In the German Federal Republic, the federal states are independent in educational matters. In spite of the independence, the educational system in the federal states is nearly the same (v. Figure 2.). Although in all states there are comprehensive schools, the normal system consists of a primary school and three branches of secondary schools: Hauptschule (general secondary school), Realschule and Gymnasium (high school). In some states the first two years of secondary school form a school on its own, the Orientierungsstufe.

The school leaving certificate of the Hauptschule entitles the student to enter into an apprenticeship. The same does that of the Realschule, under certain conditions the student can go to the Gymnasium. The leaving certificate of a Gymnasium entitles the student to go to a college or university. Roughly today one third of the pupils attend each of the branches Hauptschule, Realschule and Gymnasium. Only a few pupils attend comprehensive schools.

In most of the federal states technology education is taught only in Hauptschule and Realschule. (V. fig. 3)

**Technology Education**

From the educational discussion in the sixties an seventies two kinds of school subjects concerned with technology education emerged:

- A school subject integrating all aspects of the work and production process. The technological parts of the syllabus are only means to reach the non technological aims of lessons.

- A school subject with regard to technological contents. Regard to technology does not mean to ignore effects and consequences of technology. This school subject often is part of a subject area, combined with other subjects like economic education or house economics.

Since only in the second kind of technology education technological contents are described adequately, in the following I will refer to this and show the stage of this school subject in discussion.
Although in this kind of technology education there are differing points of view, they have many common features: objectives, content, and teaching methods.

**Objectives of technology education** (v. SCHULTE et.al., p. 10):
The objectives of technology education are:

*Factual competence*: This is achieved by imparting exemplary and both structural and functional knowledge about technical devices and processes to the student, which are not restricted to the latest trends therefore are transferable and objectively and subjectively significant.

*Method competence* is distinguished by using technology-specific ways of thinking and working in the lessons, like they appear within technology in developing, inventing, and production processes. The path towards method competence corresponds with the development of creativity and the ability to co-operate and communicate in connection with technical actions and operations.

*Competence for evaluation and assessment*: Within the area of technical operations, the student has to learn to assess and question critically the development, production and usage of technology under economic, ecological and social aspects. The ability to evaluate and assess technology is a prerequisite for forming opinions and for decision-making processes within the complex technical field.

**Content of technology education** (v. SCHULTE et.al., p. 11)
Because of the complex interrelations of technology with non-technical areas and also because of the complexity of different types of specialised knowledge in technology, it is necessary to find a theoretical overall concept for shape and content of a general technical education. The contents of general technical education can be related to several sub components of various degrees of complexity.

- systems of technology
- methods of thinking and methods of usage of technology

Figure 3 Technology Education in German Schools
• **consequences of technology and the usage of technology in society and environment**

**Systems of technology**

\[
\begin{array}{c}
\text{matter} \rightarrow \text{process} \rightarrow \text{matter}' \\
\text{energy} \rightarrow \text{process} \rightarrow \text{energy}' \\
\text{information} \rightarrow \text{process} \rightarrow \text{information}'
\end{array}
\]

Fig. 4 General technological process

In general the technological process is shown as the processing of matter, energy and information:

- **processing of matter** (e.g. in the areas of production technology, process technology, building technology and transport technology)
- **processing of energy** (e.g. in the areas of energy technology, electrical engineering and machine engineering)
- **processing of information** (e.g. in the areas of automation technology, data processing technology, communication technology)

**Methods of thinking and acting in technology**

The specific manners of thinking and acting in technology stand in the centre of technology teaching. The following specific procedures - both at the practical and the theoretical level of technology - have to be mentioned.

- representation, planning and optimisation of technology (e.g.: outline, construction, planning and experiment)
- production and usage of technology (e.g.: material processing, assembly, operating, controlling, servicing, upkeep, search for defects, repair, waste management)
- assessment of technology (e.g.: effects of technical actions and decisions in the areas of economy, society and the environment)

**Consequences of technology and technical action in society and the environment**

Regarding the effects of technology in social, political and ecological areas, technical systems, as well as their usage, have to be assessed continually under the following aspects:

- correspondence of purpose/function - service and repair friendliness
- correspondence of material/production - environment compatibility
- physical laws/predictability - society compatibility
- economy, including standardisation - individual and social relevance
- safety - historic development
- handling

**Teaching and learning activities**

Over the past years a technology specific set of teaching methods emerged. Accounting to the history of technology education - arts and crafts - the Werkaufgabe (designing and making exercise) was the predominating teaching method. It covers the whole course of planning, designing an realiseing an object. Since at an average portion of 90 minutes per week only few exercises can be com-
pleted in one term, other methods - time saving and appropriate for technology - had to be found. The present state comprises the following teaching methods (cf. HENSELER/HÖPKEN):

**Design exercise**
This method corresponds with an important technological action - designing. In the process of solving technological problems it emphasises inventing, planning, designing and creating. Examples are: Designing a circuit board for an electronic circuit, Designing a time control (traffic light, flashing light, ...)

**Manufacturing exercise**
Manufacturing an object the pupils independently plan and organise the production process. Examples are: Manufacturing an electronic wiring, ...

Design exercise and manufacturing can be combined: *Design and manufacturing exercise.*
This is the original method of didactics of arts and crafts. It includes all stages of the planning and manufacturing process. But this means also, that only few exercises can be carried out during one term.

**Technological experiment**
The technological experiment can provide unknown values, which are needed in the further course of the lesson. Examples are: Determining the adhesion of various adhesives, determining the life of batteries under different loads.

**Technological analysis**
In a technological analysis technological object or technical facts are examined concerning their components or factors. This can be done destructive or non destructive. Examples are: Disassembling an electric iron to see the components of a control loop (non destructive, the iron can be reassembled), opening the case of a power transistor (TO 3) (destructive)

**Technological exploration**
This is a planned and purposeful investigation of institutions outside school. Examples are: Traffic light, machines in a factory or workshop

**Technological assessment/evaluation**
Assessment and evaluation of technology is one of the most complex methods of technology education. It takes place after each manufacturing exercise to assess an evaluate the object made. The result can be used to evaluate the pupils standards. However technological assessment can also be a method of its own testing industrial products or even comparing types of power stations.

**An Example of Recent Technology Curricula: Schleswig-Holstein**
In 1997 the most recent German technology curriculum was published – the Schleswig-Holstein technology syllabus. It is a comprehensive curriculum for all branches of junior and senior high schools. The following overview (Fig. 5) shows the curriculum for comprehensive schools. All other curricula are subsets of this curriculum.
The representation (Fig. 6) shows the interdependence of technological aspects with aspects affected by technology. Such a graphic representation was made for each teaching unit.
The underlying structure of technology education is shown in Fig.7.
<table>
<thead>
<tr>
<th>Compulsory subject</th>
<th>7. grade</th>
<th>8. grade</th>
<th>9. grade</th>
<th>10. grade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The responsibility of man working with raw material in craftsmen like production</strong></td>
<td>Wood</td>
<td>Structure and properties of wood/ecological aspects; Basic skills in processing wood; Safety aspects; Planning and making an object; Comparing and assessing industrial goods; Wood processing vocations (24 lessons)</td>
<td>Metal</td>
<td>Structure and properties of metals, recycling; Basic skills in processing metal; Safety aspects; Planning and making an object; Comparing and assessing industrial goods; Metal processing vocations (24 lessons)</td>
</tr>
<tr>
<td><strong>Development and employment of machines change place of work and vocation. Interdependence of man and machine in production</strong></td>
<td>Development, drills from stone age to present time Using electric drills Re-inventing historical drilling facilities Comparing and assessing simple drills (20 lessons)</td>
<td>Dismantling, analysys, and assembling simple machines (drills) Drive, transmitting and transforming motion (12 lessons)</td>
<td>Designing and making a drill Matching fields of vocations (16 lessons)</td>
<td>Automating drills Impacts for the society V. examples “impacts of automation technology”</td>
</tr>
<tr>
<td><strong>Industrial production of articles for daily use and its impact on conditions of life</strong></td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td></td>
</tr>
<tr>
<td><strong>Car technology and its interactions with man and environment</strong></td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technology conceptions for environment conserving means of transport</strong></td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Former and present ways of constructing bridges- basic principles of static, selecting materials, impacts on man and environment</strong></td>
<td>Teachers’ conference arranges and prepares the matter. Project possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Using energy efficiently and sustainable energies in households</strong></td>
<td>Consequences of wasting energy; Analysing and assessing the energy consumption of a household; Developing, testing, and using ways of saving energy (16 lessons)</td>
<td>Designing and making alternative converters for energy (32 lessons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Basic electrical circuits and safety education, Basic course: Soldering</strong></td>
<td>Teachers’ conference arranges and prepares the matter. (8 lessons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Impacts of automation technology on man, working place and vocation. - From hand control to computers</strong></td>
<td>Basics of electrical engineering Analysing the employment of simple control in households Making and comparing simple controls (electric bulb, motor) (12 lessons)</td>
<td>Designing, making, and analysing simple automatic controls Inquiring the consequences of a program control for the user (20 lessons)</td>
<td>Basic course: electronic components Solving problems through control technology (as well with computers) Assessing the impacts of automation for different areas of life (24 lessons)</td>
<td>Designing, making and using CNC machine tools/models Analysing the consequences of micro electronics (computers) for industrial work and vocations (32 lessons)</td>
</tr>
<tr>
<td><strong>Interchange of information, development and impacts. - From drum to wireless telephones</strong></td>
<td>Teachers’ conference arranges and prepares the matter. (20 lessons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suggested optional subjects</strong></td>
<td>Wrapping is a burden for environment - disposing and planning wrappings, avoiding refuse through abolishing, recycling relieves environment (40 lessons)</td>
<td>People develop technology (e.g. air craft engineering) and use it in different ways (44 lessons)</td>
<td>Man as consumer - discriminating dealing with the supply of technical articles - analysing, testing, and purchasing products (44 lessons)</td>
<td>Teachers’ conference decides about projects (64 lessons) including examinations</td>
</tr>
</tbody>
</table>

Fig. 6 The 1997 Schleswig-Holstein Technology Curriculum, Overview (LEHRPLAN, pp. 75 – 78)
Fig. 6 Interdependence of Subject Matter

Figure 7 Structure of Technology Education
References

