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ABSTRACT

This paper discusses the following topics: (1) relation between nature-man-technology, (2) methodical means for the goal determination of a nature oriented technology, (3) methodical means for the solution finding of a nature oriented technology, and (4) guidelines for nature orientation as a curricular element. (JRH)

Principles for the goal determination and solution finding of a nature oriented technology - new determination of curricular elements in technical education

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1. Relation between nature - man - technology
2. Methodical means for the goal determination of a nature oriented technology
3. Methodical means for the solution finding of a nature oriented technology
4. Guide line "nature orientation as a curriculare element"

1. Relation between nature - man - technology

The environmental consciousness of man arises from his sympathy to nature, to technology and to the interrelation of nature and technology. The terms "nature" and "technology" are not absolute terms, but they are determined from the ratio of man to his history and his future development. Therefore, the terms changed again and again during the centuries.
Nature includes the totality of all by which man is surrounded "naturally", including the totality of life.
In the latin term "natura" we can find the root "naci" - to be born. Nature includes all which arises, grows, passes away, and changes from a reciprocal action of the "primary forces". Man is one part of nature.
Man will be born into a social environment which influences him and which he shapes consciously. This environment gets its name also from "naci" and is named "nation".
The nation provides the "the mental coherence" of people, nature gives people the practical foundation for life.
In the explanation with nature in the frame of his social environment (today nation) man developed those today nearly deciding third environment - the technology.
In the fifth century before Christ the two terms "nature" and "polis" - the town state as place of natural occasions and conditions and of civil law - were developed in Greece at the same time.
This consonance of nature and nation is not an accident in this period of development - father "land" and mother "nature".
In order to fight against the none-Christian, the heathen belief whose gods are to be found in nature, the Catholic Church developed very early the idea that nature is subject of man. DESCARTES said jeerly that nature can be used as a "toy".
The changing relation to nature (in that time) becomes visible in literature and painting in the different nations of the world at that time.
Today the relation and the shaping of nature, nation and technology as a social appearance has to be seen as the main point for saving the worldly living conditions. Today, catostrophes to an immense extent are not only caused by nature but also by man himself through the created technology.
The nature people observed the natural phenomenons, they tried to find out the principles of function, structure and organization of these natural occurances and they converted

creatively these principles for their cultural development.
At the beginning, especially natural materials and natural energies have been used for finding new solutions. (see fig. 1)

As a result of the arrangement of man with his environment the third environment - that means the technology - was created. This process became independent and resulted for it in the industrial era so that nearly exclusive the technology and the technical possibilities become a source of new solutions. This resulted in the well-known discord with nature, in the ecologic catastrophes, which call in question for the first time the inventions of man. Therefore, the authors turn to the question how could be the way in order to reach again a consonance between nature and nation/technology and they try to give an answer on the level of the technical education. A possible entrance to nature can be seen in the fact that the goal determination of the future technology includes the regularities of evolution of nature and that for the solution finding itself structures of biological systems will be used.

2. Methodical means for the goal determination of a nature-oriented technology

The creative transformation of the function of orientation - technology uses the analogy with the living nature - makes it possible to take up the goal determination of the developed technological system.
The finding, the creation of subjective new creations within the lessons of technology needs for the process of thinking and acting for instance foreseeing, which appears in fixing of aims.
"Aims are illustrations of a reality which not yet exists and therefore has to be created and thus the aims are connecting the present time with the future" (1, p.6)
Taking into consideration the essential element, that means the experiences of man by fixing aims, then we have to add to the above mentioned definition the aspect of the past time.
Fixing of aims for new technology could be derived from the analysis of the biological and technological evolution. Thus, the evolution of all systems turns out to regularities. If such regularities exist, then it should also be possible to use them as elements for the goal determination. They make possible an extensive orientation on the product ideas in

direction to a higher effectivity. Therefore, technological systems can be transfered from a considered level of development, e. g. considered from the level of technology, into the next higher level of development by increasing the effectiveness.

Therefore, it is possible to derive from the regularities of development potentials of development.

The following regularities of development characterize the transition from the technological starting solution to an efficient solution within a cycle of development:

1. laws of development
   - basic laws (e. g. unity and polarity; changing from quantity to quality; ...)
   - laws of structure and of tendency (e. g. the law of the inexhaustibility of the development; the law of the irregularity of the development of parts of a system; the law of increasing the degree of the idealizing of a system...)

2. trends of development
   (e. g. decreasing the used material and energy; closed cycles of materials; multiple realization of function; using natural energy potentials ...) (see fig. 2)

3. steps of development
   (e. g. aggregation of uniform elements of function; structural differentiating and functional specializa tion; hierarchical division of the total function on several levels of functions ...)

4. stages of development
   (e. g. stage of beginning; stage of optimum and formation of upper systems).

The conscious using of the above mentioned points within the problem solving process can not only lead to the formulation of inventive aims but can also promote the creativity of the problem solver.

The goal determination is performed by the following steps:

1. finding out the level of technology and uncovering the dediciency from the technical, technological, economical, ecological, social view ...

2. transfering the regularities of development on the level of technology
3. deriving of conclusions for promising trends of solutions.

There exists a many-sided direction freedom within the frame of the regularities of development for the development of technological systems.

3. Methodical means for the solution finding of a nature - oriented technology

The realization of the function of orientation - technology uses the functional analogy with nature - is fixed on the production of ideas of solution.
Within millions of years evolutionary processes of nature created biological structures of exalt fullness and multiplicity which offer an inexhaustible source of inspiration for technological shaping.
By means of the method of analogy similar operating systems from nature will be analyzed and their structure will be abstracted in order to uncover the predominant principle.
The principle gained in this way can be turned over in suitable technological solutions by variation and/or combination of structural elements on the basis of the demands, conditions and wishes to be realized. The following procedure is taken as a basis for the method of analogy:

1. fixing the wanted function;
2. finding out of patterns (animals/plants), which fulfil these function
   making use of catalogues of biological structures in order to produce associations;
3. transfering the gained knowledge on the problem to be solved (2, p.20) (fig. 4)

The systematization of biological structures takes place at a model of orientation. Catalogue-sheets containing, besides of the structural representation of biological systems also characteristics of the function, are available for the different basic functions.(fig. 5)

The problem solver has for selection a large number of examples of analogic possibilities of solution by using the catalogues and therefore, he can get various stimulations for the present technological problems.
A technology instruction, which connects nature orientation with operational structures of technological-developing activities and which includes this orientation as content

elements will enable for:

- the formation of analogies between technological and biological systems on the basis of the catagories function, structure, and process,
- the foreseeing by derivation of ecological aims in order to bring technology in accord with nature,
- insights into elementary developing mechanisms and for attitudes in order to shape the world of technology nature-consistently.

By that, the mostly one-sided relation to nature is expanded because it includes biological systems with its connections to the environment as "partner".

4. Guide line "nature orientation as a curriculare element

On the existing principles regarding the content of technological education the guide line "nature orientation" will be shaped in order to get a new quality of the process orientation. The guide line "nature orientation" can be determined by the following indicators:

content line:

- functions of the connection natur - man - technology
- regularities of the biological evolution
- principles of function, of structure, and of organisa tion of biological systems

process line:

- analogies between natural systems, between natural and artificial systems - thinking in analogies-
- netted up functions and structures of biological and technological systems -"netted up thinking"-
- variants and combinations of natural and artificial structures -thinking in variants and combinations-
- selection of artificial system structures -valuation and determination-

On figures 6-10 examples for the modules A, B, and Z are shown:

By the realization of the guide line "nature orientation" the students are trained for a complex and netted up thinking on the basis of a "change into one another" of technology and nature. By that, a contribution is made to a "development thinking" over different subjects.

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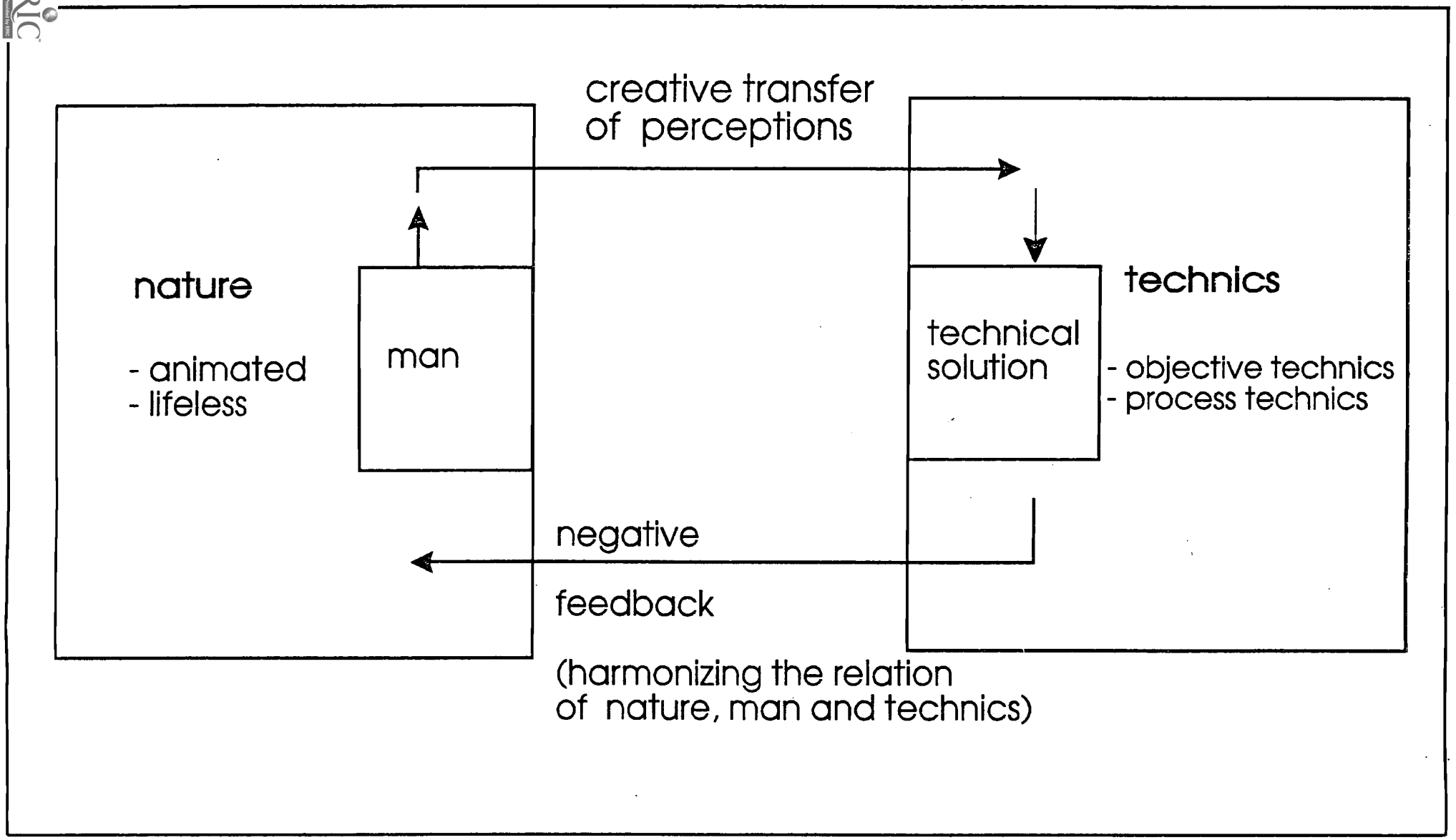


Fig.1 Relations between man, nature and technics

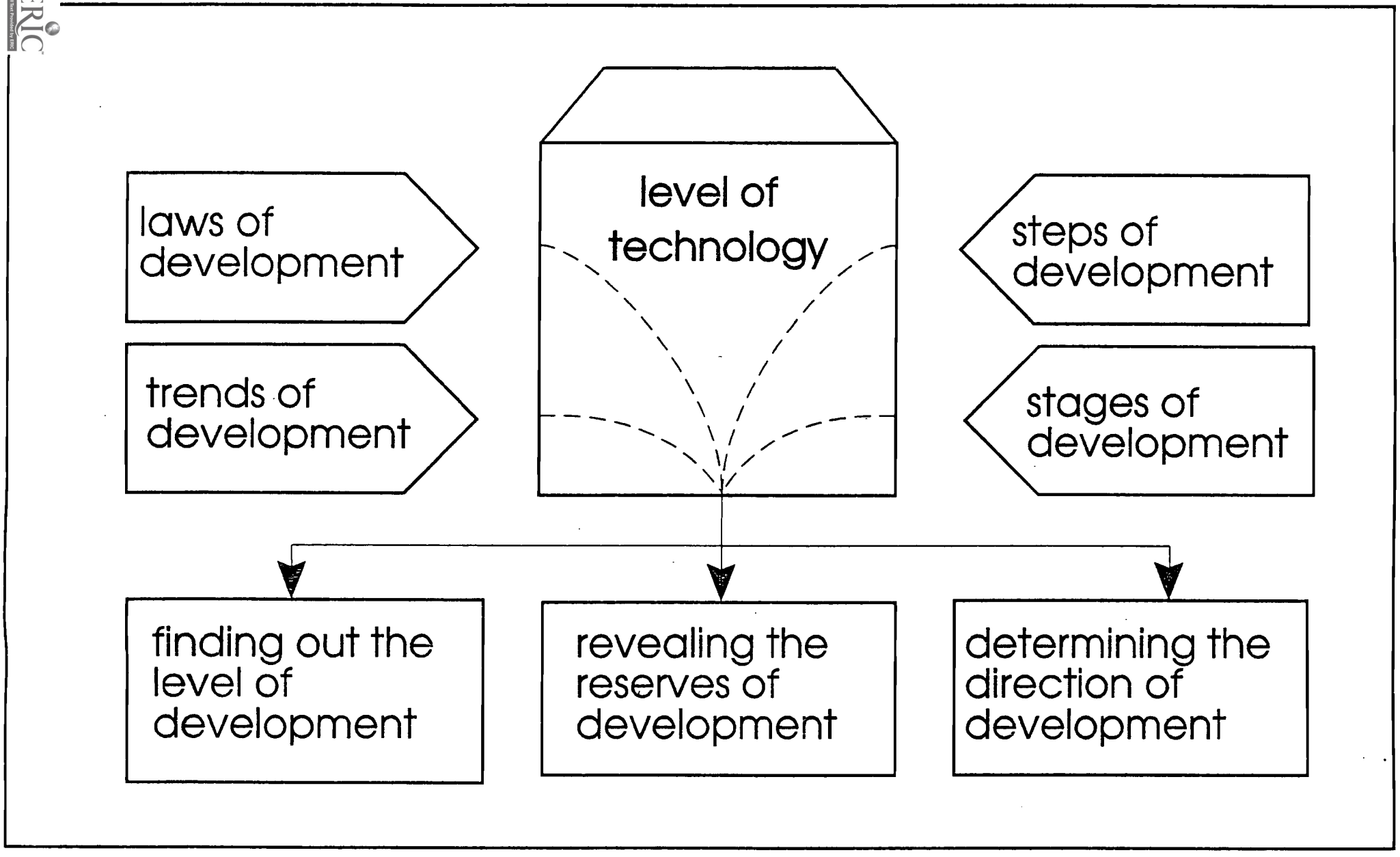


Fig.2 Determination of technological development tasks

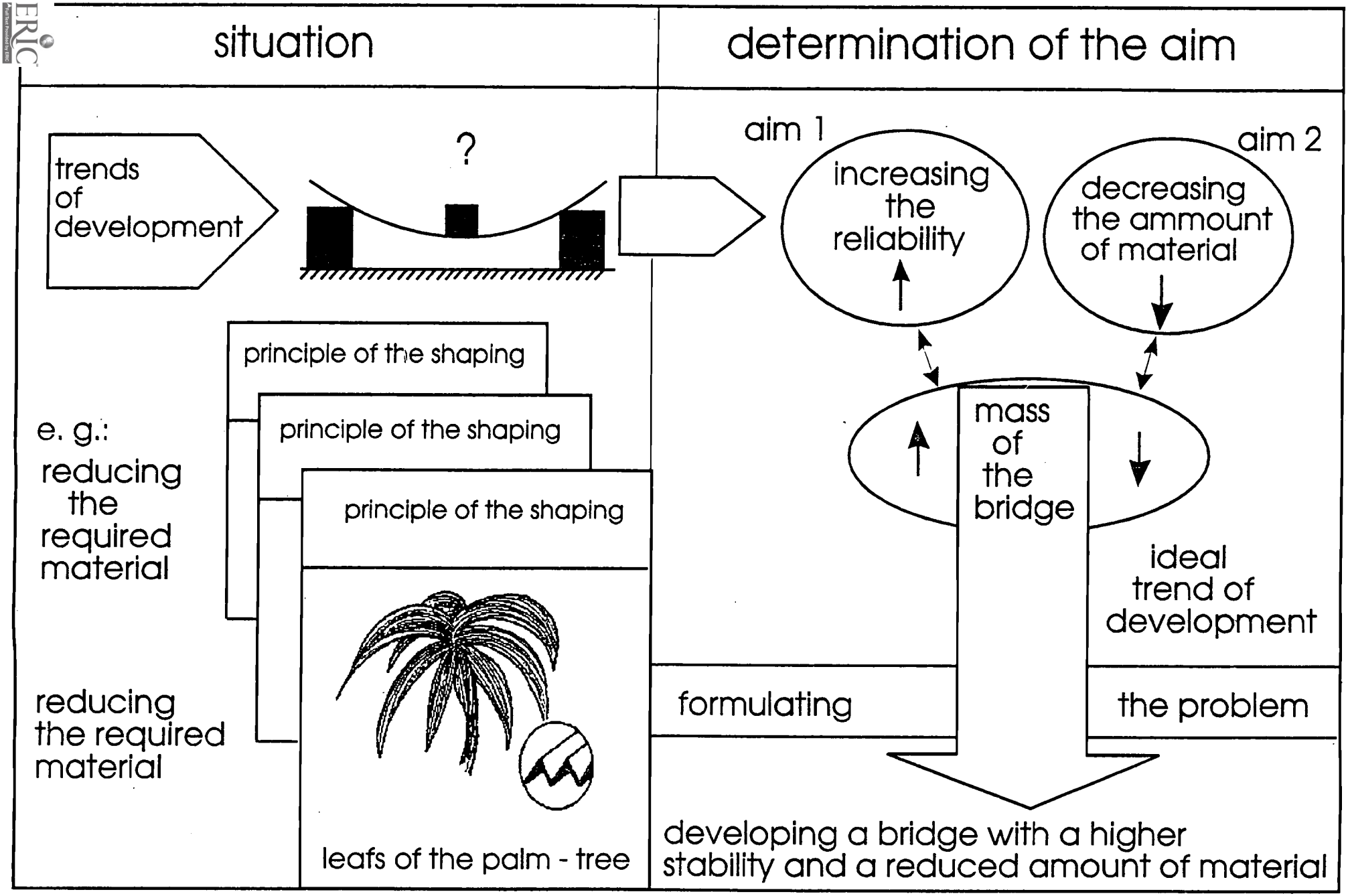
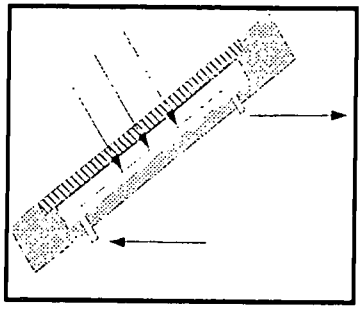


Fig.3 developing a stable bridge by economizing the material

level of technics:
flat collector

determination of the aim

steps of development



- large area is needed
- low capacity of storage

aim 1

increasing the degree of using the area ⇑

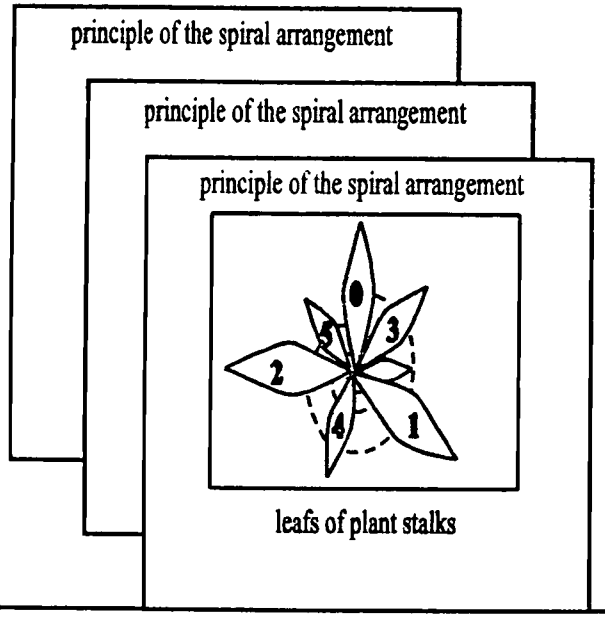
aim 2

increasing the volume of transport ⇑

ideal trend of development

⇓ setting up area ⇑

e.g.:
transition to the step of development:
hierarchical division of the total function on several levels of function



formulating the problem

developing a collector with a high capacity storage and a reduced area

Fig.4 developing of solar collectors with reduced area

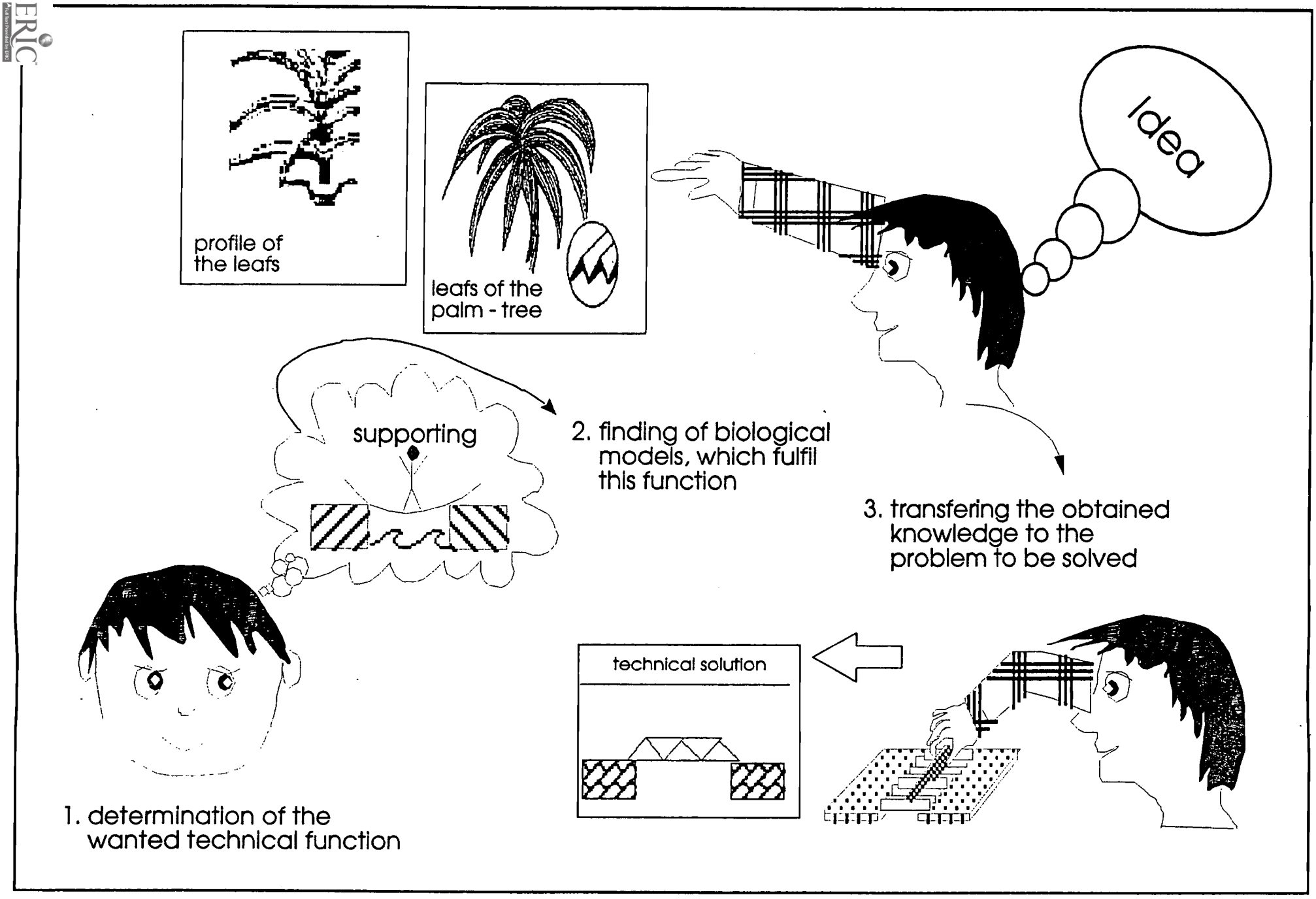
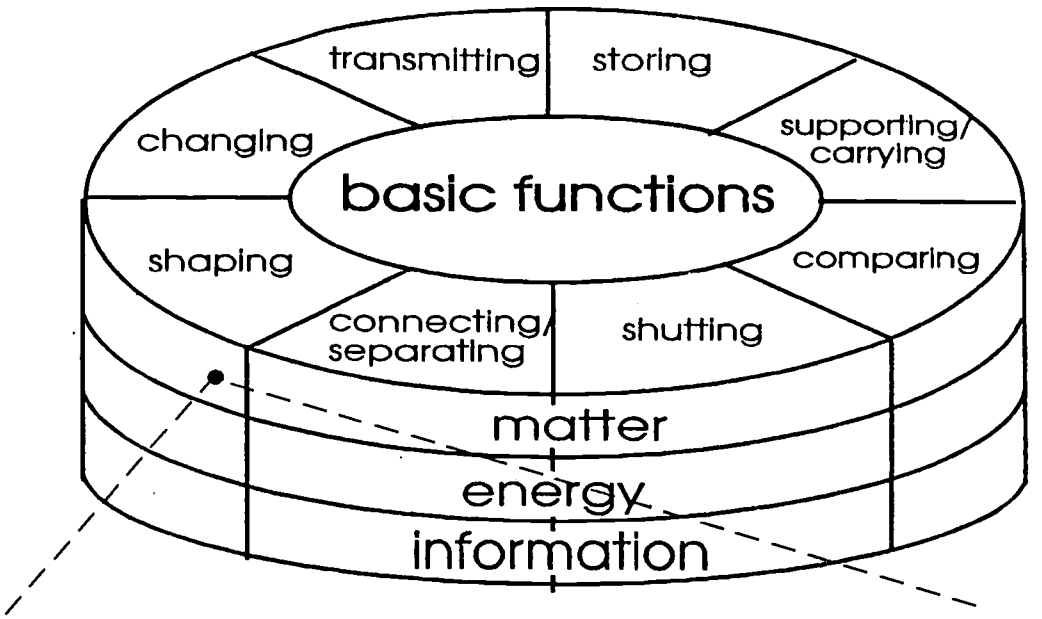


Fig. 5 finding a solution: model of a bridge



catalogue of stucture: shaping of matter

enlarging and diminishing

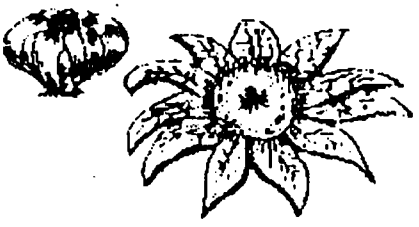
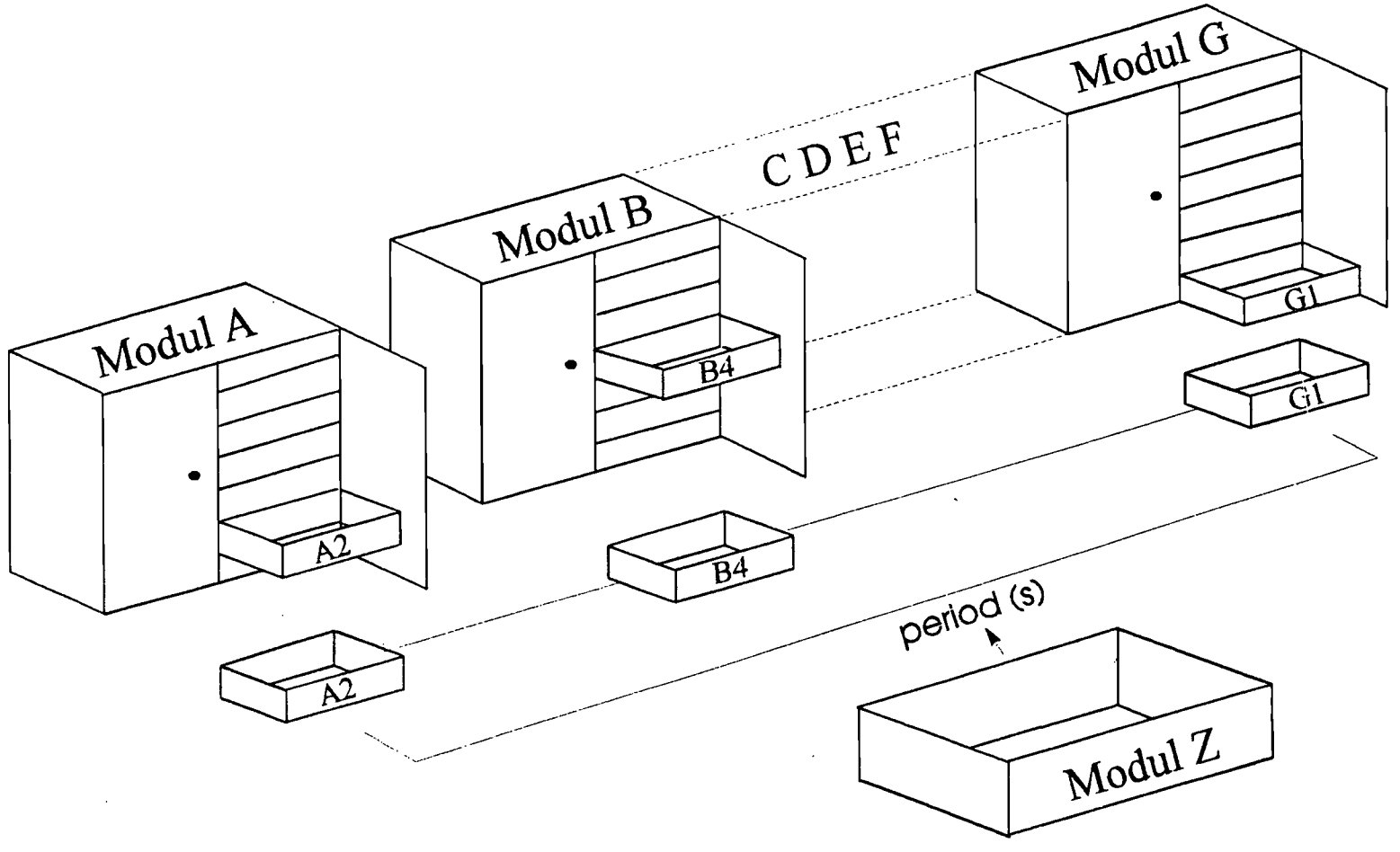
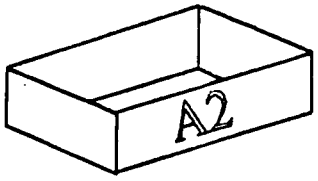
No.	name of object	structure of the object or partial structure of the object	characteristics of funktion
1	leaf of the Alchemilla Vulgaris		scalene alternation of the turgos on the upper and lower surface of a leaf - stalk leads to folding
2	cross - section of the stem of a (pillar) cactus	 water content	changing the volume by absorption or vaporization of water
3	Impatiens nolitangere	 catapult mechanism	The elastic deformed moving tissue is prevented by the resistance tissue from the equalizing of the elastic tension. If the limit is exceedet the turgow falls to pieces by a small explosion, the fruits will be thrown away.
4	geaster hygro-metricus		closing and opening movements

Fig. 6 catalogue of structure



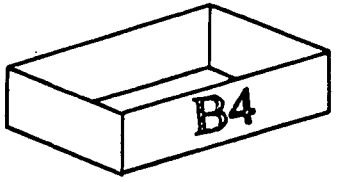
A,B, ... G = subject of instruction
Z = didactical principles for the process - variation

Fig.7 modular concept of a nature - oriented education
forms 1 to 12



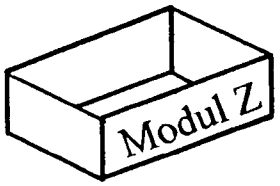
aim	content of learning	
	refered to objekt	refered to methods
The student scan conceive technoloy as a development process • • •	1. To determine the situation of technology and to trace back technology-generations to their origin	table of generations to carry out searching of patents, analysing of literature and consulting of experts
	2. To derive trends from the comparison of the single generations	to get trends → catalogue: megatrends
	3. To gain contradictions of generations	to disclose and to formulate constructions → catalogue: quantities of aim and conduct
	4. To lay down the reasons for the beginning oft the new generation	

Fig. 8 fixing the aim



aims	content of learning	
	refered to objekt	refered to methods
The students are able to shape technological solutions nature-oriented • • •	1. To lay down the functions to be realized technologically 2. To find out biological systems which fulfil these functions 3. To transfer gained knowledge on the problem to be solved	determination of basic functions → analysing analogue objects and abstracting characteristics → catalogue: biological structures varying or combining of characteristics catalogue: varying and combining

Fig.9 finding the solution



Levels of analogy forming

Elementary School : The method of analogy helps us to find solutions for a special problem.

For that, the following questions may be helpful:

level 1

- How is the present or a similar problem solved in nature?
- Which plants and/or animals can give stimulations for solving the problem?

Secondary School I/II: We persue the aim by using the method of analogy to transfer solutions from the fields of technology and nature to technical facts.

level 2

1. fixing the wanted function
2. to find out patterns, which fulfil these functions

   catalogues:differentiating for forms 5 ... 7
   and forms 8,9...12

level 3

3. to transfer the gained knowledge on the problem to be solved.

Fig.10 Levels of analogy forming

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