

# EDUCATIONAL PROCESS AS A SOCIOTECHNICAL SYSTEM

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**Abstract:** The description of designing educational systems by using the concepts and models of engineering design is a very efficient means of clearly presenting complex educational interdependencies. A model for describing an educational system is shown, which is based on the well-known model for designing technical systems. A comparison between designing educational systems and technical ones is made.

The product of the educational process lies in the purposeful influences on the individual. These influences are oriented mainly to the increase of the competencies (knowledge, abilities, skills, and know-how). Therefore, the problem is: How can we create a process which leads from the identification of educational goals to the description of an educational system that satisfies the fulfilment of these goals? This is a design problem, and it is possible to establish a model creating an educational process similar to that of the engineering design process.

New aspects of the system approach to educational processes can be found in the System Theory of Technology developed by Ropohl [1]. He tries to tie together elements of human and social sciences with elements of natural and technical sciences. He does this by using two central system concepts – system of actions and system of things. In the following we try to apply the fundamental concepts and model of both the System Theory of Technology and Design Science, particularly the model of Ehrenspiel [2], to the designing of educational processes. In that way the general theory of engineering design can be of double value for engineers, giving a logical mental framework for solving technical and educational problems as well.

## Systems Important for Educational Design

In order to realize the objectives of an educational process, we create and use suitable education systems. By an education system we understand usually the systems of educators and learners. Considering the other factors of an educational process, we can describe it as a set of main personal (learner, educator) and material-factual (objectives, content, methods, organisation, results) elements. By means of the System Theory of Technology all these elements can be seen as a sociotechnical system.

Considering the formation of a system, e.g. the designing of an educational system, a subdivision into the following subsystems is helpful (Fig. 1):

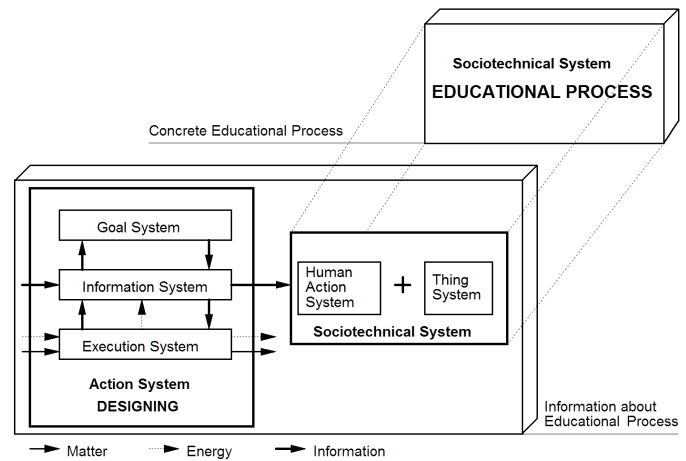


Fig. 1: Systems Important for Educational Design

**Action Systems** the personal (learner, educator) and social (group, class, school) subjects and objects of acting. The learner (personal system) and the group, class, school (social systems) are seen as subjects and objects of acting as well; the subjects in the sense of their own conscious learning activity and the objects in the sense of educational guidance;

**Thing Systems** the systems of things which should be form or built; the material-factual objects of action (content, methods, means, organisation, results);

**Sociotechnical Systems** the connections (relations) of action systems and thing systems;

**Goal Systems** the systems of objectives or guidelines for action systems (learning objectives, learning tasks, assignments);

**Information Systems** the systems of information processing. These systems supply the action systems with necessary information and store the processed information;

**Execution Systems** the systems which cause the material-energetic changes.

An abstract **action system** consists of a goal setting system, an information system and an execution system. Each of these systems fulfils specified sub-functions in the execution of actions. The goal setting system generates the goal systems as the guidelines of acting. Acting functions which transform the information are carried out in the information system. The execution system carries out the non-information, e.g. material-energetic changes. For a personal action system this means [1]:

- Goals setting system – the **motivational** sub-functions;
- Information system – the **sensorial** and **cognitive** functions which are connected with information handling, such as operating speech organs;
- Execution system – the **motorial-operative** sub-functions, e.g. those processes which are connected with physical work.

Thus, an **educational system** can be defined as a sociotechnical system in which two human action systems – learners and educator – are connected using a goal system (learning objectives), a thing system (learning and teaching content, methods, means, results) and an information system [3] (see also Fig. 1). However, an educational system is not concerned with purely technical action – as in the case of each sociotechnical man-machine system whose goal is the creation, use and disposal of technical systems (thing systems) – but regarding **educational action** which is oriented on the development of human beings (personal systems, social systems). Educational action shows, however, many technical aspects; it is concerned with technical means (e.g. media) or technical conditions.

The **main function** of educational systems is to transform the operand learner from the initial situation to the final situation. The action "teaching" is the main action of the teacher (educator); the action "learning" is the main one of the learner. Both actions concern the personal, social and material-factual objects of acting. The learner behaves; however, not only like a machine which does not have its own goals and can be merely controlled by the command functions in accordance with the external; he is an active participant in educational systems. Feedback between educator and learner exists. This feedback arises because the learner exists in the system partly as the object and partly as the subject in the sense of educational subject-object dialectics.

### Designing Technical Systems versus Designing Educational Systems

Comparing the design of educational and technical system (Table 1), we find that the fundamental differences lie

in action subject, product and system attributes while the information processing is very similar. However, an educational system is not concerned with purely technical action – as in the case of each sociotechnical man-machine system whose goal is the creation, use and disposal of technical systems (thing systems) – but with **educational action** which is oriented on the development of human beings (personal systems, social systems). Educational action shows many technical aspects; it is concerned with technical means (e.g. media) or technical conditions.

Table 1: Comparison between Designing Educational and Technical System

Point of View	Educational System	Technical System
Subject of Action	Sociotechnical System EDUCATIONAL PROCESS	Technical System MACHINE
Product of Action	Organized Teaching and Learning of Man	Organized Producing and Operating of Machine
Input Information	Requirements concerning: <ul style="list-style-type: none"> <li>• Objectives</li> <li>• Persons</li> <li>• Actions</li> <li>• Things</li> <li>• Organization</li> </ul>	Requirements concerning: <ul style="list-style-type: none"> <li>• Functions</li> <li>• Safety</li> <li>• Man-machine relations</li> <li>• Costs</li> </ul>
Output Information	Requirements list Objectives list Objectives-Topics Matrix Events of instructions Curriculum map	Requirements list (Specification) Concept features Concept schemes Part drawings Calculations Operational instructions
Attributes to be established	Educational attributes: <ul style="list-style-type: none"> <li>• Goal</li> <li>• Content</li> <li>• Method</li> <li>• Means</li> <li>• Result</li> </ul>	Technical attributes: <ul style="list-style-type: none"> <li>• Function</li> <li>• Physics</li> <li>• Working structure</li> <li>• Building structure</li> <li>• Parts</li> </ul>

So to conclude: a general theory of engineering design can be of double value for engineers, giving them a logical mental framework for solving technical and educational problems as well. However, the presented procedural model for designing educational systems does not pretend to be a reliable recipe for successful educational processes. It is only a means of decreasing the risk of unsuccessful processes. It helps to use educators' knowledge more effectively and automatically shows deficiencies. Additionally, it systemizes the work and protects the system designer against getting lost in the abundance of material which is offered and acquired, in most cases, encyclopaedically.

### Literature

[1] G. Ropohl. *Modelvorstellung für Entwicklung und Konstruktion*. 1979, 3. überarb. Aufl., 2009.  
 [2] W. Beitz, K Ehrenspiel. Modelvorstellung für Entwicklung und Konstruktion. *VDI-Z*, 126(7):201–207, 1984.  
 [3] M. Gawrysiak. Systemanalyse der Bodenbearbeitungsmaschine und Folgerungen für die ingenieurausbildung. *Diss. B. TU Dresden*, 1988.