Design of demand-oriented engineering education for modern structures of production and service
Influence factors of engineering education

**Economy**
- Structures in production and service
- Professional work
- Demands on labour

**Science**
- Matters of research and research methods in engineering sciences
- Development of techniques and technology

**Society**
- Social needs and social values
- Idea of man in society

**Learner**
- Individuals with needs
- Cognitions of psychology

Demands on engineering education relating to objectives and organization
Questions about economy as influence factor of engineering education

What fields of professional activities are in demand from the current production and service structures and how this demand will develop in future?

- development of various sectors in production and services
- development of the technological structure and organization of labour
- demand for engineering labour on labour market

What is the character of work in the respective areas of professional activity and what requirements result out of it on the employees?

- work activities within the respective professional fields
- necessary personality dispositions for the execution of the work activities
  - qualifications with relation to the professional activities
  - qualifications which are independent of the work processes
Development of production structures

- manufactory production
- Taylorism
- Neo-Taylorism
- Fordism
- Toyotism
- lean management

1800 1850 1900 1950 2000
The long waves in the economy and its basic innovations (Nefiodow 1999, p.3)
"Taylor dissected the work as a pathologist, disassembled them in motion, into smaller and smaller units, measured in time and space, newly added them together, separated them in correct and incorrect working methods, and gave them eventually its direction: higher production, lower costs, higher profit, higher pay."

(Dettmer, M.: The modern factory.) In: Der Spiegel 26/1999)

Core programe-led transformation of industrial production and work processes according to Taylor

- Analysis of the existing worker process through time with the stopwatch
- Decomposition thereof in individual handle items
- New combination of the action elements in terms of the optimization of the work process
  (avoiding idle times and unnecessary steps, etc.)

(cf. Taylor, f.w.: The principles of scientific management.) (Weinheim & Basel 1977)
The Operation of Scientific Management (Taylorism)

Basic principle: Separation of mental and manual work

Labour office
- Reorganization of the micro and macro structures of the production process on the basis of work and time
- Imputed preparation of the current production
- Conflict solution

Manual work
- Orientation at work regulations
- Increasing efficiency through routine development
- Motivation by differential wage principle

Master of function
- Technical inspection and ongoing organization of production
- Training of the workforce

"We would not use the advantages of the system, if almost on all machinery would work lower paid working people instead of trained skilled workers" (Taylor 1919)
"The problem is the thoughtless link of the worker to the machine, because he watches the work meaningless."

"In Japan, the goal is to utilize the people, not like you the machines."

(K. Sekine, co-inventor of the Toyota production system)
Essence of toyotistic mode of production:

- no democratic attempt to the humanization of work
- Team work with individual responsibility for work organisation, work plan, quality control, multi-purpose work
- Level of work-sharing goes back, work becomes more complex
- Possibility of band stop for each worker
- Product improvement in the interaction between workers and engineer
- Design tasks for individual components are given the suppliers responsibility
- Delivery of the parts "just in time"
Consequences:

- Flattening of hierarchies in the company
- Flexible production with short development times
- Smaller amount of personnel
- Lower capital investment
- Low stock
- Qualification and motivation of individuals gaining significantly
FRIELING: components of modern production structures which are relevant for vocational education:

- Process-chain-oriented company organization instead of functional hierarchies
- Customer-orientation instead of product-orientation
- Responsibility for the project/venture and budget instead of hierarchically structured task management
- Working in teams or groups instead of working alone
- Complete operations instead of individual/single acts
- Self-regulation instead of standardized input/guidelines
- Involvement instead of heteronomy
- Continuous improvement instead of hope for innovation.

(cp. Frielings (1993): Das lernende Unternehmen, p.32)
现代化生产结构的特征

- 以过程为导向的组织取代了功能等级制
- 以客户需求为导向取代了以产品为导向
- 项目和预算负责制取代了等级结构性的任务管理方式
- 团队或小组工作取代了单个个体作业
- 完整的行为取代了单一的工作
- 自我控制和管理取代了接受标准化指令
- 参与取代了依赖
- 持续性改善和优化取代了等待改革和创新

（cp. Frieling, Ekkehart: Das lernende Unternehmen. - Hochheim 1993, p. 32）
Criteria for teachers in engineering education under the aspect of structures of production and service

The design of teaching and learning processes in a demand-oriented vocational education requires teachers who have extensive experience in professional practice. This includes:

- Knowledge of current developments of the structures of production and service
- Knowledge about the nature of professional work in their respective professional fields
- Experience in dealing with the respective production facilities
- Experience in planning, execution and monitoring of professional work activities
- Ability to design work process related teaching and learning
- Mastery of methods to develop key qualifications
Questions about science as influence factor of engineering education

Which subject-matters of engineering sciences are useful as appropriate matters of acquisition for the respective professions?

→ relation to subject-matters of engineering sciences

System of scientific statements of engineering sciences with professional relation (Theories, laws, hypotheses ...)

System of professional scientific act regulatives (Principles, methods, rules, procedures)

System of professional scientific act standards (Directives, standards)
Criteria for teachers in engineering education under the aspect of engineering sciences

The design of teaching and learning processes in a demand-oriented vocational education requires teachers who have:

- comprehensive knowledge of engineering sciences (in relation to the professional field)
- Insight into the importance of subject-matters of engineering sciences for the professional activities
- Competence in suitable didactic simplification of scientific subject-matters
Questions about society as influence factor of engineering education

idea of man in the society

Which personality traits should have an ideal personality for the society?

→ Socialization mission of vocational education

Responsible (mature) citizens

- general capabilities of human and social nature
- autonomy in activity
- responsibility in the individual life and in public life
- participation in democratic processes
- autonomous lifelong learning
Criteria for teachers in engineering education under the aspect of society

The design of teaching and learning processes in a demand-oriented vocational education requires teachers who have:

- Awareness of the connection between professional education and socialization
- Knowledge about the relationship of school and professional socialization
- Ability to design target-oriented socialization processes
Questions about learning individual as influence factor of engineering education

What individual personality characteristics of learners are to be taken into account in the planning of learning processes in engineering education?

- pre-conditions of the learners
- age-specific psychological characteristics
- individual values, norms, attitudes
- needs of learners

Implications for criteria of teachers of engineering education

- Ability to psychological performance and personality diagnostics
- Ability for individual support and advice to students
Structure of training in field of engineering didactics

Module area I
Fundamentals of design of teaching and learning processes

Modules
- Planning of learning and teaching processes
- Design of communicative processes
- Control and evaluation of learning results
- Selection and design of media

Module area II
Arrangements of academic teaching and learning

Modules
- Design of lectures and seminars
- Design of exercises and laboratory internships
- Design of engineering internships and research colloquia

Module area III
Structuring of study programs

Modules
- Determining of employment-oriented study objectives
- Determining of appropriate study content

Module area IV
(Practice modules)

Modules
- Case discussions
- Teacher observation
- Colloquium
Assumptions of Act Theory

- activity is a necessary condition to personality development
- activity has to be
  - cognizant
  - goal-oriented

  → term: act

- individual needs are necessary conditions for acting

  → motive for act

- acts takes place in 3 fields of personality
  - cognitive field
  - affective/emotional- volitional field
  - psychomotor field

  → holistic act

- the basic structure of human acts has the follow components
  - orientation
  - accomplishment
  - evaluation

  → complete act
行动是个性发展的基础

发展心理学和工作心理学的一些观点

- 通过有意识、有目的的行动可以促进个性的发展。

- 动机驱动行动。

- 行动是认知、肢体运动和情感三个层面的综合。

- 完整的行动（定向、实施、检测）促进个性的发展。
Basic didactic relationships

Hortsch, H.: Didaktik der Berufsbildung
Merkblätter zur Vorlesung
Dresden 1994
教学论的基本关系

Hortsch, H.: 职业教育培训的教学论
Merkblätter zur Vorlesung
Dresden 1994
State of the Learner at the Point $t_0$ can be characterised by his/her
• Dispositions of Knowledge, Skills, Demands and Will
• Other internal conditions of the individual

State of the Learner at the Point $t_1$ can be characterised by the changed
• Dispositions of Knowledge, Skills, Demands and Will
• Other internal conditions of the individual

The Lecturer INITIATES by orientating, regulating and evaluating

Learning Act

Compensation Act

External Conditions

Hortsch, H.: Didaktik der Berufsbildung Merkblätter zur Vorlesung Dresden 1994
Thank you for your attention