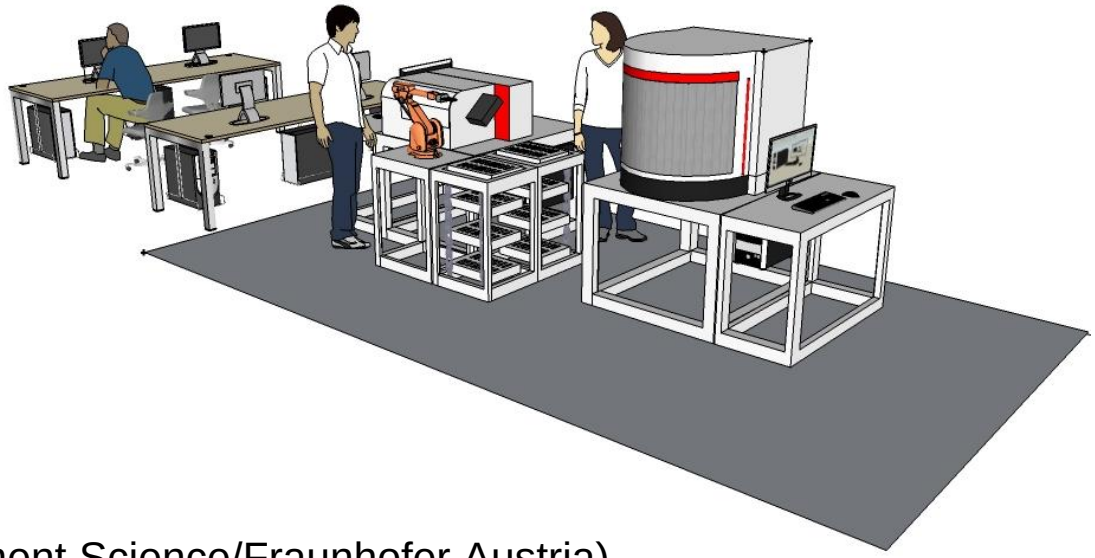
Integrated, scalable Concept of a Learning Factory

at the Faculty of Mechanical and Industrial Engineering,

Vienna University of Technology



Prof. Wilfried Sihn (Institute for Management Science/Fraunhofer Austria)

Prof. Friedrich Bleicher (Institute for Production Engineering and Laser Technology)

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Vienna University of Technology – Faculty of Mechanical and Industrial Engineering

Vienna University of Technology (TU Vienna)

- Rector: O.Univ.-Prof. Dr. Peter Skalicky
- Founded in 1815
- 8 faculties, 4.105 employees
- Students: ca. 23.000 (23% international)
- Budget: >260 Mio. € (2009)
- Degree programs: 21 Bachelor, 43 Master

Faculty of Mechanical and Industrial Engineering

- 9 Institutes
- approx. 600 first enrolments in Mechanical Engineering and Industrial Engineering (2009)

Faculty-wide learning factory through cooperation of:

Industrial Engineering

Institute of Management Science
Division Industrial and Systems Engineering/ Fraunhofer Austria

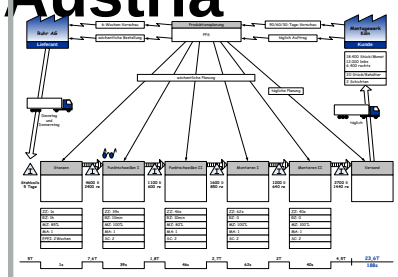
Product Development

Institute for Engineering Design
Division Mechanical Engineering Informatics and Virtual Product Development

Production Engineering

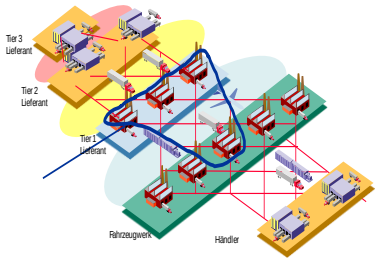
Institute for Production Engineering and Laser Technology

Institute for Management Science
Division Industrial and Systems Engineering/Fraunhofer Austria



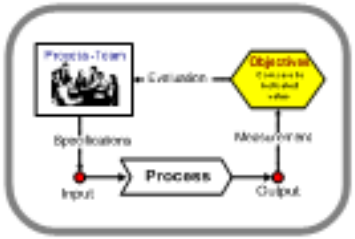
Production Management

- Lean Management/Value Stream Mapping
- Production Networks, Factory Planning, Energy efficient production
- Optimization of Production & Assembly, Maintenance
- Holistic planning and controlling procedures



Logistics Management

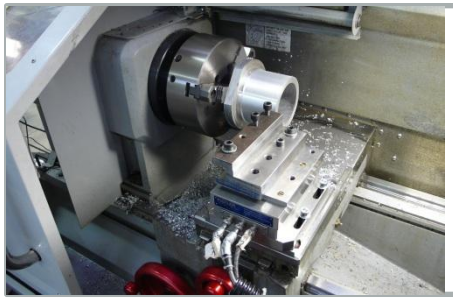
- Lean Logistics, Sustainable Logistics
- Material flow planning, Build-to-order strategies
- Transport Logistics, Cooperative logistics models
- Supplier Parks, Supplier Management, Agile Supply Chains



Process Optimization

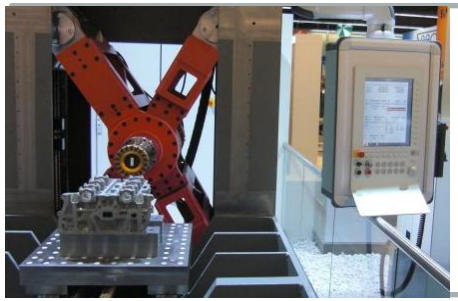
- Lean Administration, Lean Process
- Process management, Process evaluation and -controlling
- Order processing optimization, Simulation-based Process Analysis
- Performance enhancement in administrative functions

Institute for Production Engineering and High Efficiency Laser Technology



Technology and processes

- research in cutting technologies from micro to macro scale
- chemical and physical processes, like electrochemical milling
- research in innovative technologies for surface treatment



Production systems and control technologies

- research in new machine tool structures and components for high performance manufacturing
- innovations in versatile machine and control concepts

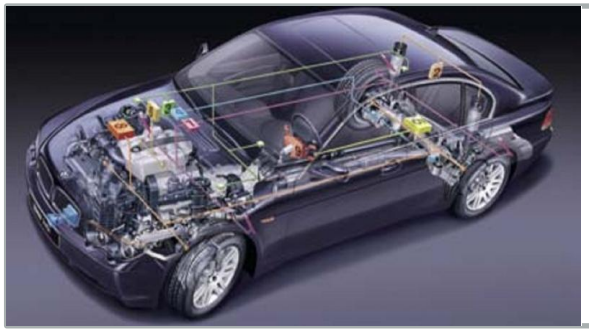
IT-supported production management and quality

- research in new concepts and implementation of manufacturing execution systems
- research in high precision metrology and quality assurance

Institute for Engineering Design
M. Engineering Informatics and Virtual Product Development

IT- Tools for tasks and processes

- Engineering IT Applications e.g.: CAx, Calculation, Analysis, Simulation, Visualization/VR
- Industrial Information Systems e.g.: PDM, ERP



IT integrated in innovative products

- Mechatronic Products and Systems
- Product-Service-Systems (PSS)
- Methods for Integrative Product Development/ Systems Engineering

Research Focus

- Closed-Loop Product Data Management (PDM)
- Semantic Web Technology und Knowledge Management
- Software Usability and Visualization Technology

Integrated Scalable Learning Factory
Target and Unique selling proposition?

INTEGRATED Concept

- Competence of 3 Institutes
- In the integrated learning factory knowledge, skills and competences of participants (students and industry representatives) are increased in product management, design engineering, production management, project management and cost accounting for a certain project. They work in a team and deepen their knowledge.

SCALABLE

- Different Depths of Training possible
- Basics – Specialization – Custom designed specialization for companies - Innovation

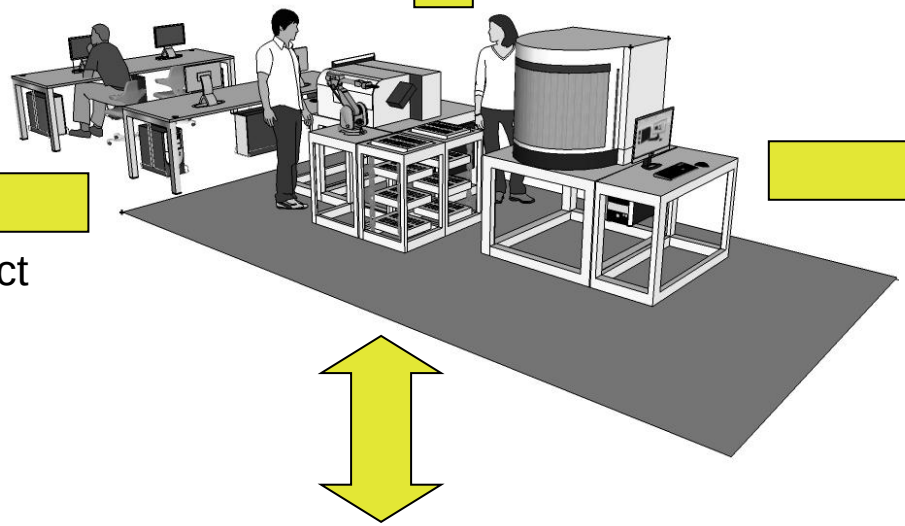
Order Fulfillment from Design to Product

3D Model ← → real Product → Delivery

	Design, Engineering	Production Planning and Control	Logistics	Production, Assembly	Quality Assurance	Economy, Management
Basics						
Spezialisation						
Custom-designed specializations (Companies)						
Innovation						

Benefits in Research, Education and Industry Cooperation (1/2)

Services for Industry
(e.g. use of a high-tech development environment,
Machine tool acceptance test)



Training
(e.g. Assembly Training,
Manufacturing Lab,
Lean Logistics Workshop,
Lean Production Workshop
Virtual Product
Development)

Education
(e.g. Integrative Product
Creation Module in the
bachelor curriculum)

Research
(e.g. Lean Assembly, Factory planning,
development of new production technologies)

Benefits in Research, Education and Industry Cooperation (2/2)

- Platform for further education and trainings in industry, e.g. for postgraduate studies or in cooperation with companies
- Research and practical trial of new technologies and methods
- Communication interface between research and industries
- Testing field for students for checking and presenting results
- Continuous Support of the students in their education in various programs
- Continuous improvement and renewal of technologies

Existing education modules in Industrial Engineering

Assembly Training Cell

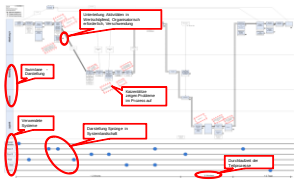
- Lean Basics
- Job Engineering
- Time Management tools

Lean Layout

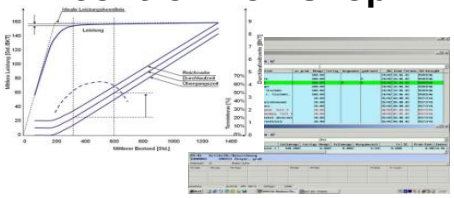
3D Model → real Product → Delivery

	Design, Engineering	Production Planning and Control	Logistics	Production, Assembly	Quality Assurance	Economy, Management
Basics						
Spezialisation						
Custom-designed specializations (Companies)						
Innovation						

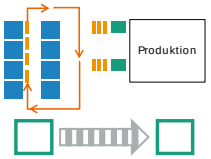
Lean Administration



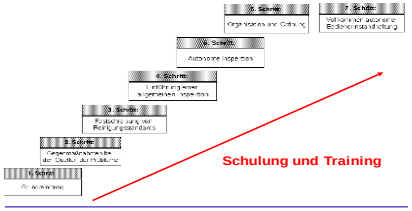
Production Planning and -control Workshop



Lean Logistics Workshop

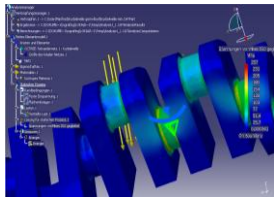


TPM Workshop



Existing education modules in Product Development

Engineering Design

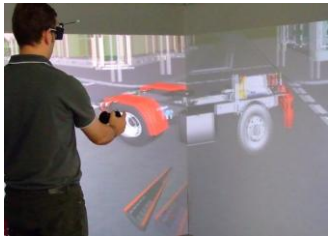


- CAD
- CAE/FEM
- Parametric Design

3D Model — real Product — Delivery

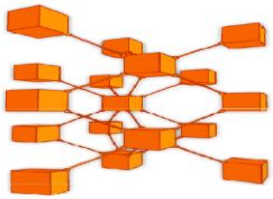
	Design, Engineering	Production Planning and Control	Logistics	Production, Assembly	Quality Assurance	Economy, Management
Basics						
Spezialisation						
Custom-designed specializations (Companies)						
Innovation						

Virtual Product Development



- Simulation
- Digital Mock-Up
- Virtual Reality
- Knowledge Based Design

Product Lifecycle Management



- Requirements
- Configuration
- Knowledge Management
- Life Cycle Analysis

Existing education modules in Production Engineering

NC-Technology

- NC-control
- Programming
- Simulation

Machine tool acceptance test

- Accuracy
- Metrology
- Acceptance test
- Compensation

3D Model → real Product

	Design, Engineering	Production Planning and Control	Logistics	Production Assembly	Assurance	Management
Basics						
Spezialisation						
Custom-designed specializations (Companies)						
Innovation						

Manufacturing execution systems

- Master data
- Data acquisition
- Functionality
- Bill of material
- Implementation

Production automation

- Control systems
- Actuators
- Sensors
- NC-control
- Control concepts

Actual situation

Merge of the existing initiatives of the three institutes (partly physically on the existing laboratory location, partly in terms of information)

- Development of an integrated teaching concept with a certain product
- Regard of dependences in the product development process: product development/design, simulation, production planning, production steps, production flow (e.g. lathing, milling, sawing, laser cutting), material supply, assembly, costs, quality
- Refining, adjusting and merging of existing systems (CAD, production plans/ part lists)
- Introduction of new technologies: (e.g. 3D-printer, generative production)

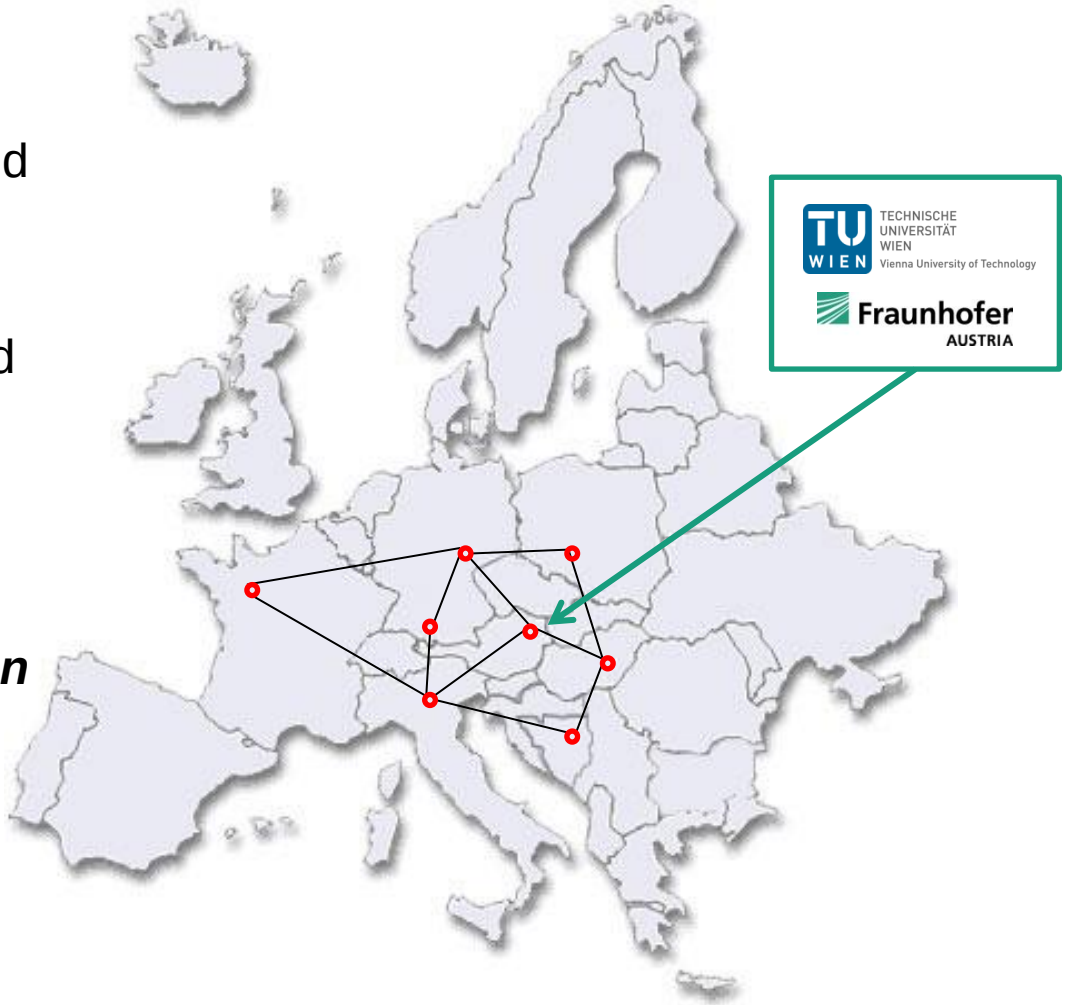
Further Steps of Development

- Integration of in-depth topics e.g. ECO DESIGN
- Concentration of activities in the newly build Vienna University of Technology Science Center
- Integration of further faculties with adjoining emphasis (e.g. informatics, construction engineering, electronics)

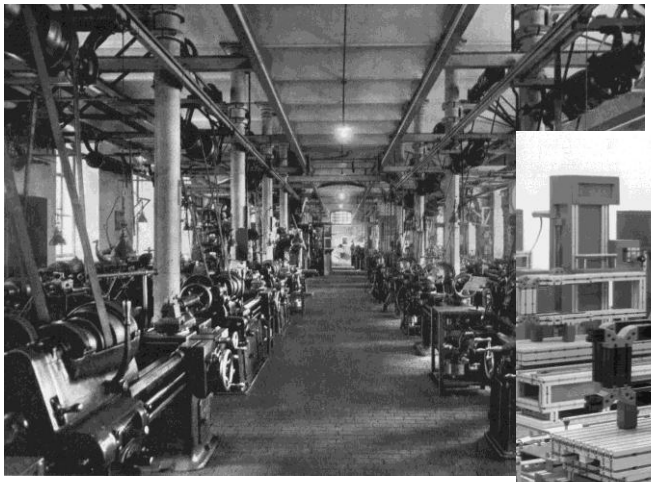
- Establishment of a modern high-tech innovation and application center as a „green field“ plan
- This should create a high-tech research environment that provides space for industry and university to develop innovative results
- Beside training and joint research projects, companies should have the possibility to create value in this high-tech environment

Vision: European Learning Factory Network

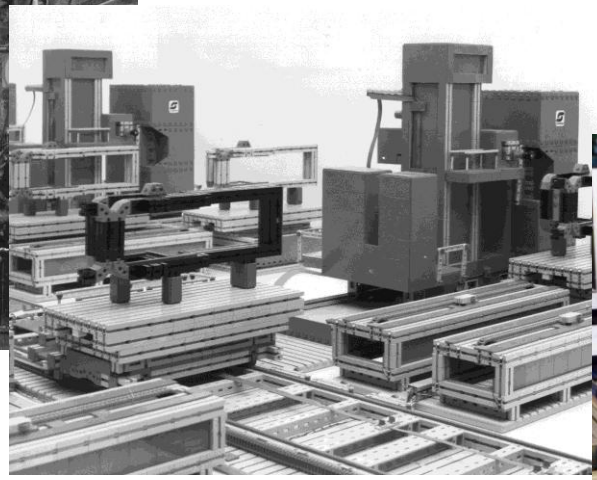
- International know-how exchange and collaborative development of training content
- Collaborative marketing activities and coordination of training content with different focus-topics
- Main focus of the Learning Factory Vienna:
  Integrated Product- and Production Engineering



Learning Factories – a long tradition at Vienna University of Technology



Job Shop in the 1920s

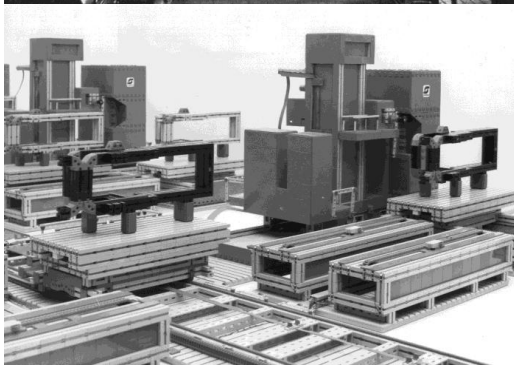


Computer controlled factory models in the 1980s

CIM Factory in the 1990s

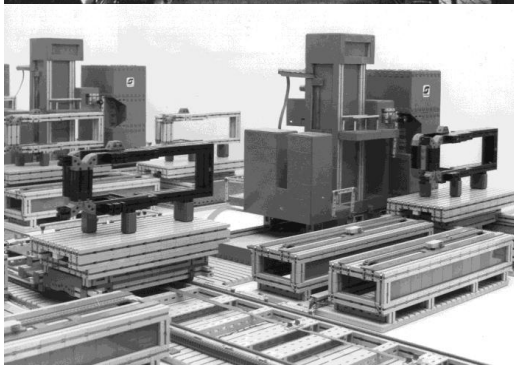
Lessons learned from past initiatives

- Learning factory is an integrated concept rather than a physical plant
- Focus on integration of processes rather than automization
- System modules (machine tools, controls, software) meet requirements of teaching concept but are kept as simple as possible
- System modules allow multiple use (teaching, r&d, postgradual education)
- System modules are loosely coupled, making upgrade and continuous system evolution easy
- System modules, architecture and communication adopt standards
- Rigid overall concept, decentralized development and maintenance of System modules



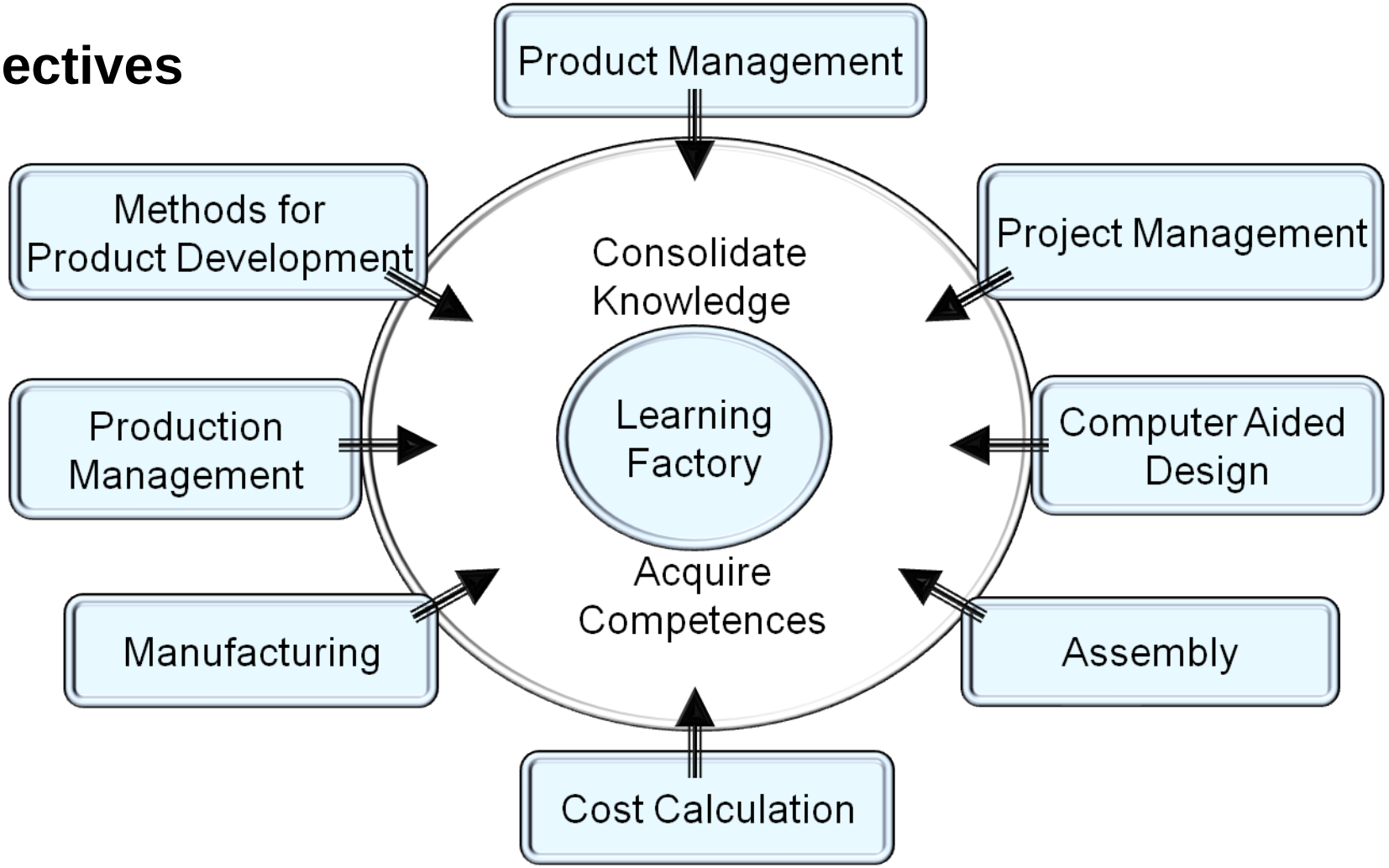
Motivation for a new Learning Factory

- Design of new curricula for bachelor studies "Mechanical Engineering" and “Industrial Engineering”
- Demand for occupational qualification
- Requirements specified by Industry (collected prior to curriculum design) lead to project- and problem based learning
  - By working together in groups, students learn communication skills, share knowledge and develop a sense of responsibility towards others
  - Knowledge integration between courses will improve. Students acquire an integrated view on the design and manufacturing process (due dates, costs, availability of resources)
  - Makes learning more enjoyable



Learning Factory in the new bachelor curriculum

Objectives

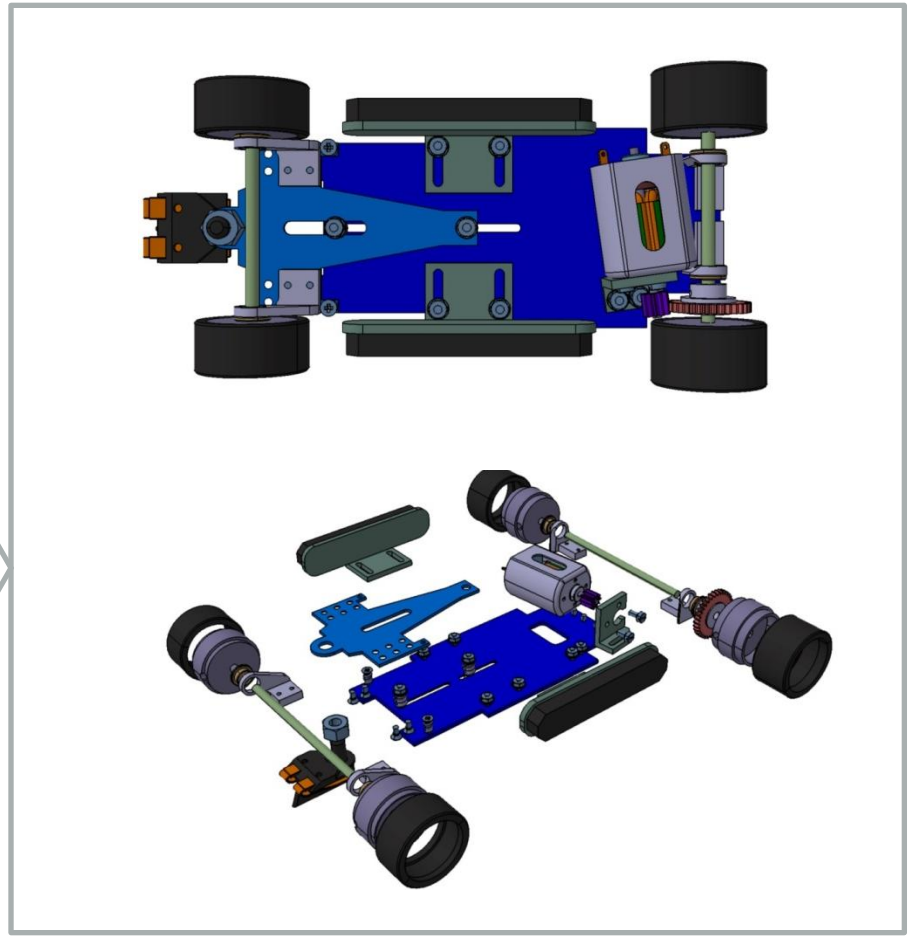


Learning Factory in the new bachelor curriculum

Product

real slotcar as initial point of work

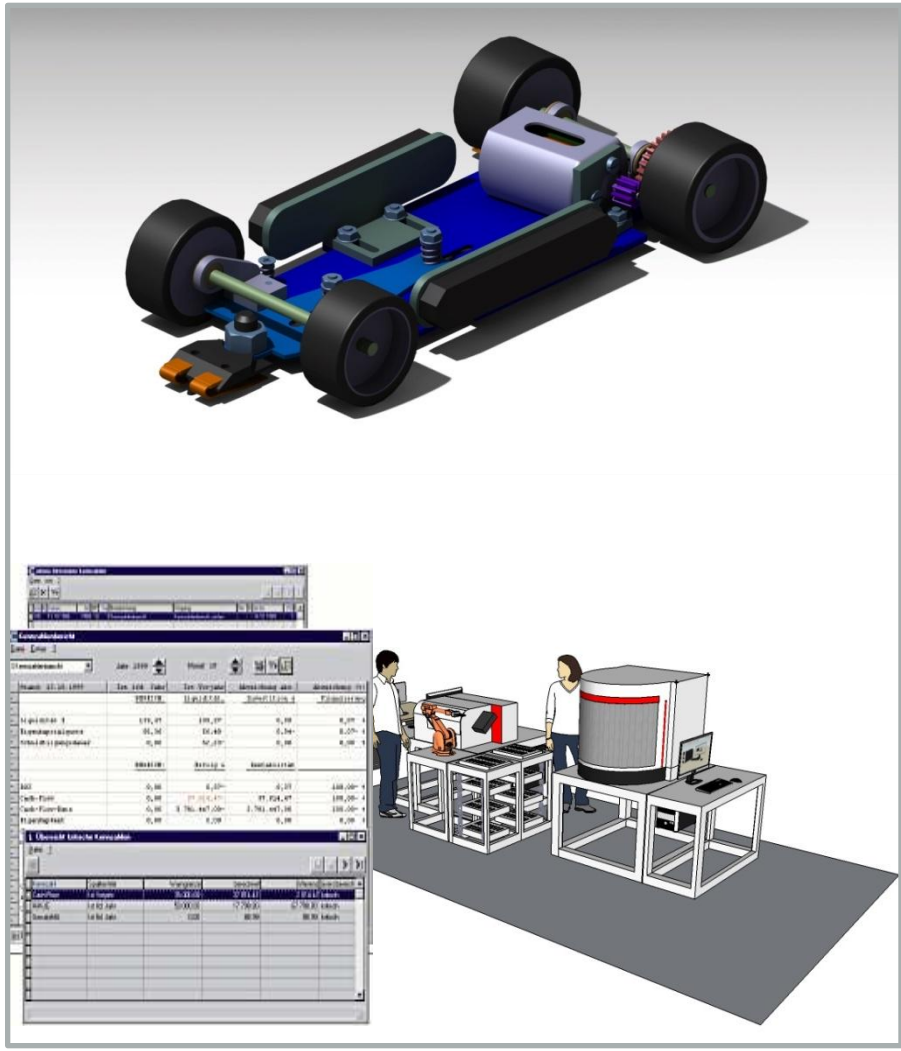
Re-designed slotcar



Learning Factory in the new bachelor curriculum

Project work

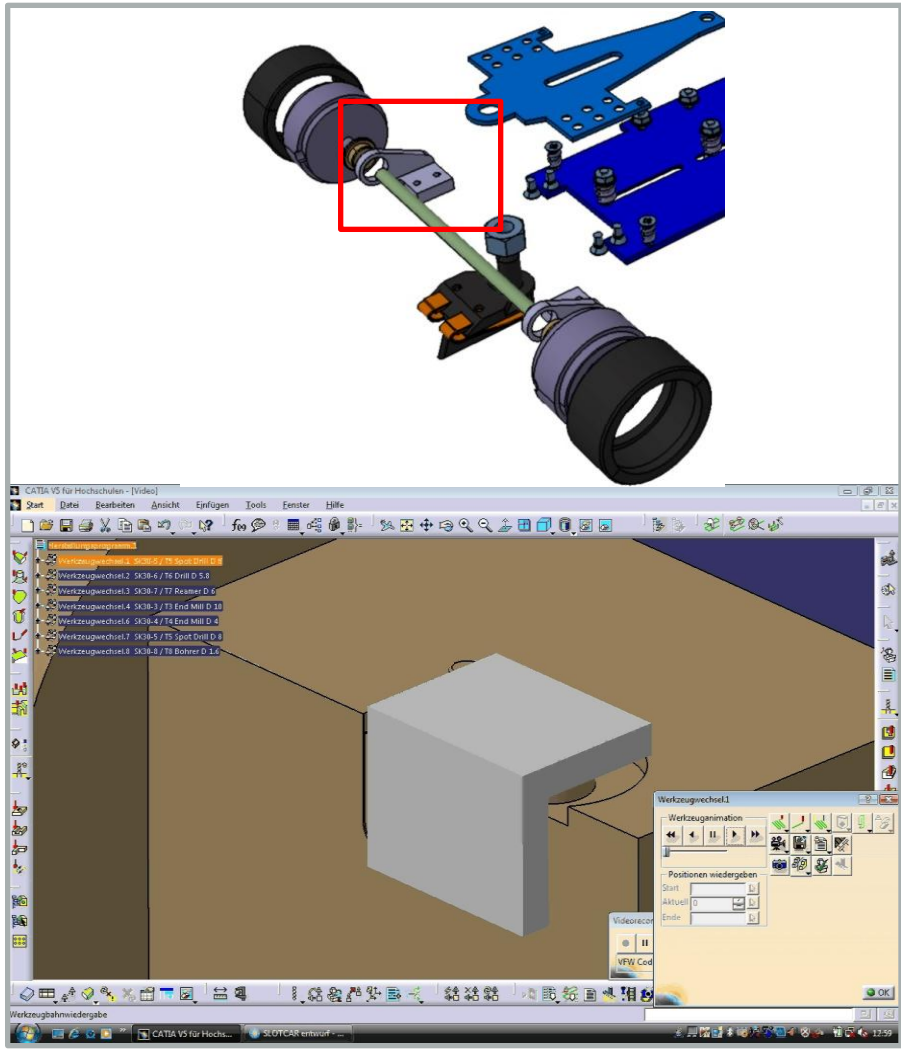
- An existing product (slot car) has to be improved by the students
  - Target: e.g. reduction of manufacturing costs
- Product analysis, definition of measures (make-or-buy decisions, reduction of parts, reduction of assembly operations, improvement of manufacturing methods etc.)
- Design of modified parts according to given constraints and CAD assembly including purchased parts



Learning Factory in the new bachelor curriculum

Project work

- Fabrication planning (selection of machine tools, operations, tools, fixtures), NC-programming and simulation using CAM
- Assembly planning (subassembly, final assembly, operations, fixtures, tools etc.)
- Preliminary calculation
- Manufacturing of parts, assembly (provision of tools and fixtures, set up of machine tools)
- Product costing analysis



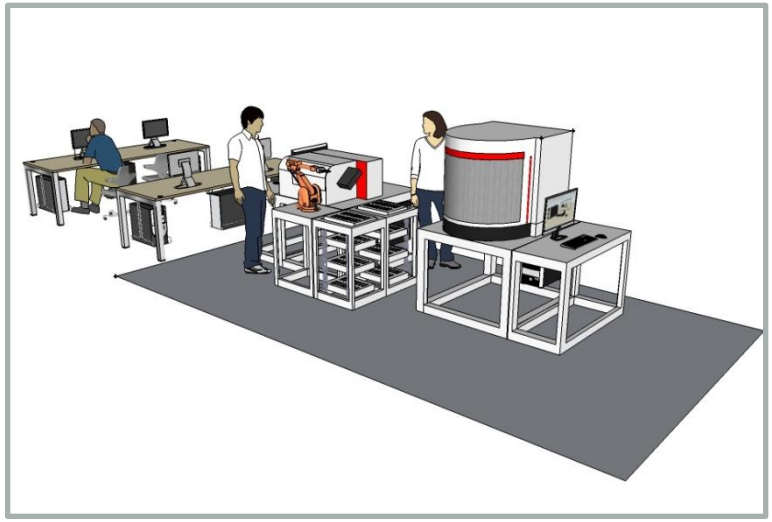
Learning Factory in the new bachelor curriculum

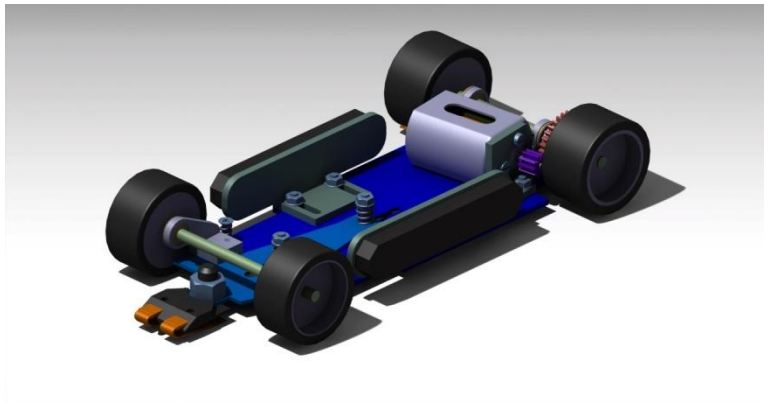
Project work

- Software tools: CAD, PDM, CAM, simulation
- Technologies:
  - NC Turning, Milling, Drilling and Laser Cutting
  - Rapid Prototyping
    - Concept models
    - Functional and visional prototypes
    - Fixtures
    - Product mockups

Learning Factory – Production Engineering

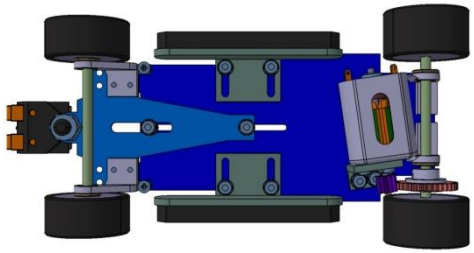
Equipment

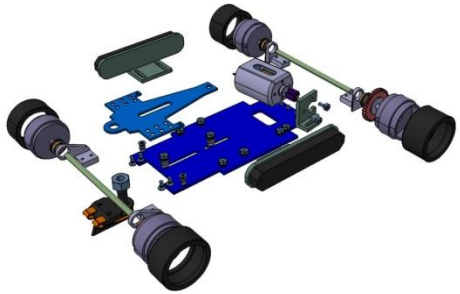




Learning Factory in the new bachelor curriculum

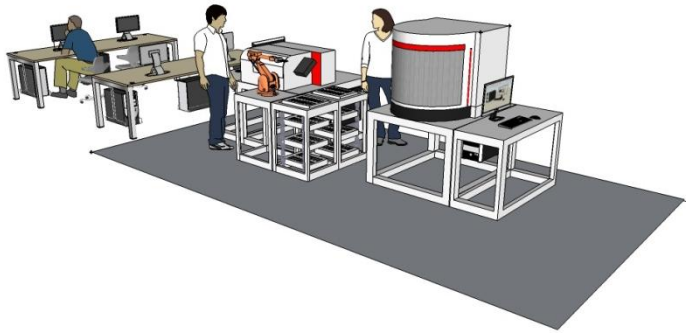
Field test



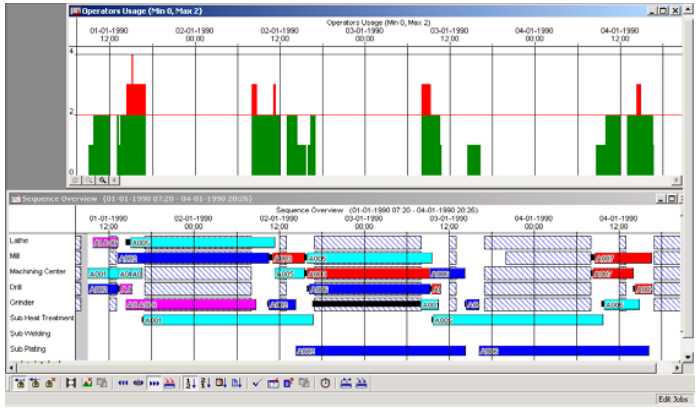


Learning Factory in the New Bachelor Curriculum

Future topics



- Further integration of Design and Manufacture (Feature Based Modeling)
- Support of design and manufacturing processes by integrated business software
  - Master Data
  - Bill of Material
  - Operations
  - Demand and Requirements Management
  - Purchasing
  - Production
  - Costing
- Adaptable automated manufacturing systems
- **Second level learning factory:** Pilot Factory for Innovation and Application in Production Engineering (real production company)



2nd Conference on Learning Factories
May 10th 2012
Vienna University of Technology, Austria

First Announcement

Competitive Production in Europe through education and training

Invitation and Scope

We cordially invite you to participate in the 2nd Conference on Learning Factories, held in Vienna, Austria. This Conference offers you the opportunity to visit Vienna, the "City of Culture" in the heart of Europe!

The objective of this conference is to provide an international forum to discuss the visions, state of the art and innovations in the field and to disseminate the recent advances and their views on perspectives of this area and thus to generate a significant impact on the future of learning factories. **...Vienna waits for YOU!**

Contact Persons

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