2.5. Hierarchy processes and hierarchy systems

2.5.0. Instead of an introduction: The textile factory as a member of mankind as society

The factory was bound up in a web of economic and social relationships. It had to sell the fabrics (cloth and blankets) it produced, but on the other hand, it had to purchase the raw materials and a multitude of other goods, machines and services. It also required workers, which, as independent individuals, had to be able to lead their own lives culturally and economically in the community in which they lived.

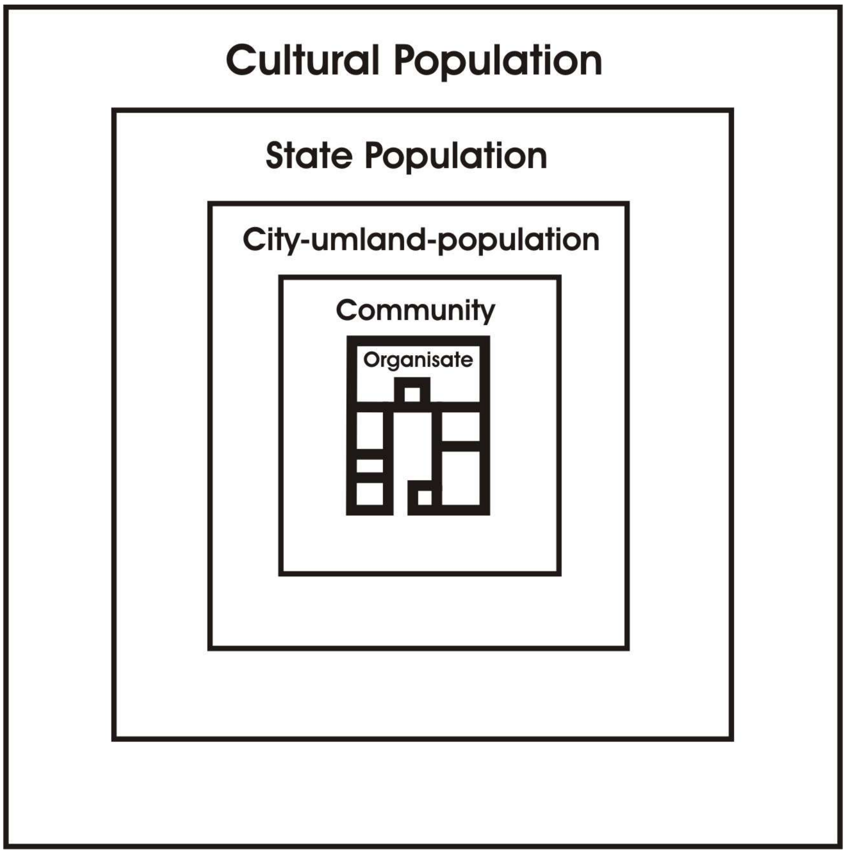


Fig. 96:
The textile company in the hierarchy of populations.

The factory was situated in a small town and was therefore part of that community (see fig. 96). It paid taxes and other duties to it, but also benefited from the services it provided. The community is traditionally responsible for the local infrastructure, i.e. for the way in which land is used, for the construction and maintenance of roads, bridges, schools, sports facilities, cultural institutions etc. On the other hand, the community must ensure the protection of the environment, conservation of the landscape, disposal of waste and sewage. It is the infrastructure which makes it possible for the organisates to function. Besides these, there are private central institutions (organisates) such as shops, cinemas, doctors' surgeries, chemists, banks etc. which are generally grouped around the centre of the community where they are easily accessible for the inhabitants. All the places of importance for day-to-day business can be reached in a relatively short space of time (in smaller communities in less than an hour) either on foot or by transport. The community offers the organisates not only the environment they require, it is also the living space of its inhabitants. These inhabitants live with one another and develop their own forms of social communication. Common festivities, clubs and social institutions, assistance among neighbours bind the people together, are the expression of a strong social coherence which also includes social control.

The smaller communities are linked with the nearest large city by public-transport systems and private vehicles. It is the economic and cultural centre of the region, with vast range of shopping facilities, banks, insurances, medical specialists, hospitals, theatres, institutions of advanced education and many other services. As a large industrial centre, it also offers employment to those who find no suitable work closer to their homes and have to commute daily. The country surrounding the city provides it with the greater part of its foodstuffs and provides recreation and living space to many of those who work in the city. Thus, besides the rural and small-town communities, a population has become established which is based on the city and its surrounding district: the city-umland population. Its function is to permit a balance between the commercial/industrial and the land-based agricultural activities in space (see section 2.4.2.2, pp.191).

This population is in turn subject to the state which guarantees safety and the protection of the law. For this purpose too, taxes have to be paid. Certain restrictions on individual freedom have to be accepted, although every citizen requires a clearly established legal framework for self-fulfilment. The police departments are present in the community, but it is principally the legislative and executive functions exercised by the state which make it possible for the organisates to develop economically and benefit from the markets and finance industries. Some of these state functions are fulfilled by local government institutions.

The inhabitants of the communities, city-umland populations and states are generally also members of religious communities. For instance, the church as an institution conveys religious and philosophical, i.e. "eternal" values, and sets ethical standards. They are a constituent part of the culture, whose carriers are the entire cultural population, e.g. of Europe, the Orient, Eastern Asia.

2.5.1. General considerations

2.5.1.0. Introduction:

The "hierarchical system" and the "hierarchical processes" constitute the 5th level of complexity.

Every working person is on the one hand part of the socio-economic hierarchical system which we will term "mankind as society" and, on the other, as a living creature, part of the biotic hierarchical system which we will term "mankind as species" (see section 2.5.1.1, p.214). Here, we are primarily concerned with membership of mankind as society.

The society appears as a hierarchically structured formation composed of populations. As an organisate, the textile mill occupied a certain position - as a socio-economic population in which individuals worked and produced. The organisate provided the economic basis for the individuals working in it and enabled them to resolve their personal cultural, physical and biotic problems (as expressed in nourishment, reproduction, rearing of children, provision for old age etc.).

In order to cope with their working lives, individuals have a multiplicity of different problems to solve. This is only possible because they are embedded in this hierarchy which relieves them from certain specific qualitatively (thematically) definable tasks which they are unable to fulfil themselves. Each individual (who himself appears both as worker and consumer) belongs to these populations. Their characteristic features and their integration in the hierarchy with regard to process and structure will be described in more detail below.

2.5.1.1. System and process

First of all a brief preview:

1. The population types have - as mentioned already - certain tasks for society. These tasks are given thematic form within the framework provided by the institutions of work, consumption, traffic etc.
2. At the hierarchical levels, the populations fulfil their tasks through processes (see section 2.4.1.2, pp.127). These too are in a hierarchical relationship to one another. The populations provide work for the hierarchically superior populations. This should be reflected in the duration of the processes.
3. The populations are arranged hierarchically in such a way that the more general institutions include the more specialised ones, and that the larger populations are in a system-subsystem relationship to the smaller ones. Two hierarchies can therefore be distinguished.
4. The hierarchy also takes effect in the spatial arrangement of populations since the superior populations encompass the inferior populations spatially. Moreover, the populations as

non-equilibrium systems have fields of influence through which spatial interlinking is possible.

The catalogue of tasks and institutions, the populations as carriers:

Originally, mankind was a species like many others, i.e. a population, a non-equilibrium system, which fulfilled all the tasks fulfilled by any population intent on survival. In the course of mankind's history, individuals have delegated more and more of the tasks necessary (or useful) for life, by coming together to form superior entities, i.e. new populations, and dividing up their activities or work. There are no completely self-sufficient individuals who can carry out all the tasks necessary for living themselves. Becoming human is causally bound up with the process of specialisation. This process of division and subdivision into specific tasks is part of cultural evolution and experienced a dramatic acceleration around 30 - 20.000 years ago with the result that mankind is now a highly complex structure.

In the last resort, it was most probably economic reasons (effectiveness) which were decisive for specialisation.
As basic requirements, the biotic necessities (health, recuperation, nourishment, security, reproduction etc.) explain an ever-increasing differentiation, for example in economy, technology, transportation etc. continued to sub-divide rapidly. Thus, mankind divided (as already mentioned above) structurally into two parts, which developed differently:

Mankind as species, within which individuals satisfy their biotic requirements, and mankind as society, responsible for the optimum utilisation of environmental resources, for energetic supply and for comfortable conditions of living (see also section 2.5.2.1, p.214). Each individual belongs to both types of mankind. In order to understand and categorise the multitude of tasks and activities of humans from their structural side, we must proceed step by step.

The single action projects resp. processes are concretised, i.e. thematically institutionalised. This includes a division of human activities according to the tasks, i.e. the thematic or qualitative aspects. In institutions, this thematic division through different norms and organisational forms (as well as through feedback, see section 2.3.1.1, pp.77) is given permanent form with the result that they represent components of order which are generally accepted by society.

In some comprehensive institutions, the basic socio-economic activities and processes are easily recognisable. Mankind as society must - like any population (see section 2.4.1.2, pp.130) - fulfil the tasks listed above (perception ... stabilisation) in order to exist. One might now enquire which of the institutions may be assigned to a specific task. These institutions which are, so to speak, of the highest rank are described as "basic institutions". Each of these institutions is embodied in a certain type of populations. They are the carriers:

- In order to have a foundation for vital decisions, it is first necessary to obtain information. "Perception" appears as a task. It is the essential pre-condition for all (non-spontaneous) action. By nature, humans possess an organism which is identically equipped with senses which permits them to perceive the advantages and disadvantages of nature as a vital resource. "Knowledge" and "science" as well as "art" are the basic institutions. They are founded on perception, and this is, in a general sense, essential for allowing mankind to cope with its environment and adapt its behaviour to it. The carrier is the mankind as population.
- How humans act depends (in the last resort) on their basic attitude to life and their environment. It is a decision. In the catalogue of tasks, "determination" now appears. "Religion" (as a basic institution) as well as the "conveying of values" in general, give mankind its fundamental orientation, its sense. They establish the desired, if not always achievable, ethical ideal. This forms the units, which are distinguished by a certain view of life ("culture"), a definable position in the cultural evolution, i.e. by the degree of division of work. The carrier is the cultural population.
- "Authority", "power" and "rule" form the basic institutions connected with the task of "regulation". They ensures that the actions and processes are carried out in accordance with law and order. They form the framework within which the process steps can be co-ordinated, in which the passage of information can be controlled. Without control, no co-ordination is possible, and work is dissipated without effect. The carrier is the state population.
- "Transportation" and "interchange" (as basic institutions) permits spatial "organisation". The resources of the inferior environment can only be utilised to the best effect by linking the differing advantages of the various localities with one another. So the services and the trades and the dwellings at the centre are linked with the agriculture and the recreational facilities in the surrounding country. The carrier is the city-umland-population.

At this level, the population types in the hierarchy are divided between those which serve the processing of information and those which serve the processing of energy. Whereas the populations situated higher up the hierarchy process more abstract information (science and art, religion and control), those lower down the hierarchy are concerned with the activities devoted directly to the processing and distribution of energy.
- The utilisation of the energy resources of the inferior environment, i.e. the task of "dynamisation" is made possible by the creation of the "infrastructure" (as a basic

institution), among other things of the earthbound artefacts (see section 2.1.1.1, p.18). The carrier is the community.
- The "processing" of the products themselves (as a basic institution) is defined by the task of "kinetisation". It is linked with the division and organisation of work. This may involve completely different things and the product may be of material or immaterial type. At this level, the immense variety of intellectual and material products, typical of a society based on the division of labour, is manufactured. The carrier is the organisate (see sections 2.4.1.1, pp.121, and 2.4.1.2, pp.127).
- Planned physical and intellectual activity may be defined as work. The remuneration for work allows man to satisfy his requirements. "Work" and "consumption" are the basic institutions located at the end of the scale, thereby fulfilling the task of "stabilisation". Here, the elements in the hierarchical system are formed. They receive their income from the services they provide, and must also provide services for the superior populations. The carrier is the individual (in his role).

In Tab. 1, the results of this section are summarised.

Tab. 1: The population types of mankind as society, basic tasks and basic institutions:

Population types	Basic tasks	Basic institutions
Mankind as population	Perception	Science, art
Cultural population	Determination	Religion, culture
State population	Regulation	Rule, power
City-umland-population	Organisation	Transportation
Community	Dynamisation	Infrastructure
Organisate	Kinetisation	Processing
Individual	Stabilisation	Work & consumption

The hierarchy of processes:

All these institutionalised tasks are constituent parts of human existence. They must be realised in temporal succession, i.e. in processes. We must take this into account in two respects:
1. Mankind as a society is in general undergoing change. A constant change can be detected, renewal against the background of social change. The renewal does not take place continuously, but in the shape of innovations (about the diffusion of innovations see sections 2.3.1.1, pp.79, and 2.3.2.2, pp.105). These arise at the individual hierarchic levels which join up to form flow-equilibrium systems. Their

elements are the populations as subsystems (see below and section 2.5.1.2, pp.221). The basic institutions are come into being in the flow-equilibrium systems. In reality, the above-mentioned list of tasks is worked through step by step in the form of a process sequence, it begins with perception, determination then follows, then regulation etc.

2. At the various hierarchical levels, the processes (in the populations) take place at different speeds. The validity of established views, technical standards, fashions etc. lasts for different lengths of time. There are "eternal values", i.e. those which are unshakeable, in particular the accumulated knowledge of the world and the basic ethical standards. Besides, the term "longue durée" (BRAUDEL 1958/92) can be applied to state policies, large-scale technical installations (e.g. the railways), artistic periods which may involve many decades or even centuries. The local infrastructure of economic activity has to be changed more frequently, every few years. Finally, the yearly, monthly, weekly and daily periods should be mentioned, which strongly influence the conditions of life and work in their details.

If one establishes that the inferior processes provide work for the superior processes, one can come to the conclusion that the processes differ by the factor 7, because each process sequence (induction process) comprises 7 stages (perception ... stabilisation). Actually, - and this is suggested by the inductive results of earlier studies (FLIEDNER 1981) - the average number is 10. Why this should be so is not well understood. In particular, this factor 10 becomes apparent in the processes higher up the hierarchy. With the shorter processes, there are variations primarily because nature imposes a different rhythm (yearly rhythm, daily rhythm).

The cyclic structure of processes observable in the "rhythms" is due to the feedback at the end of each induction and reaction process (oscillations; see sections 2.3.1.1, pp.78, and 2.4.1.2, pp.128). If we carry out a classification, we define the duration on the basis of the individual process stages (perception, determination etc.) and not on that of the overall process sequence of the induction process.

The principal process of the mankind as society is that of "cultural evolution" (see also section 2.4.2.1, pp.147). In the earlier palaeolithic era, humans were hunters and gatherers. They spread over the earth little by little and so created their living space, the ecumene. In the later palaeolithic era, a new chapter in the history of mankind began. The humanity grew rapidly; it was accompanied by the invention and spread of innovations, in particular of technical equipment for economic purposes, which indicates increasing knowledge of the (energetic) environment and the possibility of its utilisation. The hunters and gatherers became more differentiated. In the course of the evolution, mankind as a society developed structurally out of mankind as a species. Thus, the energy in the ecumene could be obtained much more efficiently. Indeed, not only the extraordinary growth of the population, but also the increase in life expectancy and living standards proved that mankind was learning to exploit the resources of the inferior environment much better. The differentiation of the flow of energy and the differentiation in hierarchically arranged populations is essential for this.

The tasks of society incorporated in the basic institutions gradually became more specific and a hierarchy came into being. In this way, mankind took the form of a hierarchical system, mankind as society. Mankind perceives the possibilities in its environment, accumulates knowledge and with this knowledge, creates the basis for its own existence. The state of knowledge is reflected in the processes. It is possible to distinguish 7 process levels (see table 2; examples see section 2.5.2.2, pp.233):

1) The cultural evolution as a whole is divided into different stages which are initiated by "revolutions" (see in particular CHILDE 1936/51). They show (provided we are correct) that mankind as society develops in a process, each of whose stages take several thousand years, i.e. in "millennium rhythm". The carrier is the mankind as a population.
2) Hierarchically, the next lower level is formed by processes whose stages cover several hundred years ("centennial rhythm"). At this second level, religion is created, the fundamental decision in the shaping of one's own culture. This is the basic task of "determination" in the hierarchy of processes. The carriers are the cultural populations.
3) The "decennial rhythm" covers several decades with an average of 50 years. It is apparent in a large number of ways e.g. in the so-called Kondratief Cycle (KONDRATIEF 1928; see section 2.3.2.1, p.104), in historical periods. The carriers are the state populations.
4) Also the "several-year rhythm" whose stages last for an average of 5 years has not yet been sufficiently studied. At this level, society is ordered spatially (in the hierarchy of processes, the basic task of "organisation"). The carriers are the city-umland-populations.
5) The "yearly rhythm" can be observed particularly easily in infrastructural measures, e.g. in settlement activity (in the hierarchy of processes, the basic task of "dynamisation"). The carriers are the communities.
6) The execution of the processes in detail (in the hierarchy of processes, the basic task of "kinetisation") is carried out in the "monthly" or "weekly" rhythm, with the result that the work is completed within one year. The carriers are the organisates.
7) Finally, individuals plan, work, eat and recuperate on a "daily rhythm" (in the hierarchy of processes, the basic task of "stabilisation") according to the possibilities at their disposal and the constraints to which they are subjected.

Here, there is little or no process sequence involved. The carriers are the individuals (in their roles).

Table 2: The population types and basic tasks of mankind as society and the duration of the processes:

Population types	Basic tasks	Duration of processes (stages)
Mankind as population	Perception	Millennial rhythm (approx. 5000 years)
Cultural population	Determination	Centennial rhythm (approx. 500 years)
State population	Regulation	Decennial rhythm (approx. 50 years)
City-umland-population	Organisation	Several-years rhythm (approx. 5 years)
Community	Dynamisation	Yearly rhythm
Organisate	Kinetisation	Monthly - weekly rhythm
Individual	Stabilisation	Daily rhythm

Through the established process sequence, i.e. its fixed program (teleonomic processes; see section 1), the overall process of cultural evolution appears as an oriented process which continuously shapes human society with many variants, at every level and in every stage, thereby leading to ever-increasing complexity. The course of the process is determined by legitimacy and individuality, necessity and chance. It is within this framework that the reaction processes take place, i.e. in the populations of the mankind as species and its various hierarchical levels (see below). This either preserves or changes the structure of the entire hierarchical system.

In this treatise, it has only been possible to describe the ideal model. In reality, populations are linked to one another in a much more varied way, chronologically, hierarchically and spatially. This fact has to be taken into account, when the model is regarded as a module.

The hierarchy of subsystems:

Introduction:

Through hierarchies, the production of the non-equilibrium systems can be co-ordinated, the processes, i.e. the flows of energy can be controlled and the energetic resources of the environment to a great extent optimally exploited.

As shown above, 7 levels can be identified in the hierarchy of mankind as a society. These differ from one another in their tasks and institutions. The institutions are arranged in flow-equilibrium systems. The processes in these various hierarchical levels are carried out by populations (non-equilibrium systems). These are - as mentioned already - the carriers of the processes. The processes differ from one another in their duration. The question now arises as to how cooperation is possible in these various types of system. The processes can only take place within an organised framework which offers them the necessary security.

We distinguish two types of hierarchy (SALTHE 2001):
1) The "specification hierarchy" arises through division by content and typology. Thus, according to Salthe the "physical realm" is an essential precondition for the "material realm" which in turn is necessary for the "biological realm" etc. Our own example: With mankind as a society, a qualitative or thematic hierarchy appears, a scale which demonstrates the degree of dependency. It is a hierarchy of flow equilibrium systems.
2) The "scalar hierarchy" is created by the sub-division of structure and space. AHL and ALLEN (1996, pp. 107; they use the term "nested hierarchy") use an army as an example. It consists "of a collection of soldiers" and "is made up of them". Our own example, mankind as a society, is divided into populations which have a hierarchic relation to one another. It is a hierarchy of non-equilibrium systems.

Specification hierarchy:

Seen in this way, mankind as society proves to be an example of a specification hierarchy because the division of the levels into tasks and institutions also possesses a sectorally based hierarchic structure (see above). Knowledge (1st level) is essential for living, for dealing with the environment. The form of living (culture, 2nd level) must adapt itself to this. Power (3rd level) on the other hand is conceivable within a cultural framework. And the control which it creates is essential for functioning transportation and interchange (4th level). In this way, the communities (5th level) can organise their infrastructure according to the overriding economic and traffic networks in such a way that the organisates (6th level) can fulfil their task with the employees (7th level) operating them. In the course of cultural evolution, the division into tasks may indeed have been of prime importance and it was increasingly stabilised through division into different population types.

If we assume that mankind as a society developed from mankind as a species primarily as a result of economic requirements, mankind as a species (as part of the biosphere, see section 2.6.2.1, pp.269) can be regarded both as the superior and the inferior environment. The individual hierarchic levels (institutions) are formed by groups of populations (non-equilibrium systems). Seen structurally, these groups are flow-equilibrium systems which define the basic tasks (perception ... stabilisation). In their context they are (flow equilibrium) subsystems (see above and table 4, section 2.5.1.2, p.222).

These flow equilibrium systems (as institutions) in the hierarchy are divided between those which serve the processing of information (like the adoption) and those which serve the processing of energy (like the production). Whereas the systems situated higher up the hierarchy process more abstract information (science and art, fundamental outlook and religion, and control), those lower down the hierarchy are concerned with the activities devoted directly to the processing and distribution of energy (see below). Between these two part hierarchies, the flow-equilibrium system formed by the city-umland population has the task of taking the energy from the natural environment (ecumene) and of passing it on to the hierarchically inferior populations (communities, organisates) and individuals to allow them to make the required products within the context of the flow of energy.

The process from above to below is the induction process, the reaction process leads from below to above. The levels are connected to one another through links of demand (induction) and supply (reaction). As outlined above (see formula 15, section 2.3.1.2, p.90), these can be described in the form of Lotka-Volterra equations. So the information and energy products of the populations on the levels can be transmitted between the demanding consumers (induction) and the supplying producers (reaction) in the form required.

In detail (the example of 3 levels): The information, i.e. the demand from flow equilibrium system A is fed into flow equilibrium subsystem B (see fig. 97). The appropriate non-equilibrium systems absorb it and they then demand energy from the inferior flow equilibrium subsystem C, which is then supplied by the non-equilibrium systems. However, they on their part demand energy from their own inferior environment. Thus, the flow equilibrium subsystems B and C are both suppliers and demanders.

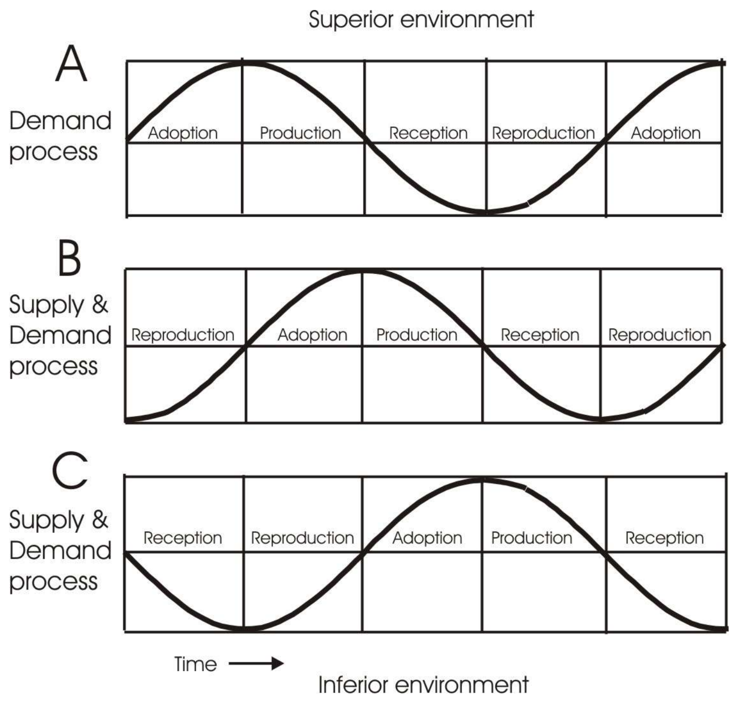


Fig. 97:
Three hierarchically adjacent levels as flow equilibrium systems.

(See also fig. 66).

This vertical flow of information and energy is made possible by the fact that the flow equilibrium systems at the different levels oscillate at ca. the same rhythm (see fig. 98). The rhythms are dictated by the flow-equilibrium systems defining the tasks (basic institutions) in the hierarchic systems responsible (see above). As all seven hierarchic levels are

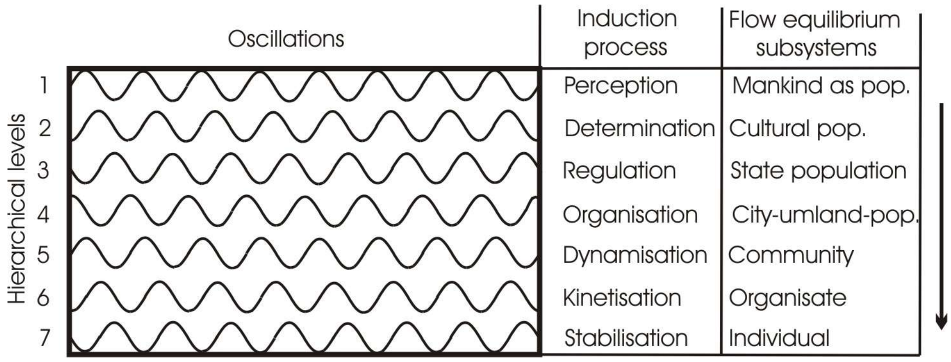


Fig.98:
Induction process in the mankind as society.
Diagram of the delay in the course of the oscillation of the hierarchic levels according to the Lotka-Volterra relationship. Delay approx. 1/4 cycle.

involved, they oscillate in all seven rhythms. For example, the organisate also has to adjust to the day-to-day rhythm of the employees, but on the other hand is also affected by economic cycles and other overriding rhythms.

The information is absorbed during the adoption phase and the energy is supplied in the production phase (induction process). The reaction process follows at the reception and the reproduction phase. Thus delays occur which last for about one quarter phase (see section 2.3.1.1, pp.77).

At the lower end are the individuals as elements in the hierarchic system. In the last resort, they are responsible for the existence of the hierarchic system of mankind as a society. On the one hand, they carry out the work, and on the other, they are the consumers, who receive the energy they require in order to carry out the work. This is the transition from the mankind as society to the mankind as species. This is the source of energy of the hierarchic system of mankind as a society and to this extent they form the inferior environment. Mankind as species forms the hierarchic system which can be placed beside the other species.

Energy should be understood here in the broadest sense. The individual has his biological basis and is shaped culturally into a personality enabling him to carry out his work in mankind as society. The induction process leads into mankind as species, "feeding in" to socio-economic goals ("demand"). The reaction process leads in the opposite direction, from mankind as species into the hierarchic system of mankind as society and organises these accordingly from the bottom up ("supply").

Mankind as species (from a systematic point of view, part of the biosphere and therefore the autopoietic systems - see section 2.6.1.1 - 2.6.1.3, pp.247-260) is also organised hierarchically. The populations are human societies: families (or corresponding partnerships of different types), communities, ethnic groups, peoples and cultural populations.

Tab. 3:
Primary und secondary populations in mankind

Primary population	Secondary population
Mankind as population	
Small cultural population	Large cultural population
Tribe, people	State population
Ethnic group	City-umland-population
Local group, community	Community
Family	Organisate
Individual	

The individuals as human beings (not only in their roles) are the elements.

Thus, we distinguish between "primary populations", in which mankind's biotic concerns (i.e. those affecting its existence) are regulated, and "secondary populations", with their socio-economical tasks within the context of mankind as a society. Everyone (by working beings) are directly or indirectly involved in mankind as a society, and as a biotic being in mankind as a species (see tab.3).

Scalar hierarchy:

Such a complex network of processes necessitates strict control. This is provided by the scalar hierarchy. We have shown (see section 2.5.1.1, pp.205) that for the entirety of mankind as a society each task corresponds to a population type.

Structurally and spatially, the populations are normally (not always) enclosed by the population which has the higher position in the hierarchy (see above). The number of populations belonging to a population varies widely in mankind as a society. (It may be a few or many thousands). On the other hand, the duration of the process is fixed in the example of mankind as society, the rhythms differ approximately by a factor of 10 (see above and fig. 99).

The hierarchy of the populations of the mankind as society is held together and controlled by the context of order and obedience (control hierarchy). The demand for the performance of work (order) passes vertically downwards to the individual via the control hierarchy, and the provision of the work (obedience) vertically upwards. Mankind as a species as a whole appears as a superior environment. On the other hand, the inferior environment is located "beneath" the individuals (in their capacity as elements of mankind as a society) and regarded from a systemic point of view also belongs to mankind

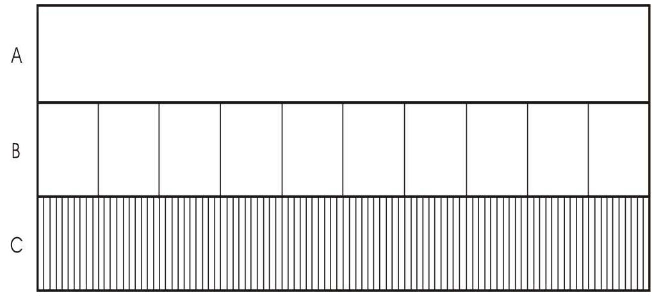


Fig. 99:
Diagrammatic ratio of the process duration of systems in three hierarchically adjacent hierarchic levels A, B and C.
The duration of the processes differs by a factor of about 10.

as a species. At the transition points to the superior environment or inferior environment, the hierarchic process merges perhaps into the all-embracing flow of order and obedience of the universal system. This would mean that the hierarchy is fetched into the system from outside.

Between the system (mankind as population) and the elements (individuals) come the subsystems (cultural populations ... organisates). To distinguish them from the subsystems formed by the flow-equilibrium systems (flow equilibrium subsystems, see above) we will call them "non-equilibrium subsystems" (see table 4, section 2.5.1.2, p.222). The populations and individuals of all the 7 hierarchical levels of mankind as society are involved. They are required to fulfil their task and they do this by working through the process sequence in their own rhythm. On the other hand, the populations are independent structures which are concerned with maintaining their existence, as are all non-equilibrium systems. This means that besides the task for the hierarchical system of mankind, the populations also have tasks to fulfil which concern only themselves. Thus, they obey the orders from above, because their existence depends on their integration in the system.

This dual aspect, i.e. the fulfilment of the task on the part of the superior population, and the necessity for the population (as subsystem) to maintain itself, causes the process structure to split up:
1) the processes follow the sequence of task stages described above (see section 2.4.1.2, pp.130) through the system and the element horizon, i.e. through all four bonding levels. Thus, the populations are able to produce and maintain themselves in the flow of information and energy (demand and supply).

2) in the context of the hierarchy, the elements of the populations at the next lower level are independent non-equilibrium systems, i.e. subsystems. The fact that the elements (individuals) are non-equilibrium systems on their own, has already been discussed (see section 2.4.2.2, pp.189).

This also means:
The order and obedience relationship between the hierarchically adjacent system levels takes place directly between the system horizons. To illustrate the processes, we will examine three hierarchic levels A, B and C more closely. The hierarchic levels differ as explained above (see section 2.5.1.1, pp.208), by the duration of the process (the rhythm). Due to this system/element (subsystem) relation, transfer of order and obedience can take place. The element horizons oscillate with the same rhythm as the corresponding system horizons. This results in the model of all the hierarchic control processes shown in fig. 100. At each level a task is solved and for this purpose the inferior system levels are used in a controlled fashion. Each level receives instructions from above. The inferior systems receive instructions from the systems directly superior to them (relation system/element), but also from those positioned much higher. For example, a community receives directives from the city-umland population (e.g. concerning traffic), has to offer the state services, has to provide a place for religious services in the form of a church etc. With the individual, this order-obedience relationship is particularly marked. The individual participates directly in the functions of the hierarchy by payment of taxes and by his right to certain services in return.

The deeper into the hierarchy, the more instructions have to be taken into account and the more varied is the actual execution of the orders. At the lowest level (i.e. the individual in human society) all the orders and conditions come together as they are specified in the catalogue of basic institutions (see above).

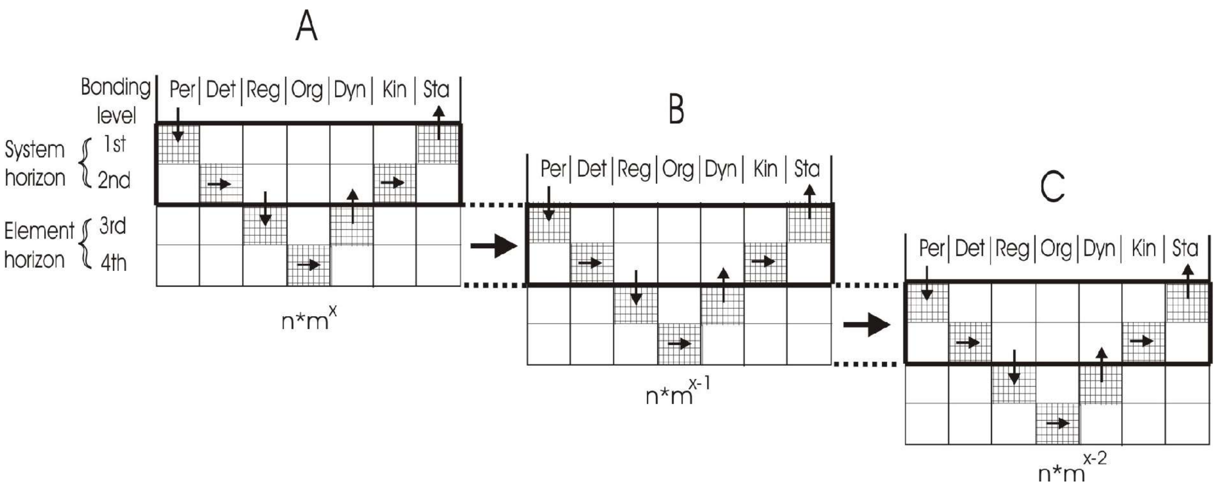


Fig. 100:

The elements of the systems of hierarchic level A become independent subsystems at the next-lower hierarchic level B and the elements of the systems of hierarchic level B become independent subsystems of level C.
The arrows show the path taken by the processes.
Task stages: Per = Perception, Det = Determination, Reg = Regulation, Org = Organisation, Dyn = Dynamisation, Kin = Kinetisation, Sta = Stabilisation. The duration of the processes: n = constant (with mankind as society approx. 5) m = constant (with mankind as society approx. 10).

Thus the order descends from the top level downwards step by step, to the individuals who receive the orders and, as such, are obliged to provide obedience (see above). The obedience proceeds from here upwards. That means that the individuals - after having received the energy - have to execute the work which is expected of them.

Secondary order-obedience relationship, upper and lower levels:

To this should be added:
The hierarchy of the populations and processes is differentiated by division into two parts (see fig. 101; see above). Just as the first process half in the non-equilibrium system serves the purpose of adoption (i.e. processing of information), and the second the purpose of production (i.e. processing of energy), the same is the case in the vertical course of the hierarchic system. The populations and processes in the subsystems are not only in direct contact with the hierarchically adjacent populations and processes. Instead, the group of the upper half forms the correlative to the lower half, as is seen in the tasks (see above).
- In the city-umland population, the population types processing information are brought together with those which process the energy. The hierarchic level devoted to the task of "organisation" has a double aspect: Seen energetically, the inferior environment (the ecumene) is contacted. Seen spatially, the populations which are compactly organised, come together with those populations which are more widely distributed. The city is joined with the umland.
- The population of the state is the next higher stage. This is the part of the hierarchic system assuring order and administration. It protects the people and the territory. In the hierarchically inferior subsystems, the community assumes some of the sovereign tasks of the state. Legislative activities are the duty of the state, whereas executive duties are mostly carried out locally, e.g. the police ensure law and order in the community, inhabitants are registered, elections supervised and infrastructure organised there. Thus, "regulation" (state) and "dynamisation" (community) are correlated with one another.
- At the third stage (from the point of view of the city-umland population) the cultural population determines the

values around which life is structured and the principles according to which communicate with one another ("determination"). These rules are implemented in the smallest populations, in the family the stable and orderly conduct of life, "genre de vie", mutual respect shown by individuals. In the organisate, this is reflected in the division of labour ("kinetisation").
- Finally, mankind as a population encompasses the whole being of man as an entity fitted for survival by his equipment and his knowledge ("perception"). The individuals carry on their lives on this basis. Through the judicious use of the natural environment they create "value" for themselves and consume it. To do this, they organise and shape the space which makes this possible ("stabilisation").

The subsystems of the 4 lower levels become subsystems of the second order in an element-like dependence on the corresponding subsystems of the 4 upper levels.

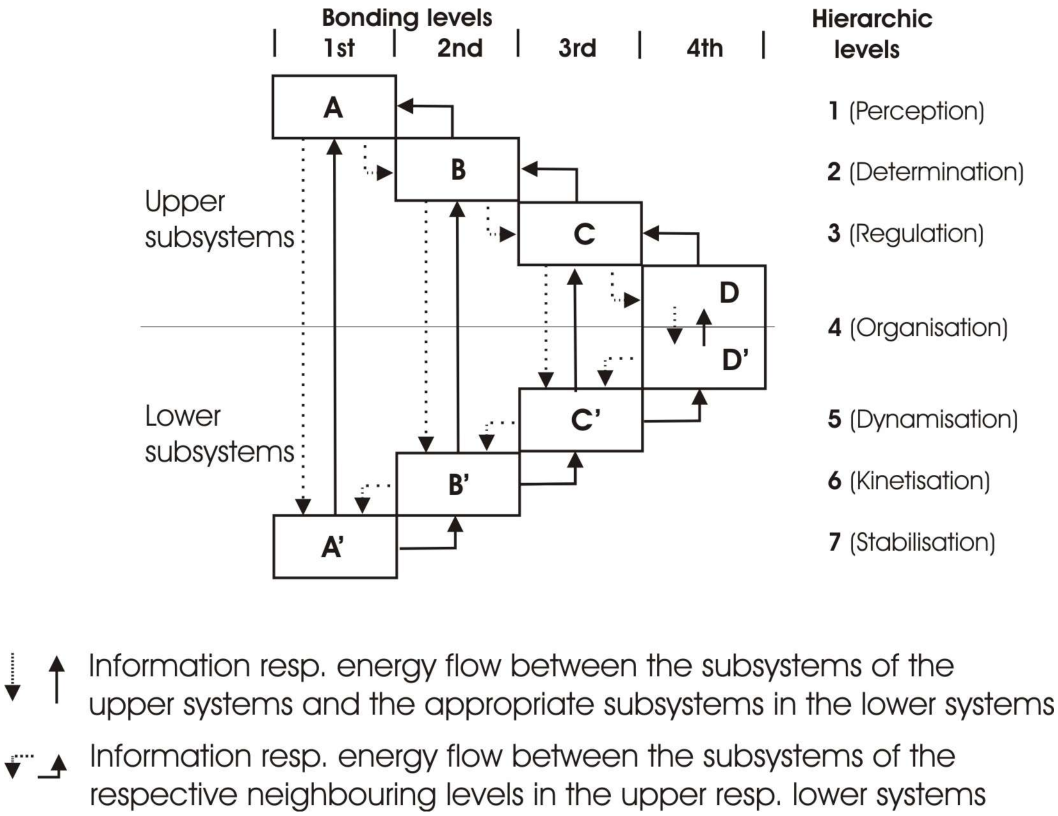


Fig. 101:
The subsystems of mankind as a society in their relation to one another. Upper and lower subsystems.
A = Mankind as population, A' = Individual; B = Cultural population, B' = Organisate; C = State population, C' = Community; D = City-Umland-Population as subsystem of the upper systems; C' as subsystem of the lower systems.

The hierarchy of spaces:

The hierarchy of the basic institutions, processes and populations corresponds to the hierarchy of anthropogenic spaces. The spaces occupied by the populations are mostly filled by the inferior populations. Thus, the space occupied by the population of a state generally contains several spaces which are occupied by city-umland populations (see section 2.4.2.2, pp.191), and these in turn contain several which are occupied by communities. Thus, at each hierarchical stage, a mosaic of spaces of the same population type forms.

As already shown, the populations of the various types ideally adjoin one another in the ecumene without gaps or intervals, i.e. community adjoining community (apart from unsettled land and land now belonging of any owner), state adjoining state etc. Thus, they form continuously the hierarchical levels of mankind as society. Structurally, these hierarchical levels are flow-equilibrium systems, in which the populations (i.e. non-equilibrium systems) compete.

The spaces shaped by the hierarchical system are derived from those of the non-equilibrium systems. We must distinguish between the spaces which are shaped by the populations themselves, i.e. non-equilibrium systems ("core spaces"), and the spaces which characterise the spheres of influence ("environments") of the populations, i.e. such spaces as are created by interlinking of the population.

Spaces occupied by the populations themselves:

The spaces which are occupied by the populations themselves are also controlled by these. The individual populations exercise their internal control in various forms depending on their tasks. Thus, the spaces are shaped differently.

Populations which are hierarchically located beneath the city-umland populations, are generally compact in shape and serve directly to process energy. The individuals can make direct contact with one another within one day. With organisates, this is easily seen. As already established using the example of the organisate weaving mill (see section 2.4.0, pp.119), the individual stages of the induction process are implemented in subsystems (departments), which give spatial organisation in a specific arrangement of population. This should be as favourable as possible for the production of the populations, i.e. when the circumstances permit, the elements are brought together in such a way that internal contact between the various work groups is facilitated. In rural communities, assorting takes place between the central institutions at the centre, the residential area and out in the agriculturally used field area. As already outlined (see section 2.4.2.2, pp.191) this type of assorting can be seen in the city-umland populations in an extreme form. The city-umland population is made up of a compact core, the city, and a more thinly populated surrounding area, the "umland". Thus, the city-umland population occupies the position of intermediary.

The populations at the hierarchical level above the city-umland populations - states and cultural populations - are loosely structured. Here the individuals cannot make any contact involving personal appearance within one day (unless modern means of transport are used). On the contrary, the populations are concerned principally with disseminating information, as is shown in our discussion of institutions and tasks (see above). Each stage in the hierarchic process is connected with the spread of an innovation (see section 2.3.1.1, pp.79). As mentioned above, in a hierarchical system, the groups of populations of the same kind should be imagined as a flow-equilibrium system.

Areas of influence of populations*:*

All populations are – depending on their structurally defined environments - surrounded by areas of influence which affect the levels formed structurally by populations of the same type, each of which together forms a flow-equilibrium system. They try to maintain and extend their influence, because their own existence depends on this.

As already mentioned, the area influenced by mankind as a society is marked by the ecumene. The ecumene is exploited most intensively in the densely populated highly industrialised areas of the world and declines progressively moving outwards towards the anecumene. In the past few decades, primarily because of pollution, it is no longer possible to identify areas of the earth which are not influenced by man. The sphere of influence goes beyond this, takes in oceans, the Arctic and Antarctic regions and out into space.

The areas of influence of the cultural populations are extended mainly by mission or migration. States secure their military, economic or cultural spheres of influence by means of policy (or war), treaties, trade relations, special cultural institutions etc. This is frequently legitimised by treaties. In the last century the USA and the Soviet Union secured their spheres of influence in this way. But smaller states also have an interest in extending their influence culturally and economically by means of radio, cultural institutions or trade relations. By definition, city-umland populations already possess areas of influence. Organisates too, as mentioned above, also have their supplier and market areas. Thus, the areas of influence are not only spatially but also thematically different.

2.5.1.2. The Model

In conclusion, the above processes can be summarised as follows. Certain differences exist between the induction process (demand) and reaction process (supply) on the one hand

and the flows of order and obedience on the other hand. The induction process and reaction process affect the flow equilibrium systems (specification hierarchy) whereas the flows of order and obedience affect the non-equilibrium systems (populations) of the various hierarchic types (scalar hierarchy). Both hierarchies interlock with one another (see table 4).

Tab. 4:
The arrangement of hierarchies of the non-equilibrium (Ne) systems and flow-equilibrium (Fe) systems.

Hierarchy of populations	Type of systems	Hierarchical Position
Mankind as population	Non equilibrium system	System
Group of cultural populations	Flow equilibrium system	Fe-Subsystem
Specific cultural population	Non equilibrium system	Ne-Subsystem
Group of state populations	Flow equilibrium system	Fe-Subsystem
Specific state population	Non equilibrium system	Ne-Subsystem
Group of city-umland-populations	Flow equilibrium system	Fe-Subsystem
Specific city-umland-population	Non equilibrium system	Ne-Subsystem
Group of communities	Flow equilibrium system	Fe-Subsystem
Specific community	Non equilibrium system	Ne-Subsystem
Group of organisates	Flow equilibrium system	Fe-Subsystem
Specific organisate	Non equilibrium system	Ne-Subsystem
Group of individuals	Flow equilibrium system	Fe-Subsystem
Specific individual	Non equilibrium system	Element

When we joint both aspects of the hierarchy (induction-reaction and order-obedience) together, this can be shown in a model (see fig. 102). The various population types with their obligatory tasks follow from top to bottom (induction process resp. from the bottom up (reaction process). In the inferior populations, the processes take only one tenth of the time of the next superior ones (in the logarithmic representation in the figure). The orders come from above and are passed on downwards. Compliance with the orders is from the bottom upwards. The processes in the hierarchic levels take place from left to right, the feedback from right to left. The circular process model serves as a basis (see fig. 69, p.134).

We must also remember that the hierarchic system also receives information and energy from outside (in this case from the ecosystem; see above, fig. 101). Both have to pass through the 4 bonding levels (like in the other non-equilibrium systems).

We already noted above that the systems of the hierarchic levels above the city-umland population serve adoption (perception ... organisation, bonding levels 1 ... 4) and those of the levels below, production (organisation ...

stabilisation, bonding levels 4 ... 1). At the level of organisation (bonding level 4) the energy is taken to the hierarchic system. Fig. 103 attempts to illustrate the different connections.

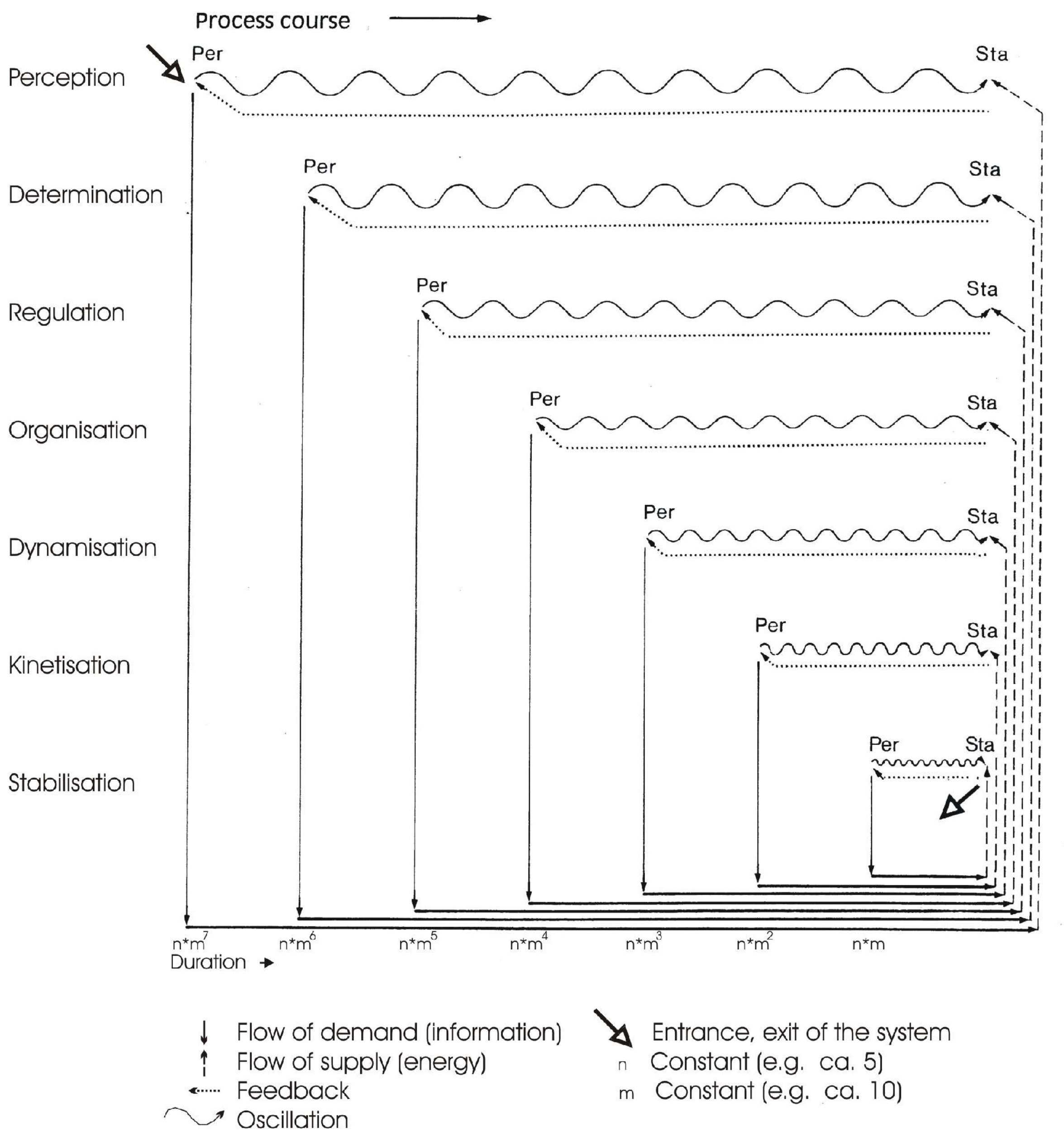


Fig. 102:
Structural model of mankind as a society. Hierarchy of populations.
It shows the hierarchy of the populations and the circular course of the processes (see also fig. 69, p.134). Specification hierarchy: In each case, the induction process (flow of demand) is from top to bottom, the reaction process (flow of supply) from bottom to top, while the course of the processes is shown horizontally from left to right and the feedback from right to left. Scalar hierarchy: The process duration is shown downwards from population type to population type to the individual on a logarithmic scale. Per = perception; Sta = stabilisation.

If we wish to describe the processes mathematically, it is important to arrange the internal sequences:
1) The hierarchic system is divided into two parts, the upper and the lower parts. Both are divided into four levels each, in which the tasks of perception .. organisation and organisation .. stabilisation are carried out one after the other in vertical succession.
2) These 8 (7) levels are formed by populations, which on their part have to carry out the process sequences horizontally. At the middle level (organisation) the upper and lower parts of the hierarchy are brought together.

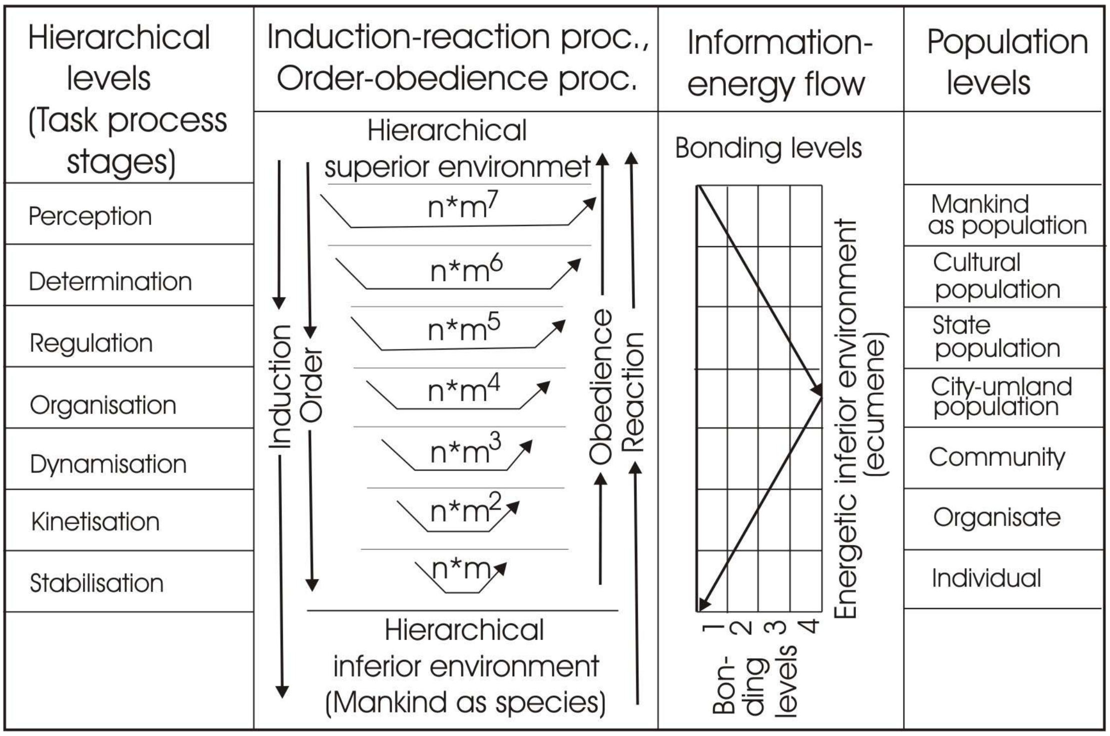


Fig. 103:
The hierarchical processes of the mankind as society (information and energy flow resp. order and obedience).
There are 3 hierarchical processes:
1) Induction-reaction process (specification hierarchy) from the uppermost level (mankind as population) to the lowest level (individuals); the hierachically inferior environment is the mankind as species.
2) Order-obedience process (scalar hierarchy)
3) Information-energy flow through the 4 bonding levels; the energetically inferior environment is the ecumene.

This can be represented in a table (see fig. 104). But additional factors also have to be considered:
1. These process sequences are embedded in a hierarchy, i.e. the superior populations include a large number of the inferior populations. It must also be remembered that the speed at which the processes are carried out in the populations also have to be differentiated in the same way.

2. With the populations, the spatial dimension is localised and does not appear in the table either.

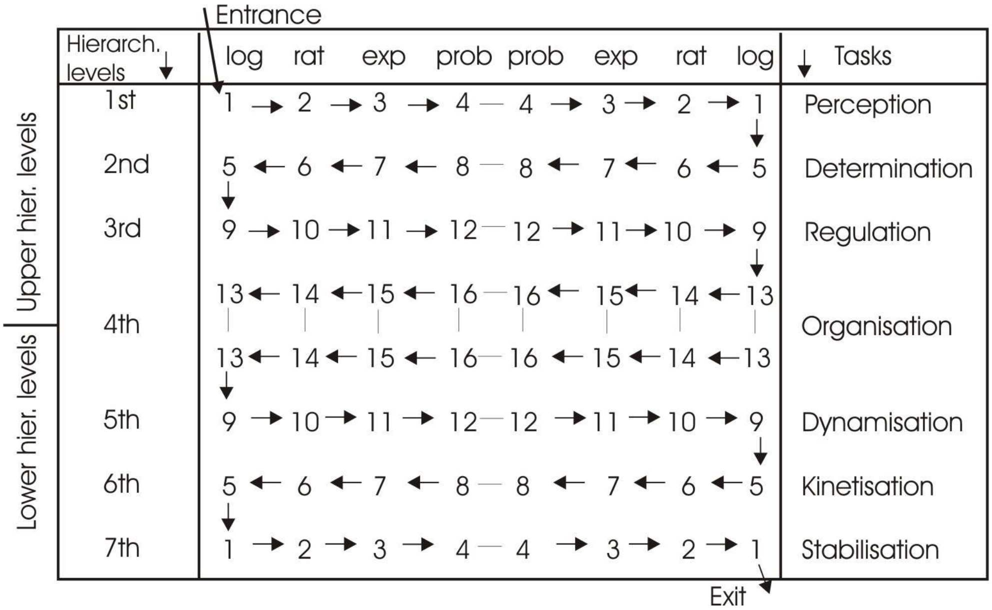


Fig. 104:
Linking of the induction process of a hierarchic system. The figures contain the numbers of the formulae of the task and control processes in the hierarchical levels (see section 2.3.1.2, pp.81).

For guidance:

From the example of mankind as a society, it therefore emerges that the hierarchy has two aspects:
1) it appears as a specification hierarchy, i.e. the superior units encompass the inferior with regard to the thematical content (task);
2) it appears as a scalar hierarchy, i.e. the superior units encompass the inferior structurally and spatially.
Behind these, there are various types of system and process – flow-equilibrium systems (flow processes) and non-equilibrium systems (conversion processes), i.e. the hierarchic levels appear as a flow equilibrium structure on the one hand and as a non-equilibrium structure on the other. The control of the hierarchic system takes place accordingly, both by a induction (demand)/reaction(supply) relationship linked to oscillations, and by an order-obedience relationship. The system (e.g. mankind as society) stimulates and structures the processes, the environment (e.g. mankind as species) supplies the energy.

In all, 7 hierarchic levels can be identified: mankind as population (task: perception) – cultural population (determination) – state population (regulation) – city-umland population (organisation) - community (dynamisation) - organisate (kinetisation) - individual (stabilisation). The processes of the inferior hierarchic levels supply those at the higher levels.

The various aspects are grouped together in a comprehensive model.

2.5.2. Other Examples

2.5.2.0. Instead of an introduction: hierarchy as seen by an artist:

In past centuries, the visual arts were concerned with hierarchy in a religious context. The representation of the divine order with God the father at the top surrounded by a host of angels and saints with humanity at the bottom (e.g. in the "Last Judgement" or the "Creation"; see fig. 128, p.268) is a frequent subject. In the Catholic church, ecclesiastical hierarchy (pope, cardinals, bishops, priests and laymen) is of greater importance than in other faiths and religions. Indeed, this is the origin of the term "hierarchy".

The state order can be seen as the epitome of temporal hierarchy. Joseph BEUYS was concerned with state order in Germany as shaped by the political parties and presented a new concept. He regarded himself as an artist, but extended the idea of art to cover the level of politics. To him, society was a "social sculpture" which it was possible to alter. TISDALL (1979, pp. 268) wrote:
"Beuys founded the 'Organization for .... Direct Democracy through Referendum (Free People's Initiative)'. ... In the political programme, nine essential characteristics of democracy were outlined:
1. Politics structured from below to above;
2. The absolute sovereignity of the people at all levels of administration;
3. A constitution made by the people;
4. Men and women without party membership to have equal rights with party members in legislative bodies;
5. No privileges for single representatives of the people or for civil servants;
6. People's veto in individual cases (where for instance no equality before the law for all is ensured);
7. Respect for the will of the electors on the part of the elected;
8. Referendum on important issues and questions of basic law;
9. Possible removal from office of unworthy or incompetent representatives of the people or civil servants.

....Beuys' political thinking is considerably influenced by the theories of Rudolf Steiner. The aim is not to mimic the dry, abstract and short-sighted formulations of offical party politics, but to bring into political activity the humane and sometimes unexpected dynamism of culture."

In a diagram he compared his ideas of a democracy controlled from below directly with the existing hierarchic structure in a democracy ruled by the political parties (fig. 105).

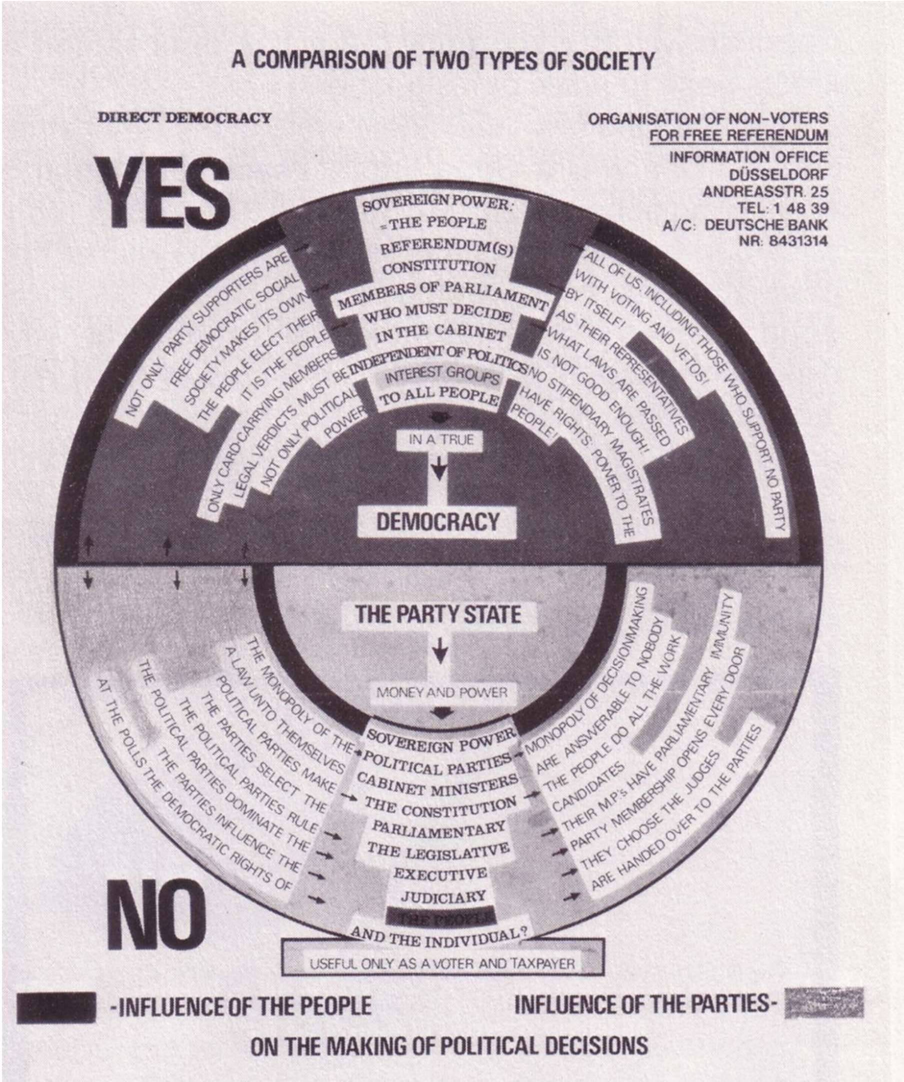


Fig. 105:
Joseph Beuys: Hierarchy in a "party state" and in a "true democracy". Scheme in which the artist sets out his ideas for the changes necessary in the hierarchic structure of Germany.
Source: See "Notes on the figures".

With regard to process theory, the old question is again raised as to whether the processes are controlled from the top down (order-oriented) or from the bottom up (obedience-oriented). From the discussion up to now (regarding information and energy flow, and system and element horizon), it will be apparent that there has to be a balance between both directions.

The following examples of hierarchy quoted are taken from the organic and the social world. It is mainly systems which are presented. In a second section, the principal emphasis is on processes (i.e. those which illustrate the remarks contained in the section 2.5.1.1, pp.208).

2.5.2.1. Hierarchy of the systems

In reality hierarchies are ubiquitous. Only a few examples taken from mankind as a society and the biotic processes are given here. Inorganic hierarchic systems are dealt with in the next section (see section 2.6.2.1, pp.273).

Hierarchy of the living world:

Biologists have created detailed systems for classifying living organisms. These taxonomic systems represent hierarchies which are based on relationships but which are intended mainly as a basis for accurate terminology in order to facilitate scientific communication. One example of this is the botanic system (see fig. 106). It is an example as well of the "scalar hierarchy" as of the "specification hierarchy" (SALTHE 2001; see section 2.5.1.2, pp.211).

The individual stages have quite different degrees of importance. Thus, the "species" has a disproportionately greater significance for the life process than, for example, the "section" or the "tribus".

Mankind as a species is itself part of the global ecosystem and as such embedded in a vertical flow of information and energy. Taxonomically, mankind is one species among many. Hierarchical structures have also formed among other species, but they are admittedly much less differentiated than in the case of mankind (WILSON 1975).

Perhaps the global ecosystem also structured itself as a hierarchical system for reasons of control. After all, mankind as a species is part of this system and as such, embedded in its vertical flow of information and energy. Then it would be possible to assign the non-equilibrium systems in the hierarchical levels to the tasks in the same way as the populations to mankind as a society. The following is an attempt to do so:

1st level: Perception of the environment. The living beings perceive the advantages and disadvantages of the environment to their own advantage. Carrier: the living world as a whole, task: perception.
2nd level: Decision on the type of exploitation of the environment. The plant and animal kingdoms define themselves as antagonists through their position in the flow of energy (see section 2.6.2.1, pp.272). Their independent existence is dictated by this. Carrier: the kingdoms, task: determination.
3rd level: Control of the flows of information and energy. The absorption of nutrients and reproduction are specified by the fact that living beings belong to certain species. This permits a control of the vital processes of life. Carrier: the species, task: regulation.

Botanik

Abteilung *(phylum, divisio)*: *-phyta*, bei den Pilzen *-mycota*
Unterabteilung *(subphylum, subdivisio)*: *-phytina* bzw. *-mycotina*
Klassic *(classis)*: bei den Algen *-phyceae*
bei den Pilzen *-mycetes*
bei den Flechten *-lichenes*
bei den Gefäßpflanzen *-opsida* oder *-atae*
Unterklasse *(subclassis)*: *-idae*
bei den Algen *-phycidae*
bei den Pilzen *-mycetidae*
Überordnung *(superordo, cohors)*: *-iidae*
Ordnung, Reihe *(ordo)*: *-ales*
Unterordnung *(subordo)*: *ineae*
(Familiengruppe: *-ineales*)
Familie *(familia)*: *-aceae*
Unterfamilie *(subfamilia)*: *-oideae*
Tribus *(tribus)*: *-eae*
Subtribus *(subtribus)*: *-inae*
Gattung *(genus)*
Untergattung *(subgenus)*
Sektion *(sectio)*
Untersektion *(subsectio)*
Serie *(series)*
Art *(species)*
Unterart *(subspecies)*
Varietät *(varietas)*
Untervarietät *(subvarietas)*
Form *(forma)*

Fig. 106:
The taxonomic classification of plants according to the „International Code of the Botanic Nomenclature".
After Weberling und Stützel.
Source: See „Notes on the figures".

4th level: Contact with the inorganic inferior environment, transition of flow of information to flow of energy. The living beings define themselves as independent objects in their environment and give the vital processes spatial order internally. Carrier: the organism, task: organisation.
5th level: Division of energy from the inferior environment in the system. The internal flow of information and energy involved in the metabolism is carried out by the organs. Carrier: the organs, task: dynamisation.
6th level: Transformation of energy into useful substances or products. The various (metabolic) products are manufactured for the body in chemical working units by a process based on division of labour. Carrier: the cells, task: kinetisation.
7th level: Organic substance preserves life. The construction of organic substance and its release from the inorganic environment are controlled at molecular level. Carrier: the organic molecules, task: stabilisation.

In the hierarchy, the non-equilibrium systems are loosely distributed at the levels 1-3, but concentrated more compactly at the levels 5-7. The organism (level 4) divides both partial areas of the hierarchy. There is a similarity with mankind as a society recognisable.

Each non-equilibrium system is securely bound into a hierarchy and possesses a defined task for this hierarchy. In the hierarchical systems, non-equilibrium systems are created structurally. One has to assume that hierarchical structures have also formed in the inorganic world, e.g. in the creation of the macro- and microcosmos (see section 2.6.2.2, pp.278). However, the hierarchies are normally much less differentiated, i.e. at the various levels several tasks have to be resolved in the vertical process sequence.

Central place hierarchies:

In the socio-economic context, the city-umland populations are of special importance. These structures are composed of the central places and their fields of influence (CHRISTALLER 1933; see fig. 107). Here the hierarchy finds its spatial expression. By way of exception, the core space here also includes the area of influence (the umland or the environment).

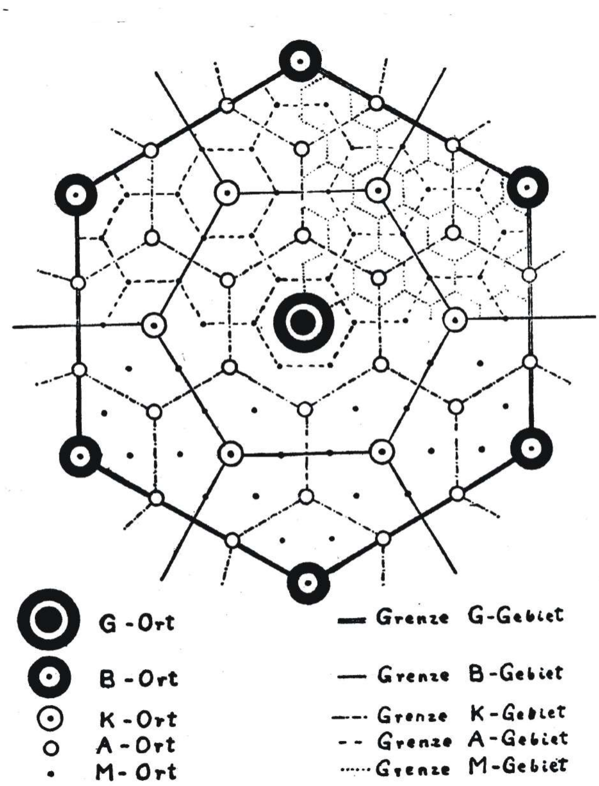


Fig. 107:
Diagram of the hierarchy and peripheral areas around a central town. (5 types of central towns). After Christaller.
Source: See "Notes on the figures".

The term "central place" is a structural term. As a rule, central places are towns, i.e. inhabited settlements, which may also be termed central towns or cities. As a rule, the people meet their day-to-day needs (e.g. grocery, physician, townhall, parish school, church etc.) directly within the community. The supply organs, i.e. the organisates, must be easily accessible. Conversely, it is the consumers who secure their existence. Organisates which are visited frequently but not daily (e.g. textile shops, hardware shops, dentists, lawyers, highschool, restaurants etc.) are generally located in small market towns and villages. These are dominated by medium-sized towns in which periodically recurring requirements are satisfied (e.g. shopping street, city hall, banks, hospital etc). And then there are the large towns with more specialised organisates which tend to be visited in episodes (e.g. central business districts, airport, state government, university, zoo).

We therefore have a hierarchy of central towns, villages etc. where the requirements of the consumers and the profitability of the producing institutions determine the location. Or conversely, the producing and distributing organisates have umlands which differ in size which they supply and from which they live. The decisive factor is accessibility for as many customers as possible (this includes the establishment of large shopping centres on the periphery of towns; see section 2.4.2.2, p.194). The areas of influence of the central towns overlap in many places forming multi-level spaces.

Rank-size-rule:

If we assume that the number of inhabitants of the central towns is proportional to the inhabitants of the entire area supplying them, we can enter the central towns of a country on a dial scale. As we see in fig. 107, the largest central town has to supply about 6 times as many inhabitants as the six next smaller towns, which in their turn have six times as many as the next 36 etc. The catchment areas of the larger central towns with its inhabitants embrace the catchment areas of the smaller central towns with the same inhabitants. The number of inhabitants of the larger towns on the scale is almost inversely proportional to the position in rank.

There are a number of intermediate figures because it is not only the supply principle which determines the number of inhabitants. On the contrary, additional special functions have to be taken into account such as administrative functions, ports, tourism, industry etc.

However, the validity of this relationship between rank and size depends on the following circumstances: 1) that all the central towns concerned are located in a country which has had the same frontiers for a long period of time (centuries) in order to allow the system of central towns to develop undisturbed; 2) that the country in question has nearly no conurbation whose size is not due to their centrality, but to other factors, especially mineral resources (such as the Ruhr area). Germany and Britain do not fulfil these conditions, but the USA (see fig. 108), France and Spain do. Thus, we arrive at the following general equation:

$$y = 1/F,$$

where y is the position of the town in the ranking and F the diameter of the area of the central town, or approximately the number of inhabitants of the central town. This is an application of Zipf's law (ZIPF 1949). This is a deterministic equation. We can also select the version based on the calculus of probability:

$$P(y) = c/F,$$

where c is the number of inhabitants of the largest town. Or the more developed version (Zipf-Mandelbrot law; MANDELBROT 1947/87, pp. 361)

$$P(y) = c/(F+b)^{a},$$

where a and b are constants. (In Zipf's law, a = 1 and b = 0).

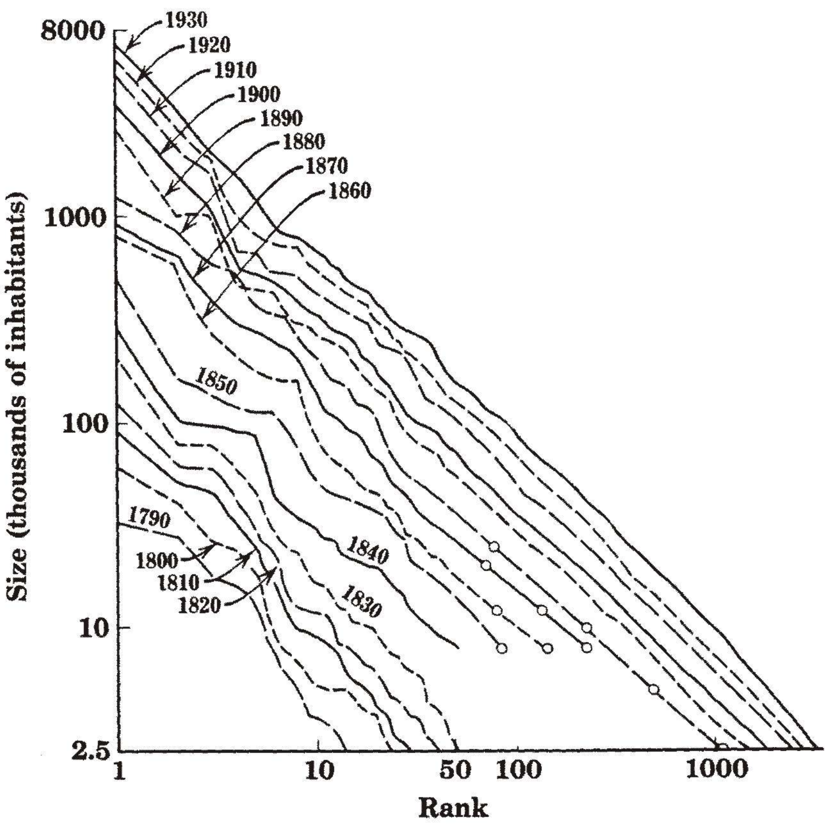


Fig.108:
Rank-size rule. Communities of 2500 or more inhabitants in the United States, ranked in decreasing order of population size. Development over the period 1790-1930. Logarithmic scales. After Zipf.
Source: See "Notes on the figures".

2.5.2.2. Hierarchy of processes: The cultural evolution.

In section 2.5.1.1 (pp.208) we discussed the hierarchy of the processes. A few examples will be given with reference to the cultural evolution in Europe (see also section 2.4.2.1, pp.147).

Millennium rhythm:

The millennium rhythm lends structure to cultural evolution as a whole. The following is a brief summary of this process (see fig. 109):

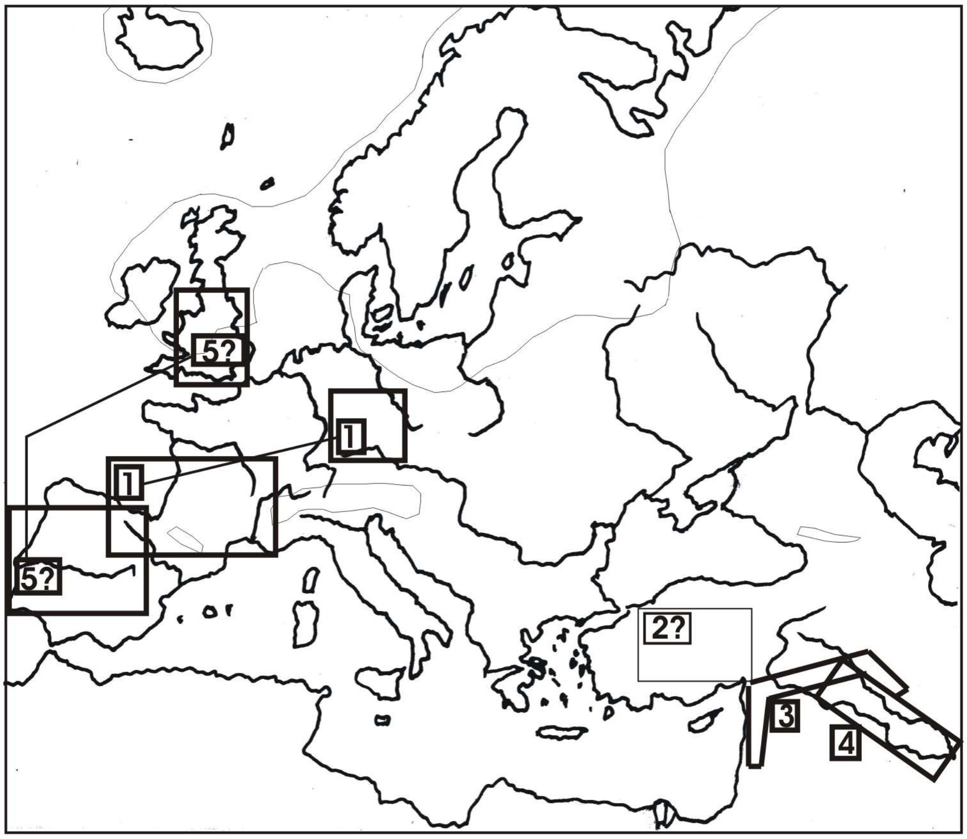


Fig. 109:
Innovation centres in millennium rhythm. An example of an irregular rotation.
1: Neo-paleolithic revolution, 2: Perhaps begin of the mesolithic (or late neo-paleolithic?) period, 3: Neolithic revolution, 4: Urban revolution, 5 (?): Beginning of the Europeanisation of the globe and industrial revolution.
The thin line marks the limit of the Würm (Wisconsin) ice cap.
Source: See "Notes on the figures".

1. "Neo-palaeolithic revolution" (approx. 30.000/15.000 B.C.): fine arts (basic institution of perception) experienced their first heyday, especially in the upper area of the Danube and franco-cantabrian region.
2. "Later neo-palaeolithic era" (beginning around 12.000 B.C. ?): No precise knowledge available. Perhaps, the first solid houses began to be built in the southern Anatolian and neighbouring regions, even though the economy was still based on hunting and gathering. Possibly these were religious sites. (The jump in space and time from the central european and franco-cantabrian area to the Orient is perhaps attributable to the increasingly difficult living conditions during the last or Würm ice age in Europe).
3. "Neolithic revolution" (approx. 9000/7000 B.C.): Introduction of cultivation in the "fertile semicircle" (i.e.

in the wide strip of territory to the west, north and north-east of the Syrian and Mesopotamian desert), accompanied by a sedentary mode of life. Structures of domination or rule may also have come into being (basic institution of regulation ?);
4. "Urban revolution" (approx. 3000 B.C.): urban cultures appear for the first time in Mesopotamia, accompanied by a re-orientation in transportation. Writing and philosophy spread westwards from Mesopotamia and Persia via the Mediterranean to Europe (as well as to India and China; HOLENSTEIN (2004, S. 84). Basic institution of organisation.
5. CHILDE (1936/51) maintained that the "Industrial revolution" (approx. 19th century A.D.) could be regarded as equal in quality to the preceding revolutions. The industrial revolution was preceded by the period of colonisation which opened up new sources of raw material. Portugal and Spain initiated this phase at the end of the 15th century. The actual industrialisation began in England. It made possible the utilisation of energy of non-human and non-animal origin to an extent previously unimagined (basic institution of dynamisation).

Centennial rhythm:

In a centennial rhythm too, the centres of innovation shifted repeatedly ("irregular rotation"; see section 2.3.1.1, pp.80). This is shown in the development of culture. In each case, the initial centre is formed by the population of a state. Innovation (or social change) then spreads outward from this centre to the remaining population.

As an example of the centennial rhythm we try to interprete the creation of European culture (on the basis of the known historical periods; see figs. 110 and 111):
1. Classical antiquity (approx. 500 B.C. up to approx. the birth of Christ): formation of art, philosophy, science in Greece and the Roman Empire (perception);
2. Late antiquity (birth of Christ up to approx. 500 A.D.): diffusion of Christianity in the Roman Empire, Palestine and Rome were the centres from which it spread (determination);
3. Early middle ages (approx. 500 up to approx. 900 A.D.): creation of state systems and administration, especially within the Frankish Empire. Paris was capital of the

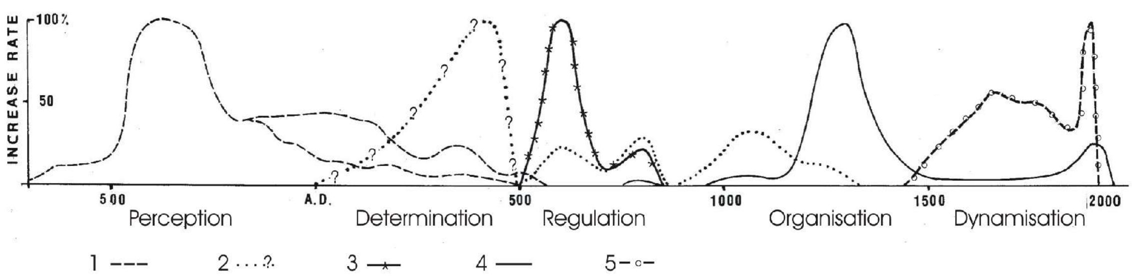


Fig. 110:
Process in centennial rhythm. The diffusion of a number of innovations essential to the formation of culture is shown:

1: Greek and Roman authors; 2: Spread of Christianity in Europe (before 500 A.D. uncertain); 3: Spatial expansion of the Frankish empire; 4: Foundation of towns in Germany; 5: Spatial expansion of European colonial empires. (Source: See "Notes on the figures").

Merovingians, the Carolingians moved the centre of their activities towards central Europe (Aachen) (regulation);
4. High and late middle ages (approx. 900 until approx. 1500 A.D.): formation of central places (city-umland-systems) and improved transportation. Germany (Ottonians, Salians, Hohenstaufens) formed the central region (organisation);
5. Modern period (begin approx. 1500 A.D.): Opening of Europe to the sea (starting with Portugal and Spain, and proceeding through France, the Netherlands, England) acquisition of colonies, exploitation of raw material and energy resources (precious metal, tropical fruits and spices, textile fibres, etc.) of the globe ("Europeanisation of the globe"; dynamisation);

The closer to the present the more difficult a clear classification becomes because the course of development is still uncertain. It seems that we have entered a new stage of the centennial rhythm, of "kinetisation". Industrialisation came in the late phase of the expansion of the colonial empires. The development first took place in England but then soon spread to Europe and the USA. This area was the centre of innovation in the multiplication of productivity. This was further affected by the political changes of the present, especially the formation of "superstates".

Decennial rhythm:

The decennial rhythm can be demonstrated in many different forms. As an example, we may take the early industrial development in Germany (see fig. 112).

In our context, it is important to recognise not only the oscillations themselves, but also the stages to understand the

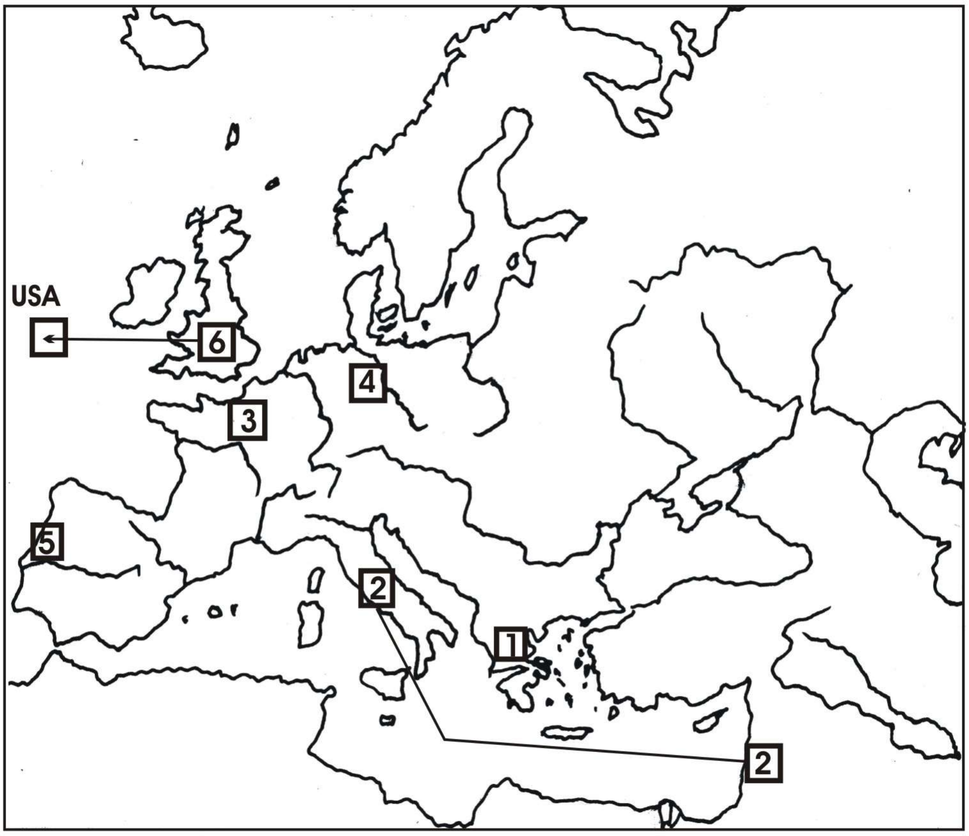


Fig. 111:
Centres of European innovation in centennial rhythm. An example of an irregular rotation. 1: Art and science in classical antiquity, 2: Christianity in late antiquity, 3: Formation of states in the early middle ages (Francia); 4: City-umland formation in the high middle ages, 5: Europeanisation (colonisation) of the globe in early modern times, 6: Industrialisation in early modern times. Formation of super power states in the present (USA).
Source: See "Notes on the figures".

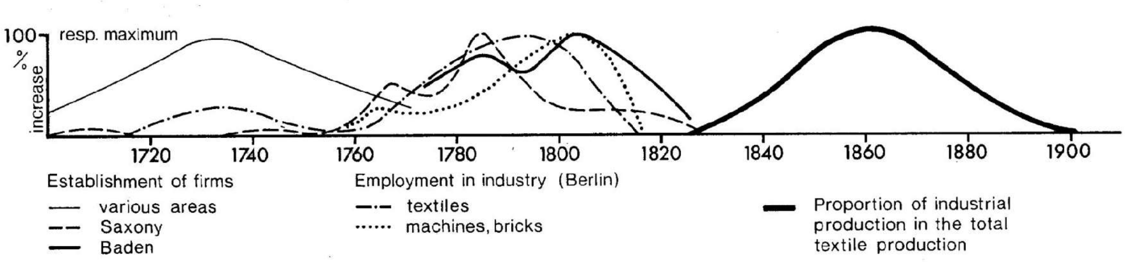
reasons behind the development. The following general remarks may be made in order to outline the development of Europe in modern times (see also section 2.4.2.1, pp.147):

1. With the Renaissance in Italy began the intellectual emancipation from the medieval view of the world. Art and science opened up new perspectives. In the course of the 15th century, the new ideas spread to Europe north of the Alps. This development reached its climax in the 16th century and gradually came to an end in the 17th century (e.g. in the field of architecture). These ideas formed the basis for new modes of thought and action which are characteristic of the modern age. For this reason, we may classify this phase as "perception".

2. In the first half of the 16th century (i.e. slightly later) the Reformation in Germany initiated a religious renewal of the Church with the Counter Reformation following from the mid 16th century (especially in Spain). These religious differences were then instrumental in the outbreak of the 30 Years' War in the first half of the 17th century. This period would therefore fall under "determination".

3. In the meantime, absolutism had become established as the new political system. The state was placed on an entirely new basis. The ideas originated in Italy, but they were implemented primarily in France (17th century). It was then adopted by other European states, especially in the form of enlightened absolutism. Absolutism also promoted the "regulation" of human intercourse including its economic aspects (mercantilism). In the mid-19th century, this political system gradually disappeared.

a)



b)

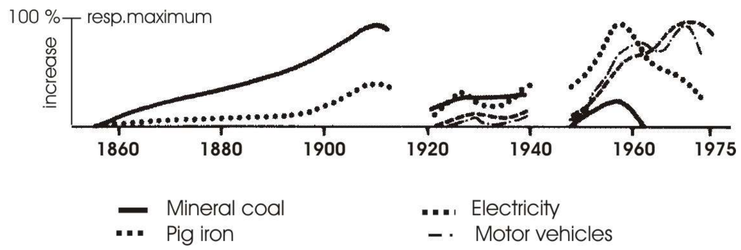


Fig. 112:
Processes in decennial rhythm: Development of mining and other industries in Germany.
a) Early industrialisation (1700 - 1900) in Germany, shown according to various criteria (manufacturing industry in several areas of Germany, beginning of the textile industry).
b) Mining and industrial production in Germany (1860 – 1975), shown according to the production of mineral coal, pig iron, electricity and motor vehicles.
(Source: see "Notes on the figures").

4. As early as the 18th century, greater attention began to be paid to road building with a view to improving communications and promoting the economic development in towns, and in 19th century Britain, the first railways created a fast and reliable means of transport. The towns grew in importance as centres of development. This stage could be interpreted as "Organisation".
5. In 18th century Britain, textile processing commenced on a large scale powered by water, and the smelting of iron powered by large reserves of coal. In the second half of the 19th century, heavy industry also became established on the continent in addition to the textile industry. It was founded on the mining of coal and iron ore. Large conurbations came into being, e.g. the Ruhr, upper Silesia, the Saarland etc. The result was a "dynamisation" of the economy.

From about here, it becomes difficult to say with certainty which institution should be assigned to which task in which process. The closer to the present, the more difficult it becomes to make a definite statement in view of the multiplicity of processes taking place simultaneously in cultural evolution:

6. At the beginning of the 20th century, Germany was one of the principal industrial countries with important secondary industries such as engineering, vehicle construction, electrical and armaments industries. Mass production became predominant, assisted by assembly-line technology. And increasing specialisation led to the growth of industrial networks. This period may be seen as a phase of "kinetisation".

7. This phase ended with the Second World War. And Germany became economically and politically integrated in the European community - a development which may be called "stabilisation". The present phase of industrialisation began which is characterised by the use of highly complex technologies (atomic energy, computer technology, automation, biotechnology, nanotechnology etc.). The USA has become the leading industrial nation. Since the 1950s, it has provided the strongest impulses in the fields of science, technology and art. This indicates a departure for a new age beginning with a phase of "perception".

Several years' rhythm:

The "several years' rhythm" is difficult to prove. No studies exist which take account of the process sequence. Although certain economic cycles have been known for some time (Kitchin and Juglar cycle; see section 2.3.2.2, p.103) there are very few documents capable of substantiating the course of a process at a rhythm of several years, unlike the decennial rhythm.

Perhaps the city-umland population provides an indication. It is conspicuous that building activity following the Second World War had a number of different points of emphasis. Taking Saarbrücken as an example (see section 2.4.2.2, pp.191):

- Development of the state administration in the 1950s;
- Appearance of large densely constructed residential complexes (1960s);
- Restructuring of industry: mining, textile industry, heavy industry etc. declined to be replaced by new industries (among others automobile and its supplier industries (1960s and 1970s);
- Construction of highways and canals (lower Saar) in the early 1970s. Disproportionate growth of commuter suburbs (early 80s);
- Re-organisation of retail trade: building of large shopping centres around city peripheries and establishment of pedestrian areas in shopping areas of inner cities (1970s and 1980s).

New investigations are necessary.

Yearly rhythm:

The yearly rhythms are also reflected for example in the activities resp. unemployment. The fact that the individual stages are so easily apparent, depends on the weather conditions in the different seasons.

A good example of the yearly rhythm is the foundation of the settlement of Wörpedorf during the Hanovarian colonisation of moorland near Bremen in the 18th century (LILIENTHAL 1931):
- Before 1747: general deliberations on the possibility of taking the moor into cultivation, preliminary surveys (perception);
- August 1747: decision to survey the moorland (determination);
- 1749/50: process of colonisation established, quarrels with neighbouring communities settled (regulation);
- July 1751: instructions to colonise the moorland, thorough planning of land allocation (organisation);
- July/August 1751: recruitment of peasants for cultivation work (dynamisation);
- Autumn 1751 - 1753: execution of work (purchase of building material, erection of huts, excavation of ditches, channels, locks, planting of trees etc.) (kinetisation);
- October 1753 - 1755: inspection by government commission, all posts are occupied, officials of self-government are nominated (stabilisation).

Monthly or weekly rhythm:

On the farm, the following sequence of task stages applies (see also section 2.3.2.1, pp.96):
- Perception: it is perceived that a requirement for certain products exists on the part of the market.
- Determination: a decision is taken to grow these products on the basis of division of labour.
- Regulation: planning is carried out, i.e. it is laid down how, when, and by which persons the work should be carried out.
- Organisation, part 1: the fields on which the products are to be grown are prepared (fertilising, ploughing, sowing the seed in the fields etc.).

This is the processing of demand (flow of information), i.e. the adoption. Then follows the production, i.e. the work itself, always in contact with the inferior environment. Production takes place, i.e. the supply is created (flow of energy):
- Organisation, part 2: the soil is tended by the workers, weeds are removed.
- Dynamisation: The seed germinates, the plants begin to grow.
- Kinetisation: the crop is brought in and prepared for sale.
- Stabilisation: the products are supplied to the market for sale.

In the "daily rhythm" the action projects are carried out by the individuals according to their own capabilities or overriding constraints. The whole process sequences (lasting about a week or longer) are not yet sufficiently investigated.

2.5.3. Process sequences and dominant systemic dimensions

Numerical sequence:

At the 5th level of complexity, another vertical alignment takes place.

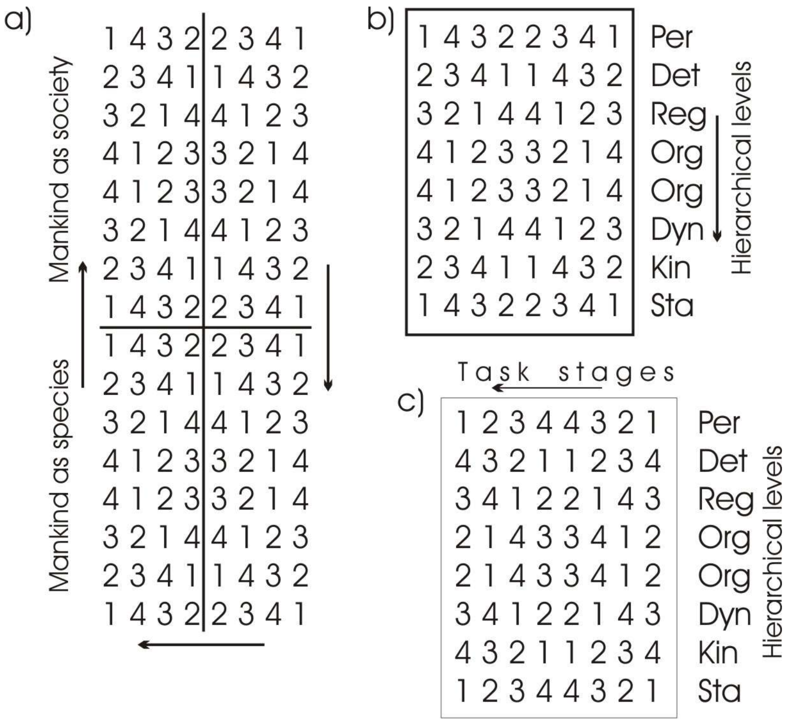


Fig. 113:
Scheme of the hierarchical process. Numerical sequence.
a) 1st rank process (U variant, see arrows) before folding: Development from above to below and from below to above.
b) 1st rank process after folding: The lower part of the process is folded behind the upper part.
c) 2nd rank process (C 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.

The hierarchical order serves the purposes of control (see section 2.5.1.2). Here the hierarchically inferior environment is involved. It is formed by the mankind as species. We have a vertically oriented process (U variant; see fig. 113a). This involves clockwise passage through the coordinate system.

As a consequence of interlacement (3rd operation of the emergence code; see section 2.2.3, pp.64), the newly organised process structure appears.
The induction process:
[f(x)], Input: The stimulus (order) enters the system from the hierarchical superior environment.

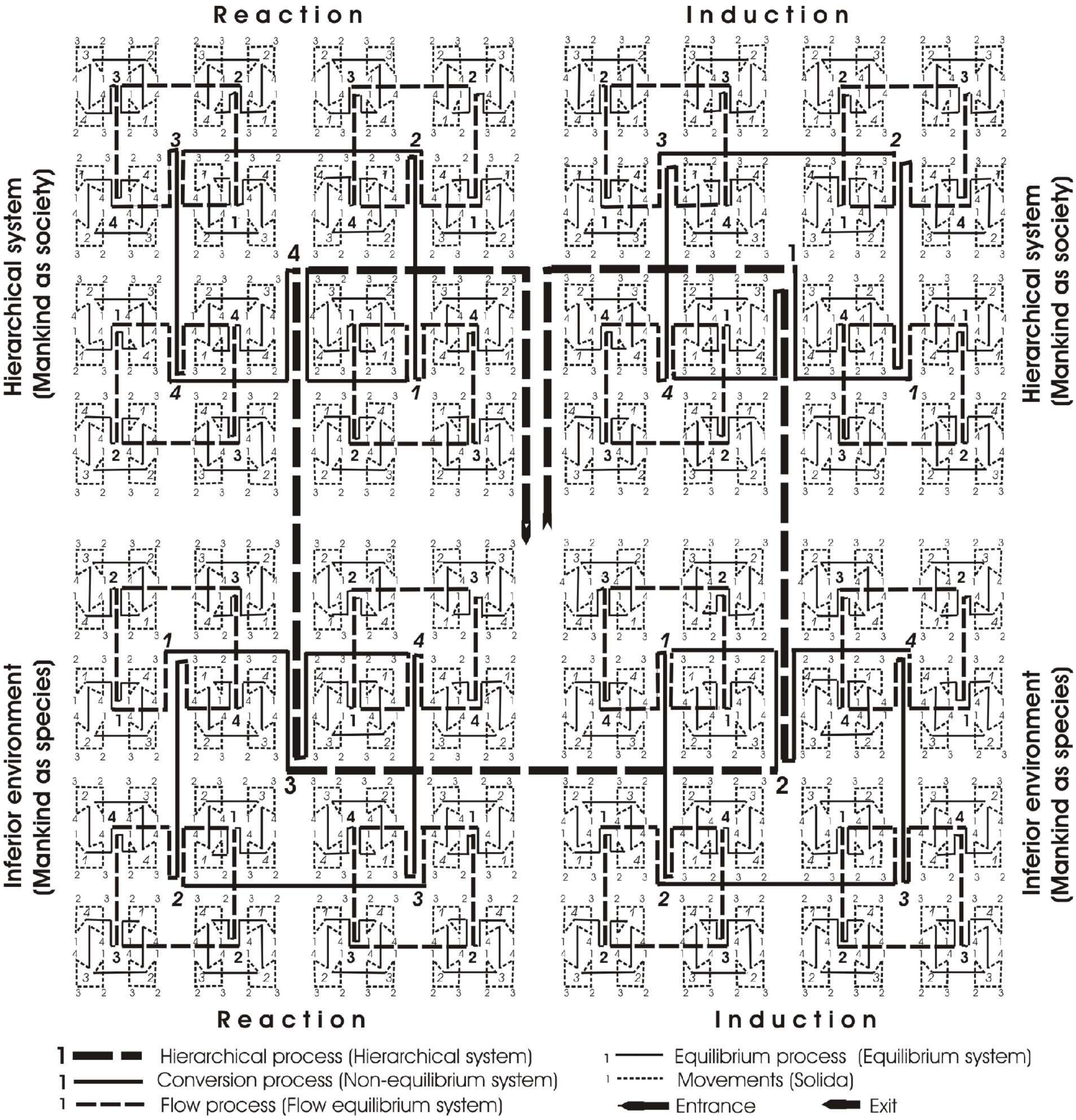


Fig. 114:
Route diagram of the hierarchical process (hierarchical system) with the processes and systems of the lower complexity levels shown.
The first rank basic process stages are assigned to the systems structured according to variant U.
To each of the four stages of the basic processes of a level of complexity is assigned a basic process of the next-deeper level of complexity. Each of the basic processes shown in this drawing represents a large number of individual basic processes.

[-f(x)], Acceptance: The stimulus moves downwards in the inferior environment (in our example the mankind as species).
The reaction process:
[-f(-x)], Redirection: The inferior environment is involved, the reaction process leads upward.

[-f(x)], Output: it is here that the reaction process arrives at the hierarchical system (in our example the mankind as society).

The 2nd rank process (see fig. 113c) takes place horizontally (C variant) and contains the process sequences of the conversion process in the different hierarchical levels (perception .... stabilisation; compare to fig. 104, p.225).

Route diagram:

Clarity concerning the course of the flows of information and energy in the hierarchic system and the involved inferior environment is obtained when the numeric sequence is unfolded (see fig. 114). The upper part represents the system (e.g. mankind as society) and the lower part the involved inferior hierarchical environment (e.g. mankind as species). The development of the process sequence takes place according to the U variant of the basic process, i.e. on the right side downwards (induction process) and on the left side upwards (reaction process).

The conversion processes are integrated at the lower (forth) complexity level. At the third complexity level, flow processes are represented, which, on their part are shaped by equilibrium processes (second complexity level) and movements (first complexity level).

The dominant systemic dimension (see fig. 115):

At this level of complexity, hierarchy becomes the independent and dominant dimension. The superior environment is located above hierarchically and the hierarchic system itself is integrated in a superior hierarchic structure (scalar hierarchy). The conversion processes or non-equilibrium systems are grouped at 7 hierarchic levels. The larger ones embrace those positioned at a lower level. They are linked with one another vertically by an order-obedience relationship. That is, the inferior systems work for the superior. The orders are conveyed downwards from the top, from the largest system to the elements while obedience is directed in the other direction, from the bottom upwards.

The induction process and reaction process are enabled by the demand/supply-relation (Lotka-Volterra-relation) between the hierarchic levels (specification hierarchy). Each hierarchic level is represented by a flow equilibrium system which has a task for the whole. The result is a sequence of tasks which corresponds to that of the task sequence in the conversion processes (perception ... stabilisation). Each non-equilibrium system must assure its own existence and is involved in the general flow of energy. Induction process comes from the hierarchic system (e.g. with mankind as society), reaction process comes from the involved inferior environment (e.g.

with mankind as species). The energy is supplied by the ecumene as part of the ecosystem (see section 2.6.2.1, pp.269).

Fig. 115:
The hierarchy as the dominant system dimension.

Outlook:

The hierarchic system is not a structure which can be interpreted deterministically, but one which is divided internally and in which many non-equilibrium systems compete with one another at the corresponding hierarchic level. In this way, a selection takes place. However, this also means that there is a permanent stimulus for internal improvement. Control is decisively improved by means of the order-obedience relationship. Thus, noise in the flow of information and dissipation in the flow of energy are kept within limits.

However, hierarchies are not spatial and material structures in themselves but only structures which control themselves. A framework running through the systems materially and spatially is necessary which might lend them strength and durability. This can only be made possible by a specific process. Autopoiesis is the essential task of the highest level of complexity within the universal system.

2.6. Autopoietic processes and universal system

A significant portion of the following discussion is based on the extrapolation of the results obtained from the reflections on the other 5 levels of complexity. They are only partially substantiated by the results of inductive research. For this reason, more study is required in the fields concerned.

2.6.0. Instead of an introduction: The employees of the textile factory in their life spheres

To date, we have regarded the textile mill as a place of production. We now propose to examine it from a purely material point of view. Seen in this way, it was also part of the natural systems of the earth – in three different respects (see fig. 116):

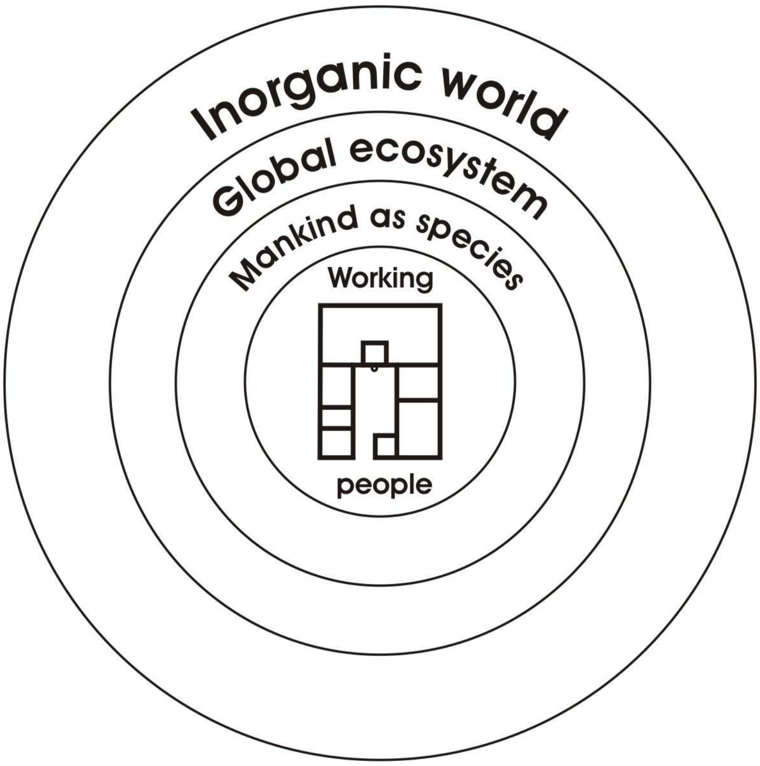


Fig. 116:
The employees of the textile factory as members of mankind as species. This is in turn part of the global ecosystem, and the ecosystem, for its part, is rooted in the inorganic world.

1) The people who worked in the factory had their own specific biographies, their own living space and their own special requirements. They needed food and clothing, founded families and raised children. They were members of mankind as a species (see section 2.5.1.1, p.214). They were free to lead their lives independently and to find the place in society and in the environment best suited to their requirements. But they were unable to change the fact that they were born, that they

had to take in energy in the form of nourishment and warmth, and that they had to age and die. As living organisms, they had to fit into the cycle of nature.

2) This also applies for the company itself. It processed organic materials, especially the natural fibre cotton. The textile products were consumer articles with a limited period of use. They then became waste and entered a number of different cycles in the form of detritus. In the production process, coal was burned to provide energy. On the other hand, the factory sent smoke through the chimney and produced liquid and solid waste which had to be removed, thereby polluting the natural environment. Here the ecosystem is affected.

3) In the last resort, the biotic substance has been formed from inorganic substance, and is mineralised again at the end of the food chain. The buildings, as earthbound artefacts, and the machines were constructed of natural materials, bricks, concrete, mortar, lime, iron etc. The formation of these materials is controlled by exogenous and endogenous forces such as tectonics, volcanic activity, sedimentation, reef formation etc. Man may influence these processes here and there, but he cannot control or prevent the forces behind them. The buildings of the factory have now been demolished and the material used for new purposes or "returned to nature" as waste where it may (in a new geological era) find some further use.

Thus, the people working in the factory as an earthbound artefact were, from a material point of view, part of the surrounding ecosystem and the inorganic world. This brings us to a new field of study.

2.6.1. General considerations

2.6.1.0. Introduction: About the shaping of materially defined spaces

Structures cannot exist on their own. They require material definition. This is related to the consolidation of the spaces, because material definition gives structures the framework within which the processing and exchange of energy becomes possible. No activity can take place without protective space in which it can take place. Intervening spaces are necesary to create clearance between the processes. Process also means movement, with the consequence that systems take up more space than structures at rest.

Matter is therefore required to stabilise complex structures. In addition, energy can be stored and transported in matter (in the form of products). Matter can assist the processes, as our example of tools as a medium and earthbound artefacts in the service of humanity show (see section 2.1.1.1, p.18).

But matter is also transient. It decays. Growth and decay are the two sides of material existence. Specific mechanisms are needed to prevent a system type from disappearing (because it is required in the concert of energy processing). The materially defined systems (i.e. the kind of systems we are discussing here) must be in a position to maintain their form, substance and structure and to pass it on to a new generation.

These problems can be illustrated best in the organic sphere. In the following, we will proceed from the inside outwards, starting with the individual, examining generative behaviour as it applies to man, as well as the use of his (ecological) "niche".

2.6.1.1. Living organisms:

Autopoietic systems:

In the introducing remarks (see section 2.6.0), two levels of being were mentioned: 1) living organisms as such and as part of the global ecosystem, and 2) the systems of the inorganic world. Matter and space are not only structured in them, but also created. The processes shaping them are linked with the term autopoiesis. As part of "mankind as species" man is an "autopoietic system" (MATURANA and VARELA 1984/89; MINGERS 1995; WHITAKER approx. 1995). Man as part of a society, may influence these processes here and there, but he cannot control them or prevent them according to his own laws.

Using the living organisms, we will examine the terms autopoiesis more closely. Organisms are autopoietic products.

They maintain their existence through constant renewal of their cells. Within the cells, the substances supplied to the creature are chemically transformed. MATURANA and VARELA (1984/89) had this process of renewal in mind when they formulated the concept of the autopoietic systems at a time when the traditional system research had actually developed a different perspective (see section 2.4.2.1, p.167). While this attempted to identify the flows of energy and the principles of systems by more and more refined methods, the authors attributed more importance to the process of self-renewal. Seen from this point of view, autopoietic systems are distinguished by the fact that they create themselves, that they represent their own product. In other words: Living creatures are the "equifinal" (DRIESCH 1908/28, see section 1) result of the autopoietic processes and possess a fixed structure which applies for the duration of their existence.

In our context, it should be regarded as particularly significant that two levels are concerned here - the level of the organisms and that of the cells. In the case of more highly developed creatures, the level of the organs intervenes. One may take the view that the organisms are the systems, the organs the sub-systems and the cells the elements (see section 2.5.2.1, p.229). The cells create the substance, thereby allowing the organisms to supply themselves internally with energy. The organisms have a shape which makes it possible for them to procure the required energy externally. Their form allows them to adapt themselves in such a way to the energetic environment in the ecosystem that the flow of energy is optimised.

At the same time, they form the raw materials for other living creatures. The ecosystem consists of a large number of populations, each of which occupies its own ecological niche. The living creatures maintain their species by means of specific reproductive mechanisms, in addition to which they create nourishment (energy) for other organisms in their ecological niches. In this way, the energy stored in the organisms is distributed throughout the ecosystem. Some of the food chains which have formed are very extensive and linked with one another by cycles. This means that it is difficult to trace the flows of energy in detail. But it is this complexity of the ecosystem which demonstrates the effort made by living creatures to use the energy available to them as fully as possible.

Living creatures only have a limited life span. However, they have the ability to pass the essential data necessary for self organisation from one generation to another. This cannot take place through a simple re-arrangement of the elements, i.e. the cells, in the same way as it does with the non-equilibrium systems. Organisms have a strictly prescribed internal order. The information is stored in the cell nuclei (DNA) and passed from one generation to another through the reproductive mechanisms.

Genetic expression, some considerations:

The controlling commands of the formation processes on which the growth of organisms is based are encoded in the DNA which is present in every cell (LEWIN 2002, pp. 59). Of particular interest to us is the process which provides the information for the structuring and shaping, and of the transfer of this information from the DNA into the process shaping a new cell. In this "genetic expression" information is transmitted in sequential form.

The result of the genetic expression is a protein, i.e. a macromolecule, whose structure controls the specific positioning of the structural features in the cell being created. It is formed by a sequence of amino acids which are joined together by peptide links. The amino acids bear the actual information. They are extracted one after another according to the plan of the specific cell being formed.

The incorporation of the amino acids in the protein is governed by a code which is transcribed from the DNA to an mRNA in the cell core and is then available in the cytoplasm for the construction of the new cell. This code is composed of "bases" (integrated in "nucleotides"), each of which are arranged in groups of three (the "codons" or "triplets"). These are hierarchically ordered. The highest in the hierarchy occupies the first position, the second the middle and the third the lowest rank. This can be illustrated using a circular diagram ("calculating wheel") as shown in fig. 117a. As a total of 4 bases are used in the mRNA (see below) there are $4^3 = 64$ possible combinations of bases in the codons. Each codon codes an amino acid. However, there are only 20 amino acids (and not 64).

A comparison with the conversion process gives rise to further considerations. The "adoption" process (see sections 2.4.1.2, p.129) involves the entry and processing of information. Here too, three hierarchic levels can be identified, as is illustrated by the circle diagram (fig. 117 b):

- The inner ring (hierarchic top level): In the "task process" the tasks of the stages are determined in chronological sequence.
- The centre ring (middle level): The "control processes" execute the tasks in detail. They can be described by 16 functions.
- The outer ring (lower level): The requirement for space is determined in the elementary processes, which are described by 4 functions.

In all, 20 different functions (and not 64) describe the conversion process (see sections 2.3.1.2, pp.81, and 2.4.1.2, pp.124).

a) b)

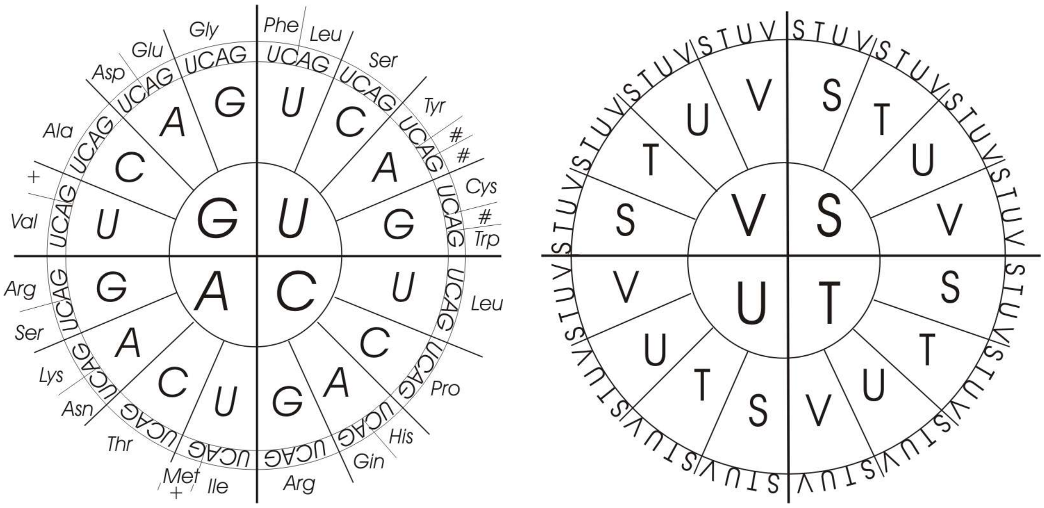


Fig. 117:
Genetic expression and self organisation. The hierarchic arrangement of the bases in relation to the stages of the conversion process.
a) Circle diagram with the assistance of which the amino acids belonging to each of the 64 possible codons can be determined. The bases are shown in the 3 inner rings, and the amino acids on the outside. Abbreviations: Phe=Phenylalanin, Leu=Leucin, Ser=Serin, Tyr=Tyrosin, Cys=Cystein, Trp= Tryptophan, Pro=Prolin, His=Histidin, Gln=Glutamin, Arg=Arginin, Ile=Isoleucin, Met=Methionin, Thr=Threonin, Asn=Asparagin, Lys=Lysin, Val=Valin, Ala=Alanin, Asp=Asparaginacid, Glu=Glutaminacid, Gly=Glycin.
+=start codon, #=stop codon.
To distinguish the code letters b, the letters are shown here in italics.
b) Circle diagram: Stages of the conversion process (adoption only, i.e. entry and processing of information), arranged by task process (inner ring), control processes (middle ring) and elementary processes (outer ring). (For the course of the process, see section 2.4.1.2, pp.138). The letters S, T, U and V are used. The sequence of letters proceeds in clockwise direction round the centre, similar to the calculation wheel a.

Each of the 4 functions of the 3 different conversion process levels cause one systemic dimension to be realised in the flow of information and energy (depending on the specific situation in each case):
1. the quantity of flow, or the involved elements,
2. the time, i.e. the duration or the speed of the throughput,
3. the (hierarchic) structure, i.e. the number of ramifications in the flow or the bond density,
4. the space, i.e. the volume demanded or granted.

As already indicated, the mRNA is composed of the four "bases" as chemical structural units. These are
1. Uramin (*U*; in the DNA Thymine), 2. Cytosin (*C*), 3. Adenin and 4. Guanine(*G*).

A more exact comparison gives rise to the supposition that *U* is parallel to the first dimension (quantity), *C* with the second (time), *A* with the third (hierarchy) and *G* with the fourth (space). If this is so, the bases are the chemical representatives of the systemic dimensions and the 16 formulae of the control processes (and the 4 formulae of the elementary processes) can be assigned to the codons ("transscription").

Tab. 5:
Possible assignment of the non-equilibrium system formulae to the amino acids (see fig. 117). As these are only the stages within the main stage of adoption, the letter (S) indicating this stage is not shown. The formulae are given in sections 2.2.1.2 (pp.42), 2.3.1.2 (pp.81) and 2.4.1.2 (pp.124). Abbreviations see fig. 117 (above).

Amino acids Start and stop		Conversion proc. stages	Formulae	
Abbrev.	Codons	(Adoption only)	Control process	Elementary processes
Phe	UUU .. UUC	SSS .. SST	1	17 .. 18
Leu	UUA .. UUG	SSU .. SSV	1	19 .. 20
Ser	UCU .. UCG	STS .. STV	5	17 .. 20
Tyr	UAU .. UAC	SUS .. SUT	9	17 .. 18
Stop	UAA	SUU	9	19
Stop	UAG	SUV	9	20
Cys	UGU ..UGC	SVS .. SVT	13	17 .. 18
Stop	UGA	SVU	13	19
Trp	UGG	SVV	13	20
Leu	CUU . .CUG	TSS .. TSV	2	17 .. 20
Pro	CCU..CCG	TTS .. TTV	6	17 .. 20
His	CAU ..CAC	TUS .. TUT	10	17 .. 18
Gln	CAA ..CAG	TUU .. TUV	10	19 .. 20
Arg	CGU..CGG	TVS .. TVV	14	17 .. 20
Ile	AUU .. AUA	USS .. USU	3	17 .. 19
Met, Start	AUG	USV	3	20
Thr	ACU ..ACG	UTS .. UTV	7	17 . .20
Asn	AAU .. AAC	UUS .. UUT	11	17 .. 18
Lys	AAA .. AAG	UUU .. UUV	11	19 .. 20
Ser	AGU .. AGC	UVS .. UVT	15	17 .. 18
Arg	AGA . AGG	UVU .. UVV	15	19 .. 20
Val	GUU .. GUA	VSS .. VSU	4	17 .. 19
Start	GUG	VSV	4	20
Ala	GCU.. GCG	VTS .. VTV	8	17 .. 20
Asp	GAU .. GAC	VUS .. VUT	12	17 .. 18
Glu	GAA ..GAG	VUU .. VUV	12	19 .. 20
Gly	GGU.. GGG	VVS .. VVV	16	17 .. 20

In the second step, the information has to be translated from the language of the codons and bases to that of the amino acids ("translation"). Each codon encodes a certain amino acid. The fact that some amino acids (e.g. serin and leucin) occupy two different positions at the second process level (see fig. 117a), may be due to the fact that these positions were not taken into account in the translation in the conversion process.

But why does the anticodon of most tRNAs accept different codons? The bases in the third positions may be also important, since they either hinder or strengthen the flows of information or energy. Furthermore, in the conversion process algorithm, these positions are described by the 4 functions which define the elementary process stages. They organise the requirement for space (not for the structure). The spatial context is important both for the protein being formed and for the cell being shaped.

The result of the considerations (here shown in outline only) between the stages of the conversion process is summarised in table 5. It is a suggestion only, which remains to be verified by empirical work. Should it prove to be acceptable, it should be of interest in genetic research and genetic technology since it offers a means of simulating the complex processes of cell formation and of understanding them better.

2.6.1.2. The behaviour of populations:

Autopoiesis is also controlled by the environments of the systems. The organisms as autopoietic systems are embedded in populations. The species (or at least regional populations) have to secure the survival over time. This is the best way possible to occupy the ecological niches and to ensure an efficient flow of energy. In the course of evolution, improvements in self-organisation can take place (e.g. via mutation) in response to environmental conditions. But how does the population behave within its own "niche"? There are a number of factors which affect reproductive behaviour. This is particularly recognizable in the case of mankind as a species, because numerous demographic studies are available. On the other hand, certain special circumstances have to be taken into account which means that the results can only be applied to animal populations with certain reservations. Through the formation of mankind as a society in the course of cultural evolution, the energy throughput in the ecological "niche" was considerably improved. Internally however, the development also generated considerable tensions.

On the one hand we have the less differentiated populations in the developing countries and the highly differentiated populations of the industrialised countries on the other. A number of examples will be used to show how populations come to terms with their environments.

Let us look first of all at the example of an undifferentiated population of Indians in its habitat to return later to the starting point of our examination of the shaping of the mankind as species as a population in the ecumene.

An Indian population in its habitat:

Oscillations:

An example is provided by the use of the agricultural land of the former Pueblo Pecos in New Mexico (see fig. 118). New Mexico is a dry country. Before the Spaniards conquered this

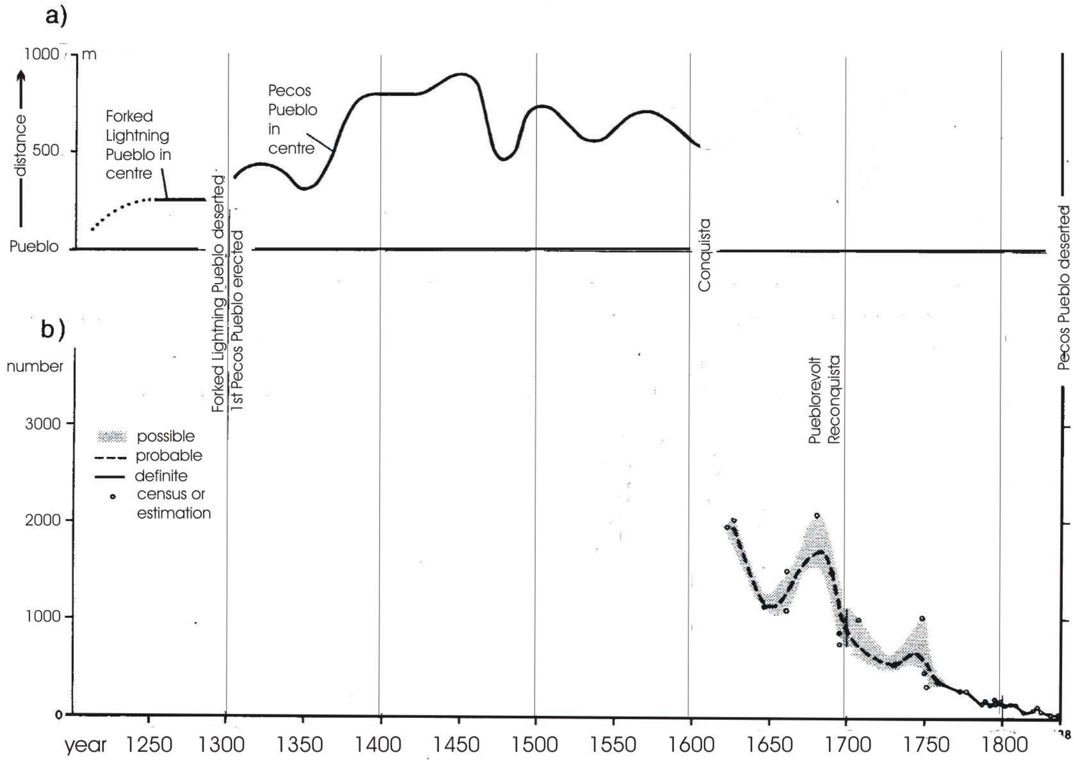


Fig. 118:
The (deserted) Pueblo Pecos (New Mexico), oscillations in field exploitation. Example of a population attempting to achieve a flow equilibrium between intensive cultivation and the self-preservation of the natural environment.
a) Single houses at a medium distance from the pueblo during different periods. Dating based on finds of sherds.
b) Population numbers.
For the time before 1620 (Conquista), the sources for the utilisation of the land are reliable. Thereafter, the documents are less clear. By contrast, the population figures are only certain for the period after 1620. Before this, only unreliable estimates exist.
(Source: See "Notes on the figures").

region, the Indians did not irrigate the land, but used it for rain farming. In the former economic territory of the Pueblo, a number of ruins of small individual houses were used as shelters by a small family unit responsible for the cultivation of a small plot of land (see section 2.2.2.3, pp.53). Examinations of the distribution of the datable ruins of field houses around the Pueblo allow us to draw conclusions concerning the extent of the arable land and its changes in the course of time. It appears that the terrain expanded and contracted at different periods. These fluctuations took place on average at 60-year intervals, as an analysis of the ceramics found in the field houses shows. Fluctuations in the population of the pueblo also appear to have followed this pattern. However, population counts were only started after the arrival of the Spaniards. It has been estimated that approximately 2000 persons lived in Pecos around this time (1620). The arable land covered an area of between 2 and 4 sq.

kilometres. In addition, there was scrub country used by the population for hunting and gathering.

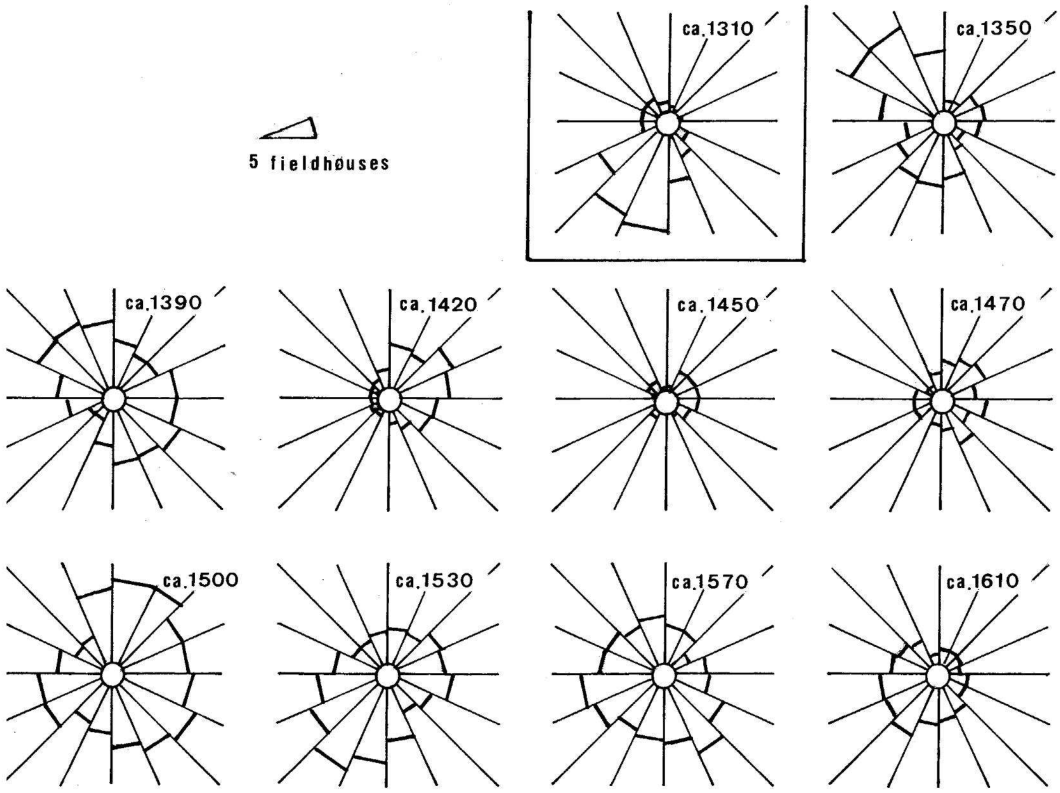


Fig. 119:
Tangential rotation in agricultural land of the (abandoned) Pueblo Pecos (New Mexico) before the arrival of the Spaniards (Conquista). Using the number of datable field houses it is possible to determine (using statistical evaluation) in which sector (16-part rose with the pueblo at the centre) the land was used more or less intensively in which years. It can be seen that in the period between 1310 and 1610 A.D., the main area covered by fields shifted in a tangential direction (on average to the right) in a series of oscillations lasting on average 60 years.
(Source: See "Notes on the figures").

The arrival of the Spaniards seriously disrupted the life of the Indians. The population declined sharply, a development which was also due to the increasing attacks by other non-sedentary tribes of Indians. At this time, the existing area of arable land became fragmented into a series of small islands with the result that it is no longer possible to estimate the amount of arable land.

Rotation:

The Indian population obviously existed at the limit of the carrying capacity of the soil. This can also be seen in the way in which the land was worked. The rhythmic expansion and contraction of arable land in Pecos was associated with a tangential rotation (see fig. 119; see also section 2.3.1.2, pp.80). In each of the expansion resp. contraction phases, the arable land was shifted slightly away from the previously used area which was now damaged by erosion, with the result that with each expansion of the area under cultivation, new terrain was developed. This was repeated several times while the main area of cultivation moved around the pueblo in a tangent.

Processes of spreading:

The agriculture practiced by this population of Indians is only one example. It was an undifferentiated population relying on the yield of its own land.

Land occupation and colonisation:

If the population continues to increase or if other factors adversely affect the quality of life (e.g. soil erosion or expulsion through warfare), a process of migration may result. This may involve the entire population or only a part of it.

The taking possession of another area for the purpose of agricultural utilisation may be described as land occupation ("Landnahme") in the case of populations with a low degree of differentiation (e.g. migrations of the Germanic tribes) or as colonisation in the case of more highly differentiated populations (e.g. of America by the Europeans). From the point of view of the process theory, both variants are spreading processes (about spreading processes see also sections 2.3.1.1, pp.79, and 2.3.2.2, pp.105). In this way, anthropogenic space was created. The elements, i.e. the farms, are situated in flow of energy and they have to ensure that they maintain a flow equilibrium between demand for and supply of foodstuffs.

Colonisation by the Spanish in New Mexico:

We would like to look more closely at a process of colonisation, i.e. that by the Spanish in New Mexico. As mentioned already, about 1600, Spanish soldiers, priests and settlers arrived from Mexico at the dry regions on the upper Rio Grande (see fig. 120). There they found Indian

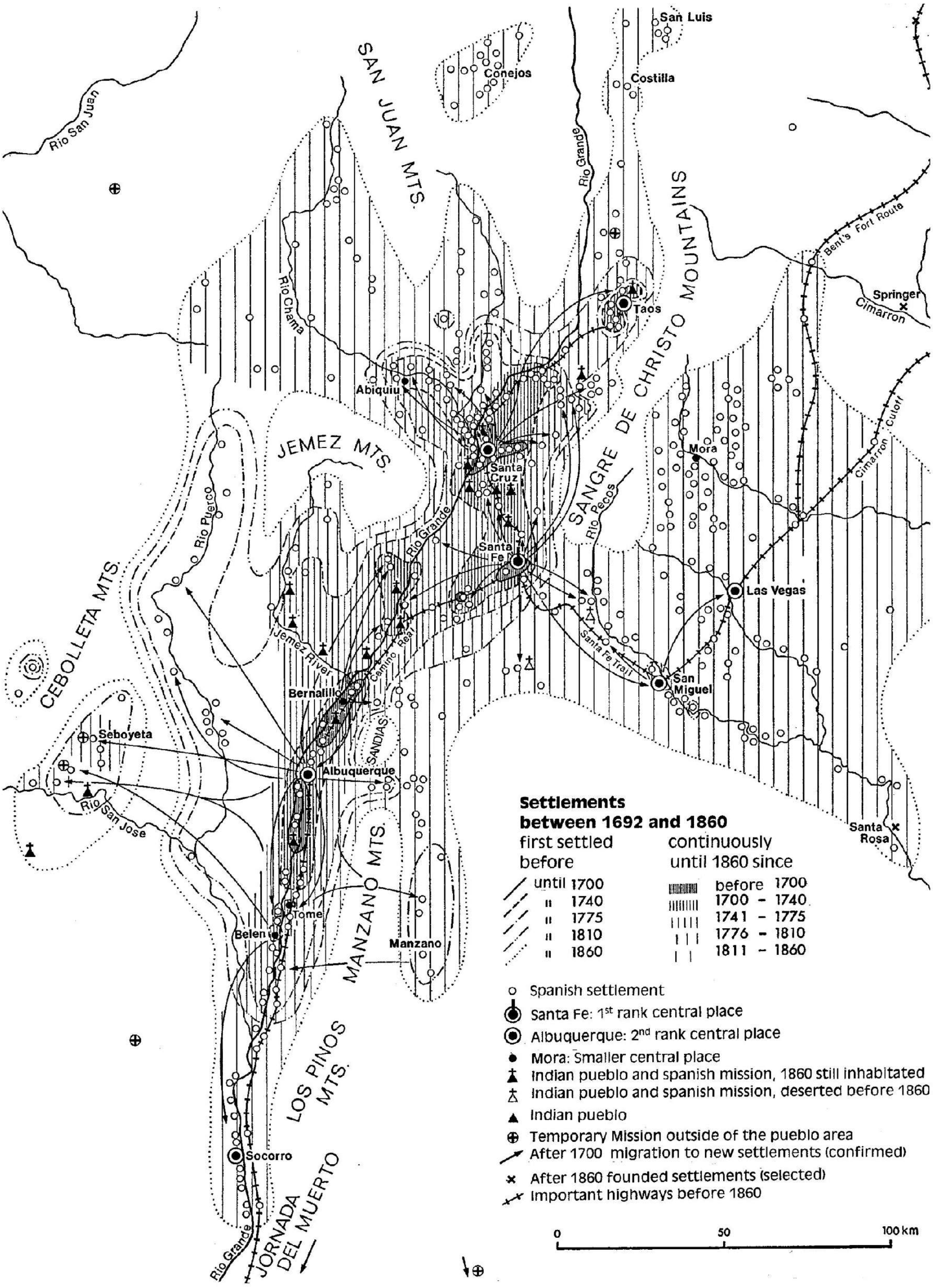


Fig. 120:
The Spanish colonisation of New Mexico 1692 - 1860. Example of the spread of a population.
(Source: See "Notes on the figures").

settlements, Pueblos, concentrated mainly in the few river basins. As mentioned above, they practised rain farming. The

Spaniard, however, looked for land which could be easily irrigated.

The process took place in waves (each of which lasted about 50 years) from the population centre of Santa Fe (see fig. 121). The reason: as the number of inhabitants increased exponentially, the supply of foodstuffs declined. The requirement for additional land increased, which produced an increase in colonisation. As the crop yields rose, the pressure to acquire new land ebbed, but as the population increased, another phase of expansion became necessary and so on. (The phases are almost contemporary with the colonisation

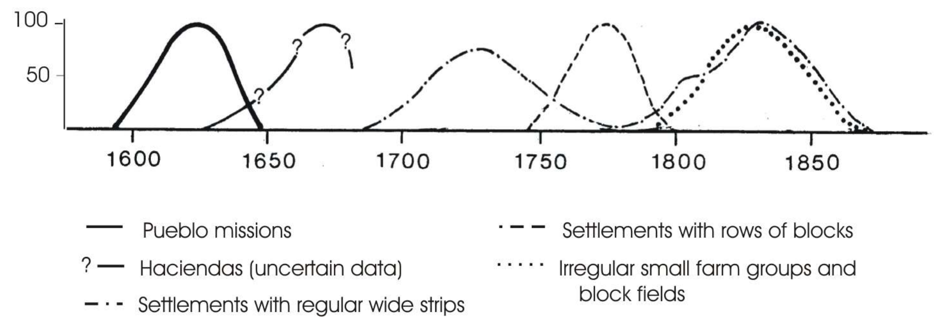


Fig. 121:
The phases in the colonisation of New Mexico by the Spaniards 1598 - 1860. The rhythmic pattern reflects the oscillations or the striving for flow equilibrium between the population and its food supply. (Source: See "Notes on the figures").

waves in central Europe, see section 2.3.2.1, fig. 55, p.105. This shows that also the world economy plays an important role).

The social and economic conditions changed with every oscillation phase which meant that new forms of settlement came into being. Thus, the oscillations are - like the economic cycles (see section 2.3.2.1, pp.103) - associated with innovations. The Conquista began around 1600 with the foundation of mission stations in or near the pueblos. Following this, the haciendas were established. A period of resistance by the Indians led to the withdrawal of the Spaniards in 1680. Following the Reconquista (1692) in the period up to around 1750, the process of diffusion was generally carefully planned. The settlements were accurately surveyed (wide strips and blocks with strips). Then, up to approximately 1800, the colonisation became much simpler in form, i.e. more irregular (rows of blocks). The last wave of colonisation in the 19th century shows signs of increasing disorder. Apparently, the governing hand of the administration (as manifestation of the system) was no longer able to resist the pressure of the increasing population and control it in well ordered channels. Many settlements (small farm clusters and block fields), show nearly no trace of centralised planning. Finally, it seems that the settlements sprang up where space was available and where it was most suitable for the settlers, i.e. where water for irrigation was available. The population of New Mexico underwent an explosion between 1800 and 1850 (the territory was annexed by the USA in 1846), increasing from 20.000 to 60.000 in this period.

Migration:

The importance of socio-economic differentiation:

Another way to absorb increasing pressure of population is by differentiation. Separation of content i.e. division of labour takes place. Since Adam Smith, the division of labour has been recognised as an essential precondition for the efficiency of economic activity. The use of technical apparatus is simplified. In section 2.4.1.1, pp.121, it was shown how the stages in work can be coordinated with one another in an organisate. In this way, capacity can be significantly increased.

The people working in the secondary and tertiary sector are not directly connected with the land used for agriculture. Spatial concentration takes place in areas suitable for work, e.g. within the road network. The foodstuffs required have to be imported. On the other hand, the conditions under which the rural population live and work have been improved, e.g. by the development of fertilisers, machines etc.

The formation of urban communities – unthinkable without a degree of differentiation – leads to migration of parts of the population from the country to the town, from agricultural to non-agricultural occupations. This is also reflected in the spatial structuring and interlinking of the population.

Two kinds of communication networks are created:

1. In an undifferentiated country agriculture dominates. The inhabitants or small populations are equal in importance. No central places have yet developed here. Seen mathematically, the distribution is of a random nature ("random networks" to use the terminology of the network theory; BARABÁSI 2003, pp. 69). If the number of contacts, i.e. the intensity of communication, is entered in a diagram, we obtain a curve which decreases on average from the centre towards the edges, i.e. is bell-shaped (conforming to binomial distribution; see section 2.3.1.2, formula no. 12, pp.87) i.e. the majority of elements (populations or individuals) have approximately the

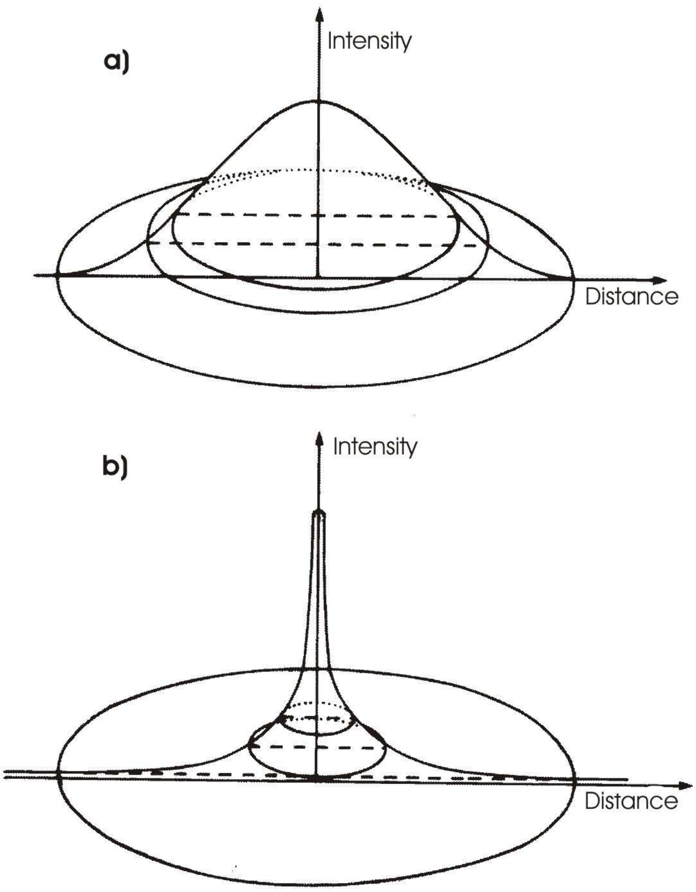


Fig. 122:
Spatial distribution of a group of people (Scheme),
a)interacting with one another, example: undifferentiated population.
Density values (intensity) correspond to the statistical standard distribution.
b)oriented towards a centre (initial location), example: city-umland population.
The non-agricultural population have been grouped together around the centre.

same number of contacts. Exchange and trade take place between individuals or small populations (see fig. 122a).
2. However, with increasing division of labour trade and industry grow, a process of selection takes place. During this process, some populations (e.g. communities) prove to be better suited for competition and assert themselves accordingly. Here the non-agricultural organisates concentrate. These communities grow larger and dominate others which supply raw materials or purchase products. The principle of long-range effect applies (see fig. 122b; see also section 2.2.1.2, p.41, and section 2.4.1.2, formula no.20, p.125;).

A good example of this is the city-umland-population. Here, the spatial effects of the process sequence can be observed particularly well. The town, with a certain central position

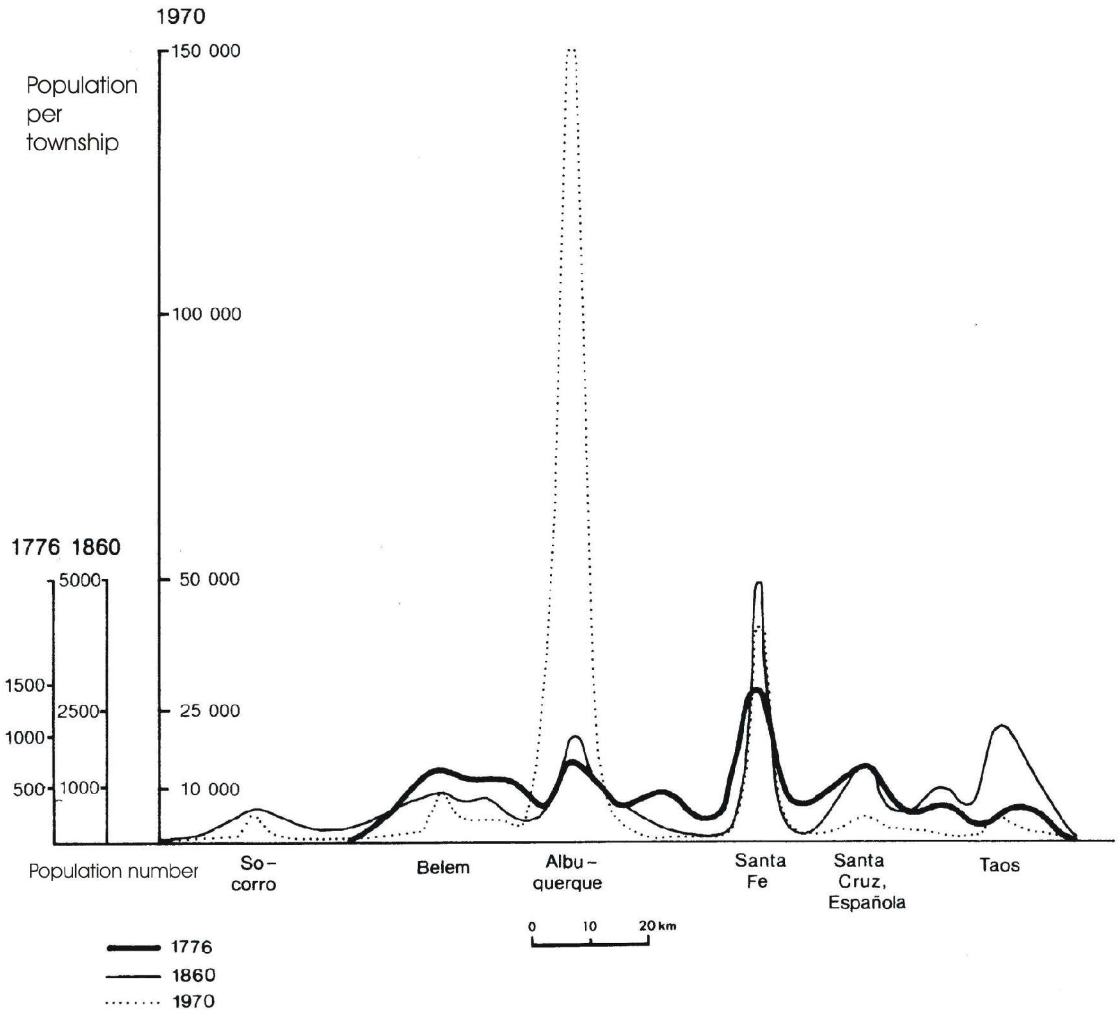


Fig. 123:
Population-density profile along the main settlement axis in New Mexico 1776, 1860 and 1970. The example demonstrates the development of a city-umland population.
Source: See „Notes on the figures".

concentrates specific functions within itself and engages in exchange with the mainly rural areas surrounding it. These dominant cities can increase their influence by a kind of self-strengthening effect. This type of communication network has another form ("scale-free network", to use the terminology of the network theory). A few outstanding hubs have many links with others and predominate in relation to many smaller hubs.

Country-to-town migration in New Mexico:

The development of population distribution in New Mexico serves as an example, following on from the above description of the colonisation of New Mexico by the Spaniards. In 1776, New Mexico had a population of around 18 000. In the past 150 years, since the occupation of the region by the USA, the region has undergone dramatic social and economic change. In the 17th, 18th and early 19th centuries, the economy was predominantly agricultural although smaller central locations existed with non-agricultural populations. In the middle of the 19th century, this relatively homogeneous regional structure changed into a field structure which was dominated by the central town Albuquerque (see fig. 123).

Through the construction of roads and railways, communications with the rest of the USA are excellent. New population groups have settled there and industry and trade have prospered. A highly differentiated society has come into being. New trends in population development have become apparent, and colonisation (see above) has been replaced by interior migration. The trend continues. Today New Mexico has about 1.800.000 inhabitants, Albuquerque (Bernalillo County) about 600.000.

2.6.1.3. The mankind as a population

Through increasing differentiation in the course of cultural evolution, also new tendencies made themselves felt in the development of the global population. The industrialised countries increasingly became the goal of international migration. Europe and the USA are currently experiencing waves of immigration from underdeveloped countries of Africa, Eastern Europe and Latin America. The principal reason for this are the very different economic conditions prevailing in the developing and industrialised countries, and related thereto, their different carrying cpacity.

On the one hand, the carrying capacity is dependent on the fertility of the soil. This applies in particular to populations whose existence depends on agriculture especially in developing countries with a low degree of differentiation. On the other hand, the degree of industrialisation and the tertiary sector are also crucial to the carrying capacity of a region, as in the industrialised countries. There are transitions between the two extremes.

The age structure of the population:

Demographic behaviour is closely associated with the degree of socio-economic differentiation. If the age scale is depicted vertically in a diagram, and the number of people (classified by sex) in the age groups horizontally, a clear picture of the age structure of the population is obtained. It varies from country to country. A large number of children gives the diagram the form of a pyramid (see fig. 124a). This is most striking in the case of the developing countries with less differentiation. In the highly developed industrialised countries on the other hand (see fig. 124b) the number of children is much lower. On average, people live to a greater age, but younger people are scarce.

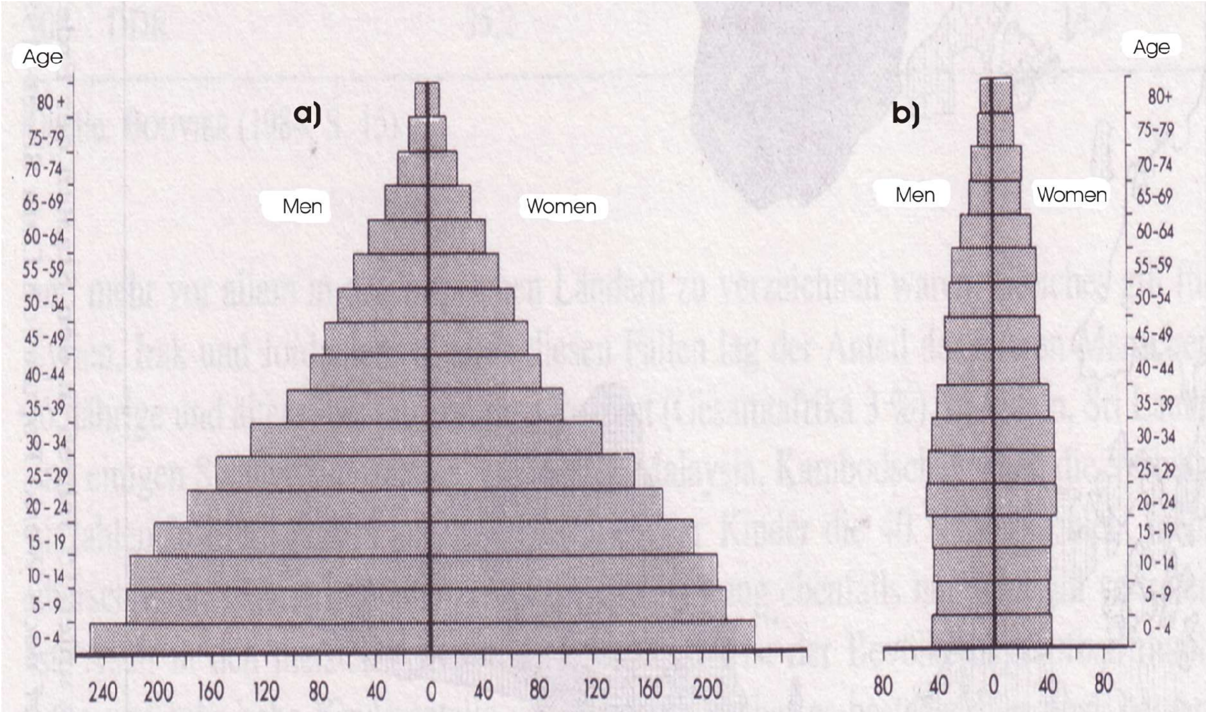


Fig. 124:
The age structure of the population in the developing and industrialised countries around 1985. *According to Bouvier. Source: See "Notes on the figures".*

Thus, the diagram shows that the generative behaviour of the population depends to a great extent on the socio-economic conditions. The degree of differentiation within the context of cultural evolution is also of critical importance for the adaptation of the population to its habitat and its own organisation in its niche.

These differences can be understood by a development diagram showing the birth and death rates. The "demographic transition" is related to socio-economic status and prosperity. In originally undifferentiated social structures, birth and mortality rates are high (see fig. 125, Phase 1). The population maintains itself at roughly the same level. With increasing prosperity, hygienic conditions improve, resulting in a decline in mortality, especially among children (phase 2). Since the birth rate remains high for a while, the population increases dramatically, until it achieves its zenith in phase 3. The birth rate now begins to decline while mortality stabilises at a low level (phase 4). In phase 5, birth and death rates converge again, causing the population

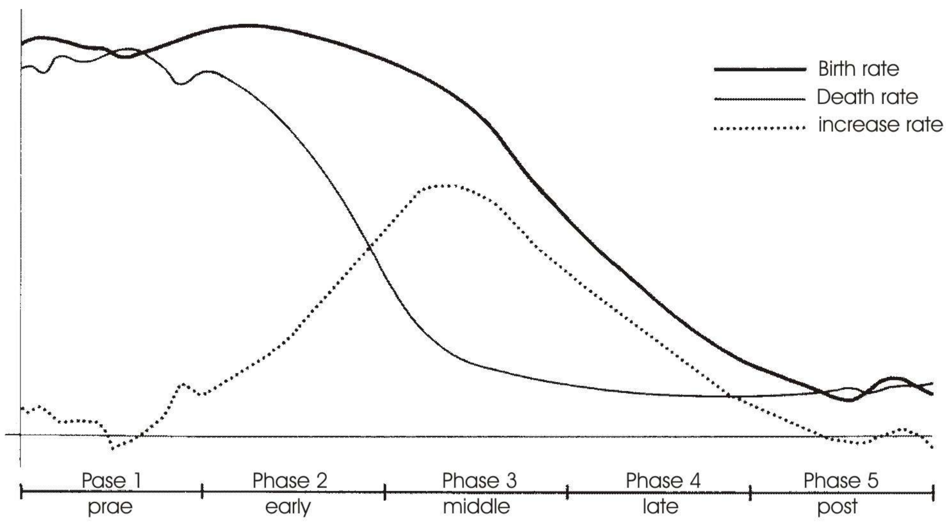


Fig. 125:
Diagram of the phases of demographic transition.
Source: See "Notes on the figures".

level to stabilise again. Projected to the population of the world: In phase 1, very few really isolated populations exist today. A number of West and Central African states have entered phase 2. Most developing countries are passing through phase 3. Phase 4 is typical of emerging economies, while industrial countries are in phase 5.

These are primarily countries which are in phases 2-4 of their development, whose conditions of life are rapidly deteriorating and whose inhabitants are seeking new sources of income, if necessary outside their native countries.

Distribution of the global population

In one sense, the human population of the earth forms a substantially definable space. Its shape is defined by the density of the population. A glance at the map shows that the space is substantially determined by the configuration of the ecumene. This can be best illustrated by taking an "ideal continent" which is obtained by drawing the continental masses together according to the parallels of latitude (see fig. 126). The main mass of this continent lies to the north of the Equator. The southern continents are smaller in size, becoming narrower towards the higher southern latitudes, thereby forming an approximately triangular land mass.

As we see, the greater part of the population lives closer to the coast (Europe, USA, China, India), with the density of the population decreasing inwards. There are a number of reasons for this. Climatic conditions produce a highly differentiated picture. Not only the regions close to the poles are hostile unpopulated, but also the dry regions in the interior of Africa, Asia and North America. This indicates that it is mainly the availability of water, mild temperatures and fertile soil which are important for the distribution of population, i.e. factors which affect agricultural carrying capacity. The history of development, especially in America, is also important for the accessibility of the settlement areas from outside, i.e. the opening up for trade and industry, as well as the general development in coastal areas with regard to international communications.

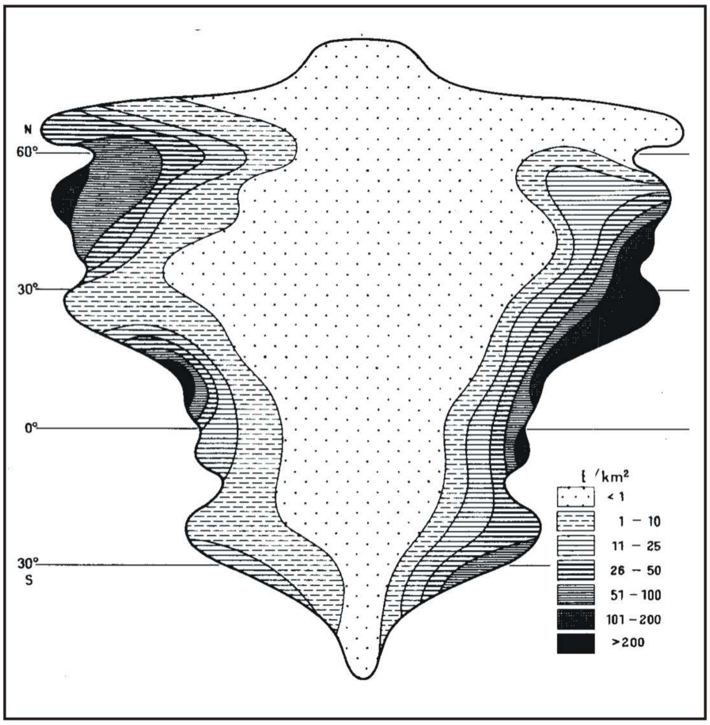


Fig. 126:
Model of population distribution according to coastal distance and degree of latitude on the ideal continent.
From Staszewski.
Source: See "Notes on the figures".

Here the degree of socio-economic differentiation comes into play. Less differentiated populations of the developing countries still live primarily by agriculture and require large areas of good soil for their livelihood. There is therefore a tendency for settlements to develop with some distance between them. At the other end of the scale, we have the socially and economically highly developed industrial countries which are dependent on mineral resources as well as geographic positions which favour trade and communications. Such areas favour the growth of cities and large conurbations with the consequent tendency towards concentration. This is a tendency only, but is striking in its global effects. There are numerous intermediate stages between these two extremes.

Adjustment of the population to its living space:

The integration of the earth's population as a whole in the ecumene - before the background of the global carrying capacity - is a problem which is particularly topical in view of the dramatic increase in the population of developing and emerging countries (see above) currently taking place. The subject goes back to the 18th century when Malthus (1798) realised that the population increases in geometrical progression, but the area available for foodstuff production can be extended in arithmetical progression only. From the geographical side, PENCK (1924/69) compiled a global review and compared the size of the populations in the various climatic zones. However, the results remained unsatisfactory because he assessed the fertility of the soil wrongly and failed to take account of the potential for development. In the 1970s, a number of researchers (Club of Rome: MEADOWS,

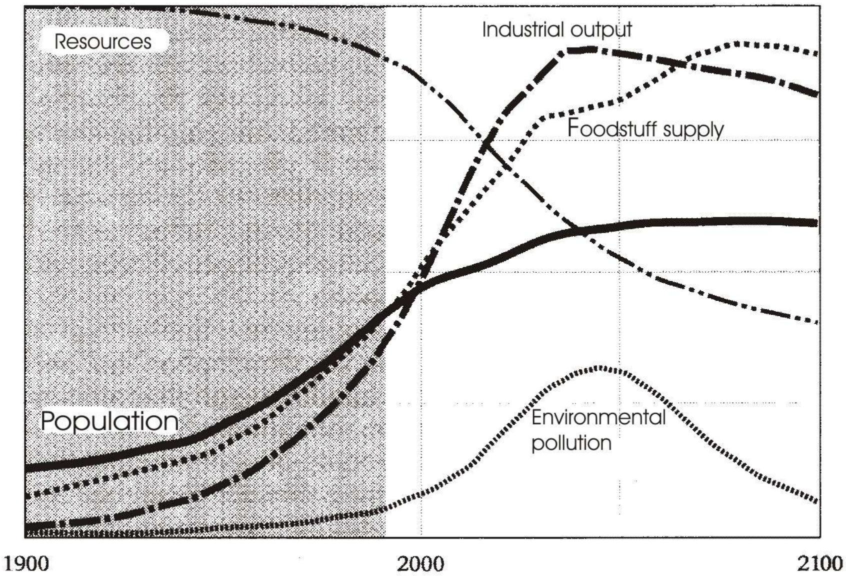


Fig. 127:
Carrying capacity (population size) of the earth taking into consideration the development of foodstuff availability, mineral resources, industrial output and environmental pollution.
According to "Club of Rome".
Source: See "Notes on the figures".

MEADOWS, ZAHN and MILLING 1972) designed a systematic model based on the Forrester Method (see section 2.3.2.1, pp.99) which takes numerous parameters into account, e.g. development of population size, foodstuff production, availability of mineral resources, industrial output, environmental pollution etc.. This enabled them to compile an overall picture of present-day mankind - even if it soon emerged that these global calculations were rather inaccurate because they saw only the (albeit important) overall interrelationships but failed to take account of the fact that many populations evolve their own means and strategies of dealing with difficult situations. This applies in particular to man's ability to invent new methods of recycling and foodstuff production (MEADOWS, MEADOWS and RANDERS 1992; ERBRICH 2004).

In spite of this, it yields an impressive picture which is capable of refinement, enabling us to come closer to the situation as it actually exists. Fig. 127 shows that a dangerous situation arises if laisser faire development is not consistently opposed by controls which make it sustainable.

For guidance:

Mankind as a species is treated as an example of an autopoietic system:

1) The level of individuals: Autopoietic systems create themselves not only structurally, but also materially. This means that it is essential for these systems "pass themselves on" if the task position in the context of the superior system is not to become vacant with the decease of the individuals. In the case of the living organisms, this takes place by genetic expression.

2) The level of population: Socio-economically less differentiated populations have adapted themselves to their agricultural environment over a certain period of time by means of certain mechanisms (oscillation, rotation). With increasing differentiation, the population increases until a new equilibrium is achieved between it and the capacity of the living space. The living space can be expanded by colonisation. In highly differentiated populations, favourable means of existence come into being which are spatially differentiated, i.e. supply and demand are brought into balance by individuals through migration.

Seen globally, an important aspect of the autopoiesis is apparent in the age structure of the populations, because it provides information on the reproductive behaviour, i.e. the modalities of reproduction. These change over the course of cultural evolution, i.e. with increasing differentiation. More favoured living spaces have come into being for mankind. As a rule, coastal regions have proved more favourable than continental ones. The present rapid growth in population must be countered by systemic controls because the carrying capacity of the ecumene is limited.

These brief comments are intended to show how a space, which is materially definable by mankind as a species, develops and how, as an autopoietic system, it creates a special "habitat" for itself among the totality of spaces which make up our universe. Other autopoietic systems have other mechanisms by which they create themselves.

2.6.2. The spheres of the Universe

2.6.2.0. Instead of an introduction: The Universe as seen by an artist.

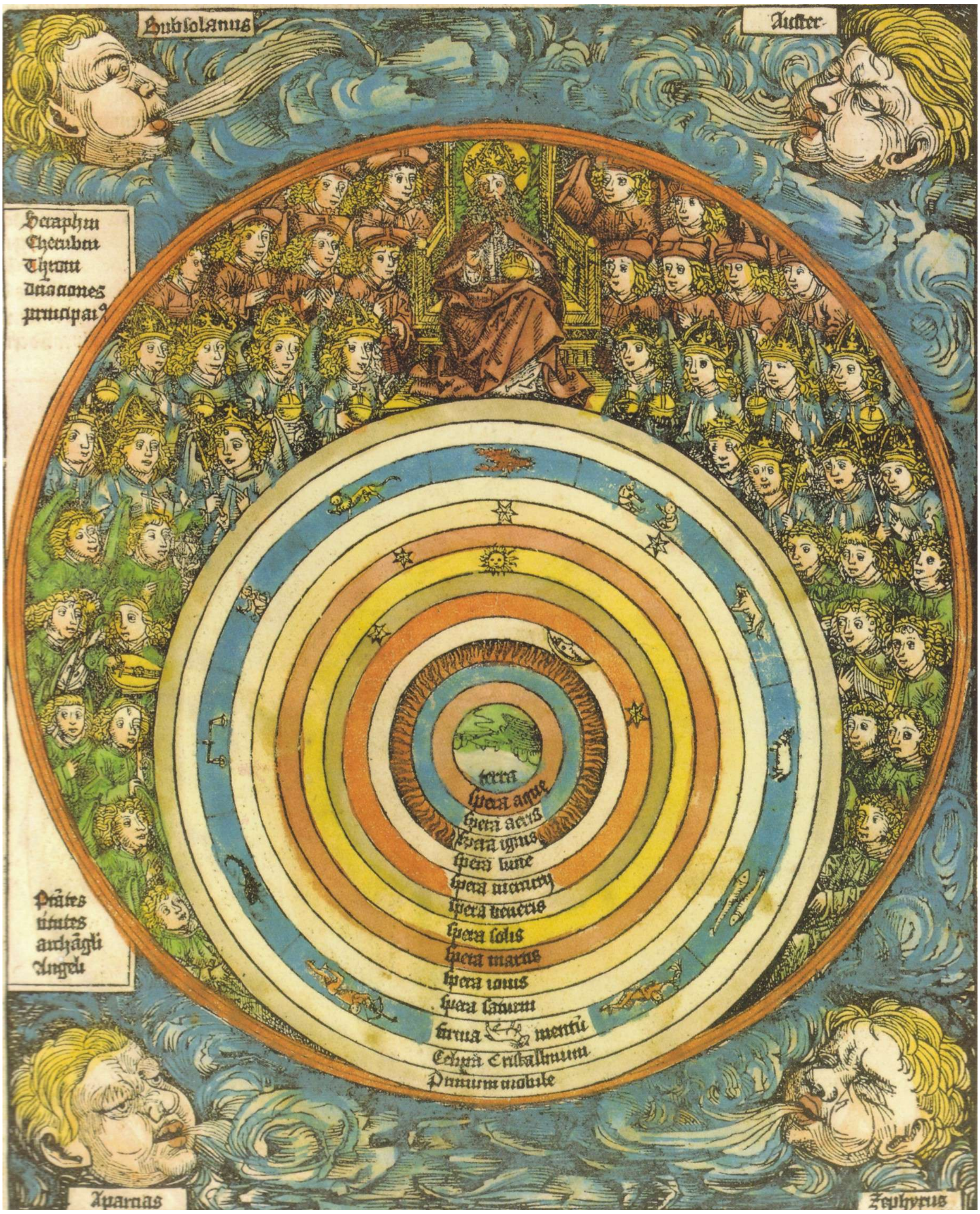


Fig. 128:.
The Creation as described in Genesis. Hartmann Schedel (1493).
Source: See "Notes on the figures".

The creation is the symbol for autopoiesis, whether it is anchored in the Bible, Buddhist myths, Hindu or naturist religion. In Christianity there are many representations of this event, especially in the late middle ages. On the verge of modern times (1493), Hartmann SCHEDEL published his famous Chronicle of the World. Schedel was a prominent humanist with an extensive education. On the other hand, his view of the world was still medieval in the sense that it was based nearly entirely on the Bible. The image described below originates from his Chronicle (see fig. 128). God the Father is enthroned at the centre above the orb of the world and surrounded by the angels in heaven and, in the four spandrels, the wind divinities. According to the Ptolemaic system, the earth is at the centre (upside down in the picture) surrounded by the spheres of water, air and fire. These are followed, moving outwards, by the orbits of the moon, and the planets from Mercury to Saturn. The outer canopy, where it was possible to see it from the earth, is formed by the firmament with the signs of the zodiac. Schedel numbered Moses among the reliable writers of history, calling him "a father of the historians of God". On the other hand, he also referred to the writers of antiquity and argued, for example, that the primitive matter "hylae" preceded the creation. When Schedel's Chronicle of the World appeared, Copernicus began his studies on astronomy on which he based his modern heliocentric system.

The example shows how, according to the notions of the time, the universe had a spherical structure and how, according to the knowledge available, the mesocosmos occupied the central space.

2.6.2.1. The individual spheres from the viewpoint of the mesocosmos

In our time too, we attribute a spherical structure to the universe, albeit in a different respect:

Biosphere, the ecosystem:

The living organisms are embedded in the global ecosystem, or seen spatially, in the biosphere.

In the 3 preceding levels of complexity, the systems (flow equilibrium, non-equilibrium and hierarchical systems) and their elements appear as structures which maintain themselves through the processes (flows of information and energy) but also represent the framework for these processes. The ecosystems too maintain themselves through flows of information and energy, through processes between demand and supply. However here, as mentioned above, the living creatures are themselves drawn into the process as the elements of the systems, are transformed in the course of the process and lateron destroyed to form the substance needed to build up new life. In this way it becomes possible for food chains to form.

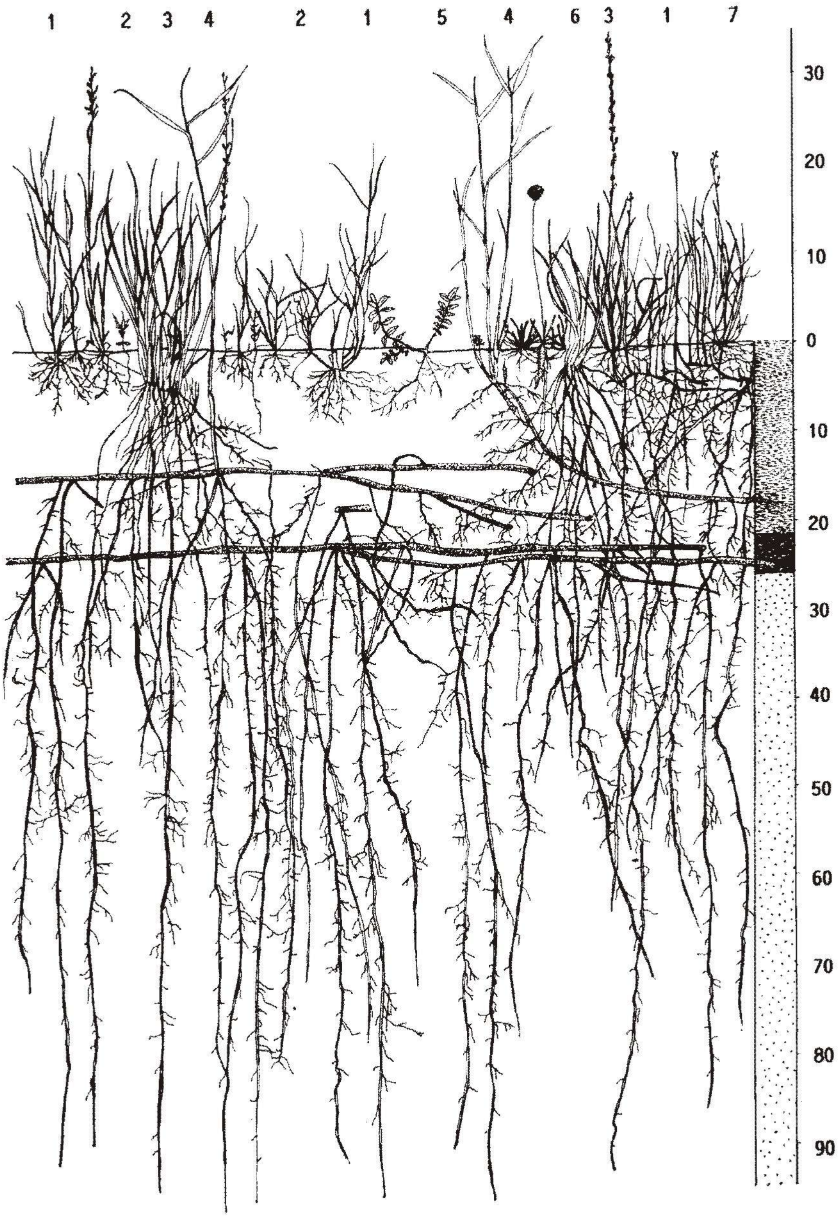


Fig. 129:
Shoot and root shape occurring in coastal grassland ("Bottensimsen-Salzrasen") in the western Baltic region. These effectively demonstrate the ability of plants to adapt to their environment.
1) Agrostis stolonifera maritima,
2) Centaurium vulgare,
3) Triglochin maritimum,
4) Phragmites australis,
5) Potentilla anserina,
6) Armeria maritima elongata.
Additional: Horizon sequence of soil profile.
After Dierßen.
Source: See "Notes on the figures".

The plants form the basis for these processes. The autotrophic plants are perfectly "designed" for their purpose. They have extensive root systems by means of which they obtain nutrients and water from the soil. In fig. 129 it can be seen how the roots of different plants form so that they reach the substances optimally and accelerate the process of weathering. Through tubular cells, these substances are conveyed upwards through the equally extensive system of stem, shoots and leaves (cormophytes). The water is sucked upwards by capillary action caused by the evaporation deficit in the leaves. Through small valves or pits, the leaves extract carbon dioxide from the atmosphere and release oxygen. In the leaves, sometimes even in the shoots, the nutrients are converted chemically into organic nutrients. In the individual cells, the pigment chlorophyl absorbs light from the sun and transforms it into chemical energy. Thus, the plants have adapted perfectly to their inorganic environment.

The plants spread through reproduction mechanisms (e.g. airborne pollen, pollination by insects) and the transport of seeds by wind, water and animals. They form populations to

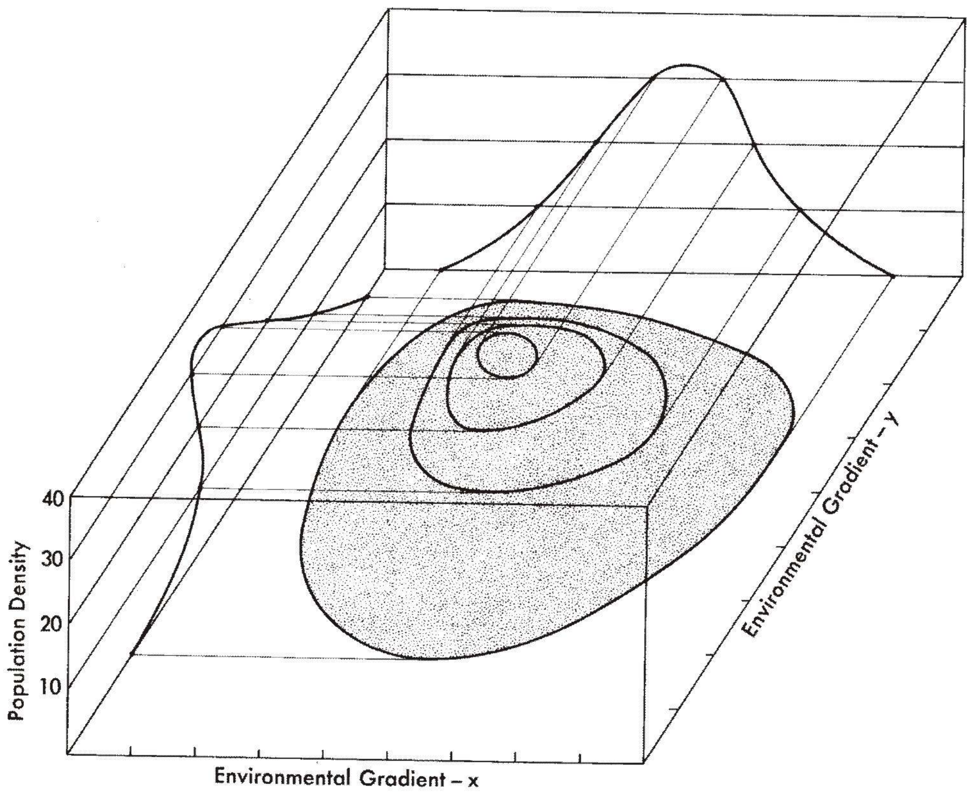


Fig. 130:
Ecological niche, population response to two environmental gradients. The distribution forms a bell-shaped figure, with population density decreasing in all directions away from the population center or peak. After Whittaker.
Source: See "Notes on the figures".

assure their survival (see fig. 130). They create their habitat and their place in the food chain i.e. their ecological niche (REMMERT 1984; BEGON, HARPER, and TOWNSEND 1991/98; WHITTAKER 1970/75).

In the course of evolution, the plants have become increasingly differentiated by adapting to environmental conditions. A multiplicity of different species arose. Besides the autotrophic plants, there are also heterotrophic plants which exist as parasites and obtain their nutrients from the host plant. Some plants exist in a symbiosis with others.

In the ecosystem as a whole (see fig. 131) the plants serve as nourishment for the animals. The plants are the "producers", the animals the "consumers". When the animals feed, the cell structure, i.e. the shape of the plants, is destroyed. The organic substance is absorbed by the body, digested, i.e.

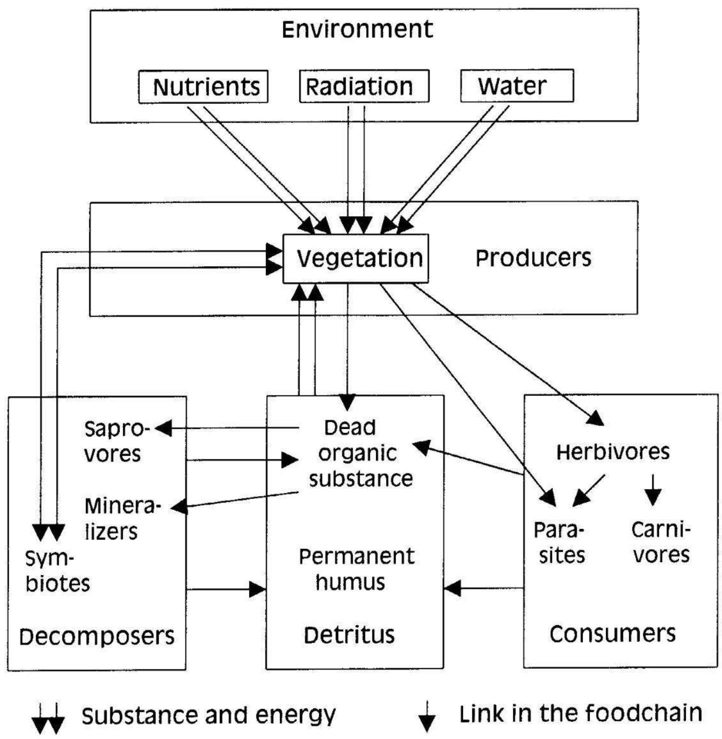


Fig. 131:
*The basic structure of the food chain in the ecosys*tem.
The autotrophic organisms (in particular the plants) thrive on mineral nutrients, through radiation energy and water. They are the producers in the ecosystem. These in turn are a source of food for herbivores, and the herbivores in their turn for the carnivores and parasites as consumers. Some animals and plants live in a symbiosis, i.e. they benefit from one another (e.g. lichens). Living organisms disintegrate to form detritus which serves as humus or a source of nourishment for saprophytes, which contribute to its further disintegration. The mineralisers (e.g. bacteria) then reduce these substances to their inorganic constituents, some of which return to the food chain as nutrients for plants.
Source: See "Notes on the figures").

prepared mechanically and then decomposed chemically by the body and, as far as possible reabsorbed materially and energetically. The process of digestion involves a number of different organs. The oxygen present in the atmosphere or water is required by the metabolism and is absorbed by other organs such as lungs or gills. Once inside the body, the substances are conveyed to the organs which require them and transform them by the circulation system. The gases which are not required for the metabolic process and the creation of organic substance (e.g. carbon dioxide) are returned to the atmosphere, while the remaining substances are excreted and decomposed by micro-organisms in the soil or water along with dead vegetable and animal matter and made available again in this way to the ecological cycle.

Unlike the plants, animals normally have the ability to move, can orient themselves in space by means of sensory organs and create their living space and habitat along with others. Thus, they are able to find the plants they require for nourishment and as well as the necessary sources of water. Man has proved to be particularly skilled at these activities. Mankind as a species has created mankind as a society which has become extremely skilful at exploiting the ecosystem as a source of energy.

The biosphere forms the core of the mesocosmos. In it macro an microcosmos unite. Whereas multicellular organisms are part of the macrocosmos, the cells which compose the organisms belong to the microcosmos. This division is justified not only from an anthropocentric point of view, but it is also inherent in reality, as survey of the inorganic environments of the biosphere shows:

Chemical and molecular spheres:

In the last resort, the energy required for the life processes is taken from the inorganic environment. The division of the biosphere into two parts expands to a dichotomy in the inorganic spheres. On the one hand, this surrounds the global ecosystem and its life forms in the shape of rocks, water and air, and therefore represents the superior environment. The soil conditions, water and weather conditions make specific requirements on the adaptation of the life forms and populations of the ecosystem and have in the past significantly affected the process of evolution. Through their form, living creatures and life in general are able to remove energy particularly efficiently from the inorganic environment as the superior environment.

On the other hand, the inorganic environment as inferior environment supplies, in the form of molecules, the substances which are absorbed by living creatures and which serve as the chemically transformable raw material for the food chain. It includes water and air as essential raw materials for all living beings. The absorption and release of water are precisely controlled by the plant, as is the exchange of gas in adaptation to the atmosphere. The soil ("rhizosphere"; see fig. 129) is of particular importance. Its ecosystem is a system with a highly complex structure. Plant life absorbs the substances, whereas the rocks, the most important sources are destroyed thereby releasing their nutrients. The process is aided by atmospheric phenomena (rain, wind, snow, frost, temperature change etc.) as well as the many forms of life in the soil, the microbe populations, fungi, larvae, worms, moles etc. which prepare the chemical substances originating in the rocks, thereby forming soil. On the other hand, organic detritus is decomposed down to its constituents, i.e. down to molecular level. Almost all the chemical substances required are dissolved in water, and thus prepared for the construction of organic material.

The living creatures for their part adapt to the inorganic environment and help to shape it. The Biosphere is surrounded on the one hand by the "chemosphere" (or "chemical sphere") consisting of the litho-, hydro- and atmosphere, and on the other hand by the "molecular sphere", which is made up of molecules, i.e. of components from the chemosphere. In the compartments of the chemosphere, flow-equilibrium systems and non-equilibrium systems (currents, layers, air masses, eddies, waves etc.) are constantly forming and disintegrating depending on combination. These systems mingle the molecules, so they are generally unstable (e.g. an hurricane; see section 2.4.2.2, pp.188). But durable substances (gases, liquids, rocks) in many different forms and compositions come into being. The flora and fauna are adapted so well to the environmental conditions at macrolevel that they make full use of every source of nutrition offered by nature (see above). Mankind interferes (often negatively) in the workings of the global ecosystem. Through his influence, not only the soil (by soil erosion, "desertification") and water (by pollution etc.) are damaged, but also the atmosphere through emission of toxic substances. Man has now realised that only sustainable utilisation of the global ecosystem can assure its future (see also section 2.6.1.3, pp.265).

Planetary sphere and sphere of ions:

In the third spheres of the macro and microcosmos, durable systems, unlike the systems of the chemosphere, transform energy. As a representative of the "planetary sphere", the planet earth (prosumedly like other planets) adds a new phenomenon, that of magnetism and electricity. Apparently the earth behaves like a self-stimulating dynamo machine (BERCKHEMER 1997, pp. 147; GLATZMAIER and OLSON 2005, pp. 54). It generates current by rotation. When a certain speed is reached, the electromagnetic field itself is strengthened. In the outer regions of the earth's liquid core (consisting predominantly of iron) convection currents may exist which are capable of reaching a speed of up to 30 km per year. On its own, this would be sufficient to strengthen the electro-magnetic fields.

The counterpart to the planetary sphere is the "sphere of ions" at the micro level. The ions are positively or negatively charged molecules or atoms. By stimulating a molecule or atom, e.g. by applying energy, it is possible to detach electrons from the shell thereby increasing net charge positively. On the other hand, the addition of electrons increases the net charge negatively. In this way, atoms and molecules are able to form chemical compounds with other atoms or molecules.

Solar sphere and sphere of atoms:

In the macrocosmos, the "solar sphere" represents the forth sphere. It is divided into the central star (the sun) and the planets (and the asteroid belt). It is here that the matter in the macrocosmos is concentrated and separated. The greater part of the mass of this system is concentrated in the sun.

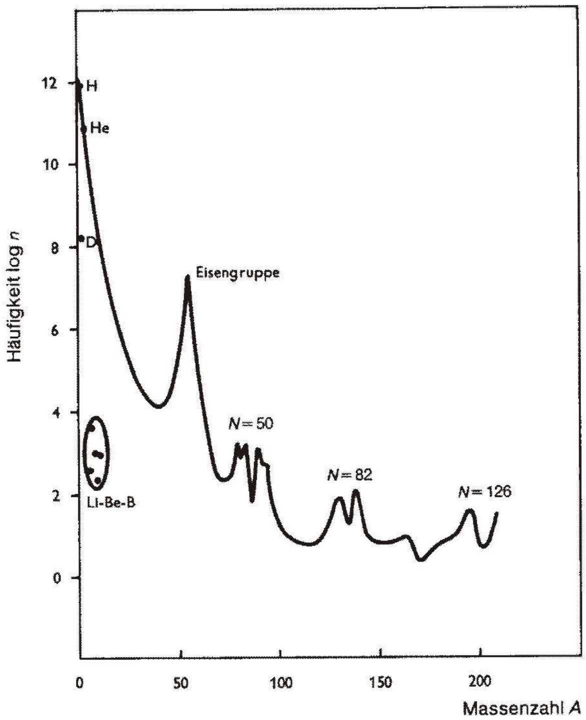


Fig. 132:
Relative frequency of chemical elements (characterised by their mass number) in the sun.
Source: See "Notes on the figures").

In the same way, passing down the hierarchy into the microcosmos, the "sphere of the atoms" adjoins. If we continue to pursue this model, it is in direct association with the sphere of the solar system, not only through the shape of its systems (if we take Bohr's model as applying to the atoms). The atoms are also created in the solar system. The conditions for their formation alter from the centre (of the sun) towards the edge of the solar system. Inside the sun, the elements i.e. the atomic nuclei are formed. The energy radiated by the sun is generated in its interior through the fusion of hydrogen nuclei to helium, and then carried to its surface by convection and radiation. Heavier atomic nuclei are also produced by atomic processes within the sun ("nuclear synthesis"; UNSÖLD and BASCHEK 2002/05, pp. 302) with the result that (in line with the periodic system of the elements) completely different atoms come into being (see fig. 132). It appears that the chemical conditions in other stars of the same category are similar to those in the sun. Atoms, as we encounter them on earth, are surrounded by an electron shell.

The short description of the structure of the mosocosmos and its adjacent "spheres" allows different levels of being to be distinguished. If we add more spheres to these, it becomes more difficult to make definite statements.

2.6.2.2. The sphere model (based on extrapolation)

General considerations:

In the area comprehended by man, i.e. the mesocosmos and its surroundings, a scale of spheres can be made out (see tab. 6). The spheres are screened off from other spheres through the

Tab. 6:
The spheres of the macrocosmos and microcosmos as seen from the mesocosmos:

.... Sphere of solar system Sphere of planets Chemosphere Biosphere (organisms)	Macrocosmos
Biosphere (cells) Molecular sphere Sphere of ions Sphere of atoms	Microcosmos

substantial consistency, structural peculiarity and order of magnitude of the systems constituting them. They are energetic interaction spaces with laws of their own. They convert energy to substances and substances to energy, structure and form themselves into matter.

We see here only a small portion of our reality. Nevertheless, a few more general considerations appear appropriate. On the basis of the above, the following statements may be made with regard to:
1) the tasks,
2) the hierarchic structure, and
3) the arrangement of the spheres.

About the tasks:

Probably it has to be assumed that the universe is a system which is preserved or altered by process sequences in a similar way as a non-equilibrium system or a hierarchic system. The aim of the process seems to be the complete control of the flow of energy. At this level of complexity it is achieved by concentrating the processes spatially. This takes place step by step depending on the scale of the sphere.

Looking at these reflections in the light of the process theory, the question then arises (in spite of many unsolved problems) concerning the assignment of the spheres to the process sequences and their position in the catalogue of tasks. We assume the following interconnections and start in the macrocosmos with the outer sphere of the mesocosmos:
- In the sphere of the solar systems space is divided into a core and its environment or hinterland. Thus, a certain phase of arrangement is reached as early as the process of the macrocosmos. This phase is similar to the organisation stage within the conversion processes (in particular the city-umland-populations, see section 2.4.2.2, pp.191). Here in the macrocosmos, the field of force is caused by gravity. We can see the task of "organisation".
- In the sphere of the planets the dynamo effect of the rotation of the celestial bodies releases electrical energy. This type of energy now takes its place beside mechanical and chemical energy which allow the formation of more complex spaces and materials. The process is "dynamised". It is probably in this sphere that the task of "dynamisation" is executed.
- In the chemosphere the systems create the vast number of materially defined spaces which characterise the universe we perceive with our senses. These spaces testify to the multifarious ways in which matter adapts to and promotes the various flows of energy, whether these are on the surface of the earth, in its interior, or in the media and artefacts created by mankind (see section 2.1.1.1, p.18). Matter is joined up in the process, with the result that complexity arises. New forms are constantly produced by the conversion of energy, and old ones destroyed. Space filled with matter binds up energy and releases it when something new comes into being. We would assume that this is what is meant by "kinetisation".
- In the biosphere the maximum of mobility, effectiveness and adaptability of the systems to the flow of energy is reached (see above). We assume that the biosphere assumes the task of "stabilisation".

The process then takes us further into the microcosmos. It is not yet possible to say whether this process (for example like the reaction process at the 4th level of complexity; see section 2.4.1.2, pp.136) commences with perception, or, the other way around, with stabilisation.

About the hierarchy:

Perhaps it is possible to deduce that the task of the systems in the macrocosmos is the creation of form, and that the task of the microcosmos the formation of substance or matter. Broadly speaking, the creation of form may be interpreted as the formation of a boundary between two substances, i.e. as a separation of these substances. The creation of form therefore means the shaping of space, because space receives its shape through the forming of matter. Matter stabilises the space. With systems however, the acquisition of space also includes the space between the elements, inasmuch as this is established by the system/element relationship. Only in this way does it become possible to interpret spaces qualitatively.

The systems making up the spheres in the macrocosmos (living creatures, systems of the chemosphere, planets and solar systems) are associated with the systems of the correlating spheres in the microcosmos (cells, molecules, ions and atoms) by the relationship of system to element (see fig. 133).

From the point of view of the process theory in the mesocosmos, the spheres of the macro and microcosmos may appear as follows with regard to the linking of their systems:

1) Linked between adjacent spheres, the flow of information travels from the higher to the next lower sphere, while the flow of energy proceeds from the lower to the next higher sphere.
2) The systems of the spheres diametrically opposite one another (e.g. the organisms G and cells G' of the biosphere, the systems of the chemosphere F and those of the molecular sphere F') are determined by the relationship of system to elements, i.e. the relationship of the systems in the macrocosmos to those in the microcosmos is that of order –

obedience. In fig. 133, dotted arrows indicate the creation of form and space and the continuous arrows the creation of matter.

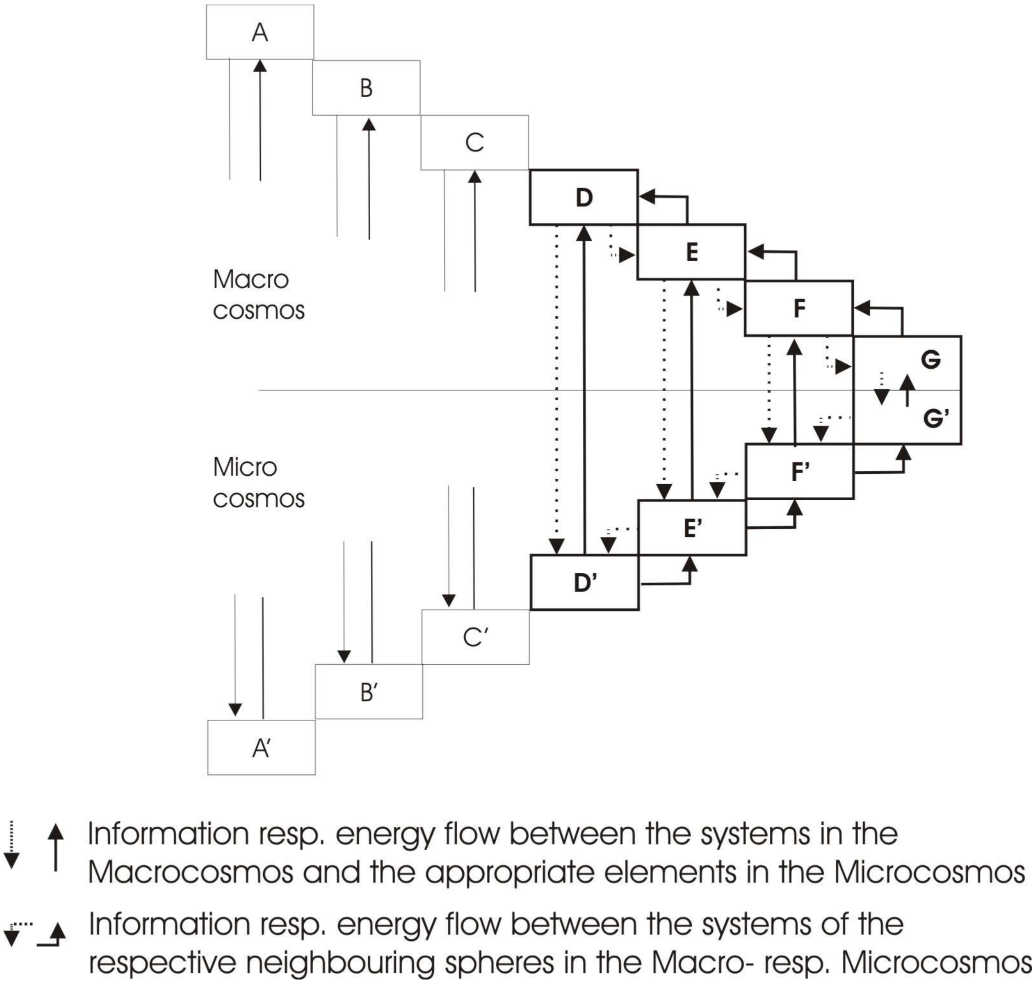


Fig. 133:
The spheres of the macro and microcosmos.
A,B ... G, A', B' ... G': Spheres in the macro- resp. microcosmos.
Within the mesocosmos or in its neighbourhood:
D: Sphere of the solar system; D' Sphere of the atoms;
E: Sphere of the planets: E': Sphere of the ions;
F: Chemosphere; F': Molecule sphere;
G: Biosphere (organisms consisting of several cells); G': Biosphere (cells, organisms consisting of only ohne cell).

We are members of all spheres. We consist of the same components as the microcosmos (quarks, atoms, molecules, cells etc.), and at the same time are part of the earth, the solar system (the universe). The autopoietic systems forming these also form us. We are therefore bound up in the general flow of information and energy.

About the arrangement of the spheres:

Seen broadly, the spheres of the macrocosmos envelope those of the microcosmos:

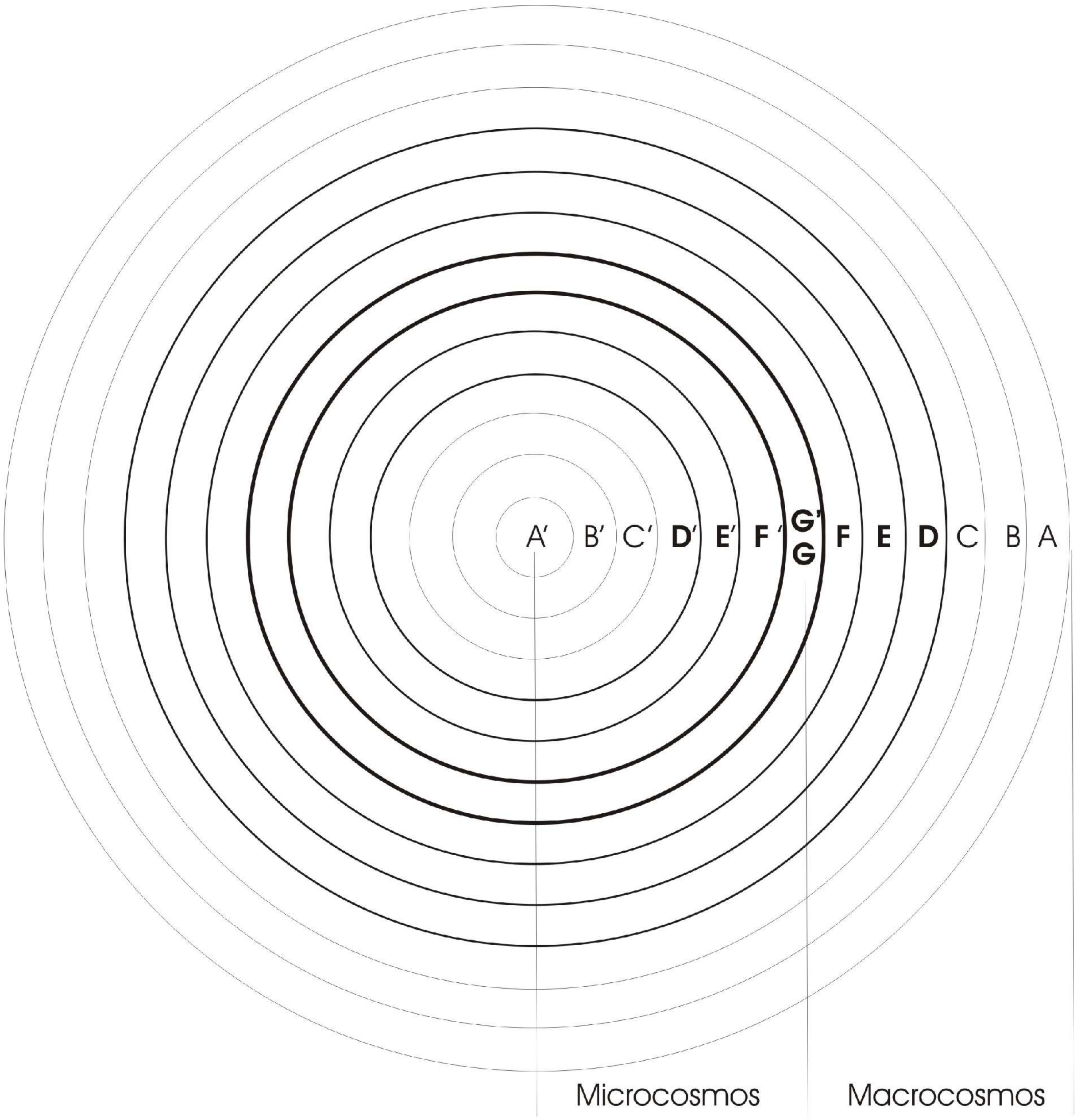


Fig. 134:
The Spheres in the macro- and microcosmos.
In the frame of the mesocosmos und its environments we distinguish:
D = Sphere of the solar system,
E = Sphere of the planets,
F = Chemosphere,
G = Biosphere (organisms),
G'= Biosphere (cells),
F'= Molecular sphere,
E'= Sphere of the ions, and
D'= Sphere of the atoms.
Spheres A - C and A' and C' are not taken into account here.

The individual autopoietic systems (e.g. ions) are encompassed by the autopoietic systems in the next higher sphere of the hierarchy (molecules), and they themselves encompass the autopoietic systems of the inferior spheres (atoms). In this way, a materially defined space is created which is similar in structure to the skins of an onion (see fig. 134).

Relationships can therefore be discerned among the spheres of the macro and microcosmos (if we start from the biosphere). Through extrapolation, we conclude that there are 7 spheres in the macrocosmos and 7 in the microcosmos.

In the complexity levels discussed above, mathematical formulae were assigned to the processes. Here too, it would be possible to compile figures in tabular form by extrapolation. However, we will dispense with this in view of insufficient observational data.

2.6.3. Process sequences and dominant systemic dimension (preliminary considerations)

Numerical sequences:

As with the other levels of complexity, we now present the numerical sequences and the route diagram. We must look beyond the mesocosmos, because the models were developed (according to the emergence code) from the models of the levels of complexity previously dealt with.

We distinguish the macro and the microcosmos. The stimulating system is the macrocosmos, the annexed material environment the microcosmos. According to our Process Theory, the space-creating processes originate in the macrocosmos and the matter-creating processes from the microcosmos. The 1st rank process is horizontally oriented. It combines the induction process and the reaction process in a through sequence both in the macrocosmos and the microcosmos.

The passage through the coordinate system is counter-clockwise (C variant). Firstly the space creating process in the macrocosmos:
[f(x)], Input: The space creating process is brought into the macrocosmos (induction process).
[f(-x)], Acceptance: The space creating process is accepted in the macrocosmos (reaction process).
The matter creating process now follows in the microcosmos beneath the x axis:
[-f(-x)], Redirection: The matter creating process in the microcosmos is stimulated by the space creating process from the macrocosmos (induction process).
[-f(x)], Output: The matter and the space creating processes is accepted in the microcosmos (reaction process).

In the 2nd rank process macro and microcosmos are vertically fused together to form a system unit if we understand the autopoietic systems forming the microcosmos to be elements of the autopoietic systems forming the macrocosmos. These processes are probably structured in a hierarchically contrary way. The creation of substance in the microcosmos and the creation of space in the macrocosmos presuppose one another mutually.

The universe therefore forms the framework within which the autopoietic systems create themselves spatially and materially. As a result, we find 16 stages (1st order) horizontally and 16 stages vertically. This results in 16 spheres in the macrocosmos and microcosmos (see fig. 135a).

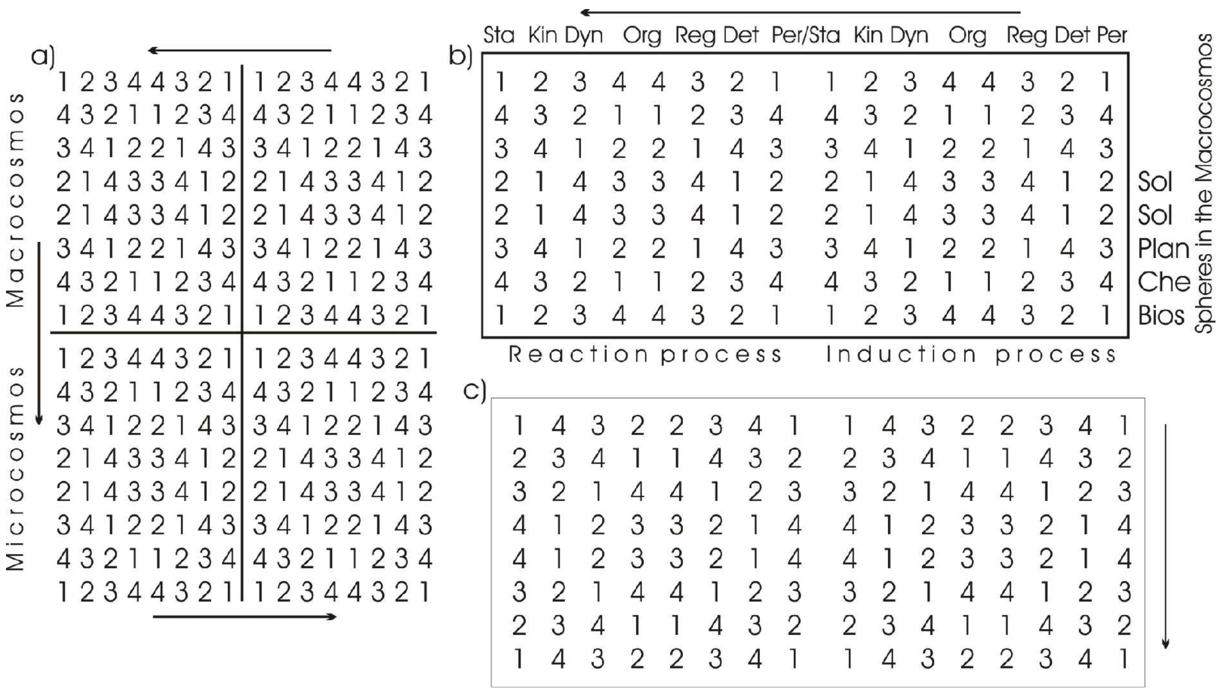


Fig. 135:
Scheme of the universal process. Numerical sequence.
a) 1st rank process (C variant, see arrows) before folding: Development above the x-axis (macrocosmos) from right to left, below the x-axis (microcosmos) from left to right.
b) 1st rank process after folding: The lower part (microcosmos, matter creating process) is folded behind the macrocosmos (space creating process). So only the macrocosos (space creating process) is visible here.
c) 2nd rank process (U variant), folded.
About the operations see section 2.2.3, pp.62.
Abbreviations: Bios = biosphere, Che = chemosphere, Plan = sphere of the planets, Sol = sphere of the solar systems. Per = perception, Det = determination, reg = regulation, org = organisation, dyn = dynamisation, kin = kinetisation, sta = stabilisation.

Through folding the system of coordinates is dissolved, process sequences form new links. In the diagram, the upper part becomes the space creating process and the lower the matter creating process. In the sequence of numbers, the processes adjacent to one another run contrary to one another. The matter creating process is concealed (fig. 135b). It is folded under the space creating process.

This horizontal process of the first order supplies the vertically arranged processes of the second order, and the direction up or down alternates for each sphere as in the systems of the previous level of complexity. The course of the second-rank process sequences is obtained by reversal (see section 2.2.3, p.65) of the numeric sequence fig. 135a and folding. Fig. 135c shows the result.

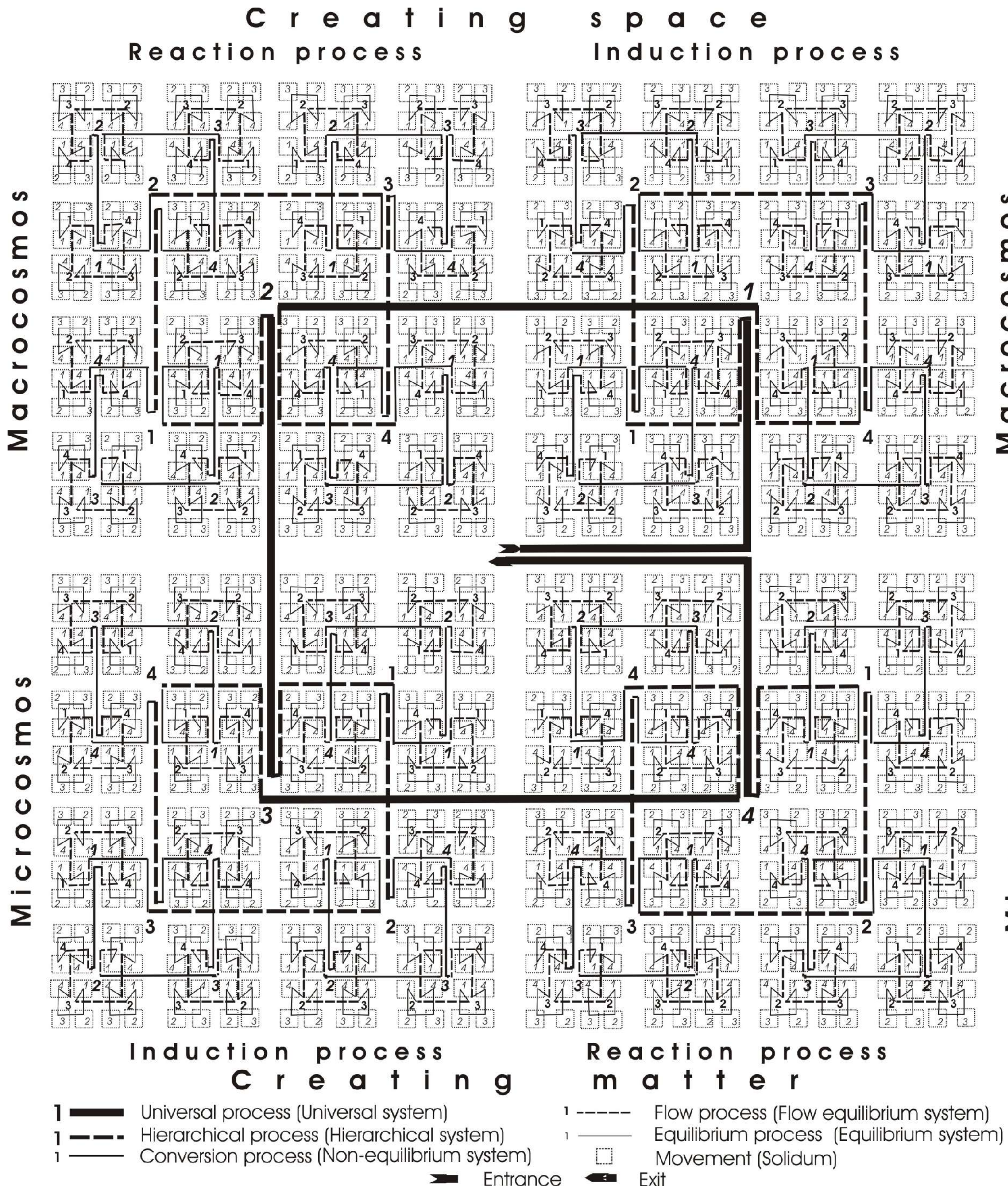


Fig. 136:
Scheme of the Universal process (Universal System). Route diagram.
Above (1 and 2) Macrocosmos, below (3 and 4) Microcosmos.
For reasons of space, the sequence at the lowest (movement) level can only be indicated by squares.
The first rank basic process stages are assigned to the systems structured according to the C variant.
To each of the four stages of the basic processes of a level of complexity is assigned a basic process of the next-deeper level of complexity. Each of the basic processes shown in this drawing represents a large number of individual basic processes.

Route diagram:

To achieve a clear picture of all the levels of complexity involved in the course of the process, it is necessary to unfold the numerical sequences of the systems (see fig. 136). Here the process travels in an anticlockwise direction (C connection) through the system:
The macrocosmos is situated above in the diagram (1, 2). From the top right (induction process, 1), the space-creating process moves left (reaction process, 2). The microcosmos is located below. Here, the matter creating process moves from the left (induction process, 3) to the right (reaction process, 4).

The hierarchic processes (fifth level of complexity) fit into it. The conversion processes (fourth level of complexity) are in turn subject to these.

The dominant systemic dimension (see fig. 137):

The flows of information and energy are fixed at the 5 deeper levels of complexity. Perhaps we are beginning to understand how processes are controlled and products created, how the system organises itself and takes on tasks for the superior systems. However, the formation of material itself had not yet been covered. At the 6th level of complexity autopoiesis predominates. This type of process can only be understood if the mesocosmos is regarded as part of the universe. The most comprehensive autopoietic process is the universal process, the most comprehensive autopoietic system is the universe.

Here it is space which is the dominant systemic dimension. The limits and distances of the processes or systems are determined. Everything is subordinated to this dimension – the quantity of energy, the divided process and the hierarchic structure. Everything is embraced, spatially disciplined. According to the theory outlined here, reality is divided into spheres which enclose one another like the skins of an onion. At the core of this structure we find the smallest systems of the microcosmos and at the periphery the largest ones of the macrocosmos. The biosphere is located in the region of the

Fig. 137:
The space dimension becomes dominant at this level of complexity.

mesocosmos. They form the transitional space from which the scale of spheres leads to the macrocosmos in one direction and to the microcosmos in the other.