications (1990-2000):**
 - Portable applications
 - Distributed processing / computing
 - Execution environment / common services
 - Shared information resources
- Integration of Physical Systems (2000-2010):**
 - Inter-system communications
 - Network configuration management
 - Data exchange rules and conversion
 - Inter-connection of physical systems

Source: Sev V. Nagalingam, Grier C.I. Lin, „CIM—still the solution for manufacturing industry“, Robotics and Computer-Integrated Manufacturing 24 (2008) 332–344

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Low Quantity Production

- job shop type, customized product, large variety of product types;
- space capsules, airplane, special purpose machine, etc.;
- maximum flexibility;
- fixed position layout type (big product)
- process layout type – functional layout, lots of movement and WIP

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Medium Quantity Production

- product range 100 to 10,000 items,
- large product variety; batch production type,
- facility changed after 1 production, order repeatable,
- production rate higher than for single product type,
- facility utilized commonly by lines,
- batch changing time is required for setup time (changeover time).

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Medium Quantity Production

- Product variety is not large.
- When setup time is minimal, various part groups are produced in a facility.
- Cellular layout type composed of with various machines and work stations.

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High Quantity Production

- mass production (greater than 10,000 items),
- quantity production : production with a single machine,
- production with special purpose machine.

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High Quantity Production

- flow line production,
- composed of several workstation,
- each workstation composed of special machine,
- conveyor belt used ,
- automobile, appliance assembly,
- good for single model production.

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Basic Manufacturing Processes

- Casting & molding
- Forming & shaping
- Machining (material removal)
- Joining & assembly
- Finishing (surface treatments)
- Heat treating

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