2.4. Conversion process and non-equilibrium system

2.4.0. Instead of an introduction: The textile factory as an organised unit

Let us now look at the factory as a unit consisting of departments whose purpose was the manufacture of products, i.e. textiles. Thus, the process itself is at the centre of the examination.

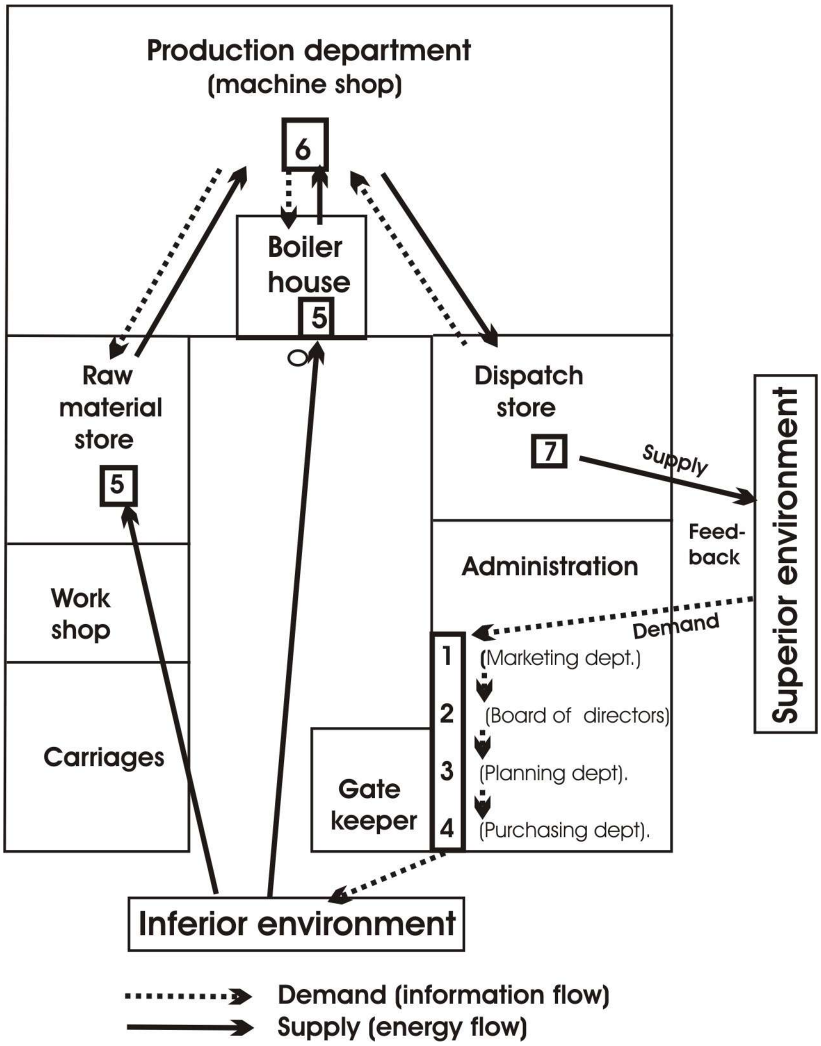

Fig. 64:
Production sequence in textile mill. Diagram.
The principal departments involved directly in the production process are all linked with one another. This is shown by the numbering.

The various departments of the textile mill with its earthbound artefacts were organised in relation to one another in such a way that they allowed the smooth co-ordination of the departments resp. the action projects of the individual workers. The factory was the place of economic activity of a group of workers who carried out tasks with one another, thereby shaping the framework for their own activities. The earthbound artefacts formed the framework by means of which organised work was made possible. On the one hand, the operations are dedicated to the production, and on the other, to maintaining the company itself (in fig. 64 localised e.g. in the department workshop).

The workers communicated with one another on the basis of a division of labour, i.e. different information and materials were altered and joined to form new products (the woven products) which could be sold on the market. Each piece of textil material was the product of many units of information and actions.

A clear, balanced and understandable structure of work and inspection formed the framework necessary for production. Precisely this is the advantage of division of labour - that the action projects and the flow processes in the departments within the factory are perfectly co-ordinated with one another in time. The preceding work and raw materials required for the production are available at any time with the result that there are no difficulties in adaptation, and the various tasks dovetail directly into one another and follow one another without delay. The result is a circular process. Thus, the control of the processes resp. departments is structurally different than self regulation based on feedback (see section 2.3.1.1, pp.77).

The structure of control and inspection requires a hierarchy within the mill. The board of directors, of which the proprietor was the chairman, represented the mill as a unit. The stimulus (information) for the processes was received by the commercial administration from the market (superior environment) in the form of demand. Here, the decisions were taken and planning carried out. The suppliers (as inferior environment) supplied the factory with raw materials, electricity, thermal energy, water etc. The actual physical work took place afterwards, especially in the production department of the mill.

2.4.1. General considerations

2.4.1.1. System and Process

Products and division of labour:

In our treatment of the first, second and third levels of complexity, the compactness of the plant was described as being perhaps its most striking feature. It provided the framework for the structures and processes described. It is now apparent that the reason for this lies in the structure of the processes themselves - in the necessity of keeping the various very different operations as close together as possible to facilitate contact. The processes depend upon a closed system which is organised essentially in rings in which the different operations follow or precede one another. The individuals (in their roles) as the elements engaged in the factory represent the "carriers" of the processes, i.e. they permit the practical implementation of the systemic links and process sequences with the assistance of the media and earthbound artefacts (see section 2.1.1.1, p.18). The concentration of the different departments is contrasted by the wide field in which the factory has built up networks of sale and supply.

This isolation of the production process from the outside world as well as the links maintained by the plant with the surrounding environment have one purpose: the manufacture of a product.

Products can be defined as energy (matter) loaded with information. In this way, the factories intervene between the market (the superior environment providing the information) and the supplier of raw material (the inferior environment providing the energy). As already outlined (see section 2.3.1.1, pp.72), they are parts of compartments, i.e. flow-equilibrium systems, and like these they are located in the flow of information and energy. However, these flows are given specific form by the transformation of energy or raw material into (more or less complicated) products so that they can be passed on to the markets, i.e. to the demanders, in precisely the form required. Put more generally, the material in the form of products becomes precisely "fitted", i.e. qualitatively specified transportable energy (for accuracy of fit, "Paßgenauigkeit", see VOLLMER 1985-86, I, p.59 f.).

As a production company structured on the basis of a division of labour, the textile mill as a structural type was on a level with other industrial companies, farms, medical clinics, food stores, lawyer practices, public offices etc. From an economical point of view, these were companies ("Betriebe") or offices. However, the fact can be emphasised that the companies (or offices) were shaped co-operatively by people, i.e. by a population. Subsystems such as departments may intervene, but not necessarily. These subsystems (in the sense of flow-equilibrium systems) play a kind of mediating role between the whole and individual worker. They have certain well defined tasks for the whole and the individual action projects were concentrated in these accordingly. From the social point of view, we may speak of "organisates". The organisate represents the persisting "non-equilibrium system" which is preserved and modified by the "conversion process". We are at the 4th level of complexity.

It is only possible to explain the organisation and shape of the organisate by taking the internal processes into account. The contacts with their environment require that the chronological rhythm of the processes corresponds to the rhythm of the superior compartment, i.e. the market. This determines the time limits for the production processes.

Due to division of labour, these are firmly linked to one another. As a general rule, the processes are arranged in time and space in such a way that they are particularly effective for the organisate. This means that they were joined up to form an unified process sequence, in which all the departments are integrated. In this way it is possible to fulfil the demand imposed from outside, i.e. by the market. This organisation requires reliability and punctuality on the part of the workers. Internally, the departments are structured like flow equilibrium systems. As part of the organisate however, they must submit to the requirements of the whole, otherwise the division of labour cannot work.

Structure conserving and structure changing processes:

The processes which preserve the structure ("structure conserving processes") are normally operating. This involves an amount of production which assures utilisation of machines with a certain degree of fluctuation. These should be in a state which allows them to provide their normal performance in spite of omnipresent wear and tear. The textile factory employed a number of mechanics whose responsibility this was (work shops, see fig. 64).

The adoption of innovations requires investments. As mentioned above, the textile factory acquired new machines as an investment in the 1950s. This made considerable conversion work necessary in the factory, i.e. a process which altered the factory itself ("structure changing processes").

In every organisate the tendency exists to expand itself or its influence in order to increase its productivity. This takes place primarily to maintain its position on the market as the superior environment with reference to competing organisates. Thus it attempts to minimise the input of energy and material (from the inferior environment) and maximise the output of products (to the superior environment). In this process, organisates also tend to organise themselves in such a way that the flow processes in the departments can be linked together as well as possible. The (spatial) self organisation serves to minimise the consumption of time and energy, i.e. the effective utilisation of the time and energy available to them. The compact shape of the organisate is the result of these tendencies. Because of its integration in the production chain and its drive to secure its own existence, the organisate developes a considerable amount of dynamism.

Process explanation:

It goes without saying that this problem cannot be explained or simulated with the causal method or hermeneutic interpretation (functional method) or even with the traditional methods of system theory and complexity research. On the contrary, a special method is required which focusses on the process sequence itself thereby creating the conditions for simulating the process. It is necessary to take place step by step.

2.4.1.2. The Model

To arrive at an explanation, we must remember that, as with the flow processes (see section 2.3.1.1, pp.75) there are two shaping tendencies which express themselves in process trains. The first process train is founded in the system itself, while the second process train is stimulated from outside, the environments.

1st process train:

To recapitulate:
In dealing with the complexity levels 1-3, we discussed
1) the solida, spatially enclosed forms which appear as a unit. From the point of view of the process theory, it is typical of these that they take physical effect through simple movements which can be explained causally. In our textile mill, the individuals, as employees, transform a definable amount of energy into action motions.
2) The individuals as employees are also carriers of the movement projects. Materially defined tasks are carried out by them systematically in various individual steps, e.g. the weaving of cloth by operating a loom. The individuals are grouped into departments, larger equilibrium systems, in which the sequence of these processes is harmonised chronologically. These are homogeneously structured equilibrium processes.
3) These departments are provided with tasks by the company as their superior environment, and receive material from suppliers in the inferior environment. They are therefore located in the flow of information and energy and strive to meet the demand with their supply. They form a flow process. This applies on the one hand to the individuals who earn their living in this way, but also for the flow equilibrium system of the department whose existence also depends on it achieving

a flow equilibrium. In order to control the flows, the hierarchy of the bonding levels is created internally (see 1st process train: section 2.3.1.1, pp.75).

Action motions of the individuals, equilibrium processes and flow equilibrium processes in the departments now have to be assembled as a non-equilibrium system in the factory. There must be an effective linking of the processes until the necessary contacts are also made between the elements and with the systems of the environment as source of energy. It is obvious that the more the system closes up and the closer the sources are to the system, the more easily this can take place. This is achieved by another process. This process of spatial concentration now has to be defined.

We have already discussed the long-range effect (see section 2.2.1.1, pp.41) which can be described fairly well using Newton's Law of Gravity. Everything which seeks contact with a point of attraction tries to move radially towards it. At the centre, the density of the objects seeking contact (the elements) is very high and declines rapidly as we move outwards and then much more slowly towards the periphery.

First of all, let us assume that the attractive power of the centre is increased by new attractive stimuli being created. This also increases the long-range effect and the space requirement. Small non-equilibrium systems generally have a low degree of attractive force and larger ones a higher degree of attractive force and long-range. To describe this, we assume that new attractive elements are taken into the initial place of a given volume of the non-equilibrium system. The density value increases. If the original density value is to be restored, the system has to be enlarged into the environment.

This happens in the 4 spatial process stages. A suggestion of describing this process mathematically:

- 1st process stage: The elements as spatial units are brought into the system as a whole. Intake of additional units *N* in the given volume *K* of the system. The density increases. The formula for negative exponential increase can be used:

[17] $$N_n = N_{n-1} + \frac{K - N_{n-1}}{k}$$

(*N* = number of elements as spatial units; *n* = number of temporal steps; *k* = constant, ascend factor; *K* = upper limit.

- 2nd process stage: It is necessary to calculate how the increased number ($N_{nz} - N_{n0}$) is transformed into an elevated number of steps $n = (n_z - n_0)$, with which the quantity of elements can be brought into a new space. The formula for a linear development

[18] $$n = \frac{N_{nz} - N_{n0}}{k} \quad \text{(shortly } n = \frac{N}{k}\text{)}$$

(*n* = number of steps; *k* = constant, ascend factor.

- 3rd process stage (adoption by the elements): The raised value of steps is the basis for the diffusion, i.e. the rise of the elements as spatial units into the system. The formula for a positive exponential development

[19] $$N_n = N_{n-1} * k$$

(*N* = number of the diffused elements as spatial units; *n* = temporal steps; *k* = constant, ascend factor).

4th process stage (expansion of the elements): The number of elements has increased. The volume of the system now has to be increased. The density of elements depends on the distance from the centre of the system (see section 2.2.1.1, pp.41). In the immediate vicinity of the centre, the least space is available, and the density is greatest. Further outwards the available space increases, and the density decreases. Proceeding from the centre to the periphery, the exponentially shaped diffusion (with the ascend factor *k*) receives a power growth *a*. This exponent *a* states the (geometrical) dimensionality of the space, into which the system expands.
1st step $N_1 = N_0^{\,a} * k$, 2nd step $N_2 = N_1^{\,a} * k$, etc.

[20] $$N_n = (N_{n-1})^a * k$$
n = temporal steps, *k* = constant, ascend factor.

For a homogeneous surface *a* = 1. For a (geometrically) three-dimensionally shaped space *a* = 2 (according to Newton's Law of Gravity). See also "Notes on the figures", fig. 89.

It is, however, also possible to interpret the formula in such a way that exponent *a* reflects the intensity of the long-range effect from a centre to its surroundings, i.e. the intensity of the readiness to adopt. If the value *a* is smaller, i.e. only a little more than 1, the acceptance is small, the long-range effect is small. If the value *a*, however, is distinctly greater than 1, this means that the centre has a greater effect on its surroundings.

In this way the system concentrates itself, takes on a compact shape and builds up its sphere of influence (its area of long-range effect), through which it interacts with the other systems. It is a spatial influence of a general nature. This process coming from inside, from the system, which shapes the spatial environment, is not strictly controlled outside the system itself, because the elements seeking contact around the centre must themselves decide how close to the centre they wish to be.

Transition from the 1st to the 2nd process train:

In our discussion of the 1st proces train we explained, how the non-equilibrium system and its environment receives spatial order developed from within. In this way all 4 process levels are involved which describe the hierarchic structure of this type of system. In each process level, the system is ordered in accordance with a system dimension. From the top downwards these are:
- 1st process level (space): The system is spatially concentrated. The other processes are subordinate to this.
- 2nd process level (hierarchy): The hierarchy system/elements develops in the flow equilibrium system through creation of the bonding levels.
- 3rd process level (time): Within the process levels, the chronological sequence is regulated (as in the equilibrium system, see section 2.2.1.2, pp.42).
- 4th process level (quantity): This is all dependent on the supply of energy at the lowest process level.

In the 2nd process train however, the influence from outside dominates and enters the system through the interactions with its environments. In our discussion of flow processes (see section 2.3.1.1, pp.75) we saw how the creation of an internal hierarchy (bonding levels) permits the controlled absorption of energy. The system involves a part of the environment (for getting a quantity of energy), and is in turn affected by the environment in form and arrangement.

The spatial concentration which took place in the first process train and gave contours to the non-equilibrium system, now also seems to be essential for time being received from outside, i.e. from the environment, and incorporated into the system. This makes it possible to re-define the chronological order. The chronological sequence was already defined in the equilibrium system (see section 2.2.1.2, p.43), but this concerned only the sequence of stages in the process, not their duration.

Here, a new operation is recognisable:
The hierarchy of the processes in the first process train is turned upside down. The processes and movements are now arranged as follows:
- 1st process level: The "main process" controlling the flow of energy and information (i.e. the quantity) of the non-equilibrium system, with its 4 stages, represents the highest-ranking process. This process guides the flow of energy (into the system or to the demanding superior environment).
- 2nd process level: The time-differentiating "task processes" with their 16 stages are subordinated to it.

- 3rd process level: Subordinate to these, the "control processes" fit the elements into the internal hierarchical structure (64 stages).
- 4th process level: These in turn are shaped in detail by the space-differentiating "elementary processes" (256 stages).

So this transition is related to a reversal of the content of the system-internal hierarchy (which remains in existence as a structure). The entity created in the first process train (from the energy input to spatial concentration and delimitation) is now completed by an inner division, where the system is regarded here as an all-embracing informational and energetic unit to which the elements are subordinate.

In both process trains it is apparent that at every process level, a new characteristic (i.e. a new systemic dimension; see section 2.1.3, pp.33) is added (see fig. 65):
- quantity (of energy or information),
- time (duration, speed),
- hierarchy (bonding density), and
- space (central-peripheral).

The systems develop in accordance with these in the course of the process. In addition, they show in which direction the processes affect the system, how they pass through it and structure it.

Apparently this reversal is an essential factor permitting the system to be linked to the superior or outer process rhythm (see section 2.5.1.1, pp.208).

2nd process train:

As mentioned above, the first level is occupied by the "main process". Subordinate to this in the hierarchy are the "task

	1st Process train		2nd Process train	
1st Process level	Space		Quantity	1st Process level
2nd Process level	Hierarchy	→	Time	2nd Process level
3rd Process level	Time		Hierarchy	3rd Process level
4th Process level	Quantity		Space	4th Process level

Fig. 65:
Transition from 1st to 2nd process train. Hierarchy of process levels. Re-arrangement of the succession in which the system dimensions are treated. This operation is characterised by a reversal of the content of the system-internal hierarchy (which itself remains in existence as a structure).

processes" (2nd level). To ensure the process can reach the elements, all 4 bonding levels which distinguish this type of system (as well as the flow equilibrium systems; see section 2.3.1.1, pp.75) have to be passed through, i.e. the system horizon (with 2 bonding levels) and the element horizon (also with 2 bonding levels). These are the "control processes".

They in turn are supplied by the "elementary processes" (4th level).

Main process:

At the 1st bonding level, the flow of information and energy is ordered because the thematically differentiated process sequence is forced into a chronological framework. This "main process" takes place in the form of oscillations in contact with the superior environment e.g. the market (see section 2.3.1.1, pp.78).

For a system based on the division of labour (i.e. a non-equilibrium system), the time structure is decisive. The flow of information according to the demand and the flow of energy for the supply take place after one another. The conversion of information and energy (from raw material to the finished product) takes time, and when the required product has arrived on the market in the required quantity, the demand may have changed. The oscillations determine the time budget and the internal sequence of procedures in time. They have to arrange the information and energy flow (from and into the environment, into and from the system), i.e. the sequence of the processes in the whole system. We will consider the process first from the point of view of demand development (it can also be treated from the point of view of supply development).

The main process can be presented in a system of coordinates. 4 "main process stages" (or in abbreviated form: "main stages") can be distinguished (see fig. 66):

- "Adoption": The demand from the market as the superior environment is represented in the y-positive half of the coordinate system [f(x)-quadrant]. At the beginning, the demand is taken upon the system and therefore increases. The energy is demanded from the inferior environment. [In the organisate, the demand for a certain quantity of a certain product is received from the superior environment, i.e. the market, and processed in the system. Adoption stimulates the processes within the company.]

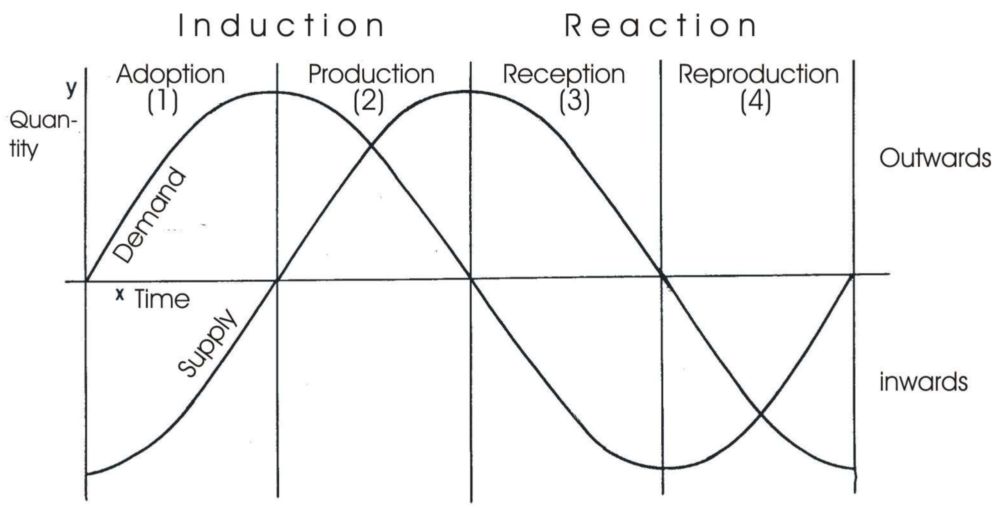

Fig. 66:
The main stages (adoption, production, reception, and reproduction) in the interaction of demand and supply.
Both stimulate each other mutually, oscillations occur which impose their rhythm on the internal process sequence. In this way, the non-equilibrium system receives its periodic division. See also fig. 45, p.90

- "Production": The supply curve is shown in the y-positive half [f(-x) quadrant]. The production for the market increases, while the demand decreases to the same extent. The demand and supply curves intersect one another. [The production of the organisate itself takes place in accordance with the information specified, but also on the basis of the energy etc. contributed by the inferior environment (e.g. its suppliers). This main stage includes processing of the raw materials up to the supply to the market.]

As already mentioned (see section 2.4.1.1, p.122), not only the market has to be supplied with energy (in the form of products). The system itself must also receive energy, otherwise it will decay. So we can distinguish between the "induction process" which satisfies the requirements of the market, and the "reaction process" which affects the system itself, i.e. the system adapts itself to the new conditions.

In the induction process, energy is transformed into products for the market. This is the y-positive part of the oscillation curve in the main process. In the course of the process, it may become apparent, that a change in the system structure is necessary. In the reaction process, the structural adaptation takes place, through self-organisation. This is the y-negative part of the oscillation curve in the main process. The system changes the number of its elements and arranges the elements in a way which is most favourable for the next induction process. Here, too, information precedes energy flow, i.e. it must first be established what has to be renewed before the renewal process can begin:

- "Reception": The demand curve leads into the y-negative zone [-f(-x) quadrant], stimulates the system to adapt itself. The supply curve begins to decline. This reflects the same development as for adoption but with a reversed situation. [An organisate must undergo a continuous process of renewal in accordance with the requirements of the market and for the purpose of saving energy. This is registered first of all as information, and planned accordingly.]

- "Reproduction": The demand curve moves within the y-negative zone towards the x-axis again. By contrast, the supply curve declines into the y-negative zone [f(-x) quadrant], i.e. the system itself is supplied with energy and is changed. The elements are increased in number with the result that this stage is comparable to that of production. [In the organisate, this is expressed in the actual maintenance and investment tasks - depending on the circumstances of the market and its own possibilities and intentions.]

Task processes:

In each of the main stages Adoption and Production (induction process) a number of tasks have to be carried out and for each of these tasks a particular stage is available. The "task

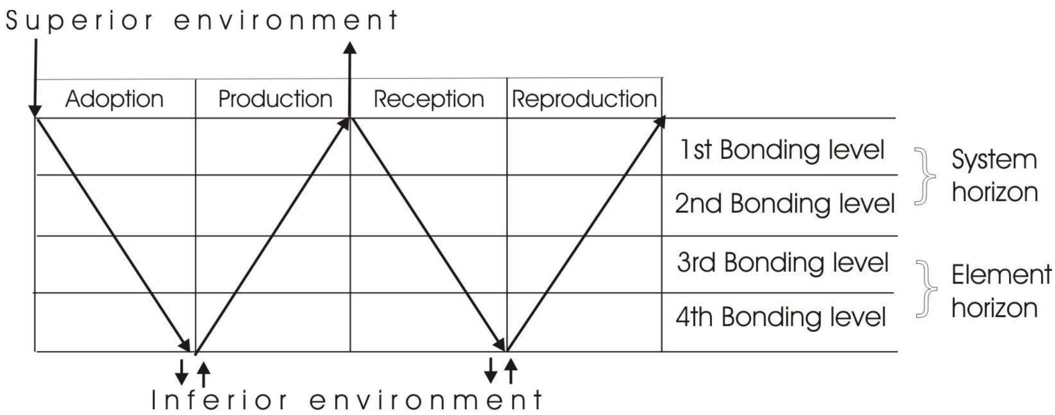

Fig. 67:
The course of the 4 main process stages through the 4 bonding levels.

process stages" (or "task stages" for short) are located at the 2nd process level. Here, subordinate to the main processes, the processes are ordered according to the time sequence specified by oscillation.

Like the flow equilibrium system, the non-equilibrium system is structured vertically by bonding levels. At the task stages, the process crosses the bonding levels, thereby joining the superior with the inferior environment, i.e. the energy-demanding environment (market) with the energy-supplying market (suppliers etc.). Both in the induction and in the reaction process, the flow of information (demand) leads downwards (adoption, reception) and the flow of energy (supply) upwards (production, reproduction). The elements are involved in the process in the various ways in which they are integrated in the system (see fig. 67). Structurally, the bonding levels are (subordinate) flow equilibrium systems, i.e. the information and energy are diffused horizontally in them (see section 2.3.1.1, pp.75, and 2.3.1.2, p.93).

Let us take the induction process first:
In the adoption process the stimulation, i.e. the demand for certain products, has to be incorporated into the structure of the system. I.e. the process leads down the bonding levels

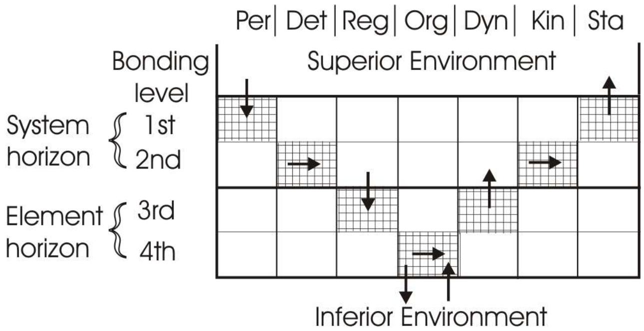

Fig. 68:
The course of the process sequence (induction process) in the system horizon and the element horizon of a non-equilibrium system (see also fig. 67).
Vertical arrows: Flow processes (demand or information resp. supply or energy flow), horizontal arrows: Changing and coupling processes.
At the perception stage, the flow of information (demand for products) is received from the superior environment and then processed at the stages of determination, regulation, organisation, and passed to the inferior environment, the energy resource: "adoption". From here, the flow of energy again leads up to the superior environment. At the stages of organisation, dynamisation and kinetisation, the energy is processed to the demanded products: "production". The supply to the demanding superior environment (market) takes place at the stabilisation stage.
Per = perception, Det = determination, Reg = regulation, Org = organisation, Dyn = dynamisation, Kin = kinetisation, Sta = stabilisation.

from the system to the element horizon. The higher the demand, the stronger the stimulus for the process as a whole. Thus, the perceived information has to be transformed and distributed according to the process structure of the system, in a similar way to the energy itself later, during the production stage. Seen vertically, the flow of energy is opposed to the flow of information (see fig. 68).

The formulae describing the task and control stages were already presented in the discussion of flow equilibrium systems (see section 2.3.1.2, pp.81). Here, in association with the remaining processes, the task stages are described by functionals which dictate the types of calculation. Let us attempt to describe these processes at a more general level using the example of the textile mill and its departments (see fig. 64).

"Perception" (1st bonding level): In this task stage, the demand from the superior environment is entered into the system, inasmuch as the size (according to the constellation of elements), permits. The system "perceives". The performance of the system demanded by the superior environment must be transformed into the system according to its size. All elements have to be considered. The greater the demand, the greater the stimulus. In this way, the extent to which the system would be stimulated is reflected. This is described by logarithmic functions. Carrier in the factory: The marketing department.

"Determination" (2nd bonding level): The system, however, cannot be stimulated at will. How much stimulation strength the elements (as the potential adopters) can still accept is determined in this task stage. Here it is evaluated and decided whether the stimulus to production should be accepted, and if so, to what extent (depending on the capacity of the company). The value of the stimulation strength must be reduced, as some elements are already stimulated. The system determines the extent of the accepted stimulation. The result is a reduced value. This is described by rational functions. Carrier in the factory: The board of directors.

"Regulation" (3rd bonding level): At this task stage the stimulation strength of the system has to "regulate" the internal distribution of the limited stimulation among the number of elements. An attempt is made to achieve an internal flow equilibrium between the stimulation which is supplied from the system horizon, and the stimulation which is demanded from the elements. The elements become definite adopters, i.e. the demand for action is accepted by the elements step by step. This is described by exponential functions. Carriers in the factory: the planning department, middle management, employees' representatives.

"Organisation" (as a part of the adoption main stage; 4th bonding level): The demand for energy is communicated to the inferior environment. The question arises as to the amount by which the factory increases or reduces its production compared to previously. This means that the proportion of the elements as a whole represented by the involved adopters is determined. This is described by probabilistic functions. Carrier in the factory: the purchasing department.

The transition from the main stage of adoption to the following main stage of production now takes place. As already discerned in fig. 66 (p.129), the upward slope of the demand curve terminates while the supply curve changes to the y-positive zone. In the production stage, the work is carried out according to the adopted information.

"Organisation" (as part of the production main stage; 4th bonding level): The systems in the inferior environment now produce the raw material or energy demanded by the system. The number of adopters which become producers depends on how much energy can be received from the inferior environment. The transition from adopters to producers can therefore only be defined with a certain degree of probability. This is described by probabilistic functions. Carriers in the factory: the purchasing department and stores administration.

"Dynamisation" (3rd bonding level): In the meantime, the systems of the inferior environment has provided the energy for production and supplies it to the system. Here, they are distributed to the workers (or work groups) and the action projects. In this way the system is "dynamised". This in turn is described by exponential functions (as for "regulation", see above). Carriers in the factory: the raw material store, coal bunker etc.

"Kinetisation" (2nd bonding level): The different individual energies or materials are combined to form new products. This is the actual production. Rational functions describe this (as with "determination", see above). Carrier in the factory: the production department (machine shop, boiler house).

"Stabilisation" (1st bonding level): The products are offered to the (demanding) superior environment. (This is described by logarithmic functions.) This decides whether the products (and the system) can maintain their position (feedback). In this way, the system is "stabilised". At the same time, a new induction process can begin (perception). Carriers in the factory: the sales (marketing) department and dispatch store.

Thus, through feedback, it is determined whether the supply corresponds to the demand. In the course of the process the demand may change (see section 2.3.1.1, fig. 39, p.78) with the result that oscillations occur. A cyclic process is described, i.e. a chronologically coordinated process with its start and finish in contact with the superior environment (see fig. 69). The control is more complete than with the flow process because not only entry and exit are controlled, but also the individual stages.

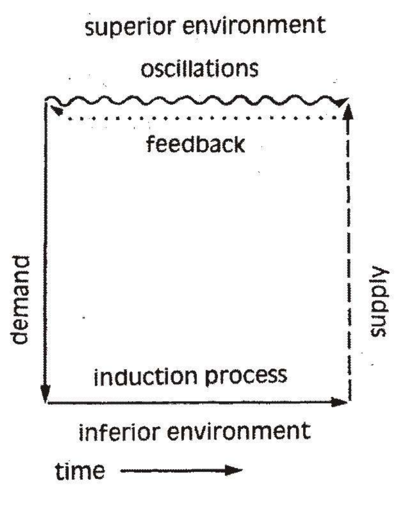

Fig. 69:

Circular process and Feedback in the non-equilibrium system. Inductionprocess.
The induction process commences with the receipt of the demand and ends with the supply to the market (superior environment). The feedback takes place through comparison of the supply with the demand.

Control processes:

In detail the control is carried out by the control processes. For the organisate, this means that the task in the next stage can only be undertaken when the requirements in the inferior bonding levels have been fulfilled, until when each element has been involved. Here the bonding levels do not appear as flow equilibrium systems as they do above in the task processes, but in their structure within the non-equilibrium system. The relationship of the whole to the elements is controlled here.

The process consists (depending on the succession of bonding levels) of 4 stages:

- 1st bonding level: the stimulus is entered from the superior environment. Here, the system may be regarded as a more or less undifferentiated quantity of elements. The limits of the system have no effect on the organisation of the internal process.
- 2nd bonding level: the stimulus is taken up by the system which is defined by its limited number of elements. This affects the course of the process.
- 3rd bonding level: system horizon and element horizon form a flow equilibrium. Both relate to one another.
- 4th bonding level: through its elements, the system comes into contact with the inferior environment in order to receive energy. The system as a whole and all the elements are now affected by the stimulus.

Thus, the elements are bound progressively more tightly ("control process stages" or "control stages" for short). These 4 levels must be gone through, and the values are transferred in each case. Besides this, in every control stage, the values from the same stage in the previous task stage are taken in.

In the discussion of the flow-equilibrium system (section 2.3.1.2, pp.81), we explained that the task processes cross the bonding levels between the superior and inferior environment and are thereby ordered. Here, in the second process train in the non-equilibrium system, the bonding levels are in turn ordered by the task processes. At the task stages, the individual control processes lead alternately downwards (order) and upwards (obedience)(see fig. 70).

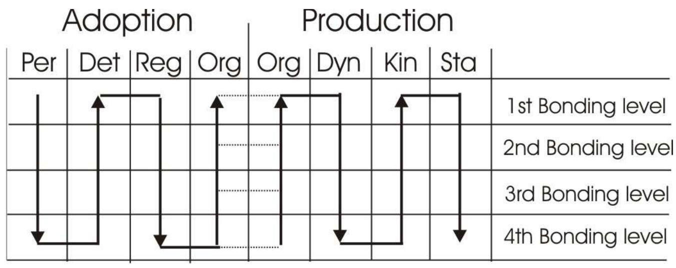

Fig. 70:
The course of the control processes at the individual task stages. The bonding levels are passed through at each stage of the task process, i.e. system and elements are connected. In the diagram, the control processes are indicated by arrows, and the links by horizontal strokes. See also fig. 77, p.144.
Abbreviations: Per = perception, Det = determination, Reg = regulation, Org = organisation, Dyn = dynamisation, Kin = kinetisation, Sta = stabilisation

In this way, a transition between task processes becomes possible. At the corner stages of perception, organisation and stabilisation of the main process stages (adoption, production, reception, reproduction) the control processes proceed parallel to one another with the result that here too, the transmission of data during the process is facilitated. Precise control of the course of the processes in all main and task stages becomes possible.

Elementary processes:

In addition to this, the question of space requirement also has to be solved at each bonding level. When dealing with the first train of processes in the non-equilibrium system (see above), we saw that the system as a whole is compact in form and affects its environment spatially (long-range effect). There now follows a similar process in the second train of processes at the 4th bonding level. Non-equilibrium systems require space not only externally, but also internally for their processes. These spaces are structured radially (between centre and periphery). The "elementary processes" order the system according to thematic and structural considerations in line with the task and control-process stages. The space requirement therefore has to be fixed for each of the 16 stages of the control process (divided up according to task) in the adoption stage. A spatial value is assigned to each of the resulting values in the different control stages. In this way, the various control stages of the conversion process receive their contours. [This also applies to the other main stages].

The mathematical formulae are given in the section dealing with the first process train (see above, p.125, and fig. 77, p.144).

Reaction process:

"Adoption" and "production" belong (as mentioned already) to the "main process" which includes a total of 4 stages. Adoption and production serve the market ("induction process"). If the market is satisfied, the company is adapted to the new situation on the basis of experience and according to feedback at the stabilisation stage. This is as the second half of the main process the "reaction process". To adoption and production are added "reception" and "reproduction". It leads to another process line (see below, twin processes).

The oscillations around the abscissa described above have an effect on the direction of the process. The fact that the induction process is located above and the reaction process below the abscissa, indicates that the induction process stimulates the production whereas in the reaction process, activities regulate the optimising of the system itself. This is where the actual "self organisation", typical of non-equilibrium systems, takes place. The system "learns".

However, the sequence of tasks from perception to stabilisation remains the same (see fig. 71). The sequence developed for the induction process assumes that (1) the information has to be processed before (2) realisation can take place. To that extent, reproduction follows on reception. However, in these main process stages the task stages too are arranged in this sequence. Stimulation by the preceding process takes place here and first has to be introduced into the system as a whole (perception) while later, energy is procured from the inferior environment for the reconstruction of the system (organisation).

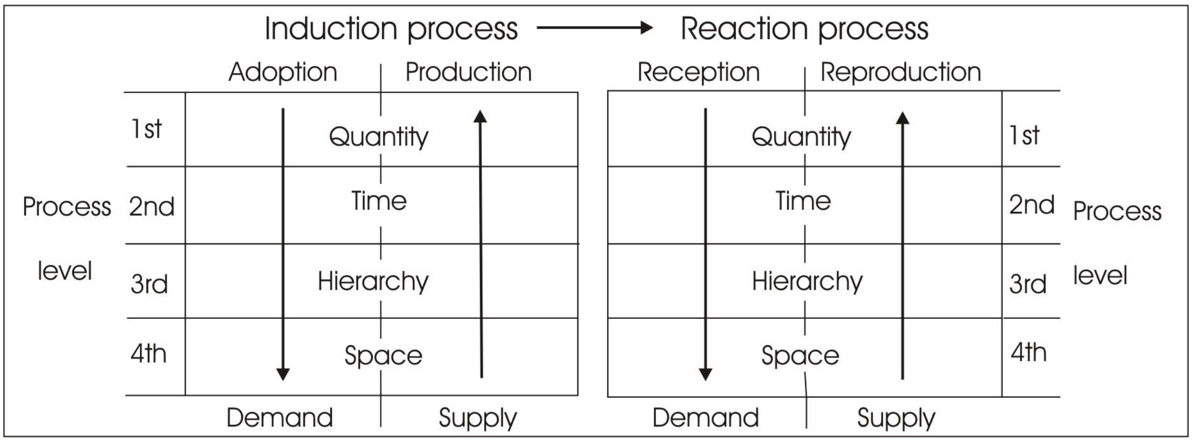

Fig. 71:
Course of the processes between the process levels at the induction and reaction process

Taking the example of the organisate:
The structure and size of the organisate required for the activities of the organisate are dealt with in the main process (1^{st} process level). At the 2^{nd} and 3^{rd} process levels, the chronological sequence (task process) and vertical hierarchy (control process, bonding levels) are ordered. The

process leads from task process stage to task process stage. Subordinate to the control process stages the space is arranged (4th process level). The process stages join up with one another in the same way as in the induction process (see above). The result is:
Reception:
- Perception: input of stimulus from the preceding induction process into the system;
- Determination: decision whether the stimulus should be accepted, and if so, to what extent (system);
- Regulation: distribution (ramification) of the information to the elements;
- Organisation (as part of the reception main process): arranging the structure for receiving energy;
Reproduction:
- Organisation (as part of the reproduction main process): reception of energy from the inferior environment;
- Dynamisation: distribution of energy to the elements;
- Kinetisation: execution of the structuring and shaping of the system (i.e. investment);
- Stabilisation: the new system structure is offered to the following induction process.

Course of the processes:

Process sequence as an entirety:

Let us now look at the process sequence in general:
Main process (containing both the induction and the reaction process), task, control and elementary processes consist of 4 stages each. Each stage of the superior processes contains one subordinate process which itself consists of 4 stages (see fig. 72). The number of processes and stages therefore increases exponentially from the 1st to the 4th process level, i.e. (4+16+64+256=) 340 process stages altogether (but only 20 different formulae; see sections 2.3.1.2 and above).

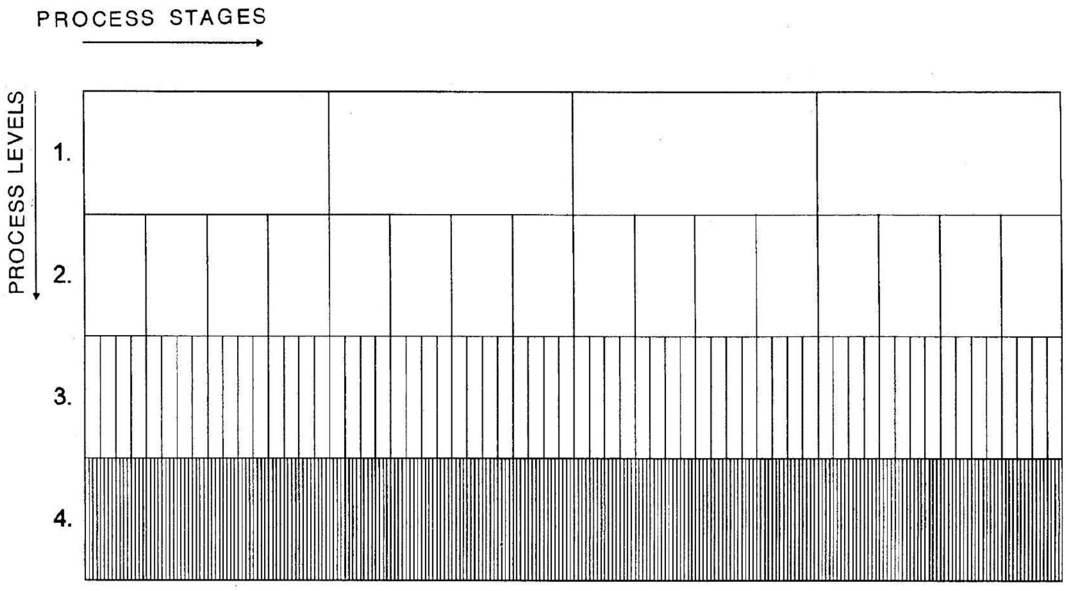

Fig. 72:
Hierarchy of the processes in the overall non-equilibrium system.
It is apparent that the process sequence is divided into 4 process levels, where the inferior processes in each case, each with four stages, are assigned to one stage of the superior process. Thus, the entire process sequence includes 4 + 16 + 64 + 256 = 340 stages.

Here, all the process stages have to be assigned codes to avoid confusion. The position of the processes can be defined in a table by means of letter combinations (see fig. 73). The different 4 stages or partial processes receive the letters S, T, U, and V. The 4 process levels are indicated by the number of these letters. Thus, 1 letter indicates the 1st process level (main process), 2 letters the 2nd process level (task process), 3 letters the 3rd process level (control process), and 4 letters the 4th process level (elementary process).

Now the formulae should be assigned to the stages. To this end, it is advisable to use a numerical code (see fig. 74). The formulae describing the four stages of the basic processes are each arranged in reverse order (1-2-3-4, 4-3-2-1; see below and section 2.4.3, pp.197). Otherwise, the arrangement of the stages corresponds to that which was compiled on the basis of the letter codes (see fig. 73). For example, the elementary process stage SSVS is identical with stage 1.1.4.4.

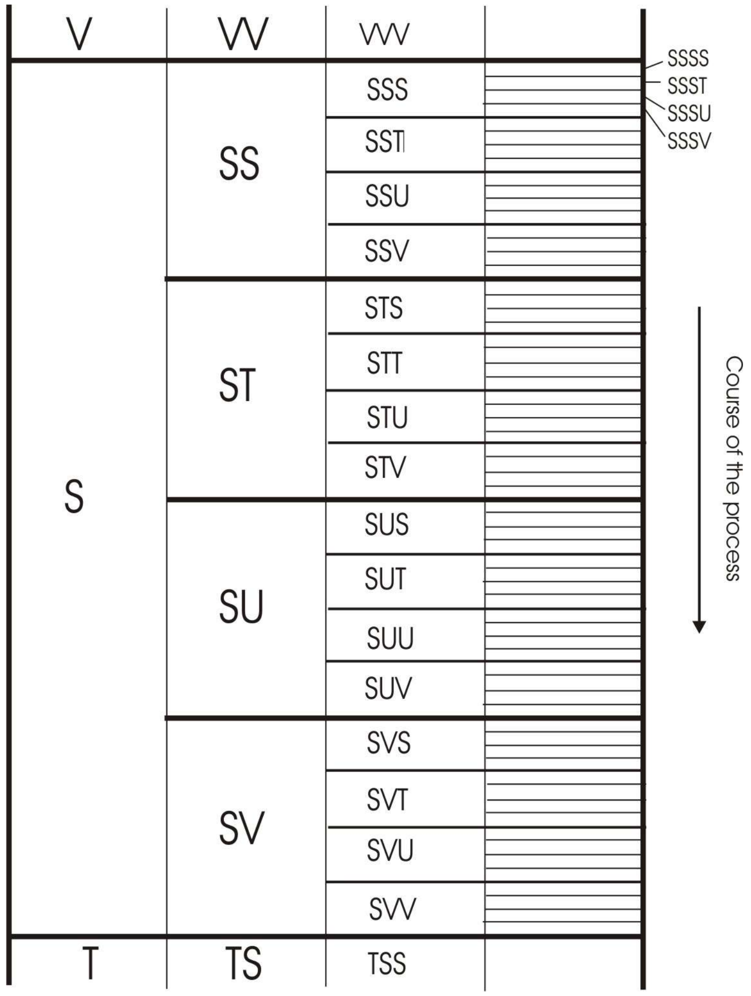

Fig. 73:
Hierarchy of the processes in the non-equilibrium system at the main stage of "adoption". *Shown on the basis of the letter codes.*

Adoption is followed by production (see above, p.129). If the order of the task-process stages in the adoption stage is 1-2-3-4, the task-process stages in the production stage are the other way around 4-3-2-1. Thus, at the fourth task-process stage (organisation), the probabilistic functions come into contact with one another and unite, with the result that there are only 7 instead of 8 task stages.

The transition from the reception to the reproduction stage in the reaction process is similar. Here, the stimulus is passed on at the 4th bonding level. Thus, instead of 8 there are only 7 stages at the second process level in the reaction process.

The corner stages also overlap at the transition from the induction to the reaction process, thereby resulting in 13 instead of 14 stages.

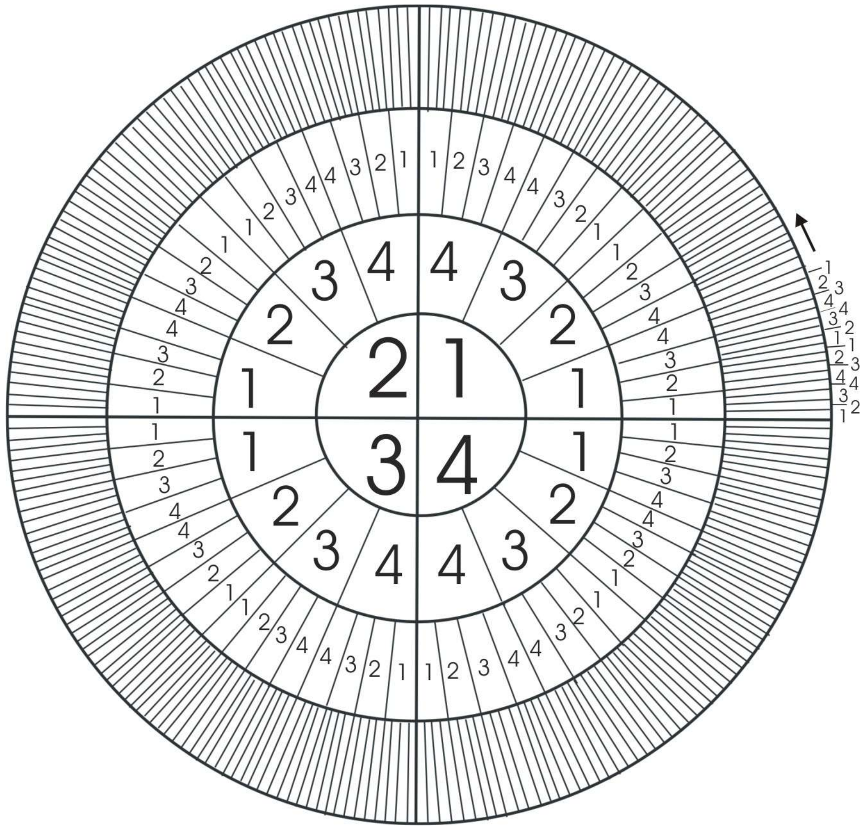

Fig. 74:
Hierarchy of the processes in the non-equilibrium system.
Shown on the basis of the numerical codes.
The main process is placed on the inside. Moving outwards, the task, control and elementary process follow. The process is aligned to the left (in anti-clockwise direction). The numerical codes (e.g. 1.1.4.4) allow identification of the appropriate functions (see text).

Structure of the process course: demand-supply-relation and twin processes:

The process sequence is not continuous. It has two interior borderlines which make it nearly indeterminable:
1) Between demand and supply at the transitions between adoption and production and between reception and reproduction:
Until now we have concentrated mainly on the demand process without giving much attention to the corresponding supply process. In the induction process, as shown, the system is stimulated via the demand process from the superior environment while it receives energy from the inferior environment through the supply process and then supplies it as a product to the superior environment. In the reaction process, the demand process stimulates the system to change itself. The supply process provides the energy necessary for this so that the system can complete the change. The relation between the two corresponds to the Lotka-Volterra equations (see formula 15, section 2.3.1.2, p.90). The supply process is in social systems delayed by about one quarter of an oscillation period in relation to the demand process and does

not start until the demand process has passed through the adoption stage and is entering the production stage. I.e. the adoption stage of the supply process is simultaneous with the production stage of the demand process. Or more precisely: at the organisation stage of the demand process, the demand for energy is introduced into the supply process. This represents a stimulus in the supply process at the perception stage. This applies both for the induction and the reaction process, both of which take fundamentally the same course i.e. have the same sequence of task processes. At the reception stage of the demand process, the demand for change in the system is passed to the system itself. At the reception stage of the supply process, the system absorbs this stimulus while the change

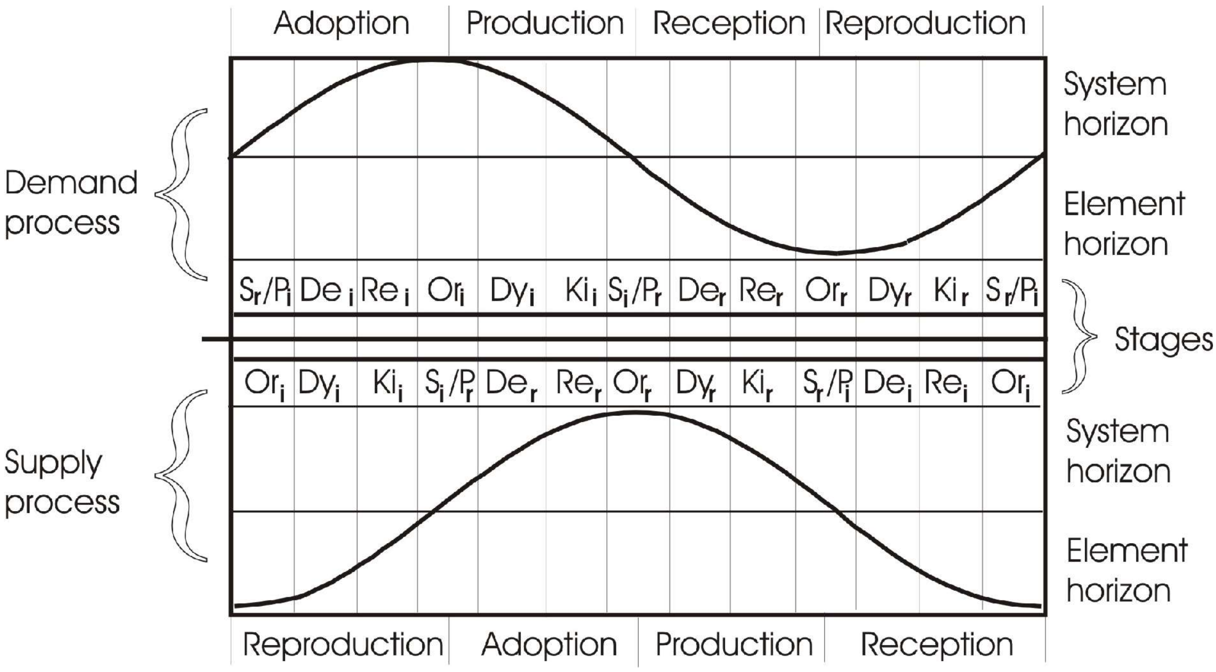

Fig. 75:
The supply curve follows the demand curve with a certain delay. See also fig. 66, p.129.
P = Perception, De = Determination, Re = Regulation, Or = Organisation, Dy = Dynamisation, Ki = Kinetisation, S = Stabilisation. i = Induction process, r = Reaction process.

itself takes place at the reproduction stages of the demand or supply process (see fig. 75). First of all the system as a whole (demand) changes and then the elements (supply) follow, which at the same time are systems of the lower environment (see section 2.5.1.2, p.217).

2) Between the induction and reaction processes, i.e. between market orientation and self organisation:
Empirical research shows that induction process follows induction process and reaction process reaction process. Examples of this are provided by phases of colonisation and the diffusion of innovations (see sections 2.3.2.2, pp.103, and 2.6.1.2, pp.255). This is a problem inasmuch as the

induction process follows the reaction process. This can only mean that two processes A and B, shifted chronologically by half an oscillation phase, proceed parallel to one another (see fig. 76). Wave A reaches its climax when Wave B is at its

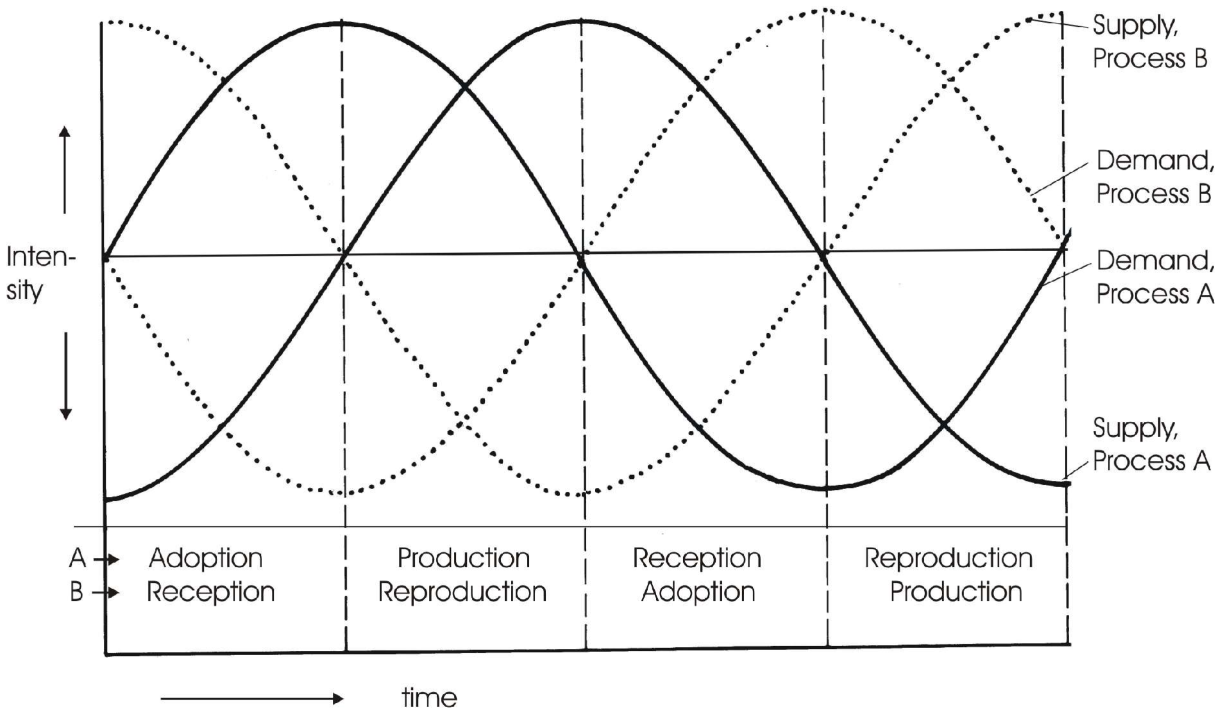

Fig. 76:
Course of the demand and supply curves of the twin processes (A and B) which follow one another chronologically offset by half a process length. See also fig. 66, p.129.
The induction processes are shown above the centre line, the reaction processes below it.

lower point. Plainly, two process strands connected by demand and supply are interacting with one another with the result that, at the same time as the induction process in the oscillation of one process strand, the reaction process can take place in the oscillation of another. This means that time is put to double use. Perhaps this is the key to the regulation of the chronological rhythm. The process strands are grouped together through the spatial limitation of the non-equilibrium system (1st process train, see above), with the result that self organisation (reaction) becomes possible as well as market orientation (induction).

Are we dealing with a stationary wave? It seems that the impulse of the second wave (B) of the twin process is contrary to the first (A). With regard to content (i.e. the sequence of stages, perception ... stabilisation), the reaction process (second wave, B) clearly leads in the same direction as the induction process (first wave, A) (see above, reaction process). Thus, perhaps not only (in the course of the reaction process) the system structure is stabilised by the second process train, but also the chronological sequence of the process in the system itself.

We describe these parallel and interacting processes as "twin processes". Let us look more closely at the twin processes. In the textile factory, the repair (reaction process) of the damage from the preceding production phase (induction process) are carried out. While this work is taking place, the production (i.e. the next induction process) continues. (In addition to its production facilities, every larger company has to maintain workshops to carry out repairs of this kind). Seen geometrically, the corresponding process halves (induction and reaction process) of the two twin processes are interwoven with one another in the manner of a plait, with the result that an induction process can follow an induction process and a reaction process a reaction process. With regard to content however, the reaction process remains connected with the induction process which precedes and causes it. It's tasks are carried out simultaneously with the next induction process.

In reality, there is no clear-cut transition between the individual process halves (induction or reaction process). This smoothness is reflected in the probability transitions (see above). This gives rise to a certain degree of vagueness. The two twin processes A and B for their part are still divided into demand and supply processes. Through them, as described above (see section 2.3.1.1, pp.78) the (superior and inferior) environments are involved and oscillations released (according to the Lotka-Volterra equations).

The result is a 4-strand process:
1) Demand process in twin process A
2) Supply process in twin process A
3) Demand process in twin process B
4) Supply process in twin process B.

There is a transition between twin A and twin B which depends on the result of the feedback at the end of the induction and reaction processes (see above). Since the induction and reaction processes begin and end at the same time, a transfer of information and energy is possible at the perception or stabilisation stages. This makes coordination possible.
In this way, a rather confusing co-existence of individual processes and intertwining at system and element level is produced. One example of an extremely complex twin process is cultural evolution (see section 2.4.2.1, pp.147).

In detail the sequence of the process is shown in fig. 77.

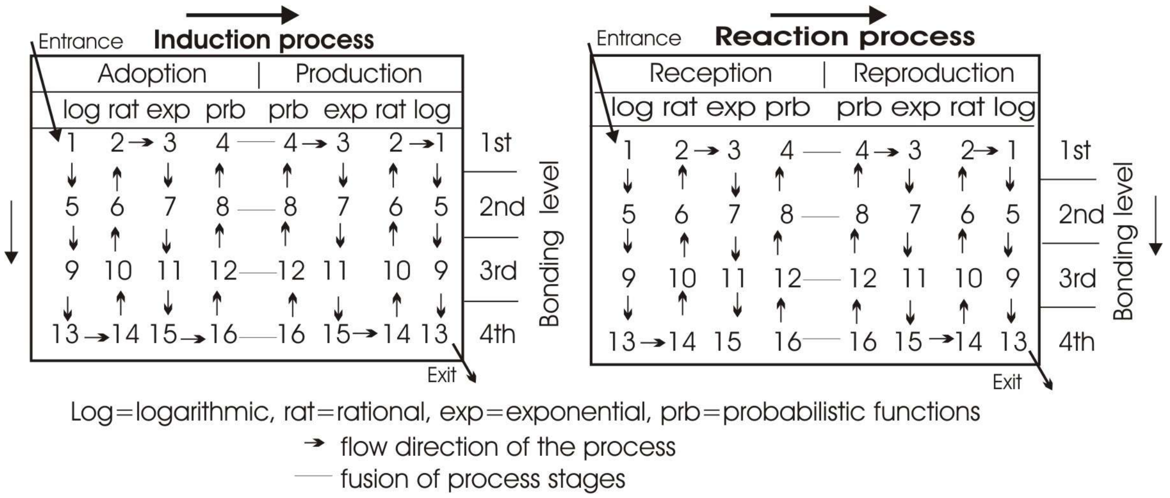

Fig. 77:
The course of the processes in the induction and reaction process. The figures reflect the numbers of the formulae (see section 2.3.1.2, pp.81).

The following now becomes apparent:
1. At the level of the main processes: in principle, the induction and reaction processes have the same course. The adoption and production process as well as the reception and reproduction process oscillate vertically opposed to one another.
2. The task processes proceed horizontally from left to right.
3. The vertically oriented control processes keep the task processes supplied. These also run in opposite directions.
The elementary processes are not shown here as this would overcrowd the diagram.

For guidance:

Mankind as a society consists of many different populations which appear structurally as non-equilibrium systems. This type of system is composed heterogeneously and is distinguished by its division of labour, i.e. various processes are coupled together thereby creating a product. It is demanded by the superior environment (e.g. the market) and is produced in the induction process. The inferior environment (e.g. the suppliers) supply the required energy (raw materials etc.). In the following reaction process, the system organises itself according to the requirements.

Two process trains should be distinguished:
1) The system is shaped spatially as a whole from within.
2) The system receives energy from outside, is chronologically determined from outside. Four hierarchic process levels should be distinguished:
a) The main processes organise the flow of information and energy (induction process: adoption and production; reaction process: reception and reproduction).

b) The task processes divide the process according to subject (adoption or reception: perception - determination - regulation - organisation; production or reproduction: organisation - dynamisation - kinetisation - stabilisation).
c) The control processes organise the flows in the hierarchy system/elements internally.
d) The elementary processes organise the space requirement internally.

The course of the process can be traced back to
1) the contrast between demand (from the superior environment) and supply (from the inferior environment). Here, the rhythm of the processes is also dictated by oscillations.
2) the contrast between induction process and reaction process (twin processes). Both oscillate against one another and each consist of a demand-supply "oscillation pair". Thus, four individual oscillations should be distinguished which are woven around one another in the form of a braid.

2.4.2. Other examples

2.4.2.0. Instead of an introduction: Conversion process and non-equilibrium system as seen by an artist

Processes which are based on the division of labour are not often seen in art. This is doubtless due to the difficulty involved in such a project.

Fig. 78:
Raoul Dufy, The Orchestra.
Example of a conversion process based on the division of labour.
Source: See "Notes on the figures".

In 1942, Raoul Dufy executed a series of pictures showing the work of a Paris orchestra with whose conductor he was acquainted. His aim was to represent the interplay while emphasising the peculiarity of the individual instruments. He wrote that different colours can be attributed to the instruments - oboes, flutes, violins etc. - depending on their role in the orchestra as a whole, and that geometric patterns have certain associations for him (KLANG der Bilder 1985, S.

254/5; MALEREI 1986, S. 196). According to him, every moving body leaves a coloured image on the retina whereas the corresponding outlines rapidly disappear again. Water colours offered him the most suitable medium to convey this. His representation shows on the one hand the movement of the musicians when playing, and on the other their interplay under the conductor (see fig. 78).

Seen economically, the orchestra is a good example of a highly disciplined jointly executed conversion process based on the division of labour. Notes are converted to music and the symphony is the product.

2.4.2.1. Example of a complex conversion process: The cultural evolution in Europe since 1800

About the method of the investigation:

There is little point in scrutinising the structure of a highly complex process by means of a cross-sectional analysis as it can convey only a very rough impression (see section 1, Introduction). We will therefore attempt to gain an insight into the structure by taking the processes as our starting point.

First of all, a few remarks on methodology:
The subject we have chosen for examination is the cultural evolution in Europe since 1800. For European society, the French Revolution opened the way into a new age. The ancient structures of absolutism were broken down, the outmoded social stratification disappeared and new hierarchies came into being. This development led us towards the industrial society. Economic structures altered radically and production in industry and mining increased along with the population. The network of settlements became more closely knit creating the large conurbations of modern times. Traffic was directed into new paths. New forms of human co-existence developed, clearing the way for an intellectual liberation. New vistas opened up in art and science.

This period in time has been examined exhaustively with idiographic objectives. However, we are less concerned with presenting a wide spectrum of facts and processes emphasising the special nature of Europe as a cultural area and the evolution of culture during this period. Instead, the following reflections are intended to throw light upon the changes in human society as a complex structure.

The first question which arises is how to obtain a differentiated picture of the course of this process. Cultural evolution consists of a large number of individual processes which affect one another mutually. They also have quite different durations, beginning and ending in different times which means that the division of the overall process into periods can only be very vague. In my view, it is necessary to start from the detail, i.e. from individual clearly defined processes. Of course it is impossible to analyse all the processes involved, but only those which may serve as indicators. The selection is based on the extent to which they represent and embody the material, structural and spatial position of man as an agent in his environment.

We will now look at those processes which permit conclusions with regard to social and cultural change itself. This means that we are attempting to view the population from inside; it is not the productive side of the process which is of principal interests. This would be equivalent to the induction process. Instead, we are dealing here with the reaction process. The productive side of the cultural evolution will be discussed in a different context (see section 2.5.1.1, pp.208, and 2.5.2.2, pp.233).

The question is this: How does man see himself in society, in his world, how does he adjust to it and come to terms with it? We will then discuss whether any common features exist behind the observable phenomena, e.g. structural features which have changed in the course of development and have decisively affected the overall process of cultural evolution.

1. First of all let us take art, and in particular that of painting. On the one hand, the painter exists as subject and on the other, the real or intellectual environment as object. Perhaps the artist attempts to reproduce a landscape or catch the character and thought of a person in a portrait. He may depict his own relationship to his chosen subject and reveal feelings or illusions with the content of the picture serving as a vehicle for these. His view of his environment and space is reflected indirectly in his choice of subject and its artistic interpretation. The artist is incorporated intellectually in his society. In many cases he may foresee certain developments and attempt to draw attention to them.

2. Philosophy concerns itself directly with the position of man in his world as seen from differing angles. The fundamental science is metaphysics, which enquires what is "behind nature", conveys a certain view of the world. Ontology on the other hand analyses being and reality and the possibility of recognising these. Philosophical anthropology sees man in his position in the development of nature and the process by which culture comes into being. Over the course of time, philosophy has given many different answers and has shown itself to be an acute observer of social development and human thought and action. In the theory of perception and science common ground exists between philosophy and the natural sciences. Methods and concepts are developed in which space, time and matter play an important part. In our essay we will refer to the natural sciences only inasmuch as they are of importance to questions on hand.

3. In this context, geography is also of importance. It deals with the earth, its physical phenomena and social structures, analyses and comments on changes in society. It covers a wide material spectrum while maintaining close contact with related sciences such as regional geology, meteorology, ecology, sociology, economic and cultural sciences. Geography has always seen itself as the "science of space" - space being given a number of interpretations. It is precisely this aspect which is of importance for the position of mankind in his universe. This is particularly true of human geography, where one of the central objects of research is the man's relationship to the natural environment on one hand and to society and culture on the other.

Perhaps these different disciplines are most suitable for covering a spectrum which may be regarded as representative with reference to our enquiry mankind-universe. In the following these indicators will be used as a basis for elaborating the development of the European cultural population against the background of the complex structure of society. There are 4 stages recognizable:
1st the material stage,
2nd the functional stage,
3rd the systemic stage, and
4th the process stage (evolving).

The material stage:

Painting in the Romantic period:

Around the year 1800, a fundamental shift in perspective took place in the visual arts, especially in Germany. Until then, there was a certain distance in the artist's relation to his subject. It was the things, persons and landscapes whose essence he tried to grasp, it was the moments whose importance he sought to preserve. The Romantic Movement brought a more dynamic view of the world. A shift in emphasis took place and the artist brought himself into the process. The subjects of the paintings remained material, they were accurately painted and easily understandable to the observer. The paintings were correctly constructed and their overall conception remained within the conventional framework. But now the artist presumed to make a general statement of his own, to show feelings and pursue certain intentions. Painting became a reflection of personal feeling and sensitivity (WARNKE 1988, pp. 35), while retaining an awareness of individual responsibility dedicated to higher purposes.

The objects in the paintings were subjected to this. They were selected in accordance with the purpose in mind, and occasionally altered when it suited this purpose. Material elements such as people, trees, mountains etc. could be removed or added to the subject being painted. In this way the artist became able to convey such things as, for example, religious feeling (Friedrich), happiness and warmth within the family (Richter), identification with the history of a people and its legends (Schwind), beauty and drama in the landscape (Constable, Turner), ironic criticism of petty bourgeois habits and attitudes (Spitzweg) or appeal to national emotions (e.g. Delacroix). Symbols became more important. Thus, new creative possibilities and fields of experience came to be explored and developed (GEISMEIER 1984, p. 10).

The artist also became more emancipated socially and economically. Where previously he had been a tradesman or servant or employee of the powerful, he now became a free

Fig. 79:
Caspar David Friedrich: Morning. Example of a romantic painting.
Source: See "Notes on the figures".

agent who was able to liberate himself from dependence and convention, but also had to forego the relative social security which these offered.

Example (forest painting 1): Caspar David FRIEDRICH: Morning (see fig. 79):

Friedrich's romantic landscapes which are so full of symbolic and allegorical meaning are intended to express wistful sensations of transience and eternity. Everything they contain is unutterable longing (BOCOLA 1997, p. 98). Friedrich painted this picture around 1820. The subject is apparently taken directly from nature, the contours of the mountain in the

background, the shore, the poles in the water all indicate that the composition is not contrived. It is interesting that Friedrich did not name the painting by the subject. He was more interested in the message, in speaking to the observer through the beauty of the scene and the religious awe stimulated by it. The scene is divided into three levels:
- First there is the shore of the lake with the fisherman which reminds of the day-to-day toil of human existence. The house symbolises security and warmth.
- The second level: Morning mist lies over the scene. The fisher is unable to see upwards or far into the distance.
- The third level: Spruce trees loom above and behind, dominating this part of the painting. The oversized forest towering above the man symbolises the Christian view of life (BÖRSCH-SUPAN 1973/80, fig. 24).

Philosophy:

Intellectual change began to take place almost simultaneously, and made itself felt most strongly in the fields of philosophy and natural science.

Metaphysical concepts: Kant's idealistic view of the world was put more and more into perspective. The Schlegel brothers developed a program which gave the new artistic and scientific impulses a philosophical framework. The guiding principles of thought were no longer harmony and universal reason. It was now subjective feeling and thinking which formed the starting point in the search for the divine which eclipses all reality. The emphasis was no longer on being, but on striving.

In this way, the individual also became involved. In the process of perception, the "human" attained much greater importance. Reason and consciousness obtained the status of the "objective" an idea which became fundamental to the development of science – knowledge as accumulated perception (CASSIRER 1922-57/94, III, p. 256/257).

An even more radical step was taken by Schopenhauer. He shared the opinion of Kant that reality, the universe in itself is only available to us as appearance, that it only exists in man's imagination. He wrote that everything which is available to perception, i.e. the entire universe, is only object in relation to subject ..., a conception of the conceiver, or, in a word, imagination ("Vorstellung"; SCHOPENHAUER 1818/o.J., vol. 1 p. 33). The human body can, on the one hand, be experienced through imagination, through the chain of cause and effect with other objects of our conception, but also through the act of will which comes from man himself i.e. from the subject.

According to Schopenhauer, the intellect (and with it, access to space, time and causality) proves to be subordinate to the will, i.e. serves the will. The will is primarily an undirected existential drive, the will to live and to act. It is unconscious and everything is controlled by it. Thus, subject and object relate to one another. An objective being is unconceivable without the subject and vice versa. The continuing process of perception of the universe is also the continuing process of liberation from the universe. Schopenhauer expresses in words the forces which inspired the artists and drove science onward to new progress.

Schopenhauer's thought also had a significant political influence. His philosophy formed an important prerequisite to the social and philosophical reflections of MARX (1867/1962-64) who analysed conditions in capitalistic society and demanded their change. Society is not a more or less static entity, but is subject to change which is stimulated by conflict (manifested in the struggle between the social classes) between the old and the new, the outmoded and the progressive. Marx saw the existing social conditions (the being) and the perception to change them (consciousness) as being in a dialectical relationship to one another.

Positivism and scientific theory: The opposition between observer (i.e. subject) and object forms an essential precondition for science which is free of preconceptions. This is the fundamental distinction between the scientist on the one hand and the philosopher and artist on the other. However, he can involve himself to the extent that he not only describes what research has learned, but also explains it. This requires consideration with regard to method. A fundamental role in the development of method in the empirical sciences was played by Comte and Mill, who founded positivism. The fundamental principle of positivism is that each sentence which is not strictly limited to a simple statement of fact, can have no real understandable meaning (CASSIRER 1922-57/94, IV, p. 15).

According to Comte (and Newton) time and space are infinite, which means that our knowledge can never be complete. Thus man is central. All research must proceed from him. Humanism is the aim of science.

Mill proposed a general doctrine of scientific method in which he separated the natural sciences from the humanities. He thought of developing the method in such a way that it could also be applied in sociology and politics. Inductive research should be founded on accurate analysis and the results should be capable of generalisation. MILL placed the historical sciences in the same category as the natural sciences.

WINDELBAND (1894, pp. 10) and RICKERT (1902, p. 226) also separated the natural from the humanities. However, they believed that the historical sciences were part of the humanities, for which hermeneutic "understanding" was the appropriate method. With the natural sciences however, it was causal explanation. Moreover, they regarded the humanities as being idiographically oriented, as relating to the special and the individual. The natural sciences however were nomothetic, i.e. directed towards the general and the regular. However, they were also of the opinion that natural-scientific questions could be treated in the humane sciences, and historical in the natural sciences.

The preoccupation with the relationship between man and the universe gave science a strong impulse. From now on, theoretical and empirical enquiries complemented one another and presupposed one another. The emphasis was on classification, the exact designation and explanation of forms and phenomena. Attention was focussed on the environment as an object. The different method of explanation and the growing awareness of the details of reality enforced specialisation and the division of science into a number of single disciplines.

Geography:

In the early stages of its development, geography had to find its own way. It took little part in the economic and cultural development of society, but regarded itself as a pure science whose purpose was to examine the earth scientifically. But first of all, it had to define the subject matter and the method more closely. "Form" was seen as being the most important unit of the terrestrial environment accessible to analysis (see section 2.1.1.1, p.17).

On the one hand it was possible to represent the forms in their spatial association, thereby allowing the identification of regions of a specific shape. On the other hand, the forms could be described as types and examined with regard to their origin. Accordingly, geography made a distinction between an idiographic and a nomothetic branch, i.e. between regional and general geography.

Regional geography: Regional geography saw it as its task to define and classify the various material phenomena of a terrestrial area (i.e. the forms or aggregates of forms) and present these in the unique spatial co-existence to the reader. Presentations of this kind were also required outside scientific geography. There was an enormous requirement for information about the "wide world". However, there was also an interest in one's own country. In the period following the end of the Napoleonic Wars, patriotism and nationalism grew in importance in Europe. People wanted to know about their own states.

The terrestrial area (which was regarded as 3-dimensional) was defined by its material content. The forms made up spatial aggregates or regions. However, the borders of these regions were generally less distinct because the forms of different kinds (e.g. surface forms, settlements, industrial plants) may be differently distributed. It was the task of the geographers to decide how to classify the different aggregates of forms and which criteria to choose for their division and demarcation. This was the work of the researcher.

The decisions were based on an understanding or the hermeneutic method (see section 2.2.1.1, p.38). However, at this early stage in the development of geographical science around 1900 they could not be treated very precisely as it was still not known that only knowledge of the structure permits a more exact statement regarding regional formation. Thus, the works of regional geography at that time were mainly compilatory in character (v. RICHTHOFEN 1903), i.e. they summed up the knowledge available at the time.

General geography: The actual research was to be found principally in general geography. It was divided into 2 large areas according to their area of interest, i.e. physical and human geography. These in turn could be divided into their fields of research which examined such things as the forms of the earth's surface (geomorphology) or climate (climatology), or patterns of settlement and economy (settlement and economic geography). They had a mutual influence on one another, formed "geofactors" (SÖLCH 1924). There was a desire to understand the effects of the "forces" themselves as well as the interrelationship and its significance for the formation of the settlements, countries or regions. The choice of words makes plain that the forms in each case were subject to causal explanation (BUNGE 1929/87; see also section 2.1.1.1, pp.17).

Human geography: In human geography (which we will look at more closely here) the central subject was the relationship between mankind and his terrestrial environment. The activities of mankind are recognisable in his works, settlements, economic forms, traffic courses, defensive structures etc. and open to causal explanation (see section 2.1.1.1, pp.17). They were described as definable anthropogenic forms and interpreted as effects, men being the cause, or more precisely, "anthropogenic forces". The form of causal explanation assumes that the same phenomena have the same causes. Those forces were regarded as causes which seemed to be most likely taking into account phenomena of a comparable nature. This permitted a scientific discussion, since with the increase in knowledge more progress was possible in identifying causes. And this in turn encouraged research. In this way theories could be tested and if necessary replaced by new ones.

One problem in this approach was represented by man himself, who cannot be interpreted as a force alone. But in view of his wide distribution, demographic peculiarities, religious, cultural, political and economic activities it was impossible to ignore him. That meant that he too became the object of scientific curiosity on the part of geographers wherever this was possible in view of the material available at the time.

Indeed, it was possible to see the relationship between mankind and the terrestrial environment from the point of view of mankind itself. RATZEL (1882-1891) had already assigned this question a central importance to mankind. He associated it with "soil" and emphasised the causal relationship. Space was living space ("Lebensraum") and the state was depicted as an "organism" (1897, pp.5). Ratzel did not yet have the opportunity of comparing the peoples as political units with all their differences. The statistical data was not yet available. His reflections therefore had to be deterministic in nature. That did not however mean monocausal (OVERBECK 1957, pp. 174). Ratzel was interested in the conditions without which peoples and states would be unthinkable, i.e. without 'location', 'space' or 'border' including the physical features of their areas of habitation and influence (THOMALE 1972, pp. 24).

For VIDAL DE LA BLACHE (1911), it was not space with its material content which reflected mankind and his culture (as Ratzel thought), but the other way round. Man adapts to the conditions of the soil, climate etc. but he shapes his mode of living ("genre de vie") himself. Thus, Vidal de la Blache points in a new direction. According to him, man has a certain freedom of decision ("possibilism"). However, one difficulty facing Vidal de la Blache was the fact that he based his theory on simply structured groups only (e.g. nomads). Highly differentiated industrial societies (which were already in existence) are closely bound up with one another spatially, practice division of labour and for this reason alone are less dependent on the properties of the soil than less differentiated groups.

It therefore appears that the causal method can produce results for simple relationships, but not when differentiated human geographical conditions are under consideration.

The functional stage:

Impressionist painting:

In the second half of the 19th century, a new artistic movement made its appearance in France associated with names like Monet, Degas, Renoir, Manet, Pissaro etc. (GOMBRICH 1950/96, pp. 519; BOCOLA 1997, pp. 123). Even more than in the Romantic Movement, objects were removed from their own intrinsic meaning. The artist took his easel and went out of doors to record his own personal impressions directly on canvas. This appears in the pictures. Although he reproduced the objects and persons correctly from the point of view of perspective and structure, but he no longer represented them in their actual context of meaning. Thus, their contours are often indistinct and the objects seem to blend into the background. Their coloured surfaces are reduced to dots, strokes and dabs and appear almost to be dematerialised. Through this technique, the artist was able to include imaginary things not seen directly by the human eye. In this way, the viewer receives the impression of the air between himself and the subject, of heat and light. The colours seem to be altered by the sunlight and the fall of shadow, i.e. the intervening space is also painted, so to speak, and the contours remain only as a framework holding the picture together.

In this way the painter "filtered out" what he saw or wanted to see. Everything else was of secondary importance or ignored completely. Thus, the balance of the interaction between the artist and his subject shifted more in favour of the artist than it had been in the Romantic period. The Impressionists took a phenomenological approach (see below): the visible world is depicted as a purely visual one and in a phenomenality whose intrinsic meaning is not recognised (IMDAHL 1981, p. 12). The subject is freed from the previous knowledge of the observer, thereby acquiring a different meaning. In this way, it is easier to convey moods and values to him: the feeling wellbeing when viewing the landscape, the exhilaration of the colours, the warmth of the sunbeams, identification with the person portrayed, the elegance of the

Fig. 80:
Max Slevogt: Forest landscape near Neukastel. Example of impressionistic painting.
Source: See "Notes on the figures".

company, the joy of dancing or enthusiasm for national sentiments.

Example (forest painting 2): Max SLEVOGT: Forest landscape near Neukastel (see fig. 80).
In 1921, Slevogt painted the landscape close to his home in the Weinstrasse area in the German Pfalz. It sketchy in appearance, offers a fleeting impression of the forest and of the cheerful mood of the painter at work. It is not only the trees which are depicted, but the sensation, the communication between the artist and his subject, the scene of the autumn in sunshine. The trees and branches lend the painting its compositional framework. The foreground appears restless, but the distance conveys tranquility.

Philosophy:

Phenomenological and ontological schemes: The phenomenological method already used intuitively by the Impressionists, did not receive its scientific justification until the end of the 19th century. HUSSERL (1913 etc./1985-86) called for philosophy to present itself as a strict science with logical structures of perception and consciousness. He was concerned with a knowledge of things free of all preconception. The subjective examiner no longer approaches an object as a material phenomenon (as he does in the first stage) whose cause he wishes to explain.

In the review of essence ("Wesensschau") or the idetic reduction ("eidetische Reduktion") a method is described by which things can be defined by their sense content or their essence. Each individual lives in a special world and is only able to see the phenomena within his special world. In this limited environment, the horizon is restricted and, accordingly, the ability to judge and to act. Consciousness is intentional. The individual enquires about the meaning of phenomena. For example, a house appears different from different angles, but the observer knows that it is one and the same object. The result is the opinion ("Doxa"). According to Husserl, true perception which is free of the preconceptions of the individual "special world" should take the place of opinion ("Episteme"; HELD 1990, p. 79). This means that subjective feelings, preconceived ideas, situatively variable moods, lack of overall view etc. must be removed. This refraining from any personal comment was named by Husserl "Epoché".

Phenomenology is concerned not with the existence of a thing because it may be that the thing at which the consciousness is directed, exists only in the imagination. The phenomenological examination concentrates on the essence of the object "Eidos". This procedure also includes the dissection of the object into its parts and the description of the parts.

The phenomenological method is therefore designed to facilitate intersubjective communication and therefore raises the problem of structure in a universe accessible to general perception (see also STEGMÜLLER 1987/89,I, pp. 56). Thus, the work of the scientist becomes much more complicated than with the causal method. He must obtain the data which permit him to penetrate into the essence of the object under examination in order to make intersubjective communication possible.

Definition of man: Philosophical anthropology in particular received a powerful stimulus from the phenomenological method. It examines the task or function of man or his position in the universe. For SCHELER (1928/47) for example, man himself was the object of examination, it was not so much the processes of intellectual consciousness which led to understanding, but the participation of the innermost core of a person in the essential being of things (STEGMÜLLER 1987/89, I, p. 97). The emotional has a decisive meaning for life, in particular for ethical understanding. On the scale of nature, man appears as a relative of the animals, but the mind gives him a position of his own, makes him into a person.

HARTMANN (1933/49) believed that the unity of the real world can only be understood when the structure and organisation of the world are understood. This unity does not appear as uniformity but as the fitting together of very differently formed diversities. Hartmann developed a layer model (p. 198) in which areas of being ("Seinsbereiche") are determined which complement one another. The actual being ("das reale Sein"; inorganic, organic, and psychophysical layer) is the unique, individual and chronological. The ideal being ("das ideale Sein") appears as an objective mind (language, science, art, law etc.). He stands above the world of individual experience and manifests himself in historical reality (HARTMANN 1933/49, especially p. 188 f.; STEGMÜLLER 1987/89, I, pp. 268).

GEHLEN (1940/62) rejected the idea of a scale and regarded man (as opposed to the animal) as a being with certain deficiencies. The resulting permanent state of danger caused him to develop well-planned systems of common action (pp. 46). He created institutions which permitted coexistence. The society with its structures and links and division of labour made life easier for the individual (pp. 62). This was how culture crystallised (pp. 80).

These theses, in particular the automatism they contain, are regarded critically from the philosophical (e.g. from the point of view of philosophical anthropology, see LORENZ 1990, pp. 68 and the Frankfurter Schule) and ethnological sides. Here in the transition area to natural science, more modern research results are touched on, which philosophical anthropology is compelled to take notice of.

Leaving aside the question of existence as Husserl had done, is, according to HEIDEGGER (1927/76), not possible for mankind

(STEGMÜLLER 1987/89, I, p. 139). Although he worked according to the same phenomenological method, he maintained that the being what ("Was-Sein") of mankind was not limited to existing characteristics but to possible ways of being. His strict approach which emphasises structure and function, is apparent in his definition of certain terms. Thus, the phenomenon and the being ("das Seiende") are separated conceptually (HEIDEGGER 1927/76, p.28/29). According to him, man is not a self-contained being or a subject without interest in relation to the rest of the universe. He is placed in a certain environment or surroundings and is absorbed in it by pursuing his activities (STEGMÜLLER 1987/89, I, p. 142). This environment affects his human behaviour, but also has a hostile and threatening character which causes fear. This means that the universe is also in man, there is no barrier between the interior and exterior universe, no contrast between subject and object as with Schopenhauer. Heidegger calls this being in the world ("In-der-Welt-Sein") (HEIDEGGER 1927/76, pp. 52).

Although the French existentialists took Heidegger as their starting point, they developed an even more radical view of being. Sartres Being ("Sein") does not mean being there ("Dasein") as Heidegger's does, but existence itself (SARTRE 1943/97, pp. 37 f). This term cannot be derived or thought from a distance. It is absolutely and directly capable of being experienced. Man is left to his own devices. At the start, man is nothing. He must create himself. According to Sartre, man is condemned to freedom, the freedom to control his own actions, while introducing himself into the universe out of responsibility towards himself and others.

Science: The work of the authors quoted above as examples, proves that the phenomenological method and its development open up completely new possibilities for viewing man and the universe in their structure and function. In this way, a hitherto unknown precision was achieved. At the same time, similar methods also led to new insights in the natural sciences.

This was the case, for example in the science of physics. It turned its attention increasingly to researching into the structure of matter, time and space. Perhaps the most important results of this were the development of the atomic model by Rutherford (1911) and Bohr (1913) and in particular the explanation of the fundamental relationships between space, time and energy as formulated in EINSTEIN's theory of relativity (1905, 1916).

Geography:

For geographers the main question was still: what is a geographical area and how is it defined. The outmoded regional geography was unable to free itself from the suspicion of serving principally for compilation purposes. The space-related characteristics are not just interconnected causally. There may be no doubt that relationships exist between the geofactors, the vertical chain of causes, e.g. between the soil and agricultural production, but this explains only partial aspects. It was also known that the horizontal "neighbourhood effects" affect the regions. But how it took place remained obscure.

Regions (see also section 2.2.1.1, p.41, and 2.2.2.1, pp.47): Thus an attempt was made to approach the varied mosaic of material forms on the surface of the earth from a different side. The knowledge of many concrete facts still did not permit clear regionalisation. A radical change in basic perspectives and methods was required. In the 1920s, the outdated observation of material forms and the causal method gave way to the study of the structure of forms and groups of forms and their functional interconnections. The question was no longer just what a region (or form) looks like, but how is it structured. The examiner maps the individual facts, e.g. the plants in a biotope, the area utilized by individual farms, the arrangement of houses in a village, the occupational or social characteristics of man.

However, this way of looking at things became more difficult when not only the co-existence of these cells but also their functional relations were analysed in detail. This lent itself most immediately to economic geography. In rural areas WAIBEL (1927/69) found regional economic units which he called economic formations ("Wirtschaftsformationen") thereby recalling certain corresponding units in the plant world. He believed he had found the structural components which interweave with one another, thereby shaping the economic landscape. The economic formations also mean forms of life, i.e. they form the basis of certain ways of living.

Social geography: At this time in human geography there was a distinct shift in fundamental outlook, as in the other social sciences ("functional period"; OVERBECK 1954/78, pp. 218). A social geography took shape, first of all outside Germany, which did not return to the scientific community in this field until after the end of the Nazi regime.

The stimulus came from sociology. In the Netherlands in 1913, STEINMETZ argued that man should be seen as a link in society - a decisive departure from Ratzels view of man in his living space. The descriptions of different peoples as provided by geographers seemed to him to be too superficial and one-sided. The sociologists on the other hand lost contact with reality. He therefore called for a careful empirical analysis and gave his approach the title of "sociography".

Various groups of characteristics could now be assigned to each individual (depending on his physical size, age, membership of tribe or religious community, professional status, income, place of residence in relation to the distance to place of work etc.). In other words, differently defined groups, the question of place of work and place of residence could now be studied and placed in relation to other factors such as settlement, nature, economy, traffic etc. The information base was becoming broader all the time and detailed statistical data was becoming available to industry, administration and science. Thus, regions and regional relationships could now be identified which had hitherto remained undiscovered because the methods were not yet sufficiently refined. The geographer now began to understand that anthropogenic areas should be studied from the inside starting with man and his various groupings.

BOBEK (1948) took up the concept of groups of life forms in which specific social forces receive expression. These are groups which appear, as he stated, to be affected both by the forces of society and landscape, and whose "functioning" causes their influence to be felt both in the natural (landscape) and the social (society) spheres. Bobek created a system of social geography and became one of the founders of this geographical sub-discipline.

The towns in particular proved to be forms in which the constituent geofactors suggest themselves as objects of research both structurally (i.e. in their construction and co-existence) as well as functionally (i.e. in their relations to one another). In this connection BURGESS (1925/67, p. 50) noticed a concentric structure of cities (see section 2.2.2.3, pp.58). In this years the Thuenen model was re-discovered (OBST 1926/69; WAIBEL 1933a; see section 2.2.2.3, pp.57). Besides this, the relations between the central towns were examined (CHRISTALLER 1933; see also 2.5.2.1, pp.230).

By studying the material aspect of form it was therefore possible to throw light upon the structure of relationships for one particular moment. Every point, e.g. in a city-umland system, has a relation to the centre which can be repeated at any time. In order to approach reality more closely, the area structure has to be defined in relation to its content. This may be people who are pursuing their own aims and who therefore "behave" and not just function according to the system. In this way, the functional relationship is modified. Deterministic models are no longer permissible and it becomes necessary to work with others, e.g. probability models. This points the way to the following stage.

The system stage:

Classical Modern painting:

Around the beginning of the 19th century, new tendencies appeared in art which ushered in the so-called "classical modern" period (HAFTMANN 1954/76; BOCOLA 1997). It was characterised by a great variety of style including Cubism, Dadaism, Constructivism, Expressionism, Futurism and

Surrealism. The paintings of Picasso, Kandinsky, Dali, Severini, Duchamp or Klee seem to the observer to express quite different things, although they all have one thing in common: The artist penetrates more deeply into the matter of the subject. The visible world which Impressionism depicted in its geometrical arrangement, is resolved into its components which are re-evaluated and then re-assembled. For example, the proportions of the objects appearing in the painting could be varied, the colours modified, physical elements removed from their structural anchor points, contours blurred and perspective distorted, and all in order to re-express the meaning of painting's subject. In a word, all the aspects and properties which the observer associated with objects in his environment could now be re-arranged and re-emphasised artistically.

Fig. 81:
Karl Schmidt-Rottluff: Bend in the path. Example of a classic modern painting.
Source: See "Notes on the figures".

With regard to content, the artist's range of expression has indeed become much greater than it was. Because the re-interpretation of a picture in its entirety with all its elements is now up to him alone. He has another tool at his disposal and can prompt certain associations or feelings on the part of the observer which would otherwise remain concealed, e.g. joy, sorrow, helplessness, fear and admiration. The variety of elements from reality becomes a construction kit for a different world, the inner world of the artist (HAFTMANN 1954/76, p. 495). This is how the shape develops and becomes a self-contained painting which has grown organically out of itself.

The emancipation of the artist as the subjective interpreter in relation to his environment, has entered a new phase.

Example (forest painting 3): Karl SCHMIDT-ROTTLUFF (see fig. 81): Bend in the path.
The picture was painted by Schmidt-Rottluff around 1960. It is a watercolour depicting a piece of woodland. The artist chose the watercolour technique in order to transfer his expressive and dynamic sensations to paper as quickly as possible. The path takes us into the picture. The ground rises to the left and right with the bulky forms of large boulders. At the bend on the upper right, rather threatening-looking trees loom, extending to the edge of the picture. To the left, bushes and low trees reveal a bright apparently stormy sky. It is not the wood as such which conveys the dramatic atmosphere. Instead, the forest is the means by which the artist expresses his feelings. Schmidt-Rottluff is one of the founders of the group "Die Brücke", and one of the main representatives of German Expressionism.

Philosophy and interdisciplinary theories:

In the 1930s, philosophical thought also underwent a fundamental change. Man now saw himself as part of a whole which determined his life but which he was also able to use in his own interest as well as to make changes. Thus, the environment and/or society were seen as a fabric of activity in which man must seek his own place. The system plays a central role as a new guiding model.

Critical social philosophy: Some philosophers took Marx' model of society as their point of departure. According to BLOCH (1954-59/73) history moves in dialectically self-correcting processes towards a future in which the ideal of a classless society, free of any alienation and in accordance with nature, will be fulfilled. According to him, the evolution of history is dictated by Utopias, daydreamers and wishful thinking. The anticipation of the future is an important driving force in human action.

A significant part of the reflections of the "Frankfurt School" (Horkheimer, Adorno, Marcuse, Habermas) followed up the ideas of Bloch (WIGGERSHAUS 1986). Critical theory dealt with problems related to social and scientific theory, in particular with regard to sociological consequences. The interconnections of a world determined by economic and technical forces, the conditions in which it came into being, its administrative coldness were all examined and ways of changing it to create a more humane social order free of estrangement were analysed.

Neopositivism: Popper criticised these lines of thought, in particular the view that history proceeded according to certain "laws" as proposed by Hegel and Marx (POPPER 1960/87). He warned of the claim to absolute truth made by "false prophets", conceded that the course of history followed certain trends (pp. 90) but that its development was open and might be affected one way or another. Clever planning may be able to correct errors step by step ("Patchwork Social Technology"; pp. 51). The ideas of Popper and the Frankfurt School assume that the course of history proceeds "normally" i.e. a social structure in an equilibrium which is capable of change.

Popper's fundamental position was (neo) positivistic, i.e. he assumed that human knowledge was limited to what could be experienced and perceived (the "positive"). This could be proved, defined and analysed in a systematic manner. In his book "Logic of Research" (1934/89) POPPER argued (p. 29) that everything we know is genetically a priori. A posteriori is only a choice selection of what we have ourselves invented a priori. And further on (p. 36): The task of all thinking beings is to determine the truth. The truth is absolute and objective. Only we do not have it in our pocket. It is something which we seek continuously and which is often hard to find.

In particular, positivism claimed complete freedom from values, i.e. objectivity. Decisions on this basis were allegedly independent of moral or political commitment. However, this was vigorously disputed, especially by Habermas, who argued that judgement which was completely free of values was not possible per se in the sense of objective establishment of the truth. The knowledge was affected by interest and intellectual formation. Thus the positivism dispute ("Positivismusstreit") affected not only fundamental questions of social structure and development, but also scientific methodology.

Modern Empiricism: Popper had his roots in the "Vienna Circle" which revived to the tradition of empiricism (at a distance from critical social speculation) within the sphere of modern scientific and technical thought. Originally, Empiricism allowed only rough insights. Mankind was regarded in its entirety, not in its characteristics. This now changed. Progress in knowledge is based on the fact that empirically treated or logically derived statements are verifiable. The steps in the operation are controllable. Metaphysical statements on the other hand cannot be verified (STEGMÜLLER 1987-89, 1, pp. 351). Modern empiricism saw it as its task to encourage science.

In his first work, the Tractatus Logico-Philosophicus, WITTGENSTEIN (1922-53/90) may be seen as a precursor of modern Empiricism, especially that of the Vienna Circle. His intention was to support the natural sciences by developing a precise language and clear terminology. Only then does communication become possible.

The truth of statements must be intersubjectively verifiable. This requires a logical rule which allows statements to be retraced to observational principles ("recording principles"). This "criterion of empiricistic sense" is connected with "verification" (Carnap). STEGMÜLLER (1987-89, 1, p. 382) is more precise: The verifiability of a statement is a necessary and adequate condition for regarding it as empirically reasonable. This means that sentences which contain partial statements which are not accessible to observation, are not regarded as reasonable.

However, this view soon proved to be untenable. Among other things, POPPER (1934/89, pp. 7, pp. 15) pointed out that many scientific principles too are not verifiable. Because these are universal principles (i.e. they claim to be valid in a general way) which can only be proved empirically on individual examples. In verification, we therefore come only to unreliable statements. Popper therefore introduced a new method which he named "falsification". The truth of a theory or hypothesis must be scrutinisable. In general, he postulated that a theory should be constructed in such a way that it can be proven false, i.e. that the reader is able to test its statements and deductions empirically and if necessary reject them. A deductive scrutiny must (a) examine the theory for any inner contradictions, (b) determine whether the theory can be treated empirically and scientifically, that it is not, for example, tautological, (c) determine through comparison with other theories whether its statement can be regarded as scientific progress.

In practice, such an elaborate scrutiny is only partially possible, and always highly complicated. From the critic it demands a degree of open-mindedness to novelty and detachment with regard to his own previously accepted view. This is generally difficult to achieve.

System theory (see also sections 2.3.1.1, p.73, and 2.3.2.1, pp.97): As early as the development of the atomic model, the question had arisen how the movement of the electrons could be observed. The conclusion was reached that it is only possible to answer this question by taking an overall view. The Quantum Theory was the result. It operates with probability scenarios. This means that the processes cannot be precisely controlled beforehand and the initial condition can no longer be determined. The laws of physics should be regarded as laws of statistics (indeterminism; see also Outlook, pp.117).

The theory of probability is based on the distinction between the whole and the parts. If we assume that the parts always have a structural function for the whole, we arrive at the System Theory. Within a system, the components co-operate with one another in such a way that they stimulate and subdue (i.e. regulate) one another mutually. The foundation of the theory of information (SHANNON and WEAVER 1949/76) and the development of the theory of self-regulating systems (WIENER 1948/68; v.BERTALANFFY 1950) created a formal basis. In this way, closer attention was given to the progress of time.

In ecosystems and social systems, living organisms "behave" according to certain characteristics and properties. Innate abilities and environmental conditions play an important role here. This problem has been discussed particularly in ethology. It examines tribal origins and the reason for certain patterns of behaviour (LORENZ 1965, I, pp. 9). The naturalist is dealing with the forms of processes, which unlike physical features, are not always visible (EIBL-EIBESFELDT 1967/99). These include the perception of form, learning, methods of expression and formation of communities.

Thus the System Theory has become established in many different fields of study, i.e. it has developed into a "General Systems Theory". As SUTHERLAND (1973, p. 19) explains: "In the broadest sense, General Systems Theory is a supradiscipline, including such special system disciplines as mathematical systems theory, systems engineering, cybernetics, control theory, automata theory. In other sense entirely, general systems theory offers a vocabulary of both terms and concepts applicable to systems of all types, with the terms and concepts drawn from many different substantive disciplines (i.e. biology, engineering, economics, quantum physics)".

Geography:

Macrogeography: Geography now concerned itself much more closely with the actual problems of society than it did previously. Under the impression of differing economic developments on a global and regional scale, numerous detail studies on developing countries, the development of emergency areas and the formation of ghettos. The problems were identified and attempts made to find solutions. The study of reality was now stimulated by the objectives in view. Among other things, these studies raised questions as to the origins of such imbalances and undesirable socio-economic conditions. And different answers were found, depending on the political and cultural viewpoint. In this way, "radical geography" (and in its train Marxist geography; HARVEY 1973) made its appearance in the English-speaking world against the background of Marxism-dominated European philosophy. Feminist Geography and the gender studies (PEET 1998, pp. 247) also appeared within the context of the international women's liberation movement.

In Germany too, society itself became the central object of research in human geography. Above all, it was realised that the social forces are of a completely different kind than the natural ones. Now, the social groupings are not defined (as in the functional phase) as groups of features, but as behavioural groups (HARTKE 1953; HAHN 1957). They are defined by their activities in space. The human beings which belong to them shape their environment in a similar way and react in similar ways to external influences, i.e. they behave similarly. Their members may have a similar attitude to economic activity, have common standards and moral attitudes etc. Groupings of this kind can be identified by certain criteria or indicators.

As a continuation of the idea behind this approach, Ruppert and Schaffer regarded the landscape as an area in which processes took place. The social groups appear on it not only as fulfillers of functions but as fulfillers of spatial processes (RUPPERT 1968, p. 171). Basic existential functions ("Daseinsgrundfunktionen") can be identified as motivation for the members of these behavioural groups (according to PARTZSCH 1965). Here too, an approach had been found which enabled socio-geographic research to be used for practical spatial planning (SCHAFFER 1968, p. 205).

Spatial approach: In the 1950s, within the context of empirical social research, reliance was placed initially on statistical methods based primarily on the theory of probabilities. Here too, the deterministic view was no longer adequate, since social scientists deal with humans whose actions follow their own intentions (and emotions).

Probabilistic models were also developed in the field of human geography ("quantitative revolution"; e.g. GARRISON 1959-60). In this field, simulation began to be used increasingly, e.g. in the study of migrations and the diffusion of innovations (HÄGERSTRAND 1952; 1953/67). An extensive data base had been created in the official statistics and elaborate methods were developed to improve interviewing technique.

The methods permit a clear approach, limit regions of different types, reveal spatial structures and allow comparisons.

Microgeography: The approaches described above attempted to comprehend the entirety of the system from the point of view of the linkages. It is only logical that human geography should turn its attention increasingly to the individual human as the element, because his behaviour determines the processes in the group context. The deterministic models postulate the existence of a "homo oeconomicus" who fully understands his environment with all its realities and possibilities. Of course he does not exist. The insights into his environment possessed by the individual human being are rather limited in nature and his behaviour is in no way perfect. By taking the individuals into account, space was defined "from the bottom" so to speak. In this way the system received a new component. The elements are not only materially definable data quantities, but the people themselves with their ideas and intentions. Thus, man was regarded as a maker of decisions.

In detail, two lines of investigation were pursued:
1) Behaviour is determined substantially by perception and decision. The processes of perception are very complicated. The impressions coming from the external world are filtered, a process in which talent, education, attitudes etc. as well as intentions (e.g. in relation to an action) play an important role. The result is a view of the world ("mental map"; LYNCH 1960/65, pp. 20). The decision based on the knowledge gained is the precondition for the shaping of the individual environment. WOLPERT (1963/70, p. 384) balanced the role of "homo oeconomicus" with the behavioural concept of "satisficer" which is satisfied with what it can achieve in a particular situation.

2) The time factor becomes apparent in the "activity-system" and "time-geographical" approach. CHAPIN (1965) observed that the behaviour of people is strongly dependent on the time available to them. Each person has his sphere of action and activity which allows him to go about his business. Within sphere or space, he has to fulfil all the actions necessary for his living within a certain period of time. Here, significant roles are played by distance, time available, accessibility by means of transport, business hours etc.. On the other hand, the individual movements themselves have been discussed in the field of "time geography" (e.g. HÄGERSTRAND 1973). The spatial decisions are also affected by the time available. Here, each individual has possibilities and limitations. In a three-dimensional model, in which the surface of the earth appears horizontally as a map in which time is entered in the verticals, the changes in location ("paths") of each individual can be marked in a certain period of time. These time periods may be days, years or phases in a person's life. These individual paths represent the material by means of which individuals with the same spatial behaviour

can be identified. In this way, time-geographical studies can be carried out in town or country or in different cultures, thereby producing a pattern for the behaviour of people in space.

All these studies indicate that we are limited in our freedom of decision and that we constantly move between possibilities and constraints. We can add our own ideas in order to influence the course of developments, but for this we require specific social structures to point the way. This problem is discussed in the following stage.

The process stage (evolving)

Art in the Present:

During the Second World War, a new period began in the development of art. Painting liberated itself from all the formal constraints of patterns and stereotypes. Whereas in the first half of the 20th century, the painter selected elements of form and structure from the world of visible phenomena and emphasised or suppressed these according to his own ideas, the painter was now quite free in his choice of content, technique and design. In this way he was able to convey his message more effectively and express his feelings more directly. Many different styles and movements came into being.

Perhaps the first of these we should mention is the Informal or Tachism movement which can probably be placed closest the classical modern (De la Motte in: INFORMEL 1983, p. 10/11). It attempts to depict feeling and thought in a way which is free of forms and constraints, almost anti-formalistic. In the 1960s other styles made their appearance, such as Pop Art, Opart, Photo-Realism, Minimal Art, Neo-Expressionism, Neue Wilde, Chromatic Painting, Zero etc.. It is impossible to assign many artists to a this group and others changed their techniques and methods of representation. It is almost as if they were looking for the right way to realise their ideas. New materials were used in addition to the conventional paint – porcelain, glass, plastic, soil, scrap and even transient substances.

The time component received a new importance. Happenings, Fluxus, Vienna Actionism, Performance, Video, Computer Simulation are all completely new types of representation. The rapidly changing information and design techniques are used to depict processes in order to draw attention to particular problems – social problems, environmental problems, political problems – and the artist's attitude to them. So the artist Tino SEHGAL said (2005) that for him, art is a celebration – it celebrates the ability of mankind to transform nature, invent things and derive a subject constitution from these. The aim of the Avant-Gardists is to change the world. The utopias they create not only depart from the traditional categories of visual art, but totally abolish the idea of art by abolishing the line between art and life (GLOZER 1981, p. 235).

The area of artistic expression is society and the world at large. In many respects, the artist and his audience come closer to one another because this art demands direct participation. The viewer is involved. The universe becomes a work of art, society a "social sculpture" (Beuys; see also section 2.5.0, pp.226). The artist (as creator) leaves his studio and approaches his subject, the human habitat, itself.

Whereas art in the Classical Modern period was still a well-defined institution, the edges now become more blurred with imperceptible transitions to technology, design, politics, events and commerce. Numerous exhibitions give the art scene a platform for self-projection which it never had before. The viewer's interest grows accordingly. And even if the artist seems not yet to have found his place in this confusion, if many of their works are still far from being self-explanatory, it is at least clear that art is a sign of a new fundamental tendency in the development of society.

Example (forest painting 4): BERNARD SCHULTZE: Deep in the Forests. 1978 (see fig. 82):

Schultze is one of the founders of the Informal School in Germany. The picture shows a structured chaos, a labyrinth of stripes, shadows and white areas. The gaze travels over doughy, gnarled, swampy, leafy, crumbly structures. Schultze works from the unconscious to the conscious - carries out a medial process of movement from the inside outwards. The hand is guided by the subconscious. The impression is of something organic, of rank growth. The viewer can read anything he likes into the picture, a forest may not occur to him right away. The development of structure from one's own personal feelings is the artist's most important concern. In the last resort it is of no importance what the painting is called (ROTERS 1981, p. 55). The title becomes a metaphor which may assist the acceptance of the viewer.

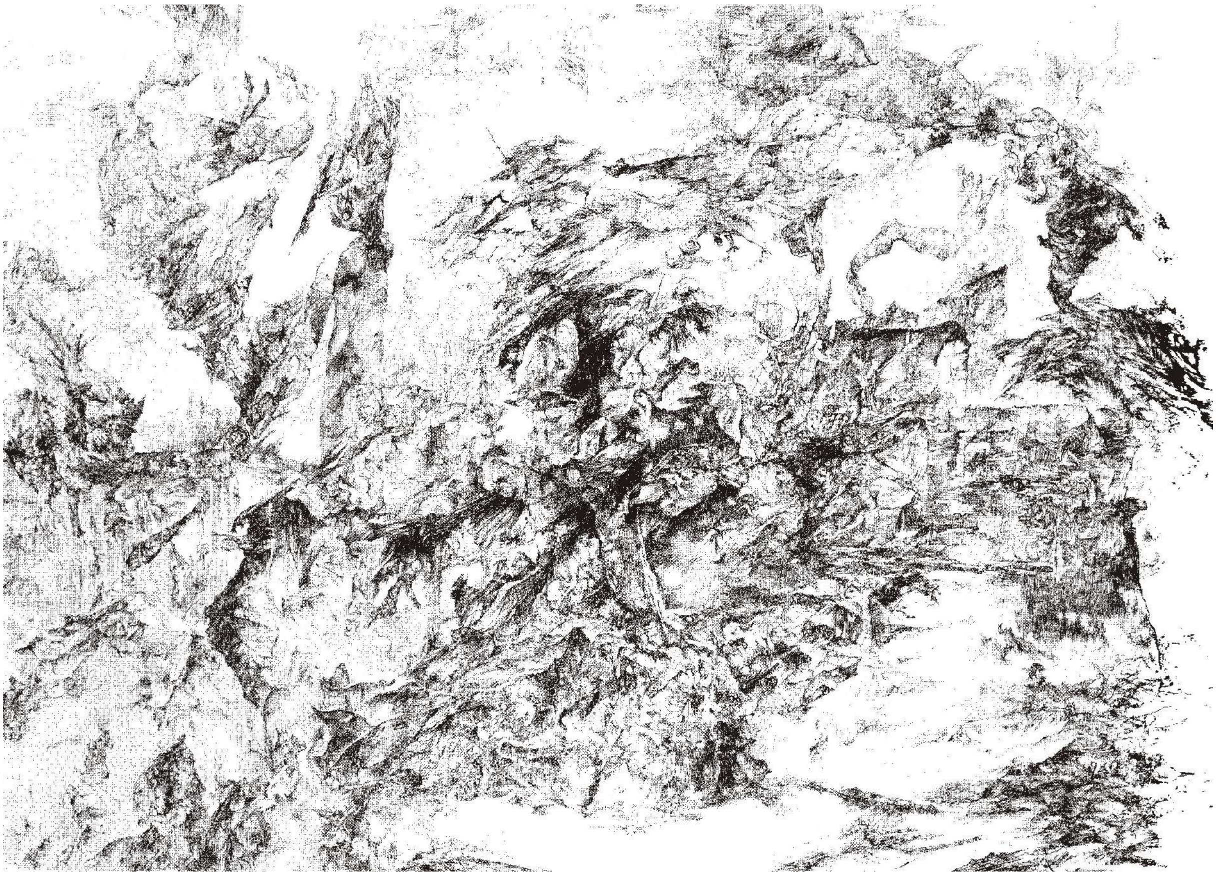

Fig. 82:
Bernard Schultze: Deep in the forests. Example of a picture of the present.
Source: See "Notes on the figures".

Philosophy and interdisciplinary theories:

Post modern: Before the development of modern empiricism, WITTGENSTEIN (1922-53/1990) had subjected language to a logical examination with regard to its expressive capacity and acknowledged its role as a general means of communication. In this way, he provided modern empiricism with important impulses.

In his "Philosophische Studien" he came to completely different conclusions. The play of language ("Sprachspiele") now took the place of depiction ("Abbildung"). The assumption is therefore relinquished that the linguistic statement coincides with the given facts. In order to apply language meaningfully, a general context has to be understood (mode of life; "Lebensform"), a kind of linguistic "creature" from which meaning can be derived (WUCHTERL 1961, p. 50).

Obviously there is a vast number of possible "plays of language". With this concept, Wittgenstein ran contrary to modern empiricism and positivistic thought. Here a certain degree of uncertainty is apparent as to what science can hope to achieve. The idea of truth becomes more blurred, thereby opening the way for the post-modern movement.

The philosophical discussions of the 1960s are characterised by a peculiar degree of confusion ("Unübersichtlichkeit"; HABERMAS 1985). Whereas Popper (see above) and the representatives of the Vienna School were convinced of the existence of a truth and developed methods for finding it out scientifically, everything now appears relative and indefinite. General communication becomes almost impossible. Far-reaching theories which could provide general guidance, are nipped in the bud. Thus, there are many hypotheses which refuse to come together in a single theory. The conviction that the processes shaping the universe can be defined in the context of system structures (as described for the third stage) is given up and the desire arises to re-define the universe and its modes of life.

The pluralism of the post-modern was assumed by the scientific historian KUHN (1962/67/88) at an early stage. He analysed the character and appearance of several scientific revolutions of the past and gave the term "paradigm" a specific meaning (p. 25). He wrote that important achievements served subsequent generations of scientists for some time indirectly as a means of defining the problems and methods of a field of research. They were able to do this, because they had two important features in common. Their achievement was sufficiently novel to attract a stable group of adherents who had previously conducted their science in a different way, and at the same time was still open enough to set the new group of scientists any amount of unsolved problems. According to Kuhn, changes in paradigm take place in the shape of revolutions. The imminence of such events is indicated by the fact that problems can no longer be solved within the existing scientific framework of the outdated paradigm, until a completely new theory sets a new paradigm. (In 1995 KUHN ceased using the term paradigm - but not the concept itself - because it had become prone to misuse).

Moreover, Kuhn thought (p. 108) that a change in paradigm did not lead to scientific progress. On the contrary, one paradigm was only replaced by another. A younger generation of researchers merely pushed the older one aside. A "falsification" as demanded by Popper (see above) was thought by Kuhn to be impossible. It was mainly psychological, social and in many cases irrational factors which caused a change in paradigm. A cumulative acquisition of unforeseen novelties represented an almost non-existent exception to the rule of scientific development. In principle it was also improbable. We will return to this problem later (see below).

What are the reasons for such delayed acceptance? There are several reasons for this (quite apart from the personal reasons which are generally known). First, it has to be seen that the "old" theory has been widely used and, within certain limitations, has proved successful. Then, the opinion of the scientists itself also has a restraining effect - to which the (necessary) working together within the scientific community, continuously cultivated in discussion groups, symposia, courses, expert committees etc., contributes. It promotes an involuntary convergence of standpoints, especially with regard to fundamental views. Thus, a deceptive feeling of security is conveyed. In addition, generalised descriptions often written by well-informed journalists create a broad basis of acceptance among the public at large. New theories attempting to deal with unsolved and (by conventional methods) unsolvable problems, can only with difficulty develop beyond this solidified network communication.

FEYERABEND (1976) even rejected any binding commitment to scientific methods and insisted that much greater importance should be given to imagination and creativity free of all restrictions with regard to methodology i.e. "anything goes".

The post modern is seen as a plurality of ideas, facts and processes which stand alone. They are only anchored "in the social". However, society for its part, is a creation of ideas, facts and processes. LYOTARD et al. (1979/99) places more importance on the "immaterial". News, interaction, language etc. form the "materials", the actual substance. Thus, there are many trends of thought and debate which cannot be compared with one another. Communication is only possible through reflexion. Reason is the "common asset" (see also WELSCH 1987, pp. 307/308).

Using examples from history, a similar conclusion was reached by Foucault with regard to the growing independence of speech and thought, which affect the modern individual in the course of the discussion (WALDENFELS 1991, pp. 191).

However, since the 1980s, remarks can be found in the works of some authors which indicate a certain reserve with regard to relativism which is too naively practised (NIEMANN 1996, pp. 274). KUHN (1995) stresses that he is not a relativist, because he does not believe that all conclusions are of equal value. In his view it is always possible to arrive at a conclusion which is preferable to others. And in 1982 Feyerabend wrote in his preface to the new edition that "anything goes" is not his own principle, but a fact to which he wished to draw the attention of his opponents regarding the theory of science.

These extenuations could originate in the realisation of the autors that they have used populistic methods, as Niemann (pp. 274) thought. It could also be argued that they are signs of a change in attitude paving the way for new lines of thought. Moreover, it became apparent (SOCAL and BRICMONT 1999) that some post-modern authors had made over-free use of scientific terminology with the result that some of their statements may be rather doubtful. Without any knowledge of the results of scientific research, philosophy can only arrive at conclusions whose soundness is of a limited nature only.

As in present art (see above), more recent philosophical reflections show an increasing preoccupation with ethics. JONAS (1979) emphasises clearly man's responsibility in a civilisation dominated by technology. Modern technology confronts us with questions, actions and consequences of such magnitude and importance that the former framework of ethics is no longer able to contain them. He therefore calls for a new system of ethics. This however requires a degree of foresight, a prediction of developments in order to obtain an idea of the long-term effects of ones own actions. We have a responsibility towards our descendents and to nature. Man's responsibility for man is primary. To this has now been added his responsibility to nature. The overriding problems with regard to the supply of food, raw materials and energy must be approached with long periods of time in mind. Referring to Kant, Hegel and Marx, Jonas argues that we can no longer trust the inherent "reason of history" and that it is pure negligence to speak of a self-fulfilling "sense" behind events. We must take control in a completely new way of the processes which are striving aimlessly onwards. It would be a fatal error to believe (as Marx did) that the "empire of freedom" begins where necessity stops. On the contrary, there is no "empire of freedom" outside the "empire of necessity".

From chaos research to complexity research: In system research, a new development (towards self-formation of the environment) is taking place. The self organisation of matter and society is becoming an object of research.

As early as the 1970s, research into non-linear systems, including the emergence of chaos research was established. Again new methods of explanation were demanded, and simulation became the most important investigative instrument. The use of computers made a decisive contribution to this. It was recognised that there are phenomena and systems in nature and society whose elements behave unpredictably when they interact, even though, taken alone, they obey certain deterministic laws. For example, slight differences in initial conditions may, unless controlled, lead to completely different developments. In their simulated development, they may be driven to the "edge of chaos", thus causing new patterns to come into being. Against this background, it became apparent that spatial patterns can also develop, so to speak, "from the bottom up".

These fields of research can be summed up in the terms "physics of becoming" (PRIGOGINE 1979), "chaos research", and "synergetics" (HAKEN 1977/83). The phenomena of self-arrangement are indications of a non-linear dynamic process. In the 1960s, Prigogine observed that such systems existed in addition to the equilibrium systems and that they can develop and maintain themselves at a distance from the energetic equilibrium. These systems (he did not yet distinguish between flow and non-equilibrium systems) are able to give themselves a shape. For this purpose they consume energy, of which a part escapes (e.g. as heat), dissipates, with the result that they have been given the name "dissipative systems".

These systems always have a tendency to move from a higher-order state to a lower-order state. Thus, the processes are directed according to the course of time. On the one hand there is the objectively measurable external time which is generally valid. On the other hand, we also have to deal with a second time which is internal to the system (PRIGOGINE and STENGERS 1981, pp. 259) and which finds expression in the changes to which the dissipative systems are constantly subject. This time flows parallel to the external universal time, although their speeds are different.

During the 1980s and 90s, parts of the natural sciences and social sciences were moving towards one another on a more abstract level. Chaos research developed into complexity research. With considerably more ambitious objectives than chaos research, it opened up the prospect of unfolding not only more complicated spatial patterns, but life itself and human society, in other words highly complex structures. It was recognised that self-organising systems occupy a key position in our understanding of complex structures such as the living world or human society. Using the method of "cellular automata", attempts are being made to simulate "artificial life" (LANGTON 1989) and "artificial society" (EPSTEIN & AXTELL 1996; see section 2.3.2.2, pp.106).

Although obviously it is not possible to create differentiated, permanent systems based on division of labour, e.g. self-organising populations in this way, the observations and hypotheses already made demonstrate the desire to understand more not only about self-regulation but also about self-organisation and emergence. However, to date, the research into dissipative systems has not ventured to take the step to research into processes. Only this offers a way out of the currently unsatisfactory situation.

Geography:

The present discussion in scientific geography is characterised by a number of approaches (PEET 1998, p.10), which, as many geographers believe, are not compatible with one another. They deal with a number of important and much-discussed topics. Most of these have their origin in the preceding period (e.g. radical geography and feminist geography). The post-modern approach is new.

"Post-modern geography" notes that (as Wittgenstein would observe) different languages are being spoken and that different images of mankind co-exist with one another. This does not permit any comparison (REICHERT 1987). These spaces are constantly assigned new values (SOJA 1989). DEAR (1988, p. 271/272) believed "that society is best characterized as a time-space fabric upon which the details of political, social, and economic life are inscribed. There are many theoretical approaches available to describe the creation and evolution of this fabric. A post-modern social theory deliberately maintains the creative tensions between all theories in its search of better interpretations of human behaviour. At the core of the wonderful 'geographical puzzle' lies the dialectic between space and society".

Many individual observations are made without arriving at a common theoretical concept. RELPH (1991, p. 104 f.) states that: "If I were to choose a single word to describe post-modern geography as it is manifest in actual places and landscapes it would be 'heterotopia'... Heterotopia is the geography that bears the stamp of our age and our thought - that is to say it is pluralistic, chaotic, designed in detail yet lacking universal foundations or principles, continually changing, linked by centreless flows of information; it is artificial, and marked by deep social inequalities..".

The tendency towards relativism is unmistakable. This view has its roots in post-modern philosophy (see above; see also PEET 1998, pp. 194). For a discipline that regards itself as the scientific companion of a world in need of improvement, such a relativistic view is not sufficient. The confusion should be understood rather as a problem whose solution can only be achieved by intensifying research.

A first step would be a more precise examination of the systems at microlevel.

Microlevel: At the 3rd stage behaviour was interpreted as a characteristic of individuals and social groups with methods which, allegedly, produce exact results. This point was much criticised in the 1980s. Indeed, it is difficult to interpret behaviour correctly. Can the cause be determined from the results of surveys and can reliable conclusions be drawn from mental maps (WIRTH 1981, pp. 174)? Although the empirical data are well handled, a certain unease remains, and many a geographer wonders if the reduction of reality to spatial connections, probabilities and systemic involvement is really the purpose of scientific research.

The content and its meaning must be given greater consideration, because this is what moves people to action in the last resort. What does the individual aim to achieve? Are his motives personal or does he feel himself forced to act by the system or society? With this in mind, a Humanistic geography has become established. JOHNSTON (1983/86, p. 55) writes: "The basic feature of humanistic approaches is their focus on the individual as a thinking being, as a human, rather than as a dehumanized responder to stimuli in some mechanical way, which is how some feel people are presented in the positivist and structuralist social sciences. There is a variety of such approaches, for which there is no agreed collective noun. Their common element is a stress on the study of people as they are, by a researcher who has a few presuppositions as possible. The aim is to identify the true nature of human action...".

In the last resort however, it is not the individuals themselves who structure society. It is their actions. Through actions, the individuals express themselves, make contact with other individuals. Interaction is made possible and social structures created. Actions on the other hand, are controlled by intentions and constraints in the widest sense (action projects; see section 2.2.1.1, pp.38). The most general aim of this view of research consists in decoding the complexity of social circumstances and problem situations on the basis of the actions of the members of the society, or, more accurately, to understand and explain and, in problem situation, make reasonable proposals for changing problematic behaviour (WERLEN 1988, p. 22; about the term action see section 2.1.1.1, pp.18).

Micro and macrolevel: But how can individual actions be transposed to a higher magnitude? This has to be examined if we wish to understand how actions can shape society. Seen on their own, actions do not create socially relevant structures.

The sociologist GIDDENS (1984/88) believed that the actions are subject to conditions, which themselves are seen as the consequence of information in space and time (within the context of economic, legal and moral systems), which are

specified by overriding social structures. In this way, patterns of action are created at the level of the individual. On the other hand, it is these time and spatial structures which are stabilised by feedback mechanisms.

Reflections on the subject have not yet become definite enough. The assumption that the microlevel (of the actions) can be joined to society by means of a three-stage hierarchy (individual - structure - society) points at least in the right direction. However, the difficulty with this theory consists in the vague definition of the term "structure". Are the structures institutions or populations?

In a similar way, the sociologist LUHMANN (1984 and 1998; see also section 2.3.2.1, p.102) is unclear as to what is to be understood by a system. According to him, communication forms the basis of social systems. Three levels of integration may be identified (LUHMANN 1970/75, II, pp. 9):
1) Simple interactions between the actors present. They exist for a short time only (microlevel).
2) Organisations which are made up of members and communicate via media. They have a past, decide in the present, and plan for the future (mesolevel).
3) Society, which contains all interactions and organisations and develops over long periods of time (macrolevel).

Two statements are of importance here: 1. A three-stage hierarchy is assumed (as with Giddens). Thus, the actions are effective in superior systems. 2. Time is involved in the hierarchy. However, essential factors still remain unclear. It is uncertain how the systems are structured.

Thus, it is not possible to test the theories in real society. However, they still have a heuristic value.

From action to process: On surveying the development of human geography over the last decades, it can be seen that we have moved forward with increasingly accurate methods from the undifferentiated human groupings via the "social groups", "institutions", "behaviour" and individual "roles" to individual "actions". Now that we have arrived at the microlevel, we cannot find our way back to the macrolevel of wholes and processes. So, here too, it has not been possible to distinguish plausible constant and limited human populations with structures intrinsically based on a division of labour. Apparently, many social geographers still believe they can arrive at a definition of social reality without the assistance of the knowledge possessed by the natural sciences - only by humane-scientific hermeneutic-phenomenological methods of explanation. Thus, empirical research remains confined to disciplines concerned with human society in its many forms, but without a satisfactory theoretical basis.

Actions are fixed in time. They are parts of processes (see section 2.2.1.1, pp.38). Every individual case, every type of behaviour, every action (project) at the microlevel fits into superior processes. This is reflected already in the above-mentioned approaches (see the "systemic stage"). In the sense intended here, process means an entity within a period of time, in which various stages develop logically in succession. This already applies for the actions themselves. The main focus of consideration shifts from individual behaviour and action to the process.

Summary and interpretation:

From the brief review of the last 200 years of intellectual development and cultural evolution in Europe, certain principles become apparent. In view of the complexity of developments, we have had to select certain processes, which may be used as indicators. Art, philosophy and geography are particularly suitable because they describe the social change from inside, from the point of view of those concerned, the individuals. Thus, we obtain not only a quantitative but also a qualitative insight into the process.

Process development:

For the past two centuries, four stages are apparent, all of which covered several (approximately five) decades. The processes overlap one another. There are transition phases covering from one to three decades in which the developments can affect one another mutually. The principal reason for these overlaps is that the individual processes (here the indicators) are shifted in time in relation to one another. The innovative ideas (if they have proved suitable) move the disciplines of the individual processes in the new direction only with a certain delay.

Thus, two process levels with different degrees of complexity can be made out in decennial cycles (see section 2.5.1.1, p.209):
1. The single processes which are defined thematically as indicators and which can be elaborated by inductive examination. These processes form sequences of single processes which are distinguished by their qualitative characteristics. Thus, in painting for example, a number of different styles follow on from one another (Romantic, Impressionism, Classical Modern, and art of the present).
2. The complex processes which these single processes serve as indicators, are what constitute social change. To define these as processes, we must proceed to a more abstract level and ask what the main theme of this change was from a system point of view.

Interpretation of content:

For this, we should firstly summarise the most important conclusions of the above discussion (see fig. 83):

1. Material stage:
- In the painting of the Romantic period, the artist incorporated his own feelings and views in the depiction of a certain subject.
- Philosophy argued that man was no longer a remote observer of the universe but that he is involved through his desires and emotions.
- The geographer observed the phenomena on the surface of the earth and identified certain forms as the subject of his research. He described and explained them. Geography saw itself as a science of space.

2. Functional stage:
- In Impressionist painting, the eye of the painter penetrated the subject, laying its structure free. In this way, the artist could interpret it in his own way.
- Philosophy saw the development of the phenomenological method, with the help of which things could be observed and analysed free of all preconception in order to understand

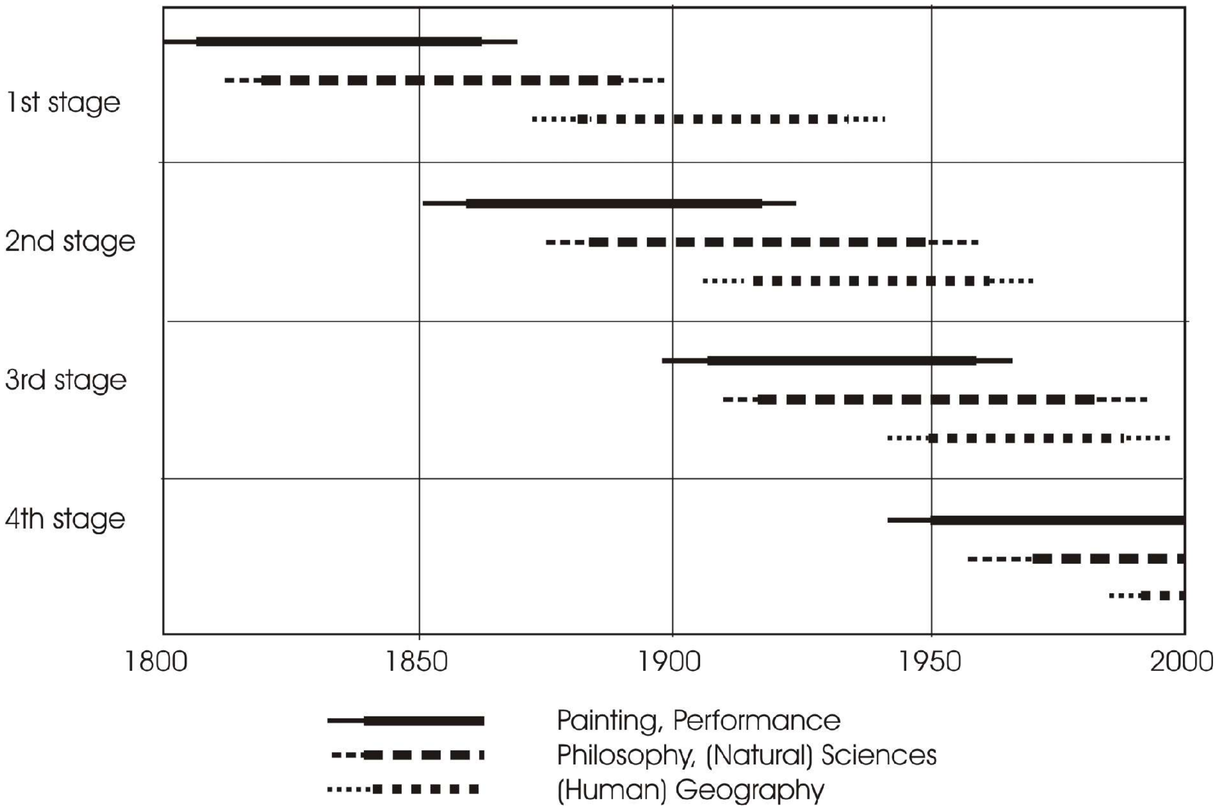

Fig. 83:
Classification of the stages of cultural evolution over the past two centuries.

correctly their meaning and position in the superior structure.
- The geographer studied the structure of forms. In human geography, humans appear as defined groups whose members display certain characteristics. They have a certain function for the forms. The objective was to define the structure of relationships in subdivided space and to gain knowledge of the parts in their functional context.

3. Sytem stage:
- The painters of the Classical Modern period took elements of reality and re-composed them according to their own ideas. In this way, they were able to create new entities and elucidate their own message.
- Philosophy concerned itself with the involvement of man in society. The deviations from the desired and expected were studied and analysed.
- The geographer examined the cooperation between materially defined components in different areas. Man appeared against the background of his dependencies. Developments take place within a structure which is oriented according to standards.

4. Process stage (evolving):
- In the art of the present, the painters free themselves completely from a subject. The picture is re-shaped according to the intentions of the painter. At the same time, other artists attempt to approach society's problems directly

through their own actions in order to change society (overlapping of two corner stages of centennial periods? See section 2.5.1.1, p.209).
- In philosophy the individual is the agent in his environment. Many different units of communication co-exist with one another. At the same time, research into chaos and complexity takes place in order to understand the formation of patterns and processes of spatial self organisation.
- The object of geographical research is man himself in his environment. He has gained influence as a member of society and with regard to his environment and attempts to shape these to his will. The process theory described in this book attempts to show how this takes place.

Behind this development, we see that the fundamental perspective of man has changed successively. This was expressed in the changes in the way in which man sees himself within his surrounding environment:
- At stage 1 he perceives a material environment (consisting of solida) which, (with his own intentions) he shares spatially with others;
- at stage 2 he takes his determined place as an element in a structured whole which consists of functioning elements (equilibrium system);
- at stage 3 he is part of a self regulating whole whose elements are interconnected by the flow of information and energy (flow-equilibrium system). He can affect their course;
- at stage 4 he is part of a self organising whole as an element in association with other elements (non-equilibrium systems). System und process blend together to form a unit.

Thus, translated into the terms of the process-sequence model (see section 2.4.1.2, pp.132), these 4 stages could be equalised as perception, determination, regulation and organisation. Seen vertically, the process of change penetrates more deeply into the specified object, i.e. society, at each stage. This can be represented in a simple diagram (see fig. 84). The 4 bonding levels are included one after the other (see fig. 67, main stage “reception”; section 2.4.1.2, pp.136). At each stage, people gain more influence on changes in their society and become more emancipated. Put in a general way, this means that, as complexity increases, the elements in the processes shaping the systems gain an increasing importance.

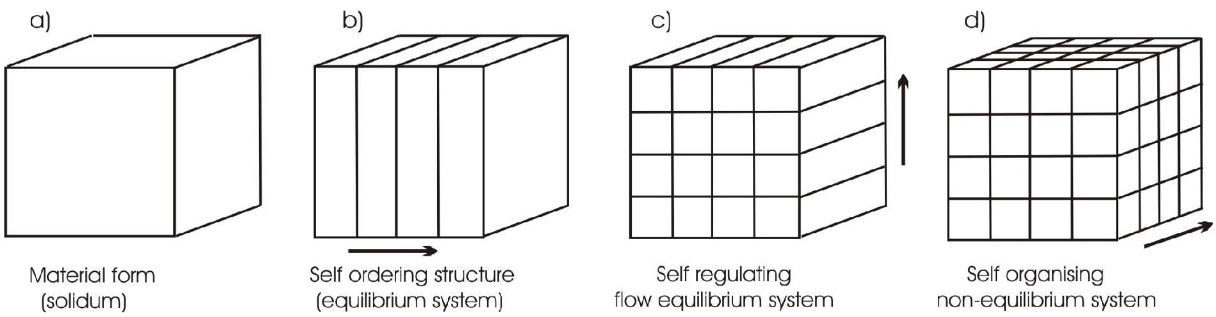

Fig. 84:
Geometric diagram illustrating the increasing complexity in the development of cultural evolution since 1800 (stages 1..4). Arrow: Direction of differentiation.

Kuhn's theory: These considerations bring us back to the study by KUHN (1962/67/88) quoted above. On the one hand, his assumption that the history of science does not progress continuously but in stages in the form of revolutions, is confirmed. These revolutions give rise to new theories and new perspectives.

On the other hand, contrary to Kuhn's assumption a certain progress can be made out in the sciences, at the metalevel. In this review over the last 200 years, scientific development has not been treated in isolation, but as a part of social development. The progress of knowledge is anchored in this.

Even if Kuhn has now (as mentioned already) modified this assertion, this contribution perhaps provides additional arguments through its new way of looking at things.

The processes in the superior context:

How can we fit these stages into the overall process of cultural evolution? In another context (see section 2.5.2.2, p.233) we have investigated the process which shaped the modern European age from the Renaissance to the present day and focussed our attention on the development of communications and industry in the period following 1800. We identified four stages, in which, among other things, traffic and industry underwent renewal and allocated them to the tasks of organisation, dynamisation, kinetisation and stabilisation. This is a process initiated by the superior environment and which serves production ("induction process"). In the process now presented, it is the population, which provides the energy for production through its labour, which itself is changed. We interpreted that process as a reaction process.

The question with which we are now confronted is:
How can we fit these stages into the centennial rhythm (see section 2.5.2.2, pp.234) of the overall process of cultural evolution? Induction and reaction processes could perhaps be seen as parts of twin processes which in turn consist of two process trains (A and B; see figs. 85 and 86). In another

Year	1800 1900 2000
Induction process Reaction process	- Org - Dyn - Kin - Sta - - Per - Det - Reg - Org -

Fig. 85:

Stages in the development of communications and industry (induction process) in chronological relation to the development of thought (reaction process) in the European cultural population since approximately 1800 AD.
Per = Perception; Det = Determination; Reg = Regulation; Org = Organisation; Dyn = Dynamisation; Kin = Kinetisation; Sta = Stabilisation.

context (see section 2.4.1.2, pp.142) we noted that process trains taking place simultaneously are typical of the process sequence. Thus, induction process may follow induction process and reaction process reaction process. For their part, these two process trains consist of a demand process which is followed by a supply process (displaced by a length of ca. 1/4 oscillation) in accordance with the Lotka-Volterra equations. If we plot these 4 processes as curves in a diagram, we may conclude that the development of communications and industry (in Germany, induction process) since approximately 1800 is part of the demand curve of process train A, and the development of thought (reaction process) part of the supply curve of process train B. Both complement one another, thereby stabilising the process. The opposing orientation should be of decisive importance for the course of the cultural evolution in Europe.

In the period under consideration, the European cultural population was the most important centre of innovation of mankind as a society. Some of the impulses were passed on in a modified form to other cultural populations. This process continued, although the centres of innovation moved to other

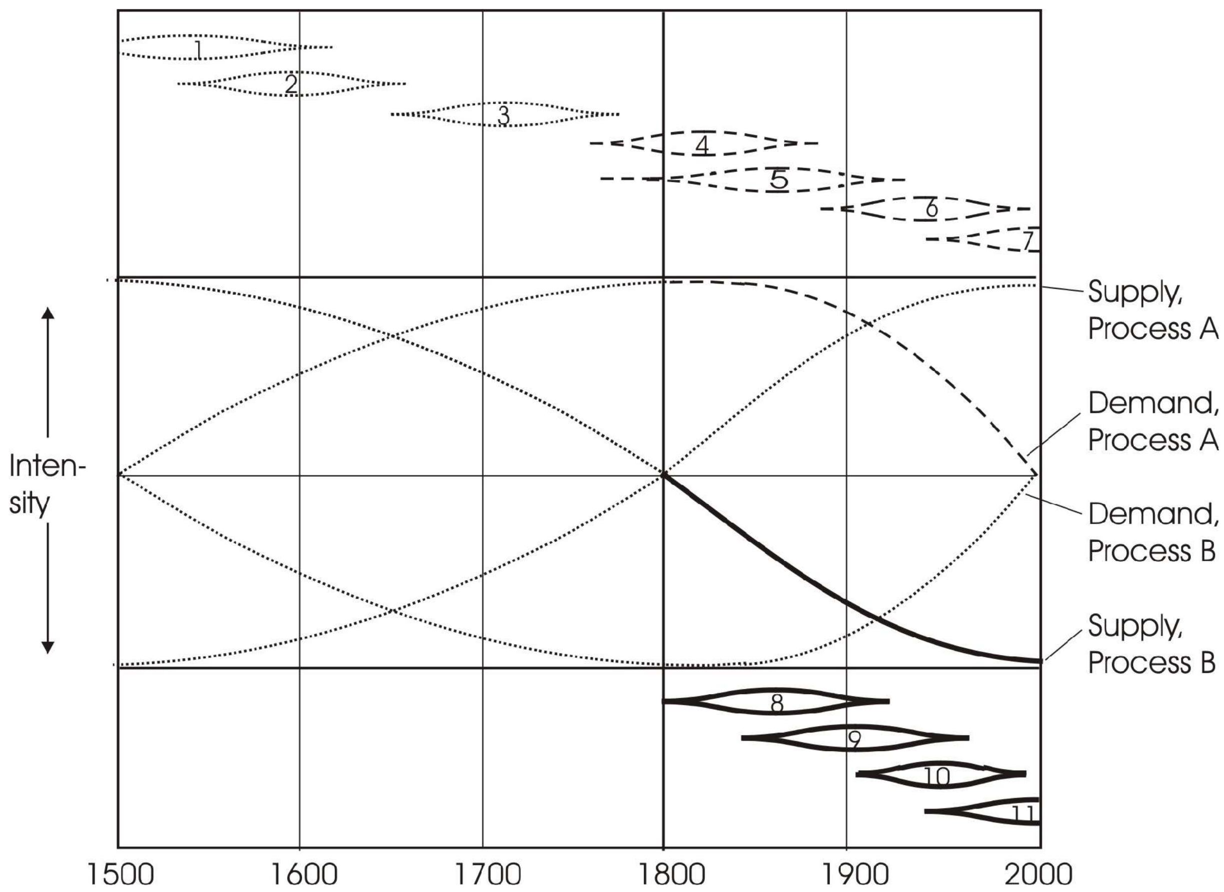

Fig. 86:
The development (in diagrammatic form) of the European cultural population in the past two centuries (lower section), showing how it fits into the rhythms of population development in modern times.
For information: In the top section (process train A): 1) Renaissance; 2) Reformation und Counter Reformation; 3) Absolutism; 4) Improvement in communications in the 18th and early 19th centuries; 5) first phase of industrialisation (old industry); 6) second phase of industrialisation (mass production); 7) high technology of the present.
In the bottom section (process train B): development of art, philosophy and science: 8) Material Stage; 9) Functional Stage; 10) Systemic Stage; 11) Process Stage.

parts of the globe (initially, it seems, to the USA). This also means that the process discussed here will continue in the phase of production or reproduction, but now spreads to the whole of mankind as a society. It remains to be seen how culture with its prominently European bias will be changed in the process.

Whether all these events and processes justify our division into periods is a matter for history to decide. To a certain degree the choice of institutions used as indicators plays an important role. The processes are of varying importance for cultural development. Here, the researcher has to make a decision of his own. In our theoretical discussion, it is only possible to give a superficial impression. The development of better defined criteria for decisions of this kind is without doubt one of the most important tasks for research.

2.4.2.2. Examples of non-equilibrium systems

We will now turn to examples of non-equilibrium systems from quite different areas of existence in order to illustrate the many different forms in which these may appear.

A technical system:

In many technical systems, energy and/or information is transformed. These systems are also non-equilibrium systems which carry out their work continuously. Technical non-equilibrium systems are tools in the hands of human beings. They function in accordance with the process sequence. The adoptive and reactive tasks are mostly specified by man or are

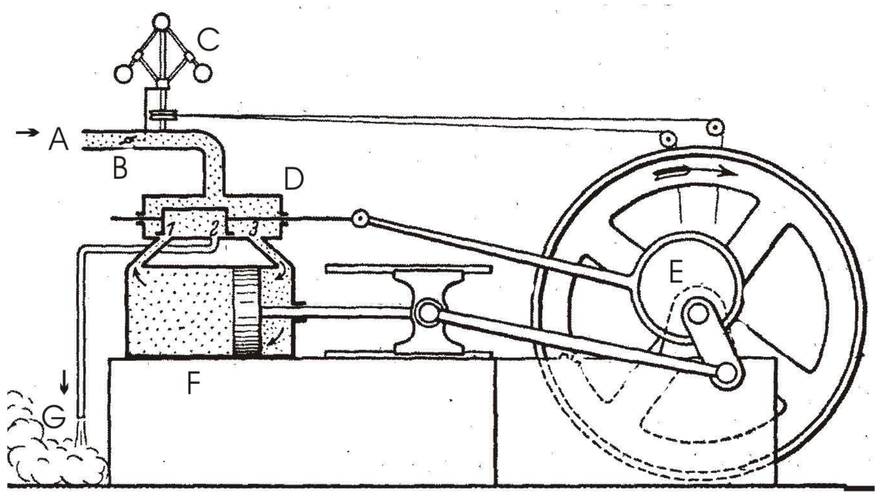

Fig. 87:
Diagram of a steam engine.
A = steam from the boiler, B = pressure valve, C = speed regulator, D = slide-shaft box, E = flywheel with eccentric cam, F = cylinder, G = exhaust pipe.

controlled or taken over by him. It is mainly the productive stages, i.e. the actual transformation of energy which is left to machines. One example of this is the steam engine, in which thermal energy is converted to kinetic energy (see fig. 87). The parts have certain tasks:
- Perception: the running of the machine is stimulated by man. He needs the power in the machine shop of the factory (as the superior environment).
- Determination: the machine is set to a certain power. This must be supervised by man.
- Regulation: Control of the machine is exercised by the steam-pressure valve B, the speed controller (C, set in motion by the flywheel) and other devices. Lubrication is also carried out to a certain extent automatically.

- Organisation: The steam is generated from the boiler (the inferior environment) through pipe A.
- Dynamisation: steam is fed to the slide-shaft box D. In the slide-shaft box, the steam is fed into the cylinder (F) or the exhaust-steam pipe (G).
- Kinetisation: The piston drives the flywheel (E) via the piston rod and the connecting rod. The flywheel in turn drives the slide-shaft box.
- Stabilisation: the power is transmitted to the looms via rods and drive belts.

Thanks to the development of control technology, machines now exist which are able to carry out several tasks on their own. Also the computer is a man-made machine. Its designers created it to process information and to provide useful data (as products) which enable other machines to process material products in accordance with the given information.

Organic and inorganic non-equilibrium systems:

The biotic non-equilibrium systems form the second large group in this type of system. It includes the cells and organs, but also the biotic populations such as the area systems, species and kingdoms. Living organisms play a particularly important part here. They transform energy, i.e. they produce. They are also programmed in such a way that they can organise themselves, i.e. that they can structure their elements and processes in such a way that they can fulfil this task while consuming as little energy as possible. Besides this, living organisms are also autopoietic systems, i.e. systems which organise themselves not only structurally like the non-equilibrium systems, but can also reproduce themselves materially and are therefore integrated in the general energy cycle through their own corporeality. They therefore also belong to the 6^{th} stage of complexity (see section 2.6).

Systems in the micro and macrocosmos (e.g. atoms, molecules, star systems and galaxies) also occupy a double position. On the one hand, they constantly convert energy as non-equilibrium systems. On the other hand, they also create themselves materially. In our order of magnitude, i.e. in the mesocosmos (see section 1) inorganic non-equilibrium systems as enduring self-maintaining structures characterised by division of labour and task processes do not seem to exist. However, many flexible constantly changing non-equilibrium systems emerge in the large compartments of the earth's crust (litho-, hydro-, and atmosphere). For example, they may take the form of swirls. Atmospheric examples of these are tornados, tropical hurricanes or the depressions in the temperate zones. Various bodies of air are moved structurally and dynamically and joined together to form new dynamic entities. These non-equilibrium systems are on the move and exist only for a few hours or days before breaking up again.

An impressive example is offered by the tropical cyclone (BLÜTHGEN and WEISCHET 1980, p. 415 f). The weather chart (fig. 88) shows a hurricane with its centre to the west of Cuba. It is a centrally and peripherally organised system of about 500 - 800 km in diameter which is characterised by a difference in air pressure of 1016 bars at the periphery and 968 bars at the centre with winds circulating at up to 45 knots (approx. 80 km/h). Areas of precipitation with lengths of up to 800 km can be seen running parallel to the isobar lines.

An essential precondition for the formation of a tropical cyclone is a layer of warm moist air lying over warm sea water (minimum temperature 26°C) as well as low air pressure provided by a depression originating from outside the tropics. This fringe depression sucks up the warm humid air in its vicinity. However, this air does not reach the centre directly but is deflected by the Coriolis force (already perceptible at 10° latitude north and south) and pulled into the system in a spiral path. In this area of converging air currents the warm humid air is forced to rise, resulting in cloud formation and extremely high amounts of precipitation (up to 1000 mm and over). The condensation releases warmth which in turn considerably accelerates the convection. This then increases the flow of air from outside producing wind velocities of over 100 km/h and locally over 200 km/h. Due to the vertical convection currents, an area of high pressure is created in the cooler layers of air around the top of the troposphere (approx. 12 km high) from which air is withdrawn to enter the general atmospheric circulation. At the centre of the cyclone, the so-called "eye", which has a diameter of approximately 10-30 km, there is a compensating downward flow of air which dissipates the cloud and causes the wind to drop.

Thus, the tropical hurricane can be seen as a gigantic heat engine in which the thermal energy is converted to kinetic

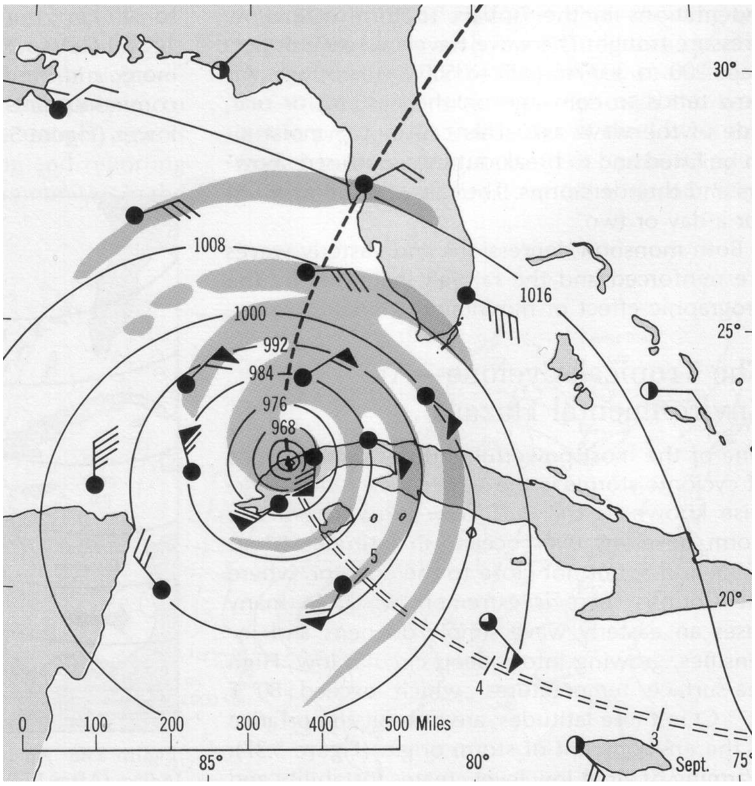

Fig. 88:
A hurrican in the West Indias as an example of an inorganic non-equilibrium system (weather map). The centre of the storm ("eye") is over West-Cuba. The shaded areas are the precipitation areas. The dashed line is the storm track.
After Strahler and Strahler.
Source: See "Notes on the figures".

energy. The processes of conversion from the gaseous to the liquid state of the water also plays an important role. By far the greater part of the energy is expended in the processes of elevation and only a smaller part in the horizontal movements i.e. the winds close to the surface of the earth and export movement in the upper layers of the atmosphere.

On the mainland, the tropical cyclone quickly loses its energy since the source of its energy, the warm humid air above the surface of the ocean is cut off, and forces of friction (including the damage to entire regions) slows down the movement of air.

Individuals as elements and as non-equilibrium systems:

In all the types of system reviewed, the elements were regarded as units and their internal features (structure, processes) not discussed. However, in doing so, we assumed that the elements have an existence of their own, that they strive to maintain their existence. We attributed to them certain interests and abilities of their own which make it possible for them to react individually. This is especially apparent in the example of the individuals. They play a decisive part in understanding the populations.

These elements should be interpreted differently from the "agents" of the "artificial society" (see section 2.3.2.2, pp.106). These have no existence of their own and are controlled from outside. For these, either fixed characteristics (e.g. sex) are prescribed or such characteristics as change through interaction with other agents or the peculiarities of the landscapes. These agents are not the image of a living being which aims to satisfy its own requirements, which depends on carrying out certain actions which are essential for its existence (action projects, see section 2.2.1.1, pp.38).

However, the agents too may be regarded as individuals in their specific roles, as elements of which it is possible to describe using the model of non-equilibrium systems. We have to take two basic facts into account, i.e. 1) that humans are incorporated in a society and contribute to changing it (this is their role), and 2) that humans are beings which have to satisfy their own (cultural, biotic) requirements. This must also be considered in the case of the agents.

Firstly in the tasks of the humans inasmuch as they belong to mankind as a society (see section 2.5.1.1, pp.205):
1. Perception: this is necessary for orientation in the environment. It is used for exploration, the formation of new communication links, the channelling of information and therefore the expansion of knowledge and experience.
2. Determination: individuals decide how to use their knowledge. In this way they exercise self-determination, give their actions, along with others, a direction and a purpose (e.g. "cultural functions" according to BOBEK 1948).
3. Regulation: humans adjust themselves to the hierarchy, e.g. of the state community ("political functions" according to BOBEK 1948). This allows them continuity of actions within regulated channels and the provision of protection from external influences ("Basic requirement of security" according to MALINOWSKI 1944/75, pp. 123). Communication is essential to this (PARTZSCH 1965).
4. Organisation: the individuals and their actions require space. The demand for space obliges them to co-exist on the surface of the earth. This raises the question of competition and the problem of the optimum location (Bobek's "toposocial functions"). This includes movement and transport ("overcoming of space")(PARTZSCH 1965: participation in traffic as a basic function of existence; Bobek's "migrosocial functions" are included here).
5. Dynamisation: individuals require the infrastructure of a community which allows them to utilise the environment to the best effect ("oikosocial" and partly "toposocial" functions according to BOBEK 1948).
6. Kinetisation: the actual action then follows. It is expressed in many ways. It includes for example, work in an

organisate through which energy from the environment becomes usable. It is here that the tasks mentioned in the above categories are completed.
7. Stabilisation: the extent of this supply has to be adjusted to the requirements of the demand and this is determined by consumption. The harmonisation of supply and demand produces stability.

Secondly: Whereas the people here are seen as producers procuring the materials they require by acting as part of the superior populations, the consumption starts at the 7th stage, i.e. the individuals as living organisms (as members of the mankind as species, see section 2.5.1.1, pp.214) absorb the materials they require. The induction process therefore leads into the reaction process.

This process in turn includes perception (finding out), decision, incorporation in a group, the overcoming of distance, as well as the intake of food, enjoyment of rest periods, reproduction etc. Unlike the populations, the individuals as non-equilibrium systems order the sequence of these action projects themselves in accordance with their own requirements and the requirements of the populations in which they are integrated as elements. It is important to remember that each individual can only carry out the projects one after the other and that he therefore has to adhere to a time allocation, e.g. day or week or year.

Thus, we take into account the multifarious links in a society due to the flow of information and energy, in which individuals through their private and professional lives and intentions are integrated.

City-umland system:

The city-umland-population is of special importance for the mankind as society (see section 2.5.1.1, p.206). This is reflected in the assignment of the concrete utilisation activities involved in the tasks of the process sequence. A clear ring structure is recognisable (the city of Saarbrücken as an example; see figs. 89 and 90; see also section 2.2.2.4, pp.58):
- Perception: The centre of the town is (from a geometrical point of view) the most accessible point, i.e. among other things because it is here that producers and consumers can come into contact with one another most easily. The retail trade forms a link between the two groups.
- Determination: This centre also attracts the organisates which are most important for making decisions in the economy, i.e. representative offices of companies, banks etc.
- Regulation: the public administration adjoins towards the outside. It supervises the good order and legality of activities, thereby forming a link between the system as a whole and its inhabitants.

- Organisation: The actual elements of the city-umland-system are the inhabitants. They consume. The workers also produce and live either from their work in the central business district or in the industrial areas around its periphery. It is here that those districts of the town and country population begin, which are engaged in the actual production.

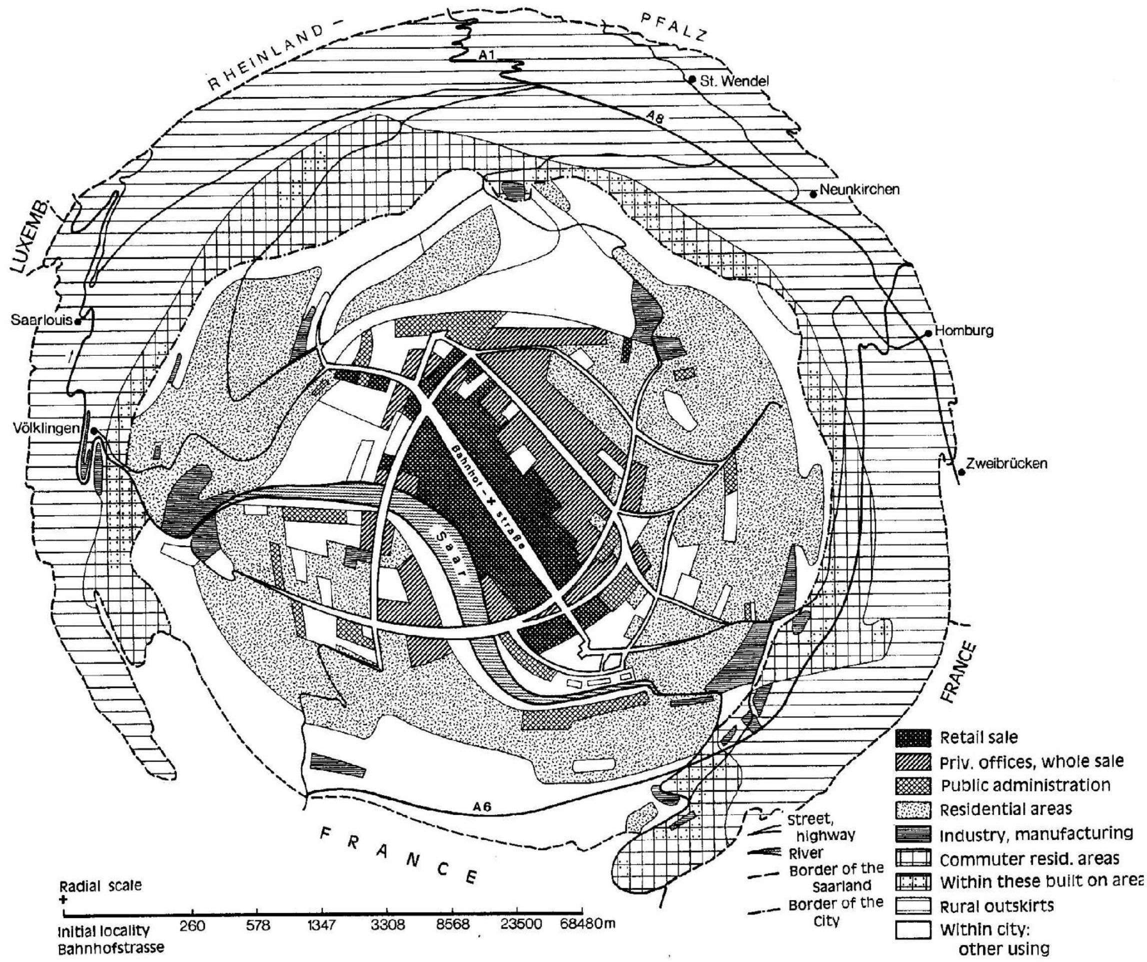

Fig. 89:
City-umland system Saarbrücken/Saarland, zoning of socio-economic activities (A). Result of mapping in the 1970s.
The distance from the centre to the periphery was entered according to the potential scale.
(Source: See "Notes on the figures").

- Dynamisation: Moving outward, places of high productivity and high energy consumption become more common, industrial plants, intensive agricultural units, market gardens etc..
- Kinetisation: Then come the large traffic facilities (railway shunting yards, airports, highway junctions, canal ports etc.). Here the communities are concentrated in which the commuters live, i.e. those population groups which are dependent on effective communications systems with the city.
- Stabilisation: The extensive outlying districts are occupied by agriculture and central places of lower rank (see section 2.5.2.1, pp.230). It is in the area of transition to the field

of influence of the neighbouring city-umland-population, that the system stabilises.

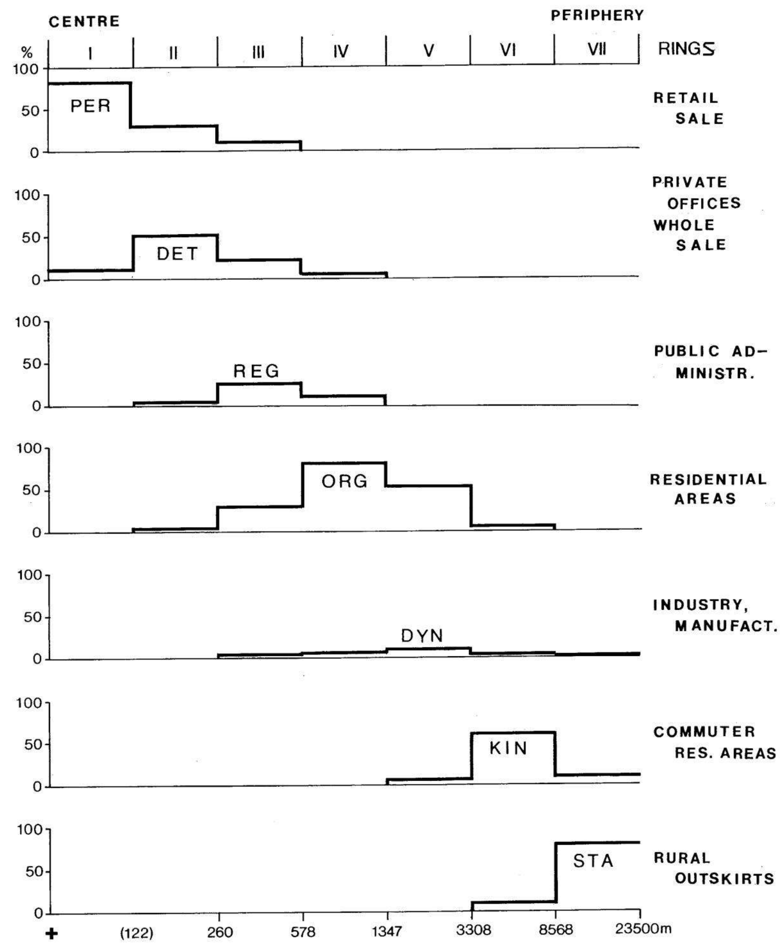

Fig. 90:
City-umland system Saarbrücken/Saarland, zoning of socio-economic activities (B). Result of mapping in the 1970s.
In the arrangement of the rings, the scale of tasks can be seen in accordance with the process sequence perception ... stabilisation.
Abbreviations: Per = perception, Det = determination, Reg = regulation, Org = organisation, Dyn = dynamisation, Kin = kinetisation, Sta = stabilisation (Source: See "Notes on the figures").

As the process goes on, the tasks change in radial direction (see fig. 91) from the centre of the system (in this case the central business district of the town) outwards towards the periphery of the umland. The task stages of the system are passed through gradually, as is typical for conversion processes in non-equilibrium systems.

Since the 1970s, the picture has changed slightly. The private car has become the favoured means of transport of the commuting population at the expense of the previously predominating public forms of transport. Many of the inhabitants have moved into the country, thereby attaching these areas more closely to the centre, i.e. the town as employer and shopping centre. On the other hand, new shopping centres with large car parks have appeared close to the residential areas. These too have loosened the economic relations between the retail business, the trades and agriculture, because the cost of transport no longer represents the same proportion of the final sales price as before. Thus, in certain sectors, the markets are dominated by extensive trans-regional and trans-national fields of influence. All this promotes change in the structure of production and population of the city-umland-populations.

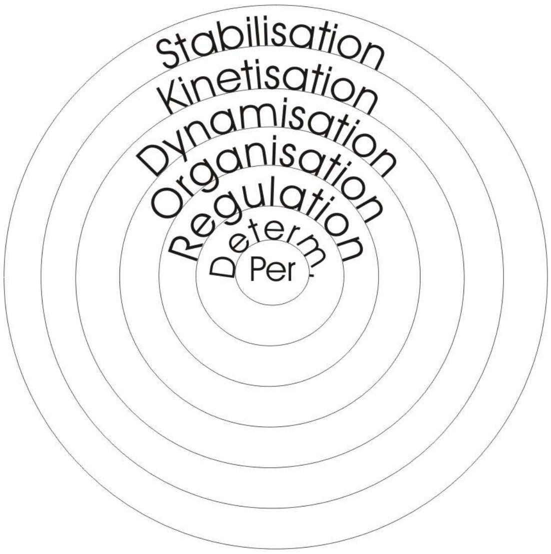

Fig. 91:
The process pattern in a spatial central-peripherally shaped non-equilibrium system (city-umland population). Scheme. The process leads from ring to ring, from the inside outwards (induction process). Per = perception; Determ. = determination.

Nontheless, the central-peripheral organisation of the population itself, i.e. of the actual system, is clearly recognisable. It will be interesting to observe how this development continues in future.

In each case the city-umland population is limited by the accessibility of the city. The commuters and the inhabitants of the surrounding area making use of the services provided by the town must be able to reach it, carry out their work or other business and return to their homes in the course of a single day, as is the case with the city-umland population of Saarbrücken in the Saarland. Very high-ranking centres have other functions (e.g. Frankfurt am Main which possesses a big airport and is a centre of finance) which go well beyond those of the city-umland population.

Time maps:

In section 2.2.2.4 (pp.59), we looked at an isochronal map in which the times taken for journeys were shown. With time charts, the procedure is reversed. The maps take the time duration as its basis. They depict "time space". These maps display features such as borders, rivers, towns, coastlines etc. on the surface in such a way that the distances between two points on the map are not shown in proportion to their spatial distance, but to the time taken to travel between them. I.e. with shorter travel times, the towns move closer together, whereas with longer ones they appear to be further apart. This leads to a geometrical distortion of the map.

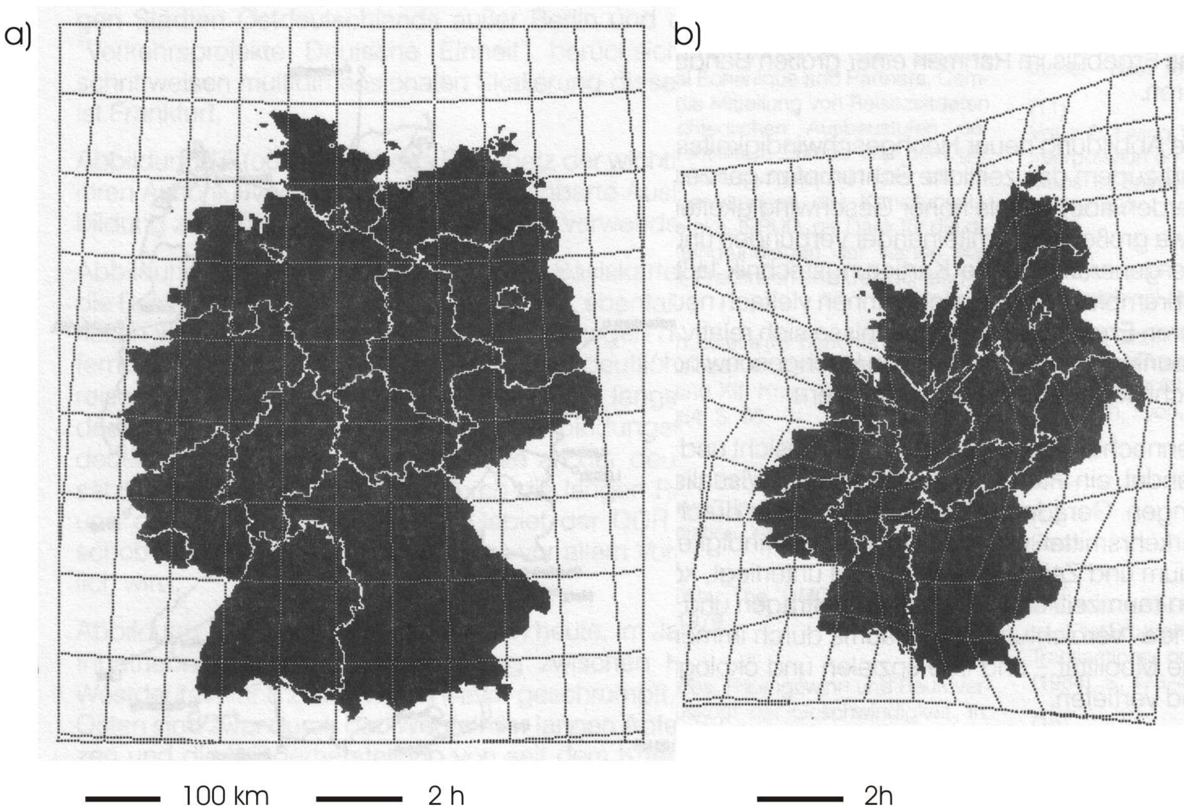

Fig. 92:
Time map using the example of rail travel in Germany.
a) Basic map (60 k.p.h),
b) Railway travel times 1993. The scale is not the spatial distance as in a) but the time taken to cover it.
After Spiekermann und Wegener.
Source: See "Notes on the figures".

If it is assumed that journeys everywhere in the region displayed on the map are undertaken at the same speed, the maps are similar to the conventional topographical maps (see fig. 92a). SPIEKERMANN and WEGENER (1993) called these basis maps. They are necessary for reasons of comparison. The example quoted here uses travel time by rail in Germany. It is assumed that all the distances are covered at an average speed of 60 k.p.h. The strong distortions (im fig. 92b) indicate that on most of the railways the speed of travel is greater than 60 km. per hour. The period has contracted, although to a different extent. Regions with a highly developed network are specially privileged. Time-space is especially reduced by high-speed railway systems. In West Germany, space seems to be condensed, whereas the territory of the former GDR to the east seems disproportionately large.

2.4.3. Process sequences and dominant systemic dimensions

Numerical sequence:

The conversion process is specified and arranged in a hierarchy of 4 process levels. The differentiation of the process dominates with a total of 16 task process stages (the fact that, in reality, only 13 and not 16 task process stages are defined is not taken into account here; see section 2.4.1.2, pp.139), and at the inferior process levels there are 64 control and 256 elementary process stages.

The non-equilibrium system is also anchored horizontally (temporally) in the environment, or, seen from a different angle, the non-equilibrium system has annexed a part of the temporal environment, i.e. taken over control of it (see twin processes, section 2.4.1.2, p.142).

The coordinate system is again passed through in horizontal direction (anti-clockwise, variant C of the basic process; see fig. 93a). As a result of the interlacement (see section 2.2.3, p.64) appears the new structure:
[f(x)], adoption (input): The demand (information) is entered as a stimulus from the previous environment.
[f(-x)], production (acception): The energy is absorbed from the inferior environment according to the capacity available, and in so doing is processed into the products demanded.
Now, the market-related flow of information and energy turns into the system itself:
[-f(-x)], reception (redirection). The succeeding environment is involved.
[-f(x)], reproduction (output): The system re-shapes itself as specified by reception and emerges in a new shape (self organisation).

Through folding the coordinate system is broken up and the process sequences are linked up. The task processes are horizontally ordered in the sequence. Here, the basic processes are doubly opposed. This corresponds to the sequence perception ... stabilisation in the induction resp. reaction process (see section 2.4.1.2, pp.128). In fig. 93b, the process of reaction (reception and reproduction) is folded behind the induction process ("emergence code"; see section 2.2.3, pp.64).

The second-order processes are vertically aligned (U variant). The "control processes" shown here keep the "task processes" supplied. The number table, fig. 93a, should be reversed accordingly. The newly formed numerical sequence (see fig.

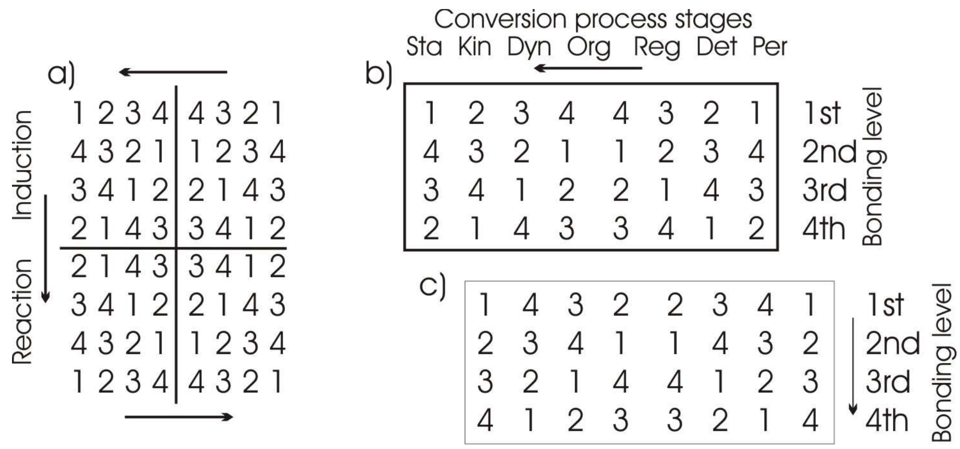

Fig. 93:
Scheme of the conversion process. Numerical sequence.
a) 1st rank process (C variant, see arrows) before folding: Development from right to left. The main processes are sub-divided chronologically by the task processes. Both of these together form the first-order processes. The reaction process (see section 2.4.1.2, pp.136) i.e. the opposing part, is symbolised in the y-negative area (from left to right).
b) 1st rank process after folding: The lower part of the processes (reaction process) is folded behind the induction process. So only the induction process is visible here.
c) 2nd rank process (U variant), folded.
About the operations see section 2.2.3, pp.62.
Abbreviations: Per = perception, Det = determination, Reg = regulation, Org = organisation, Dyn = dynamisation, Sta = stabilisation.

93c) can now be compared with the table representing the course of the process with the corresponding formulae (see fig. 77).

Route diagram:

The course of the entire process is shown in fig. 94. To achieve clarity concerning the flows themselves, it is necessary to unfold the numerical sequences of the systems. We are dealing with variant C of the basic process, i.e. the process course tends to the left. The entrance from the previous environment and the exit to the succeeding one are shown at the centre of this diagram. In particular, it should be noted that two different halves of the overall process must be distinguished. In the upper half, the induction process (stages 1 and 2, adoption and production) is located. The lower half is taken up by the reaction process (stages 3 and 4, reception and reproduction). Here, the order in which the processes take place is reversed. In the main stages of adoption and reception, the task stages of perception ... organisation can be seen, and in the main stages of production and reproduction, the task stages organisation ... stabilisation. These processes are structured as flow processes (see section 2.4.1.2, pp.130).

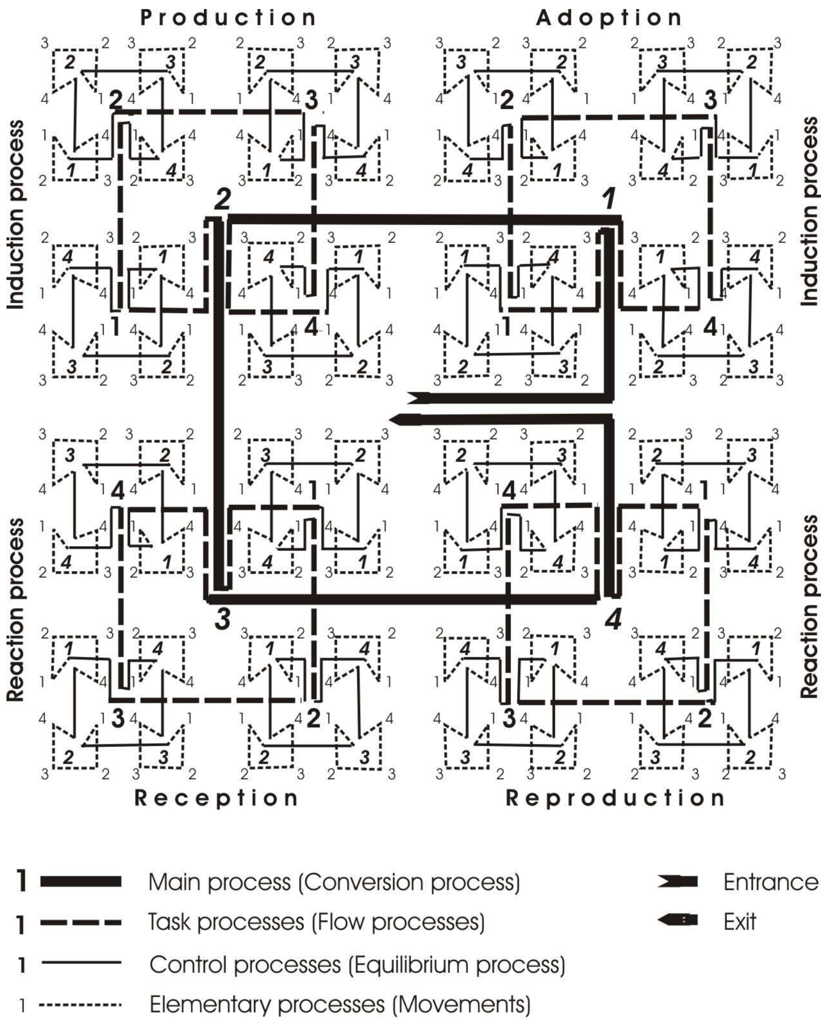

Fig. 94:
Route diagram of the Conversion process (Non-equilibrium system), assigned the processes and systems of the lower complexity levels.

The stages of the 1st rank basic processes can be assigned to the systems structured according to the C variant. Each of the lower basic processes shown in the diagram represents a large number of individual basic processes.

The dominant systemic dimensions (see fig. 95):

Time: In the conversion process, not only are the beginning, sequence and end determined, but also the chronological rhythm fixed (2nd process train). The chronological rhythm from the environment (oscillations) is brought into harmony with the internal processes of the system. The environment is seen as being chronologically preceding and succeeding and can therefore be linked with the process in the system. Inside and outside (e.g. market) the sequences can be coordinated with one another, i.e. the process rhythms can be harmonised. In this way time is established as an independent system dimension. The planning of time and the shaping of space can be undertaken independently of one another. For the structuring of this type of system, the time dimension is predominant.

Space: This requires an internal spatial order and an external border. This core space can now be organised to suit the process sequence. The processes in the different internal departments can be linked with a minimum of space between them. System, departments and elements form a unified organisation. The self-organisation represents the internal predominance of the system dimension of the space. Process fluctuations peculiar to flow-equilibrium systems are reduced by stricter control.

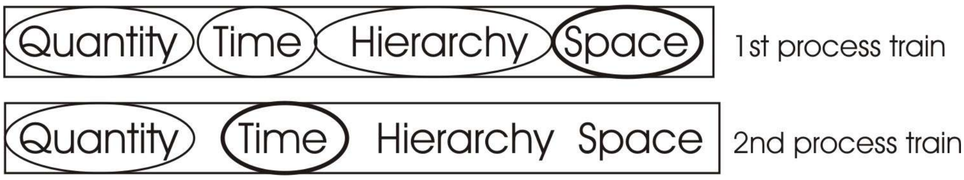

Fig. 95:
Space appears as the predominant system dimension in the 1st process train and time as the predominant system dimension in the 2nd process train.

Moreover, this requires an external space of influence which allows contacts with other systems. The superior and inferior environments are realised spatially as areas of influence. These areas also consist of non-equilibrium systems which stimulate or are stimulated. The superior environment is formed by those systems which demand and receive products through the market (marketing area), the inferior environment of the energy and material suppliers (supply area). Thus the flow process rhythms can be harmonised and the process sequence co-ordinated. The environments are not subject to the same control as the internal departments. Here, it is self-regulation which takes place, as with the flow-equilibrium systems.

Outlook:

Products generally consist of different parts which have to be processed and assembled. This takes place in processes of conversion. These require a division of labour and accurate coordination of the various operations. They have to be organised in such a way that the products are available when the market (i.e. the superior environment) requires them.

This type of process is therefore very different from a flow process. However, the objects of study as such are the same. They are either non-equilibrium systems, which construct the flow equilibrium systems (= compartments) and are stimulated to activity by these through the diffusion of innovations (e.g. factories in the operations of the market), or flow equilibrium systems, which are involved as compartments in the flow of energy of a non-equilibrium system (e.g. a factory).

There are a number of possible results depending on the question asked and the method of examination. Unless the right approach is adopted, this border zone between the third and fourth level of compmlexity is elusive, and it is easy to understand why the different nature of the two types of system remained concealed for so long.

The internal flows of information and energy in the non-equilibrium system are optimised in the conversion process. But the contact with the superior and inferior environments is achieved only through feedback, i.e. only after completion of the conversion process is it certain whether the products meet the requirements. It may therefore be advisable to incorporate a more precise control here in order to moderate the fluctuations associated with feedback. The non-equilibrium system must receive a task for the overall proceedings at a higher level. This can only be achieved in a superior hierarchic system in which every non-equilibrium system is allocated an exact position and has to maintain itself there. The hierarchy becomes the predominant systemic dimension at the next higher level of complexity.

Re: Dietrich Fliedner:

Processes constitute our complex reality. A theoretical investigation

<http://scidok.sulb.uni-saarland.de/volltexte/2005/482>

Correction

Page 125, line 4 – 10:

- 2nd process stage: It is necessary to calculate how the increased value is dosed and tansformed into an elevated number of steps, with which the elements can be brought into a new space. The formula for a linear development:

[18] $$N_n = N_{n-1} + k$$

(n = number of steps at the moment n; k = constant, ascend factor.