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Dietrich Fliedner

Society in Space and Time

An Attempt to Provide a Theoretical Foundation from an Historical Geographic Point of View

Saarbrücken 1981

Arbeiten aus dem Geographischen Institut
der Universität des Saarlandes

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PREFACE

The idea of developing a theoretical conception for explaining anthropogene structures and processes in space and time, reverts to the early 1960's, when I discovered latent rotation effects in the course of an investigation of population and traffic movement in various West German cities (D. FLIEDNER, 1962a). However, at the time I was not yet in a position to interpret these "cyclonic tendencies" as the expression of an universal phenomenon. Having subsequently been engaged in various historical geographic investigations, I felt it appropriate to take up the theme once again. I found further encouragement in numerous stimulating discussions with my brother, Dr. Siegfried Fliedner, Bremen, on basic and methodological problems concerning the complex of questions dealt with here.

This treatise should be seen as an attempt by an anthropo-geographer to recognize phenomena, structures and processes in the scientific environment he is familiar with, to bring them into proper perspective and to understand their underlying basic order. During the course of this work it very soon became evident that a limitation of these considerations to anthropo-geographical facts and circumstances in the traditional sense could not lead to success. The fact that the conventional structure of science is rooted in a different conception of reality sometimes proved to be an impediment to a more comprehensive theoretical interpretation. Thus, it was necessary in several points to venture far beyond the limits of geography. Of course, the further away I moved from anthropo-geography, going on into related branches, the more difficult it became to evaluate the facts. However, this had to be the course of procedure, as it was also a matter of breaking the spell of isolation surrounding more or less every scientist in his own discipline. May my colleagues involved in related sciences or in those branches touched upon in this treatise not regard my exposition as an encroachment on their domain.

Due to the extent and scope of the subject-matter dealt with, the literature is vast. For this reason reference is not made in every case, and quite often publications that many readers may feel to be particularly important will not be included. It seemed more appropriate to quote representative publications, in order to demonstrate their position in our context.

Preference was given to the inductive method, i.e., conclusions were drawn from concrete observations. Geography (like history), has a long tradition in this method of procedure. Certainly, this inductive method is open to doubt, and conclusions are merely interpretations. However, they are conducive to discussions, which is precisely what is being aimed at in this treatise.

The most important basis for statement is the historical-geographic investigation of a small, easily surveyable and comparatively simply structured Indian tribe that lived in the southwest of what is now the USA between the 13th and 19th centuries. Conditions were particularly favourable for studying the relics of these peoples' activities.

Together with my wife, I carried out the necessary field work in 1975 and 1976. I think back with great gratitude on the help and support we received during our stay from all my colleagues at the Department of Geography, University of New Mexico, especially from Mrs. E. Barrett, Mr. R. Murphy and Mr. I. Bennett, from archaeologists of the National Park Service and the museums of New Mexico (Santa Fe) and Arizona (Tucson), above all from Mrs. Snow, Mr. Nordby, Mr. Peckham, Mr. Wiseman and Mr. Vivian. Mr. Giles, the superintendent at the National Monument, Pecos, cleared many technical problems out of our way. Mr. and Mrs. Fogelson, from Dallas, gave their permission to our carrying out field work on their ranch areal; the National Park Service, Washington, gave us permission to investigate the monument region.

Our work was made possible by the substantial subsidizing of our travelling expenses by the Deutsche Forschungsgemeinschaft and the Wissenschaftliche Gesellschaft des Saarlandes, which establishments, together with the Universität des Saarlandes, also considerably aided the evaluation of the results. It is my pleasant duty to extend my thanks to these institutions.

I have, for the sake of clarity, endeavoured to present these reflections as simply as possible. In order to test the comprehensibility of this treatise, I previously gave a lecture on the basic thoughts underlying the theory to a small group of interested assistants and students at the Geography Department of the Universität des Saarlandes. I am very grateful for the helpful suggestions made on that occasion.

Whilst establishing the manuscripts I received assistance from many sides. I am above all indebted to my secretary, Frau Schichtel, and to her precedessor, Frl. Wobido, for their tireless work, and also to Frau Klein and Frau Commer. Herr Paulus very diligently plotted the diagrams and maps and Frau Scholl completed the photographic work. Herr stud. phil. Körner assisted me in many technical projects (the procuring of literature, evaluating of statistics, reading the proofs etc). Herr stud. phil. Rothe read section 5.3. of the manuscript and contributed several valuable hints.
I owe particular thanks to Frl. Weiner for her laborious work on the translation.

December 1980

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INTRODUCTION

In the course of the past hundred years, the emphasis on the main themes for research within geography and history has shifted more than once (cf. A. HETTNER, 1927; R. HARTSHORNE, 1939; H. OVERBECK, 1954; G. HARD, 1973; J. SCHMITHÜSEN, 1976; E. WIRTH, 1979, from different geographic viewpoints; and e.g., F. MEINECKE, 1959a, b; H. RITTER v. SRBIK, 1950/51; K. BRANDI, 1952; G.G. IGGERS, 1968/71, for the historical approach). However, in general we can say that both sciences still differ from each other in their basic tendencies.

The traditional topic for research in geography is a part of the earth's surface, understood to be three-dimensional, with the structure and arrangement of objects, the informative and factual links between them and also to the other parts of the earth's surface. Spatial organization of human society and its actions do not appear as an object for research in geography until the emergence of social geography (R. BUSCH-ZANTNER, 1937; H. BOBEK, 1948; D. BARTELS, 1968; H. UHLIG, 1970; E. THOMALE, 1972; J. MAIER, R. PAESLER, K. RUPPERT and F. SCHAFFER, 1977; E. WIRTH, 1977).

The chief matter of concern in history is the investigation of the kind and order of the course of processes and events that are incorporated into a network of informative and material interactions. In this context, the human being himself has always stood more at the centre of interest, as the one acting and being acted upon, than was ever the case in geography (Th. SCHIEDER, 1968; K.G. FABER, 1972; Chr. MEIER, 1978). Time is not primarily an integral part of a geographical approach, and spatial arrangement and relationships are not a matter of central interest in historical research. The segregation of space and time corresponds to our powers of imagination and finds expression precisely in the parallel existence of the geographical and historical sciences.

However, there were and still are quite a number of researchers who, at the same time, concerned themselves to a large extent with subject-matter taken from both these sciences, particularly if they were working in the field of regional history, economic or social history, settlement archaeology or the history of cultural landscapes (e.g., from different viewpoints, H.

SCHLENGER, 1951; H. AUBIN, 1965; SETTLEMENT ARCHAEOLOGY, 1968; W. WÖHLKE, 1969; H. JÄGER, 1969; H.-G. WAGNER, 1972; M. BORN, 1974; VALLEY OF MEXICO, 1976; H. JANKUHN, 1977). Within a certain range of themes there even resulted an effective blending together of both approaches and a linkup of space and time, starting with the description of the objects concerned (diachronic method; M. GODELIER, 1965, p. 41). From this viewpoint, the processes move into the centre of interest. Themes such as these were and still are, for instance, colonization (F.J. TURNER, 1920; I. BOWMAN, 1931), late medieval desertion processes (W. ABEL, 1943/76; H. MORTENSEN 1944; K. SCHARLAU, 1957), the expansion of cultural realms (H. SCHMITTHENNER, 1938/51), the diffusion of cultured plants and domestic animals (C.O. SAUER, 1952). T. HÄGERSTRAND (1952) gave the processes a clear methodical foundation. A process (cf. e.g., D. HARVEY, 1969/73, p. 407f; also section 2.6.) is a spatially and temporally ordered, determined, i.e., limitable formation. It emanates from an initial point and spreads out, its intensity increasing to a maximum, to subside again. The conditions created by the process may remain constant over quite a long period of time before a new process starts, bringing new changes. Every process is given an orienting meaning by its identity as a whole.

The recognition of wholes has been an important part of geographical research for a long time. The constituent elements of these wholes are related to one another and arranged correspondingly. This approach is based on the recognition of the ties between the single components or actions to higher units, as elaborated in the functional method (R. HARTSHORNE, 1939, p. 260f; E. WINKLER, 1946/67, p. 231f; H. OVERBECK, 1954; D. HARVEY, 1969/73, p. 433f). This approach was supplied with scientific foundations in "gestalt" psychology in particular (H. DRIESCH, 1928, p. 365f; W. KIRK, 1963, p. 365f; W. KÖHLER, 1971). The whole dominates over all its parts, the shape is transferable to other parts, the elements can be exchanged. Furthermore, history cannot dispense with registering higher units that are superposed to single actions (Chr. MEIER, 1978). With periodization, a striving for the registration and characterization of quite long units of time, distinguished by specific traits, becomes evident (Th. SCHIEDER, 1968, p. 42f, 83f). Similarly, the processes can also be regarded as spatio-temporal wholes. The existence of these entireties, not merely as models, but as realities that can be investigated, constitutes a

sustaining element of the theory presented here.

However, it must be made quite clear that we are not concerned with entireties in a totalitarian sense, i.e., with the totalities of all traits or aspects of a thing and particularly of all relations existing between its constituent parts (K.R. POPPER, 1961), but only with those traits and relations that substantiate these entireties as such, and let them appear as units with a structure of their own (cf. for this problem complex, besides K.R. POPPER, 1961, also E. NAGEL, 1952/65 for the social sciences; for geography, G. HARD, 1973, p. 96f). The processes acquire their character of wholes by their meaning. However, obviously it is not possible to interpret history as such as a whole, provided with a certain meaning.

By using the holistic concept the following theory receives its special accent. It differs from the "time geography" of T. Hägerstrand (K. ELLEGARD, T. HÄGERSTRAND and B. LENNTORP, 1977; TIMING SPACE, 1978) which is based on the individual demands and activities; in this remarkable approach Hägerstrand tries to understand the processes from the basis (cf. section 3.7.1.1.3.) This does not mean that both concepts cannot be tied up with one another in the future.

The following theory of society in space and time - we may call it process theory for short - is meant as an approach. Without going into the many-faceted problem complex surrounding explanation and the philosophical questions involved (cf. C.G. HEMPEL and P. OPPENHEIM, 1953; C.G. HEMPEL, 1952; W. STEGMÜLLER, 1969/73, pp. 72ff; K. POPPER, 1935/69; J. RITSERT, 1975; for a geographical approach: D. HARVEY, 1969/73; G. HARD, 1973) we may state that explaining means placing the object into its structural context, i.e. to show its relationships with the other objects that are important for its existence. To explain a complex process means recognizing the elements and clarifying their position in relation to the elements connected with them (inner system) and to put the process as a whole in its context (outer system). The relations should be seen qualitatively, temporally, hierarchically, and spatially. One finding has to support the other. In many cases I could not attain this target, but I hope that I could show some ways leading in this direction.

It is my opinion that such complex objects have to be developed verbally

first. In doing so the facts have to be presented in such a way that they are reconstructable. Thus it was considered important to ensure that the illustrative material serving to substantiate this theory can be controlled (cf. annexes); they may also be supplemented by further investigation. The theory is thus open to falsification.

Moreover the statements should constitute a basis for a mathematical formalization. Basically, processes represent a physical problem. They may be regarded as an expression of four-dimensional space (D. FLIEDNER, 1980; 1981). Although the investigations involved in this go beyond the traditional frame of geography and even of the social sciences, some preliminary statements are made at the end of the treatise.

1. PARTICIPANTS

1.1. SOCIAL GROUPINGS AND POPULATIONS

A theory that places processes at the centre of interest should first of all be concerned with identifying the participants, i.e. those causing the processes or suffering them as individuals or - together with others - as elements of units that are superior from the point of view of hierarchic order. We shall give these superposed units the neutral designation "groupings" irrespective of their structure and composition. The term group has been predetermined by sociological and social-geographical discussions (W. BERNSDORF, 1972; H. HAHN, 1957), and moreover, it usually covers small groups whereas we also include large groupings that may inhabit and characterize countries or even continents.

In the social sciences the most important criterion for defining groupings can be considered cohesion, or to put it another way, the extent and nature of interactions between members (G.C. HOMANS, 1950). These general findings could form the basis of a classification. 7 types of groupings can be distinguished:

Type 1 is more or less an unstructured crowd. Short-lived encounter group are characteristic (R. BALES, 1950; P.R. HOFSTÄTTER, 1957; cf. section 4.1.).

Type 2 is typified by certain common characteristics. Members interact together to varying degrees and in different ways. Their identity becomes comprehensible by considering the higher context (for instance, members of different economic sectors or occupations; cf. section 4.2.1.2.).

Social strata are the next and 3rd type to be defined. In their case, a certain amount of solidarity amongst the members is a requisite condition. Social strata are the expression of an hierarchical order. Thus the class system is proof of social stratification, of "inequality" (R. DAHRENDORF, 1961, p. 359f), of an hierarchical structure in industrialized societies. Similarly, social rank or caste distinctions can be found in non-industrialized societies (cf. section 4.3.1.2.).

For short-lived encounter groupings, distinctive groupings with specific

characteristics and social strata, spatial concentration is not required as a defining feature. Another, 4th type of grouping clearly shows more pronounced cohesiveness and an orientation towards a centre. This also applies to the spatial arrangement. A bell shaped or circular structure is formed; in the latter, each respective peripheral area can be seen to have approximately equally strong links to the centre. Commuters exemplify this; they are oriented towards a town. This centralization finds economic expression in the Thünen Rings for example (cf. section 4.4.1.2.).

Members of the same groupings with distinctive characteristics, social strata or spatial orientation often feel attracted to one another. Thus, persons provided with similar interests or problems will live in connected areas; town districts with the same residential structure develop, etc.. This is the 5th type of grouping. We shall call these units "aggregates" (cf. section 4.5.1.2.). Sometimes we find that members of aggregates come closer together by joining certain processes. Thus, in cities, the inhabitants of certain areas may come together for joint actions (e.g., ghetto revolts). Regardless of whether they are groupings with distinctive characteristics, social strata or aggregates, we are concerned with behavioural groups, because these groupings are characterized by similar spatial behaviour (W. HARTKE, 1959; F.St. CHAPIN, 1965).

The next type of grouping may be regarded as the carrier of a specific process. This 6th type is a production unit. The process gives cohesiveness and spatial fixation (cf. section 4.6.1.2.).

Such a grouping can stabilize itself in its environment in order to carry out joint processes in the future as well. Groupings of this kind - this is the 7th type - may keep on changing their structural make-up, they are, however, conserved as units over a prolonged, relevant time span (periods, cf. section 2.7.1.). Actions, the transfer of information and material substances based on mutual interrelations with the environment give them stability during the process course (cf. section 4.7.1.2.).

In order to distinguish the groupings of the types 6 and 7 from aggregates, the term population, as used in biology, seems suitable. By a population, biologists understand the entirety of individual members of a type of organism with specific demographic behaviour and concentrated

in a delimited area (R.H. MACARTHUR and J.H. CONNELL, 1966; E.O. WILSON and W.H. BOSSERT, 1971). Populations constitute biological units, occupying a particular place in the ecosystem and filling their ecological niche which they strive to maintain (cf. sections 1.2; 2.3.1.).

The term population can also be applied to human groupings. Groups (A. VIERKANDT, 1928/75, p. 195f; G.C. HOMANS, 1950), ideal associations ("ideal-verbände"; W. SOMBART, 1931), ethnia ("ethnien"; W.E. MÜHLMANN, 1964, p. 57) or complex social bodies (H. BOBEK, 1961/69, p. 102) are further terms used for the same entities, though in connection with other units of size. Strictly speaking, only mankind as a whole can be seen in connection with biotic populations, otherwise the term population is only suitable for single functions and roles. Every individual belongs to a whole range of populations at the same time. Moreover, it is significant to emphasize the temporal constancy and spatial extension of the populations. Regional unity or at least, in the case of disjunctive distribution, regional determinability, reveals different orders of magnitude, upon which a systematization of populations can be founded.

> Let us take a society with a simple structure as an example; the Pueblo-Indians in the south-west of what today are the USA. Until its abandonment in 1838 Pueblo Pecos was located in this area. The inhabitants lived in the cramped space of two large dwelling complexes (northern Quadrangle and South pueblo, Fig. 1). During periods of highest population concentration, something like 4000 people lived in an area of, in all, approx.one hectare (A.V. KIDDER, 1958, p. 122, estimated smaller numbers). The buildings had 2-4 storeys and about 1020 rooms in all. Excavations carried out in the 1920's and 30's (A.V. KIDDER; 1958, p. 121f) revealed that the pueblo buildings, especially the big northern Quadrangle, were divided into dwelling units. In each case 6-12 rooms, located one behind the other and above one another and thereby forming segments within the buildings, appear to have been joined together into dwellings. They were probably connected by doors and ladders. If we compare this type of arrangement with modern pueblos, e.g., in the territory of the Hopi Indians (F. EGGAN, 1950, p. 29f) who, due to the fact that they came into very little contact with Europeans, have preserved the most original social organization of this kind, we can infer that the individual dwellings were inhabited by extended families (e.g., 1st and 2nd degree relatives); the single rooms or small groups of rooms were probably occupied by families, i.e., by parents with their children.

Generally speaking we can distinguish the smallest unit, above the individual, as being the family, that is, parents and children (R.C. THURNWALD, 1932; R. KÖNIG, 1946/74, p. 88f; 1974; W.J. GOODE, 1949, called this the nuclear family). It is already capable of looking after itself, of feeding and

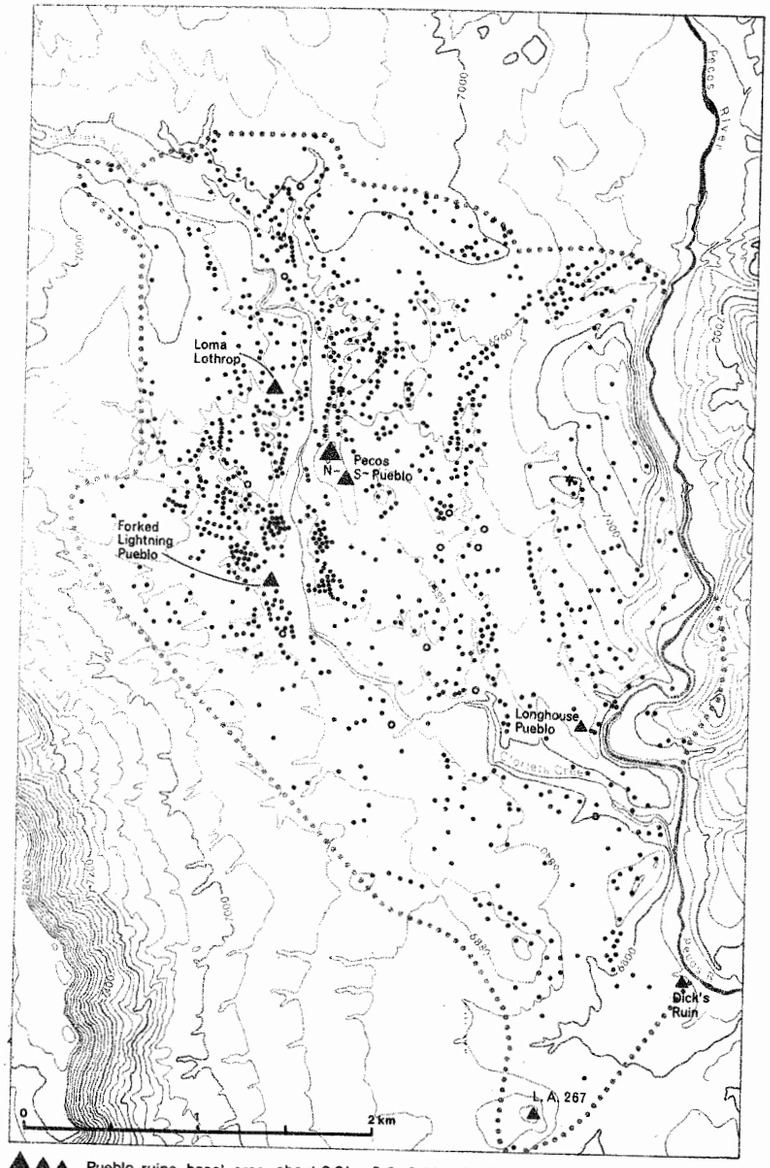


Fig. 1: Pueblo Pecos, ruins of the villages and single houses. A survey.

protecting itself etc., for a certain time, for a generation. It can, but does not have to be part of a large family or clan.

Several families may live together as a local group, community (R. KÖNIG, 1958, p. 19, 28) or settlement population in settlements.

> The pueblo Pecos was such a settlement. To the west of a high range of mountains, other Pueblo Indians had built their villages. Their immediate neighbours were the Galisteo Indians (N.C. NELSON, 1914), who differed from the Pecos people by their language, their mode of building and temporarily by their pottery (H.P. MERA, 1933; M.F. LAMBERT, 1954; A.V. KIDDER, 1958). The inhabitants of the pueblos elected their own priests and, in the following Spanish period, a secular governor. The tribes, consisting of a number of village populations with a common language, the same way of building pueblos, the same pottery etc., did not have a common government, though their actions, e.g., during migrations, when there was danger etc., were pretty uniform, so that we can assume that they were able to reach agreement on general political questions. While we speak of a community or a settlement population in the case of the Pecos people, we refer to the Galisteo people, living in several pueblos, as a tribal population. However, the Pecos Indians also achieved this kind of independence, e.g., with regard to language (only the Jemez Indians who lived a long way away spoke the same language), and with regard to their art (e.g., pottery), so that we can consider them a tribe at the same time.

In more differentiated societies, there exists a special population type, larger than the settlement population or community. Members of these so-called ethnic groups feel that they belong together in the sense that they have common traditions, e.g., within the German people, the Bavarians or the Frisians. Particularly colonizations produce this type of population (D. FLIEDNER, 1975). Such ethnic groups may also bear the traits of ethnic or cultural minorities.

In the population hierarchy peoples take the next highest rank. A characteristic trait of peoples is the desire to attain political selfdetermination (E. FRANCIS, 1965, p. 42f; 95f; seen from a geographical point of view, above all F. RATZEL, 1897a). In less differentiated societies, as in the case of the Pueblo Indians, the tribes should be considered as occupying a comparable position at this hierarchical level (M.D. SAHLINS, 1968, p. 16, 20f).

> The Pueblo Indians constituted a cultural population ("Anasazi-culture' H.M. WORMINGTON, 1947/68, p. 27f). Despite the differences between

the tribes, there is evidence of common traits, such as settledness, based on agriculture. The characteristic way of constructing compact villages, with buildings of several storeys induced the Spaniards, who conquered this area in 1598, to call them Pueblo people, that is, village people, and to distinguish them from other Indians in the area (hunters and gatherers, "nomadic" tribes). The construction of rooms for ritual activities, the Kivas, and the basic structure of their religion are common to all Pueblo Indians. Although the tribes did not have a common chieftain, they were still in a position to carry out joint actions, as in the case of a revolt in 1680, when nearly all the Pueblo tribes united against the Spaniards.

Cultural populations come into evidence even more in higher differentiated societies (H. SCHMITTHENNER, 1938/51). Due to the present expansion of the European cultural population, a further traditional type of population in this order of magnitude is being replaced: race. The way to define and delimit race is of course not obvious in all cases, and its systematization depends on the choice of traits (I. SCHWIDETZKY, 1974, p. 19f, 153f). It seems clear that races are explainable biogenetically, but possibly in connection with adaptation to their natural environment (G. KENNTNER, 1975). Cultural populations owe their existence first of all to adaptation processes, especially social differentiation (cf. sections 2.2.2.; 3.2.1.1.3.).

Thus, two different types of population of the same order of magnitude appear. This phenomenon can also be shown to exist in hierarchically inferior levels of populations. So tribes and peoples can be substituted for state populations, ethnic groups for city-umland-populations, local groups for rural communities. On the family level the organisate has developed (cf. sections 2.2.2.; 3.6.1.1.3.).

We can therefore distinguish between primary and secondary populations; the secondary populations had developed on the same level as the primary populations, namely by differentiation (cf. section 2.2.2.).

In the orders of magnitude, therefore, the spectrum ranges from individuals and single families, as far as mankind. Altogether we can distinguish 6 orders of magnitude for populations (excluding individuals; table 1).

Table 1: Classification of primary and secondary populations

Primary Populations	Secondary Populations
mankind	(mankind)
race (?)	cultural population
tribe, people	state population
ethnic group	city-umland-population
local group, community	settlement population (rural, urban community)
family	organisate

Every individual is a member of all population levels. However, this has no visible effect until he becomes active, through his actions. That is to say that the individual keeps changing the role he plays in society as a whole. He functions for the family, for the people or the cultural population in turn, and also for himself as a consumer. Thus in this respect, populations do not consist of the sum of their individuals, but merely of the roles played by their individuals and brought to bear on the populations.

Populations change their composition, their size and their structure as time passes. They can therefore not be registered with the features peculiar to them by means of temporal cross sections, but only by taking the changes in the course of time into account as well. They become clearly identifiable as soon as they are not only spatially delimited but also in the process sequence. This we shall attempt to illustrate in the course of this treatise (cf. also section 2.6.; 2.7.).

1.2. ENVIRONMENT

Populations require a portion of the earth's surface to live on, to draw the necessary food and materials from, to shape according to their intentions, to whose peculiar features however, they too must adapt, thus becoming moulded into shape together with it. In this way the earth's sur-

face is brought into the anthropo-geographical context. It forms the "mantle" enveloping the population and guaranteing its existence (F. RATZEL, 1897b; 1901).

> In order to illustrate this train of thought in more detail, we shall again refer to Pueblo Pecos. The village was located in the centre of a basin approximately 50 square km in size whose subsoil consists of soft sandstone, conglomerates and in the east also of limestone layers from the permian and triassic periods (R.B. JOHNSON, 1969). Precipitation amounting to about 450 mm annually is low, particularly as it descends as heavy rainfall. Potential natural vegetation takes the form of sparse, dry conifer woods (A.W. KÜCHLER, 1964; J. SCHMITHÜSEN, A. HANLE and R. HEGNER, 1976; NEW MEXICO IN MAPS, 1979). Two perennial rivers traverse the basin; almost all the other valleys are dry all the year round. The population procured food in this natural area by farming, hunting and collecting, and drew from it raw materials for building houses and producing clothing and tools. The Pecos basin with its natural resources was thus a precondition for the subsistence of the population. We refer to it as the economic territory.
>
> The village itself was situated on a hill. It protected the inhabitants from enemies, the cold and weather, it permitted the development of familiy life without disturbance from outside, enabled communication, religious activities, control etc. A small additional wall, running round the village complex at a distance of only a few metres, made this area stand out. This was the private sphere of the Pecos people, the residential territory.

Thus the earth's surface serves as a residential territory and for economic purposes, but also as a basis for other activities, such as transport, religious practices etc. Therefore, a territory is that part of the earth's surface required for a particular activity. The part of the earth's surface that is appropriated for and characterized by all the activities of a population, and is inhabited by plants and animals, constitutes the living space (G. IPSEN, 1933, p. 426). By means of more or less carefully carried out land cultivation, sparing hunting and fishing activities, and generally by observing certain rules and regulations, human populations prevent the early depletion of the natural resources present in the living space. This shows that the living space represents a fact of its own, whose reactions and ecological persistence (H. LESER, 1976, p. 186) have to be taken into account by the population. The population must adapt to the living space and take its place permanently in the cycle of production and consumption of the ecosystems. However, at the same time the wild animal and plant populations also have to yield largely to the human population's intentions. They give way to substitute domestic animal and plant populations. Between

the nucleus and the outer margin of the living space we can distinguish catenas, reflecting the different degrees of human impact on the natural ecosystems, e.g. from the village outwards to the boundary of its economic territory.

Seen the world over, the ecumene is the living space of mankind (O. MAULL, 1934, p. 14f). In this order of magnitude there is also a recognizable sequence, starting with the closely populated nuclei of the old cultural realms, in which cultivated plants occupy the largest areas, going on into the extensively exploited and thinly populated areas, in which human beings have only effected small alterations in the ecology of nature, and then to the "pioneer fringe" (I. BOWMAN, 1931; W. CZAJKA, 1953; H. HAMBLOCH, 1966). Only in the an-ecumene have natural or even untouched ecosystems been preserved.

The activities of the population are influenced by the specific structure of the living space, the resources existing in it, as well as their accessibility. The long-term maintenance of a state of equilibrium between population and living space, and the best possible exploitation of the available resources go together with an adaptation on the part of the population (e.g. A. BASTIAN, 1886, p. VIIf; R.M. KEESING and F.M. KEESING, 1958/71, p. 131f; M. COE and K.V. FLANNERY, 1964; I. ROUSE, 1972, p. 158f). This adaptation implies recognition of the possibilities and requirements offered resp. demanded by the living space, and also comprises the behaviour derived from knowledge. The activities of the population are essentially dictated by the pressure to adapt. The success of adaptation is, above all, a question of the division of labour and of technological development (cf. section 2.2.2.). Social processes may be considered identical with adaptation processes in the broadest sense.

In consequence, the population shapes the living space, adapts it to its own requirements through the structuring of the settlements, the planning of the transport network, the construction of security facilities, in short, by producing earthbound artefacts (cf. section 2.4.1.). In this way the cultural landscape is moulded into shape. These earthbound artefacts should be regarded as belonging to the living space. Thus the living space ist not identical with the natural environment, though the latter is encompassed by it, H. BOBEK (1957/67, p. 299) referred to an artificially

created living space.

The living space of a population has its limits where the resources end or are no longer needed, or where the living space of other, hierarchically equal populations adjoins.

> The living space of the Pueblo Indians of Pecos was thus limited by the living spaces of the Galisteo Indians in the west (cf. section 1.2.), the high range of the Sangre de Christo Mountains in the north and the living spaces of the ("nomadic") Plains Indians in the east and the south.

Fundamentally, all populations on the same hierarchical level are competitors for living space. Conflicts can be avoided by cooperation or by the influence of the hierarchically superior population. To this end rules can be established to help determine the delimitations of the living spaces. State and community borders for instance, should be interpreted along these lines (cf. section 3.3.1.1.3.).

The population is in many ways linked not only with the living space, but also with the populations superior to it, with hierarchical equal neighbours and inferior populations. They exchange goods with the neighbouring populations, and keep personal, religious and economic etc. contacts. The term "umland" has for a long time now been employed in this context (cf. section 3.4.1.1.3.).

By their interrelations, populations influence one another in their activities. Anthropologists use the term acculturation to express the adoption of ideas and of material goods (cf. section 3.2.2.1.). The superior population also influences this sort of development, be it in a detrimental way or in a way that is beneficial to the population in question. Conversely, the inferior populations also influence the processes through their own interests, e.g., peoples can integrate more or less thoroughly into cultural populations, which naturally has an effect on the cultural population, as for instance with regard to their cohesion. Thus acculturation ought also to be described as an adjustment process. They will turn up repeatedly in the course of this treatise. At this point we should first of all establish that populations have several contact surfaces: the living space, the hierarchically superior population, the competing, and the inferior populations. It is

assumed that the observations are made at one given point in time (cf. below).

Besides the spatio-structural aspect, the functional aspect should be considered. The term niche refers in particular to the position of individuals or populations in relation to the superior system (D.L. HARDESTY, 1972; 1975; cf. section 2.3.).

However, environment must also be conceived in a temporal frame. In the course of a process, demands are continually being made on the environment in an number of different ways, and the influences coming from the environment cause changes to come about in the population (K. LYNCH, 1972). When the process is completed, the environment is not the same as it was in the beginning; and the population itself has changed as well (cf. section 1.1.). Ultimately, this applies to every event, every activity (H. P. BAHRDT, 1974, p. 19f). Therefore, the notion of the future, of afterwards also belongs to the environment. Conversely, the process comes out of the past. The past gave the process amongst other things, its meaning. Therefore, the past, the antecedent, is also a part of the environment.

For the terms "horizontal" and "vertical" environment, cf. section 2.3.2.

2. BEHAVIOUR

2.0. INTRODUCTION

Populations act and react as wholes, in the perception and in the determination of the processes that sustain them, in their vertical and horizontal self-structuring, and in the shaping of the environment. Populations endeavour to hold their own; they tune in to the superior processes and participate in shaping them. These acitivities are referred to as the behaviour of the populations. It can be directly observed or inferred from performance.

2.1. IMAGE AND STIMULATION

In general, the method and intensity of penetration or exploitation of the environment cannot be regarded as being optimal for the population. There may be attempts made to reach an optimum with the population's own intentions in view (P. HAGGETT, 1965). However, normally this is not achieved. The reason is an inability to grasp the totality of the environment with all its advantages and disadvantages as far as intended actions are concerned. Perception of the environment and as a result, knowledge of it, go to form the frame within which decisions on the nature of the process can be made. Knowledge includes the ability to perceive the way in which the environment is likely to react.

Perception is first of all a psychological phenomenon. Perceived environment differs from influenced einvironment (J.J. VON UEXKULL, 1921, p. 45). Impulses coming from the environment are processed in the individual or in the population. They provide the acting individuals with an "image" upon which they can build their future actions. From this it becomes plain that we should differentiate in particular between:

1. the acquiring of knowledge of the spatial environment by the individual and the population, and
2. the evaluation of this knowledge with regard to one's own behaviour.

The decision whether to act, whether the process starts rolling, comes subsequent to this.

Impressions from the environment are taken in a way specific to the individuals or populations. During the course of processes, experience is continually being added to, which in turn affects the process sequence, enabling the latter to be corrected. Thus, "images" of the environment come into being (e.g., IMAGE AND ENVIRONMENT, 1973). Certain aspects in the observation and evaluation of the environment can be illustrated in mental-maps (e.g., P.R. GOULD, 1973; 1975). Perception activities have undergone much profounder investigation on the individual level, mainly in psychology, than the corresponding collective perception activities of populations. But precisely these are essential for an evaluation of processes, e.g. image forming of peoples in international systems (K.E. BOULDING, 1959/69; M.KOCH-HILLEBRECHT, 1977). There are several methods of gaining an insight into these phenomena, for instance by interviews. But we can also draw certain conclusions from works of art, iegends and myths (e.g., R. CHRISTINGER, 1965; A. NITSCHKE, 1973; H.-J. KLIMKEIT, 1974/75).

The images and the kind of cognizance allow conclusions to be drawn on the evaluation of the environment (K. LYNCH, 196O; J. BURTON and R. W. KATES, 1964; P. ORLEANS, 1973; K. COX and G. ZANARAS, 1973; Th.F. SAARINEN, 1973). They stimulate or stress the individuals or populations, and so serve as a basis for the orientation of the following actions and processes. Perception always stands at the beginning of the processes.

2.2. TASK SETTING

2.2.1 Task categories and institutions

The processes, not of course history as such (cf. introduction of this treatise), have a meaning for the populations that initiated them (N. LUHMANN, 1971; 1970/75, II, p. 72f). This meaning finds expression

in the orientation of the members. The processes and populations become interlinked as units. The orientation of the members of the population signifies a determining of the position of the population and of its tasks within the superposed system.

On an individual level, the role corresponds to the task. We can join E. WIEHN (1968, p. 18) in saying: "Not the individual is the unit of social systems, but the role" (cf. R. DAHRENDORF, 1958/74, p. 20f; 32f).

The populations create and make use of institutions in order to solve these tasks, for instance, government, religion, trade, transport (cf. B. MALINOWSKI, 1944; S.F. NADEL, 1951/63; A. GEHLEN, 1963; H. SCHELSKY, 1970/73; N. LUHMANN, 1970/73). Institutions regulate and stabilize the actions; they are made conscious to the individuals by norms. The institutions and the underlying meaning linking them together may be interpreted as constituting the life-form or the culture (cf. about the problem of culture R.C. THURNWALD, 1936/37/66, p. 362; J.S. HUXLEY, 1955, p. 16f; W.E. MÜHLMANN, 1964; 1972).

At this point, let us consider the tasks, whereas the institutions will need to be dealt with separately (cf. sections 3 and 4). The populations' tasks, and thus also the processes, can be typified and traced back to a few categories, to be regarded as basic concepts.

A number of anthropologists (e.g. B. MALINOWSKI, 1944; W.E. MÜHLMANN, 1966, p. 19f), psychologists (e.g. J.P. GUILFORD, 1959), regional scientists and geographers (H. BOBEK, 1948; D. PARTZSCH, 1965; 1970a, b; K. RUPPERT and SCHAFFER, 1969; 1974; G. LENG, 1973) have taken an interest in these questions; however, there are many instances of overlapping. H. BOBEK's (1948, p. 121) 6 "social functions" can be applied to best advantage:

1. Bio-social functions: maintaining the species
2. Eco-social functions: satisfying economic requirements and establishing wealth,
3. Political functions: asserting oneself and bringing to bear one's own influence,
4. Topo-social functions: regulating the settlement of the inhabited and the exploited land,

5. Migro-social functions: migration, changes in location,
6. Cultural functions (inasmuch as these are relevant to geographical studies).

According to BOBEK, these functions constitute the "social field of forces" and are supposed always to have been of interest to geographers.

Following especially BOBEK's ideas, another brief attempt at assigning basic needs or "functions" or, more precisely, tasks or categories, is to be made at this point. In the course of the treatise further criteria will be pointed out. In principle, categories cannot be mono-causally substantiated or proven by mathematical methods, but rather only by incorporation into the context as a whole with as little inconsistency as possible; for categories are of an axiomatical nature. Their recognition is based on observation and combination, and up to a certain degree, on intuition (cf. e.g., K.R. POPPER, 1935/69, p. 7, 41f).

A fundamental condition for survival is the biotic REPRODUCTION of the population, so that the population can assert itself within the ecosystem. We can here include fertility, growth, health, recreation, bringing up the children, etc., so that the population can be provided with healthy, producing and consuming adult human beings (cf. BOBEK's "biosocial functions"; cf. section 4).

These activities dedicated to the biotic substance of the population belong to one task complex. Yet another covers the next seven categories. It comprises the social or adaptation processes (cf. section 3.0.).

1. PERCEPTION is of vital importance for establishing contact with the environment. It serves exploration, helps in the setting up of new communication links, and generally in conducting information aiding the optimal exploitation of the environment, and providing personal protection. Every population creates its own institutions to facilitate the solution of this problem. Science is included here. Perception is at the beginning of all behaviour (cf. section 2.1.). It normally constitutes an unknown factor preventing a deterministic explanation of the shape of the processes for the quality of the results of perception depends on many facts and varies a great deal (cf. section 3.1.1.).

2. Individuals and human populations decide on how to hold their own in their environment. They thereby determine over themselves, they give themselves an identity, a significance, a motivation. We call this task category DETERMINATION. It provides the processes with an orientation. The kind of behaviour can be subsumed here. Determination finds concrete expression in institutions ("culture"; e.g. religion; cf. section 3.2.1.1.1.).

3. The cohesion of a population and joint actions are achieved by giving and following instructions. State and legislation are of significance in this context. BOBEK's "political functions" come close to this task category. Control requires delimitation, i.e., protection against influences from outside. However, exclusive control is not possible on a longterm basis without an echo coming from the members of the population (feedback) (cf. section 2.3.1.). The precondition for this is a flow of information in both directions, or communication. The entire area of functions thus described shall be referred to as REGULATION (cf. section 3.3.1.).

4. The population's processes are facilitated by good spatial allocation and grouping of the inferior populations and activities. The claim to space dictates a co-existence on the earth's surface, which in turn raises the question of competition for land and the problem of optimal locations. Bobek spoke of "topo-social functions". The spatial juxtaposition of activities makes the transport of people and goods, the transfer of energy and information within the population and between the population and the umland, between producer and consumer necessary. We call this task category ORGANIZATION (cf. section 3.4.1.).

5. Individuals and populations require energy to live and to keep the processes going. It has to be brought in from outside, either directly from the living space or via other populations. In Pecos, the economic territory served this purpose (cf. section 1.2.). In more differentiated societies (cf. below, section 2.2.2.), a complicated meshwork of processes requiring a wide variety of tools and instruments developed. Material goods give the populations and processes their substantial frame. As far as the processes are concerned, it is a matter of absorbing raw materials resp. of making investments. It therefore seems necessary to prove DYNAMIZATION to be a separate task-category (BOBEK's "oico-social functions"; cf. sections 3.5.1.).

6. The populations refine the raw materials or raw products. This refining constitutes production in the fullest sense of the word which can be taken to mean several different things. Primarily, it has economic significance and in addition embraces all the processes, whether they be concerned with organization, transport movement or defense actions. Here the tasks specified in the categories already named are completed. We refer to this category as KINETIZATION (cf. section 3.6.1.).

7. Production has to be adjusted to fit the requirements of the population for which it is intended. This demand becomes apparent from the amount consumed. Co-ordinating both production and consumption brings stability to the population. The task-category is STABILIZATION (cf. section 3.7.1.).

These task-categories cannot replace one another. The processes required to deal with them keep the population alive. The population dies or is absorbed into other populations if one task is not completed. Or, put another way, every activity undertaken by human beings and every process must be assigned to one of these task-categories. Later on in this treatise (cf. sections 3 and 4) the task-categories which we have only briefly mentioned here, will be presented and explained in more detail. The classing of institutions and processes under these categories will be particularly important. The tasks covered by the categories are split up further in the course of the division of labour.

2.2.2. Division of labour

If the individuals do not differ in their positions in society, each one of them has to carry out the work (according to the seven task-categories, cf. section 2.2.1.) necessary for self-maintenance, on his own. Interactions related to these activities do not exist, so that we cannot yet refer to a population as a system. If population density, i.e. the need for consumption, is too high compared with the amount of available, i.e., self-produced, refined energy, stress will arise. One way out is the division of

labour, a qualitative separation of competences and actions. Ever since ADAM SMITH (1776/86), the division of labour has been regarded as one of the most important conditions for efficient economic activities. Specialization helps improve the working peoples' skills (G. SCHMOLLER, 1890/1968; F.W. TAYLOR, 1911). Furthermore, the simplification of working activities, resulting from specialization itself, aids mechanization. From a technical point of view, the operational steps become more efficient. They can be coordinated so that much useless labour (e.g. in the transportation of goods) can be avoided. Thus, entropy, or the uncontrolled energy escaping, which accompanies every process, is counteracted ("negentropy"; cf. section 2.6.2.). So the flow of energy is facilitated. The less the different processes merge, the more distinctly separate the individual activities are, the clearer they can be linked up. The division of labour implies the differentiation of the society (K. MARX, 1867/90/1966, 1st volume, p. 356f; H. SPENCER, 1876/96, above all, part II; E. DURKHEIM, 1893/1922), because these interactions cause the previously undifferentiated mass of individuals to form a system. Due to the increase in production, a greater number of producers and consumers, i.e., of individuals, can participate. Thus, population density can increase.

With the division of labour, a new section in the processes becomes set apart and perpetuated as an institution or it provides an existing institution with a new shape. At the same time, people take on definite new types of work, thus creating or changing a secondary population, which sustains the institution (cf. section 1.1.).

> Let us illustrate this with an imaginary, but not inept example: to a prehistoric agricultural society, the working of bronze or iron to produce a variety of special objects, such as trinkets, weapons or the shafts of carts, may have seemed desirable. The working of bronze and iron in particular, requires specialized knowledge and aids and devices such as furnaces, moulds and other special tools. Workshops such as this have been found to have existed in bronze-age and iron-age villages (H. JANKUHN, 1969, p. 89f). We can assume that one family in the village became entirely devoted to this task in particular, thereby setting aside other tasks, such as agricultural production, i.e., specialization came about. The foodstuffs required by the family will have been obtained by trading them against the products of the smithy. The village population was thus exempted from producing stone and wooden tools which had previously been used to the same purpose as the metal tools now. They could therefore devote more of their time to agriculture, working the land more intensively or exploiting greater areas of land, in order to increase the yield. The overproduction on the agricultural sector served the particular purpose of acquiring the metal tools.

During the course of this division of labour, a new branch of production was institutionalized by establishing a new, selfsupporting business. We refer to enterprises such as this, evolving in the course of the division of labour, as organisates (cf. section 3.6.1.1.3.). Presumably, the innovation of new techniques was often connected with the formation of organisates making work easier and bringing about greater productivity in general. In modern highly differentiated societies, organisates have been established to deal with all important tasks. They are enterprises, associations, offices, practices; establishments therefore, in which something, a certain product, is made and passed on to the consumer who may in turn also be an organisate. Division of labour, or the differentiation of society becomes significant when the population has reached the limit of its capacity (cf. section 4.7.1.2.). Conversely, populations can dedifferentiate, if for example, the population numbers drop, as in that case the most highly specialized organisates, who depend on a large clientele, would not be used to full capacity. They would lose their viability and would have to be given up. Thus, whole institutions can disappear if this dedifferentiating process continues.

In the first instance, the division of labour means only a horizontal structuring of the population's functions (groupings with distinctive characteristics, cf. section 4.2.1.2.); a given number of workers carries out a variety of jobs. It can also be regarded as a splitting up of tasks. A vertical component is added with regulation, with which an hierarchical structure is associated (cf. sections 2.3.2.; 4.3.1.2.).

2.3. SYSTEM AND CONTROL

2.3.1. Aggregate, process and population

Obviously, there can be no division of labour without communication, i.e., without directing, transferring and receiving information. The orderly course of the processes requires certain integrating mechanisms. By this

means the cohesion of the population is ensured. For the researcher these structures must be conceived as units, as wholes (cf. introduction to this treatise).

The systemic approach provides the means for entering into an understanding of the dynamics and the sequence of the processes. Systems consist of groups of elements related to one another by interdependence and mutual interactions, so that they represent superior units. Elements can be delimited by their determination. We are concerned, basically, with populations, e.g., organisates, dealing with tasks, or with individuals, though not as such, but rather merely inasmuch as they contribute to the processes with their specific roles. This approach is aimed at revealing the relationships between the elements. They come about on two levels:

1. the flow of consumable energy and materials between the elements,
2. the means of control of the processes in question.

The flow of consumable energy and materials can also be represented by input-output links. This flow of energy and material is regulated by the transfer of information between the elements. We can distinguish two fundamentally different types. If input and output are not directly coordinated, one element can refuse to receive products from the other element. Thus the producing element cannot react until after the transfer of the product. This delayed feedback identifies an uncontrolled system. However, as soon as the supply of information, energy and materials, or the output of the producing element and the input of the receiving element, are permanently coordinated, the system is controlled. In that case, special arrangements are required (control media), by which information can be fed in and transferred. Production and the flow of information, energy and materials are embedded in superposed processes, thus stimulating the systems. We are therefore concerned with open systems in the thermodynamic sense. With the regulated flow of products, systems can keep in balance over a certain timespan. This dynamic equilibrium (cf. section 2.5.2.) is characterized by the fact that inflow and outflow ensure a constant production by the elements; i.e., oscillations fluctuate between tolerance limits that lie within the system's capacity. Thus, all the elements in the system are conserved in their structure, appearance

and state (L.v. BERTALANFFY, 1950; 1960, p. 151; 1962/72; J.W. FORRESTER, 1968).

Ecological studies have for some time now been concerned with systems analysis (cf. e.g., D.R. STODDART, 1965/70). A.G. TANSLEY (1935, p. 300) already emphasized dynamic equilibrium as being the most important feature of ecosystems. Ecosystems are composed of different species of living creatures interacting amongst themselves and with the inanimate environment on the energetic sector, and regulating themselves (e.g. J. SCHMITHUSEN, 1976, p. 287f). The term energetic means that heat, and chemical etc. energy are absorbed from outside, but that eating and being eaten also imply a transport of energy (H. ELLENBERG, 1973a, p. 2f). The ability to be self-regulating allows the system to compensate to a certain degree for disturbances from outside with reactions coming from inside. By this means, the system can be loaded (P. MÜLLER, 1977a; 1977b; O. FRÄNZLE, 1971; 1978; R.J.BENNETT and R.J. CHORLEY, 1978).

V.B. SOCHAVA (1963; cit. 1971, p.10) attempted to apply the methods used in the study of ecosystems to landscapes. He coined the term "geosystem" and defined it as the relational structure of regions, the landscapes. The investigations encompass the relations and the exchange between vegetation, the animal kingdom, human beings, soil, water and air. Ecosystems are, according to SOCHAVA, biocentrically conceived geosystems. In principle, this concept can also be applied to human societies, aiding the clear understanding of it (cf. J.W. FORRESTER, 1969; W. WÖHLKE, 1969; R. PREWO, J. RITSERT and E. STRACKE, 1973; from a psychological standpoint L. ECKENSBERGER and P. BURGARD, 1976).

However, there are additional problems to solve. In the study of ecosystems, the supply of energy can be directly measured. It becomes comprehensible by conversion to calories as a unit of measure. In dealing with human geosystems, this is only possible in part, as - due to the division of labour - information, energy and goods are qualitatively so different that they are hardly comparable (cf. also section 2.5.1.). Moreover, production itself is referred to in the study of ecosystems only incidentally. The elements of the ecosystems are represented by chemical, physical, and biotic values, and not by populations which are spatially definable as units.

In the study of the ecosystems, equilibrium systems or stimulance-response-systems are thus placed in the fore. This approach is quite legitimate. However, for an understanding of the processes in human society it is not sufficient. Production, processing and consumption take place in the populations. The flow of information, energy and materials in the system with its changes can only be developed scientifically, if the populations themselves, as acting units, are focussed upon. So the meaning of the processes becomes important (cf. section 2.2.1.) and decision processes can be considered and placed within their proper framework. In order to achieve this, we shall refer back to the reflections on the population and its environment (cf. section 1.). The population as a complex unit in itself and in its relations to the surrounding environment is here conceived of as a system. The populations are the dynamic centres holding their own in the environment in the course of the processes by means of their actions and reactions. The processes have a specific meaning for the superposed population. We speak of goal oriented systems. With these systems, we distinguish a system-nucleus, i.e., a population from the system environment extending towards the outside or projected on to the earth's surface, the system-umland. The environment is engaged in interrelations with the system-nucleus, i.e., there is an exchange of information, energy and matter, and also a biotic exchange. We are, as we have already emphasized, concerned with open systems. (About this subject from a psychological viewpoint cf. L.H. ECKENSBERGER, 1979).

The system-nuclei are as such clearly delimitable. On the other hand, the system-nuclei are also elements of larger systems, and from this viewpoint the relations between the elements can be studied. In this case, it is more difficult to find clear limits. In both methods of approach we are concerned with anthropogeosystems. In the first case we refer to geo-quanta, and in the second to geo-aggregates or in brief, to quanta and aggregates (cf. section 1.1.). When considering aggregates, the equilibrium (or the disturbance thereof) is brought to the fore (as is the case with research into ecosystems), while the changes that occur can be better registered when considering quanta.

The term quantum expresses that the populations are limited and centrally controlled. It was introduced into geography by H. TSCHIERSKE (1961). H. HASS (1970) coined the term "energon" in a similar sense, for carriers

of energy and functions centrally controlled, embracing plants, animals, "menschliche berufskörper" (human professional bodies) and "erwerbsorganisationen" (activity organisations) who are able to "obtain more working energy from the environment and to press it into service, than the totality of their activities as such consumes" (H. HASS and H. LANGE-PROLLIUS, 1978, p. 64).

Aggregates are not controlled centrally, or if so, only on a short-term basis. They are accumulations of individuals or populations, i.e., of quanta of a lower order.

Every population must complete the tasks set from all seven task categories (cf. section 2.2.1.), for the sake of self-preservation. In order to be able to analyse the processes required for self-preservation and meant to solve the task-problems in these categories, the relations within the system-nucleus, and between the system-nucleus and the system-environment have to be studied. G.C. HOMANS (1950) thus differentiates between an inner and an outer system of a human group. In this respect one could speak of a population. Within the populations, the controlling organisate (cf. section 2.2.2.) or individual (office, director etc.) has the qualifications, due to previously acquired experiences for instance, to control the processes solving the task in such a way that they can take the most advantageous course for the population, or system-nucleus. This presupposes that the controlling parties have power of disposition over the units involved in the process as well. Thus, a controlled process implies an hierarchy. Instructions are given and observed. Moreover, special control arrangements are required so that control can be practiced in the course of the processes.

Control arrangements can vary according to the type of system. The human individual consciously carries out activities, i.e., they are controlled by the consciousness with the aid of the intellect (cf. section 3.7.1.1.3.). In addition, the instinct functions as a controlling device in human beings and animals (I. EIBL-EIBESFELDT, 1973; E.O. WILSON, 1975, p. 26f, 151f). The human populations have established the institutions mentioned earlier on, as constituent parts of society (cf. section 2.2.1.). They are maintained by individuals or populations, and are required to hold their own in the face of selection against rival institutions with the same meaning or

rival forms of institutions. The form of institution that proves to be the best able to complete the tasks is most likely to be accepted by the population.

Controlled or kybernetic processes are characteristic for quanta, while the uncontrolled processes are related to aggregates (cf. above). The controlled process requires a closed system within the task. Steering the controlled processes gives human beings scope to make decisions, while the uncontrolled processes, directed from outside, by the output, can be described as being deterministic (J. LANGTON, 1972, p. 155). But these alternatives should not be related directly to a given grouping of people. Quanta (populations) as such only exist as far as specific processes are concerned. One and the same number of persons can be a quantum and an aggregate at the same time, and a controlled system as well as an uncontrolled system, depending on the task categories under consideration. Controlled and uncontrolled processes continually influence one another within a population, stimulating or checking one another. We refer to mutual interactions.

2.3.2. Hierarchy and delimitation; vertical and horizontal environment

An effective means of control requires the setting up of facilities for giving and receiving instructions. This implies the establishment of an hierarchy which is characteristic for all quanta, or in our case, populations. In a vertical direction, contact is necessary in order to allow interactions to come about.

On the other hand, it is necessary to isolate the populations, to set up a delimitation, if communication is to be free from disturbances (i.e., without "noise"). Every population has its territory requiring protection. If it is infringed, a situation of stress results and can lead to conflict. All populations determined in the same way are in competition with one another with regard to their tasks and the processes that can be assigned to them. However, as far as other tasks are concerned, they each belong to the respective environments. For example, the peoples within a cultural population compete with one another as far as regulation is concerned. However,

they trade with one another and thus each constitutes a part of the environment of the other peoples. To be more precise: the system-nuclei or populations are delimitable, closed systems, as far as the processes connected with their tasks are concerned. Within this frame they are centrally controlled and in a position to make decisions. So they are able to set their own processes into motion. However, these populations consist of individuals who for their part are also involved in other roles and thus belong to other super- or infraposed populations, which can be considered as belonging to the environment of the first populations (cf. section 1.2.). Thus we can refer to open systems as well. As a result, we can speak of two kinds of environment: the horizontal environment is composed of equivalent populations (same order of magnitude, same task), and the vertical environment designates the superior or the inferior populations.

2.4. SPATIAL ARRANGEMENT

2.4.1. Areal competition; earthbound artefacts

Tne hierarchy and structure of the systems are reflected in spatial order on the earth's surface. We ought to establish the fact that all systems require space and that the theoretically feasible three-dimensional arrangement has to be changed largely into a two-dimensional juxtaposition on the earth's surface (areal or spatial competition). Each organisate occupies its own space and no other organisate can occupy that space at the same time. The same applies to all quanta or populations of the same order of magnitude (e.g., states, cultural populations). An arrangement with specific rules is required and results in specific spatial patterns (R. ABLER, J.S. ADAMS and P. GOULD, 1971).

One significant reason for the populations' need for space lies in the fact that the processes to be performed by them require a constant setting for a certain length of time. This is accomplished with the aid of earthbound artefacts which are differently shaped according to the tasks involved. This includes for instance, houses (for the organisates and families), roads, bridges and canals (for transportation), ditches, fields (for agri-

culture), mines and pits (for mining), bunkers (for defense), in brief, all buildings and earth-works created by man with the purpose in mind of better exploiting the living space. These are the real testimonies of a cultural landscape. For here we are concerned with settlements, the network of roads and highways and similar complex formations of this kind.

The cultural landscape in its rich variety of forms can in fact be regarded as resulting from processes and representing a compromise between the intentions of the populations and the pre-existing pattern of the living space.

> Let us return again to the example of Pueblo Pecos. In the former economic territory, a number of ruins of small individual houses (Fig. 1) can be distinguished. Various criteria prove that they were used as shelters (cf. section 2.5.2.) by a small family unit responsible for the cultivation of a small plot of land. The houses had been set up in the course of woodland-clearing processes. Their arrangement and relation to one another enables us to draw conclusions about the way the processes were controlled. Presumably, the families living in them were required to complete their tasks, answerable to themselves within certain limits, thus representing organisates. However, there was probably no private property in the land, so that the families must have been subject to directions. They had their place within the hierarchy of the populations. Perhaps they received their instructions directly from the chief of the pueblo. Or maybe an intermediary instance functioned as a contact between the family and the pueblo population: in the fields, concentrations of single-room houses (group of houses) or single multiple-room houses could be distinguished, for their part representing small economic centres. A few dozen single-room houses scattered over an area nearby seem to have been associated with them. It cannot be ruled out that they were in some way connected with the clans or large families that were so typical for the pueblo cultural population. In that case a three stage hierarchical structure would be revealed. Apart from the economic goals and the hierarchic structure of the population, the characteristics of the living space are also reflected in the arrangement of the earthbound artefacts. For instance, the single houses stood in a privileged position in the vicinity of rivers existing at the time, on the edge of raised terraces, and the groups of houses on exposed hills from where a larger area could be surveyed. Single houses, groups of houses and the areas covered by fields were in fact (with the exception of the pueblo itself) only involved in areal competition with a small number of other earthbound artefacts serving different purposes (footpaths, field shrines; cf. section 3.4.1.1.1.; annex 2, explanation of Fig. 1).

In higher differentiated populations the patterns of spatial arrangement resulting from areal rivalry between the organisates assignable to the various institutions, and from the distribution of resources, are a good deal more complicated. The behaviour of the different populations and the resulting spatial patterns can be studied in detail (cf. H. QUASTEN and D. SOYEZ, 1976a; b).

2.4.2. Overcoming distance; equifinality

Overcoming distance requires investments which the populations strive to keep as low as possible. This has consequences as far as the spatial arrangement of the populations and their earthbound artefacts are concerned.

> This will be demonstrated with reference to Pueblo Pecos again. The extension of the systems and thus also the effect of some important traits in the cultural landscape result from this question. For instance, the size of the land cultivated and surveyed from the single houses, the groups of houses or the multiple-room houses and finally, the pueblo must be taken into consideration. The shorter the distances between the producing organisates and the pueblo (as the "market"), the smaller the input (due to the shorter time required for travelling and for the transportation of the goods), with the same output. Put another way: with the same input (labour for cultivation and transport) a greater output can be attained. If theground were cultivated with the same intensity but at a greater distance from the pueblo, then the time required in excess would have to be deducted from the relaxation period, the time for religious practices, for bringing up the children etc. In an economy near subsistence level, the Pecos people did not feel motivated in this way. The result was a reduced rate of cultivation as the distance from the market (pueblo) increased (cf. sections 2.5.2.; 4.4.1.2.). This J.H. VON THÜNEN (1826/75/1966) had basically already recognized.
>
> Of course, the cultivation-intensity near the pueblo could not be increased to an unlimited extent. The productiveness of the land was limited by the lack of fertilizer, and excessive exploitation would have caused soil erosion. In other words: the intensity of rain cultivation was limited by the resources available in the living space and, furthermore by the fact that the cultivation area could not exceed a certain distance due to the increasing time demand. At this point the "law of diminishing returns" (cf. section 2.6.2.) becomes relevant. An increase in the intensity of cultivation (per areal unit) would have caused a decrease in production in the long run, while an extension of the cultivation area would have produced negative results for life in the group due to the higher time requirement tied up with this. It may even have had consequences for the health situation. This means that the size of the economic territory determines the volume of food production and at the same time the size of the settlement population. If the population augments beyond a specific limit of tolerance (cf. section 2.7.1.) then part of the inhabitants has to migrate and set up another settlement (colonization; cf. sect. 4.7.2.3.).

> Otherwise the system is thrown off balance. The village population could control its own size to a certain extent, e.g. by observing marriage regulations. Over a period of about 5 centuries the population could thus accomodate to its living space.

This could be regarded as the expression of equifinality. Open systems equal in structure (organisms can also be included here) can only grow to a certain magnitude, while the size at the beginning of the growing process is unimportant. An increase in size beyond this limit would either bring about an enforced restructuring within the system, or the system would suffer detriment or destroy itself (H. DRIESCH, 1928, p. 133f; L.v. BERTALANFFY, 1950, p. 25; 1960; 1962/72). Equifinality is also peculiar to higher differentiated populations. This is particularly clearly manifested by the dependence of the size of city-umlands on the importance of the cities as market centres (cf. sections 3.4.1.1.3.; 4.4.1.2.).

2.4.3. Principles of spatial order

In areal competition and in overcoming distances are manifested the principles of spatial order of the populations, processes and cultural landscapes: the principle of coherence and the principle of long-range effect (D. FLIEDNER, 1974c). The processes within the systems have to adjust to them. Here too, it must be mentioned that the behaviour in an actual situation can diverge within a specific margin, and that the processes by no means reach an optimum.

The distribution of the people in a human population over an area basically corresponds to the distribution of plant or animal populations. In the centre, the density is highest, decreasing towards the outside and phasing out quite rapidly at the periphery (bell shaped profile; R.H. WHITTAKER, 1975, p. 123). Here, the principle of coherence becomes recognizable (D. FLIEDNER, 1974c; Fig. 2). The fact that the populations remain established in this arrangement over long periods of time is the expression of a certain cohesion, or coherence, representing a force, which in turn is based on a need for communication and interaction.

Further patterns of distribution are created in connection with an in-

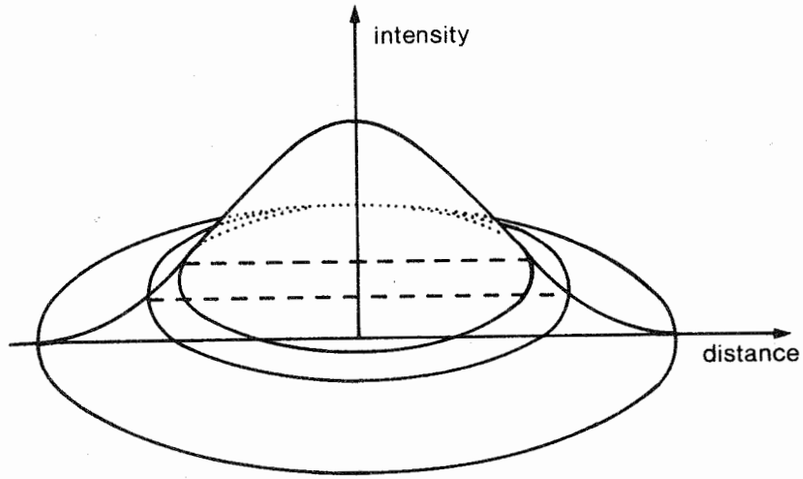


Fig. 2: Principle of coherence; intensity and distance (cf. text).

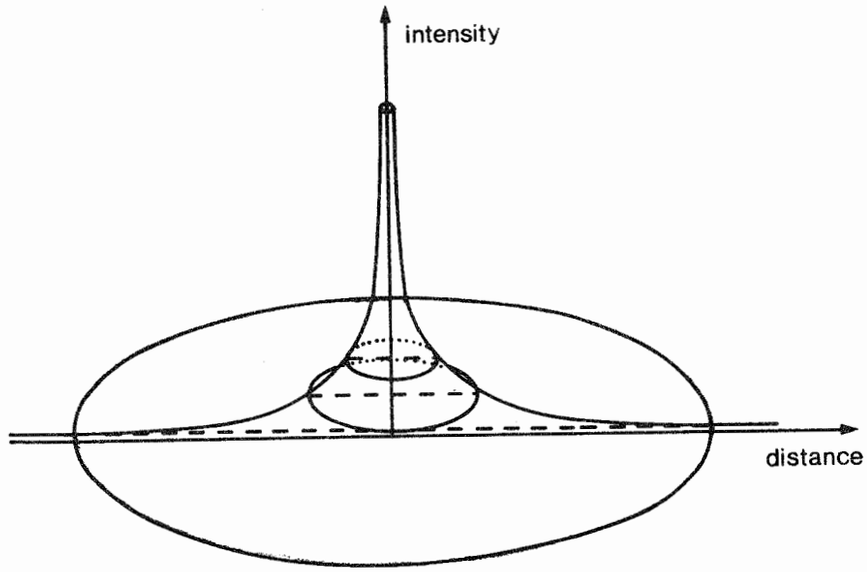


Fig. 3: Principle of long-range effect; intensity and distance (cf. text).

fluencing of the environment. For instance, the bartering contacts of the population of Pecos with the tribes living in the immediate neighbourhood of the pueblo were very intensive. As the distance increases, the intensity of these relations or bartering processes drops quickly at first, and then more and more slowly. Well-known examples in higher differentiated societies are commuting or migration fields. Here, we can see the principle of long-range effect emerging. Every activity carried out from an initial locality or an initial area, e.g., from the residential territory of a population, influences the environment, or, seen in a two-dimensional light, the umland, and is thus organized in a central-peripheral manner. We refer to long-range effect fields (e.g. gravity model; ISARD and BRAMHALL, 1960/66). As different to spatial units, formed according to the principle of coherence, the long-range fields radiate towards the outside without showing pronounced boundaries (Fig. 3). They are not homogeneously structured, and the populations taking their place in the fields are (viewed from the centre towards the periphery) characterized by their diversity. Concentrically arranged rings with similar structures emerge (e.g., von Thünen Rings; cf. section 4.4.1.2.).

2.5. ACQUIRING ENERGY

2.5.1. Forms of energy

The populations require a supply of energy from the environment for their existence or for the controlled completion of their tasks:

1. The individuals in the population need food, i.e., organic and inorganic substances that can be converted into energy and matter inside the body. The amount, measured in calories for instance, can be taken to be nearly the same for each person (apart from variations according to age). This food-energy is converted in part to human labour. This too, must be regarded as proportional to the number of individuals.

2. It is a different thing again if there is a requirement for matter, i.e., material substances and animal or mineral energy to be converted into labour and goods. In that case, the amount is not necessarily proportional to the number of individuals (cf. below).

The food-stuffs are consumed by the individuals in the population. They have to be taken from the environment by means of work and may then be refined. This means the more effective the performance of the system or the population, the more individuals can be fed.

2.5.2. Dynamic equilibrium and energy flow

The populations can, depending on the number of individuals, only muster up a certain amount of human labour in order to keep supplied with the energy they require. Similarly, there are also other kinds of work needing to be done, e.g., within the scope of reproduction. The chances for including more work into the schedule are thus restricted (time budget; for this complex of questions, cf. section 3.7.1.1.3.). An increase in the population numbers can thus only be compensated for to a certain degree by increasing the human labour in the populations (cf. however, division of labour, section 2.2.2.). In any case, the environment has to be made greater use of within a given living space in order to increase the amount of food-stuffs available. But here too, certain limits must be observed.

The population must keep in balance with its vertical environment (cf. section 2.3.2.), and this includes the living space as well. The ecosystems can stand a certain strain, as the organisms, plants and animal populations produce more substance than they need for survival (E.O. WILSON and W.H. BOSSERT, 1971; O. FRÄNZLE, 1978). The load capacity of the ecosystems varies from one area to another. It depends on the extent to which they are able to regenerate. An increase in exploitation also implies an increase in input, or effort, to maintain this regenerative ability. This means that the investment must be optimally suited to the production within the individual populations and the resources of the living space, so that there is a state of equilibrium between the population and its vertical environment. A state of equilibrium with the living space can only mean dynamic equilibrium, i.e., substances and energy are withdrawn from the living space by the population, and instead, other substances (manure, water, minerals

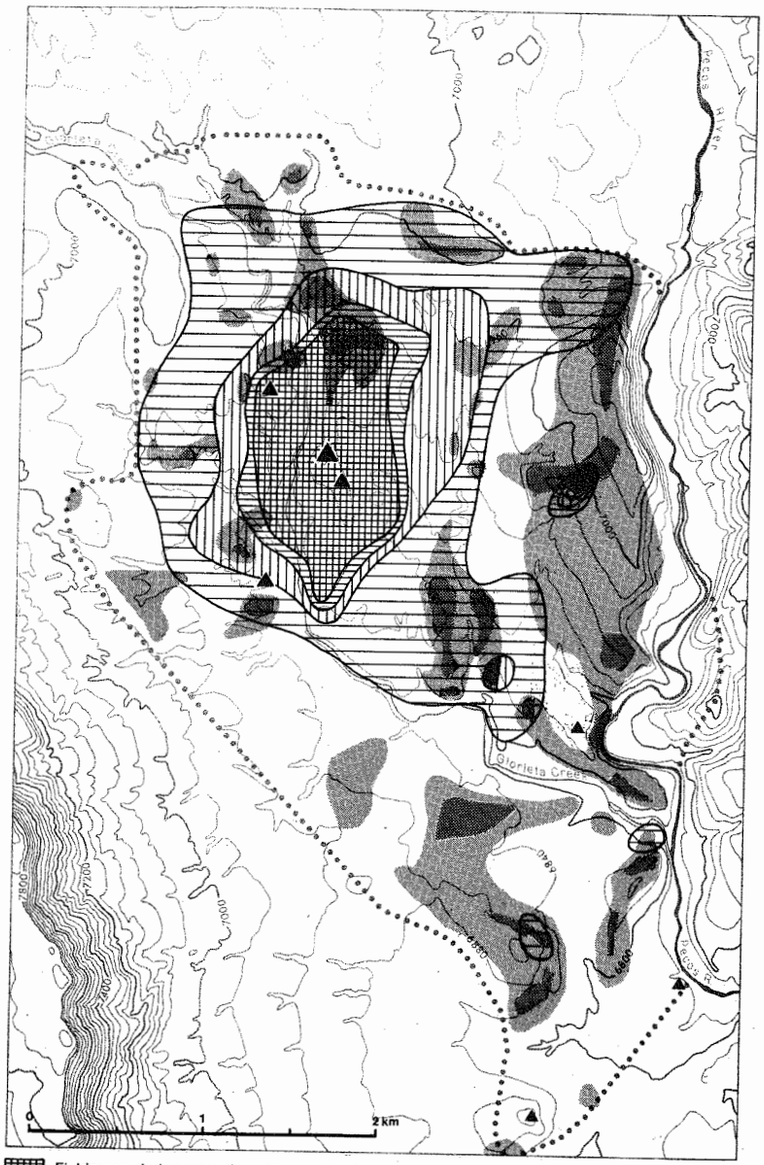


Fig. 4: Pueblo Pecos, duration of field exploitation and area from where hunting was undertaken.

from the subsoil etc.) and forms of energy (e.g., human work, solar energy) are reintroduced into the living space, enabling the ecosystems to regenerate.

Let us illustrate this by taking Pueblo Pecos as an example again:

The Pecos basin as the living space, briefly described above (cf. section 1.2.), held all the raw materials required for subsistence. There are several traces that indicate the land-use. About 1200 ruins of single houses could be mapped. Most of them contained only one room, a few two or three rooms (excavation of a building by G.L. WOOD, 1973). The steeper mountainous area on the fringe contains hardly any ruins of buildings of this kind as far as could be made out. They were, however, used for hunting and collecting fruits. The flatter, central sections of the basin constituted the more intensively used economic territory. Next to the single houses, the remnants of waste materials produced in them (sherds, stone implements that had been left or thrown away) were found, some of which could be dated and interpreted with regard to specific activities. On average, the areas situated closest to the pueblo revealed the highest amount of pottery of the kind that suggests land cultivation (Fig. 4). Rain cultivation was customary; not until the Spanish period (after 1600) was the land also irrigated (perhaps there was also an irrigation period in the 13th century; cf. section 2.6.1.). Maize, beans and squashes were cultivated. We shall interpret the single houses as field-houses, inhabited by single families during the warm season (fragments of cooking vessels, bowls and jars etc., used for the preparation and storing of food). It seems, that the fields were supervised and cultivated from here (for the Jemez area, cf. D. FLIEDNER, 1974a). Towards the outer regions the amount of pottery found decreases according to the long-range effect curve (cf. section 2.4.3.; Fig. 5), until, at a distance of about 1 km, starting from the pueblo, a zone begins in which the ruins represent former field houses but were also used for hunting during certain periods, as the remnants of implements show (arrow-heads, scrapers etc.). Analogous to the generally accepted terminology (FLUR UND FLURFORMEN, 1967), the limits of the field land could be drawn here, although, as we have mentioned, there was no division into lots as in European settlements. Beyond this approx. 0,5 km wide zone begins an area which was almost exclusively used for hunting (elk, deer, puma etc.) and for gathering the fruits of the pinyon-pine for example. The houses in this area should be considered shelter huts or hunting houses. This area cannot be sharply delimited towards the outer fringe. Up to a distance of about 10 kilometers, hunting implements can be found scattered here and there. Ethnobotanical and zoological research has thrown much light on this section of the Indians' methods of procuring food (e.g., J. HENDERSON and J.P. HARRINGTON, 1914; W.W. ROBBINS, J.P. HARRINGTON and B. FREIRE-MARRECO, 1916). Thus, the Indians could draw vegetable and animal food from their own living space, and probably also vegetable fibres for clothing. They had wood and clay at their disposal for building houses; stones for tools (arrow-heads, scrapers etc.) were taken from the outer, hunting zones, in particular from the extensive areas of gravel there,

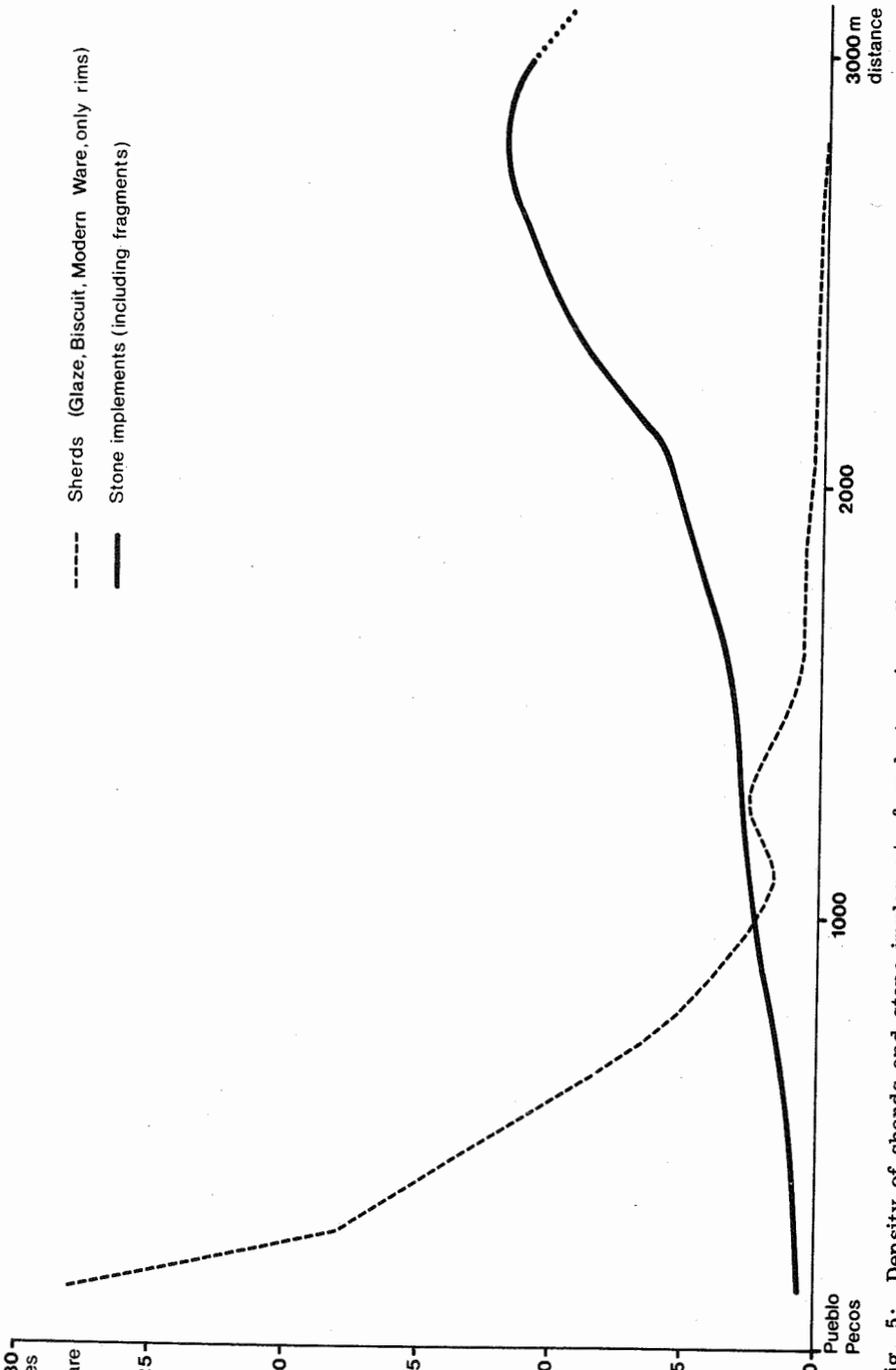


Fig. 5: Density of sherds and stone implements found at various distances from Pueblo Pecos.

clay and temper materials for making pottery were taken from the soil.

In various portions of the fieldland, particularly in those areas that served land cultivation as well as hunting purposes, there was evidence of land over-exploitation (Fig. 12). Here, soil erosion reaches such an extent that the surface gives the impression of badlands. In this border area of field cultivation, the effort invested for the conservation of land was evidently not sufficient. From this we can infer that the time available to the Pecos population was only fully utilized for certain periods, so that there was not enough left for the conservation of land. This means that the inhabitants, and also the ecosystems in the living space would have reached the limits of their load-capacity during these periods. As a result, the ecosystems suffered damage and in consequence, the population numbers dropped (cf. section 2.7.1.).

Excavations in the pueblo and the material found at the detached houses, give evidence of a certain amount of trading with neighbouring populations. Particularly pottery and materials more suitable for making pottery were procured from the neighbouring Pueblo Indians in the West (D.H. SNOW, 1973), and stones and animal foods from the food-gathering and hunting tribes of the eastern region (A. V. KIDDER, 1931; D.A. GUNNERSON, 1956). This trading would not have been necessary from the point of view of supplies available in the living space; nevertheless, it was useful. Various products that could be produced more easily by one of the populations were exchanged for products that other populations could spare. The result of this trade exchange was that the populations involved did not need to invest so much labour. Thus, there was a certain amount of division of labour between the populations.

The pueblo population was thus economically only partially autonomous in its decision-making.

2.6. REFINING ENERGY (PRODUCTION)

2.6.1. Structure-conserving and structure-changing processes (innovations)

Seen within a single order of magnitude, two different types of processes can be distinguished: processes that change the existing structure and processes that conserve the existing structure.

An example:

In the course of time, the economic territory of Pueblo Pecos under-

went several changes in expanse and shape. For instance, in the decades around 1300 the fieldland was extended enormously. A number of small pueblos came into being. While around 1250 an area of only about 80 ha was cultivated (without the surrounding area used for foodgathering and hunting which exceeded several times the acreage for the fieldland), in about 1320 the fieldland covered about 500-550 ha. This is indicated by the distribution of field houses and the pottery associated with them (cf. sections 2.4.1.; 2.5.2.). Furthermore in the economic territory of the 13th century a very strong concentration of single houses in the immediate vicinity of the old pueblo (Forked Lightning ruin; A.V. KIDDER, 1958, p. 5) can be observed (Fig. 6a-o). They were built on low terraces above a spacious valley floor. After 1300 a large number of new single houses was constructed, scattered over a wide area. It could be that the high concentration of single houses around the old pueblo before 1300 was due to a more intensive cultivation based on irrigation of the valley floor. But if so, there are no traces that could prove this assumption due to the devastating damage caused by flooding and the extraction of gravel in modern times. From the scattered distribution of the single houses of the later phase, we can infer that at this time cultivation depended on rainfall. After 1300 both patterns may have existed side by side for a few decades; but the scattered single houses may also have substituted those standing together in close concentration (fragments of pottery from the same period can be found on the site of single houses of both patterns of distribution; Galisteo black on white, Rowe black on white, Wiyo black on white). In any event, we must assume that the economic exploitation of the living space changed in a fundamental way. The Pecos people's economy was reorganized and given a new structure. The colonization of New Mexico by the Spanish around 1600 (cf. below, section 2.6.3.) can be interpreted along similar lines. A completely new trend was introduced from outside into the development of the Indian populations.

We call developments such as these, structure-changing processes or transformations (e.g., O.FRÄNZLE, 1971; J. LANGTON, 1972). They are observable as innovations. Structure-changing processes have received a good deal of attention from geographers and anthropologists (T. HÄGERSTRAND, 1953/67; H.G. BARNETT, 1953; CH. BORCHERDT, 1971, E.M. ROGERS and F.F. SHOEMAKER, 1971). Historians are slowly beginning to show an interest in discussions on the significance of process analysis (e.g., N. ELIAS, 1969; CHR. MEIER, 1978). Therefore, terminological correspondence has not yet been achieved with the other disciplines. This opens up an important field for future discussions.

Structure-changing processes require additional energy and a change in performance. Frequently, greater investments are necessary, e.g., equipment and machines are installed or earthbound artefacts are built, which

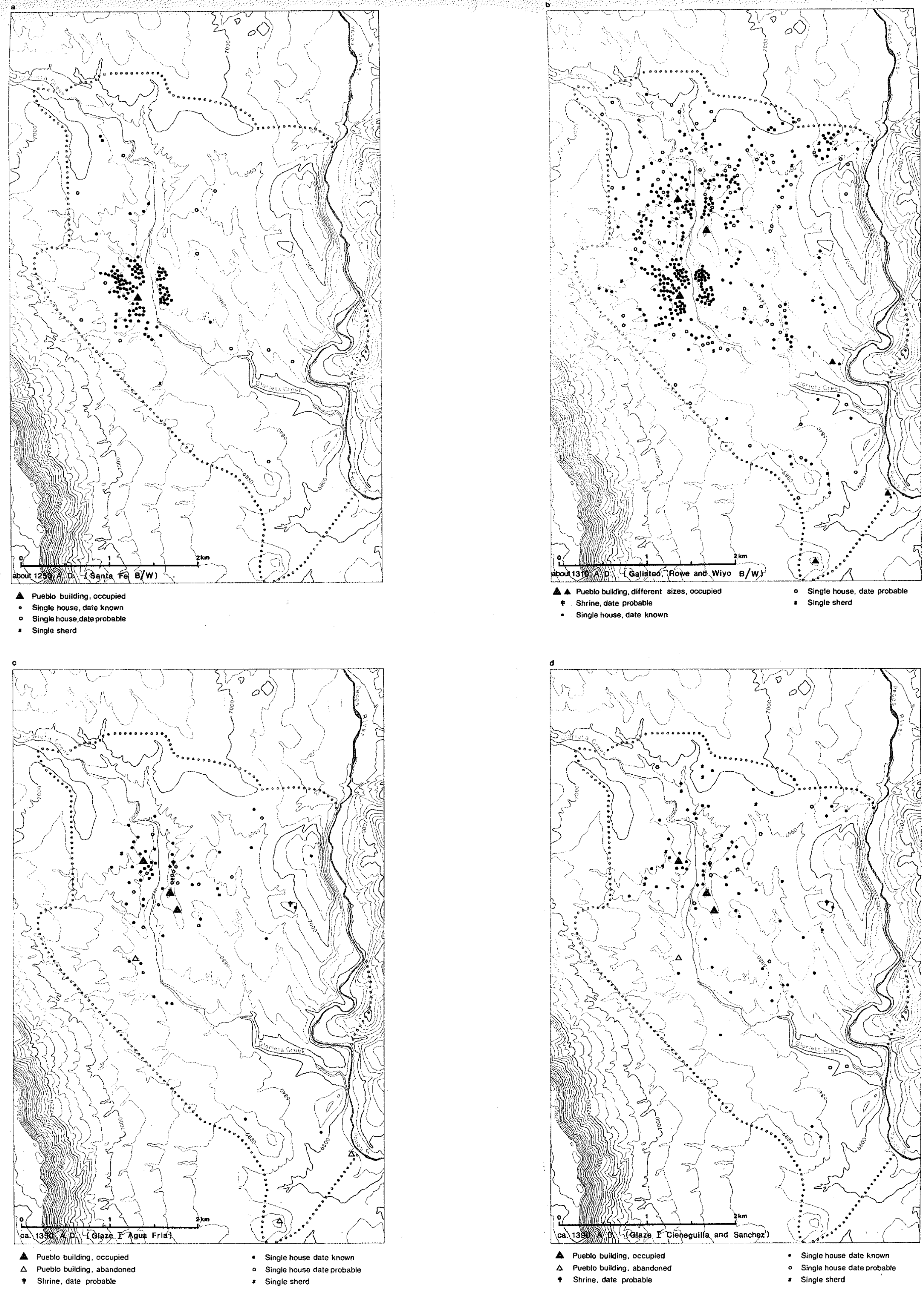
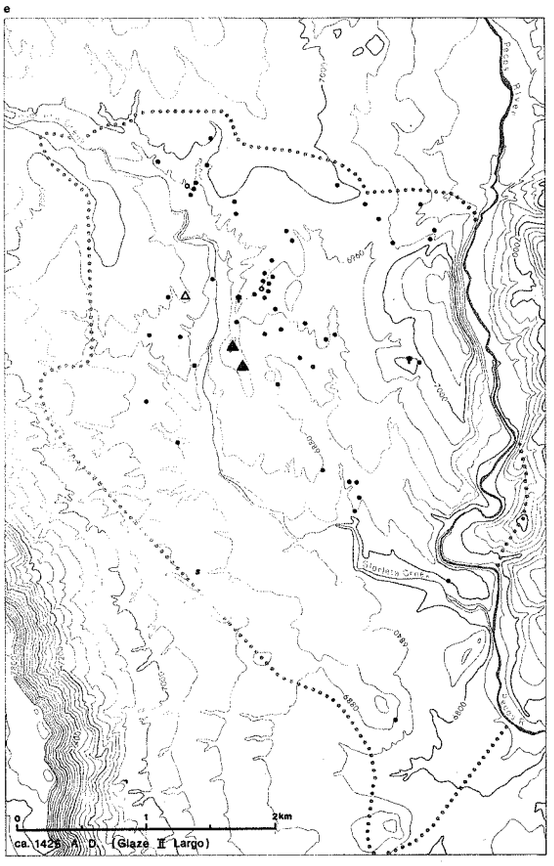
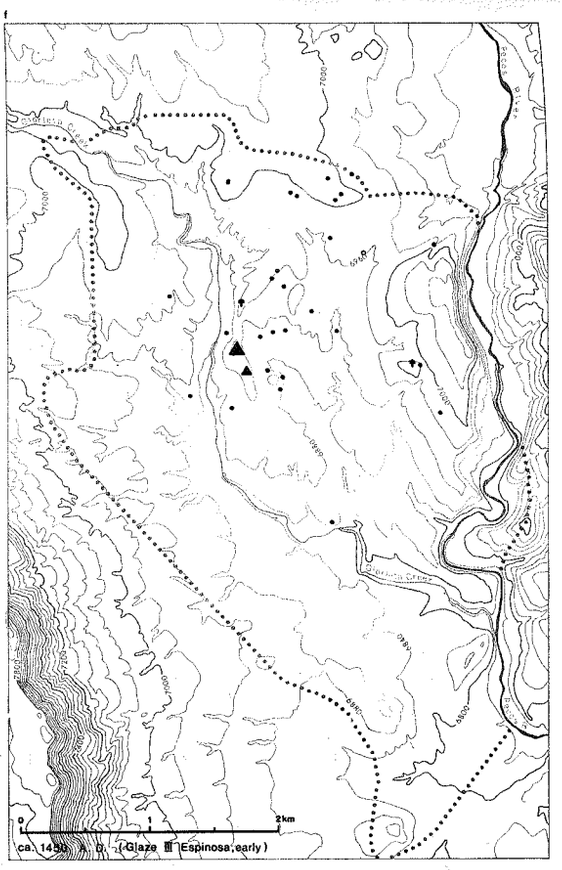
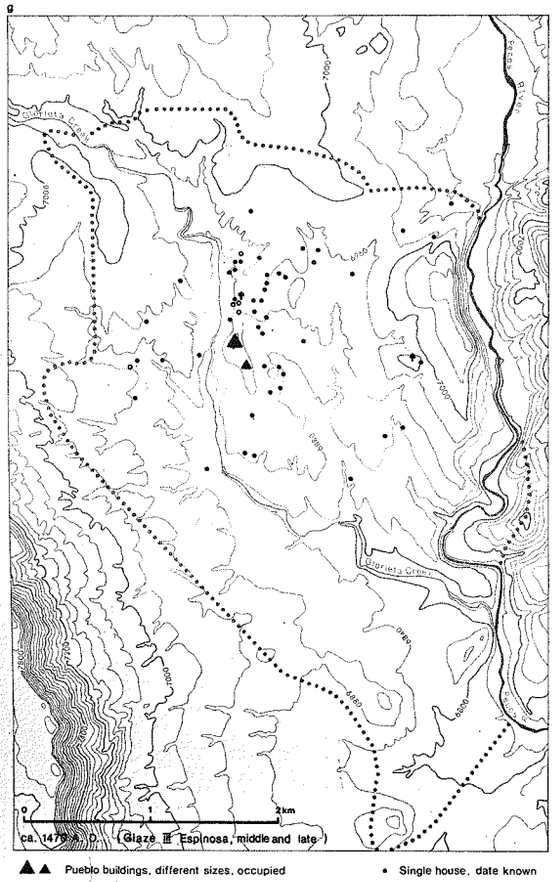


Fig. 6 (a-d): Pueblo Pecos, village settlements and single houses, ca. 1250 - ca. 1390.







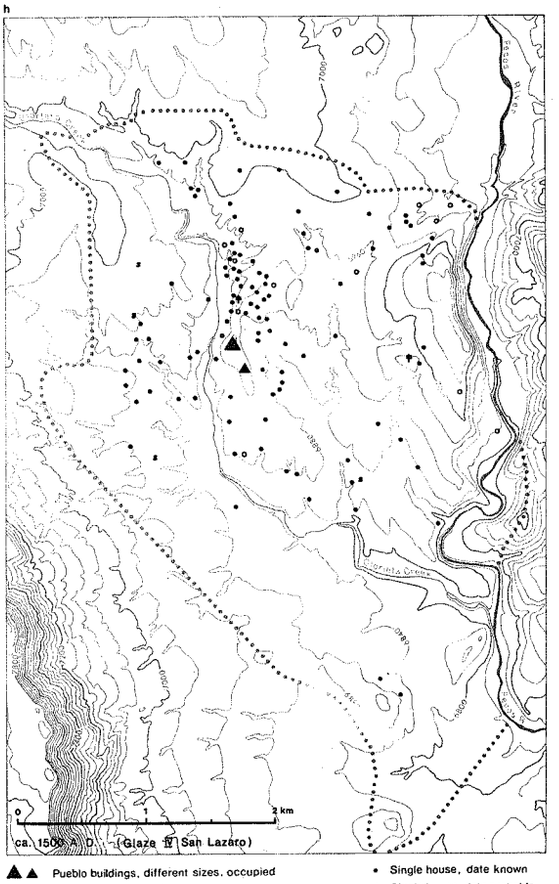
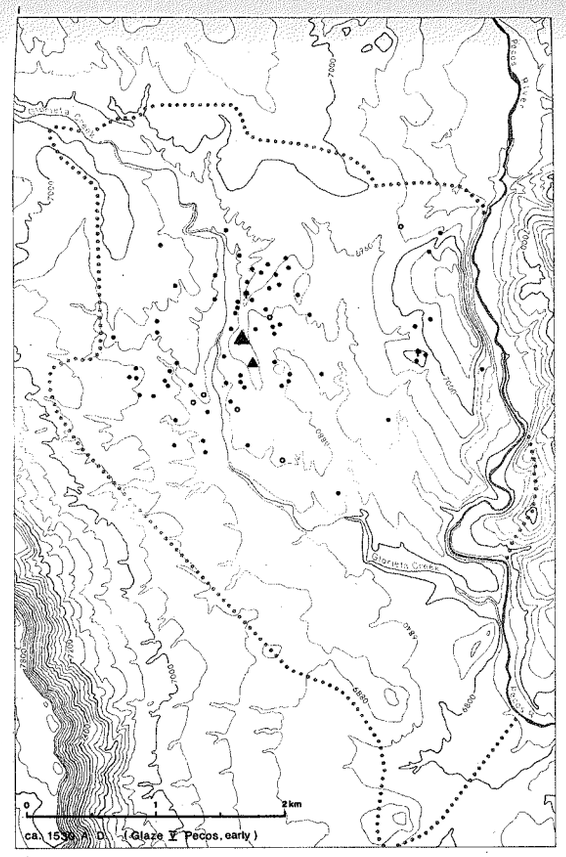
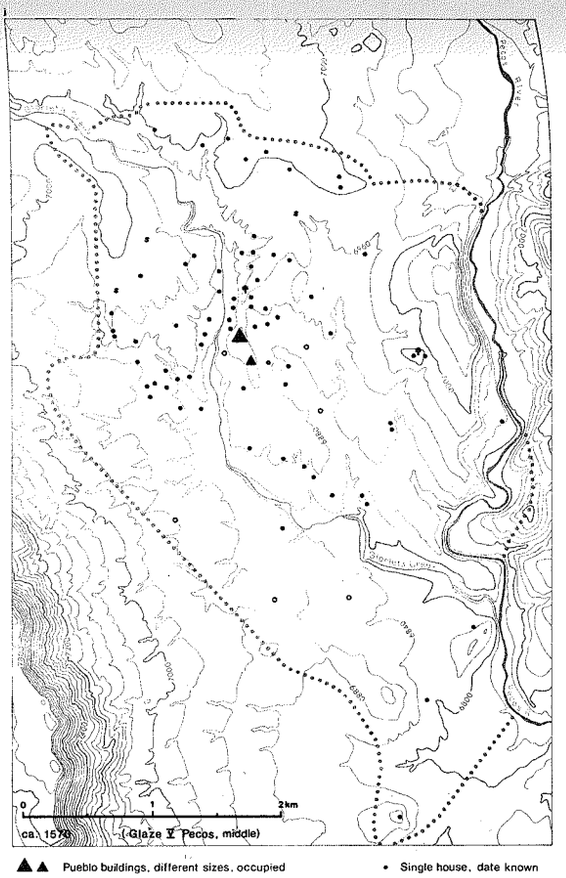
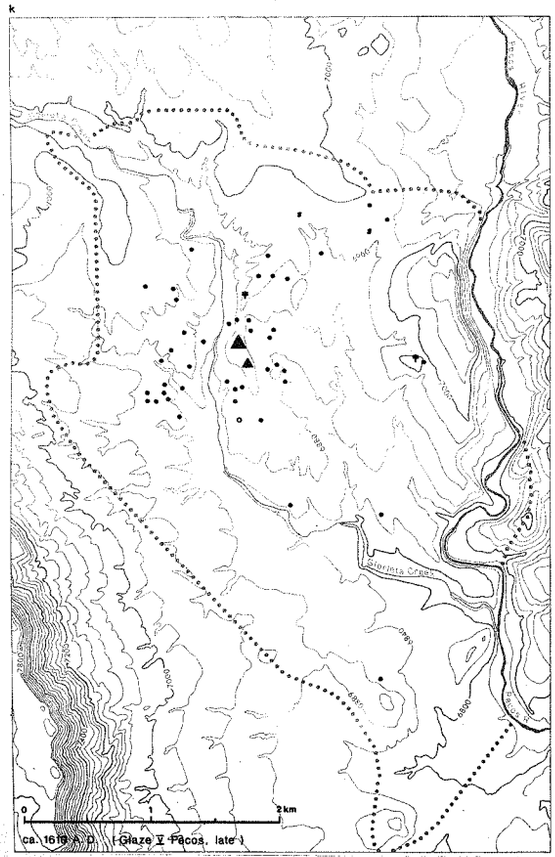


Fig. 6 (e-h): Pueblo Pecos, village settlements and single houses, ca. 1425 - ca. 1500.







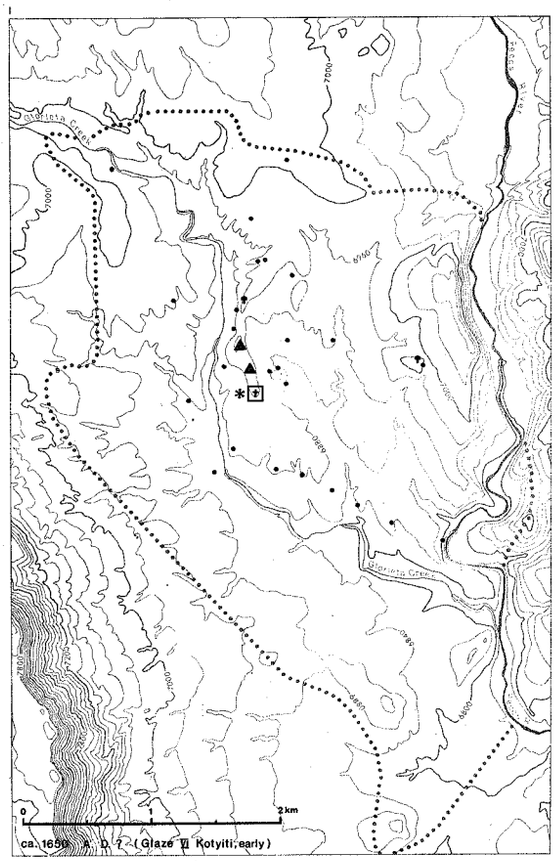
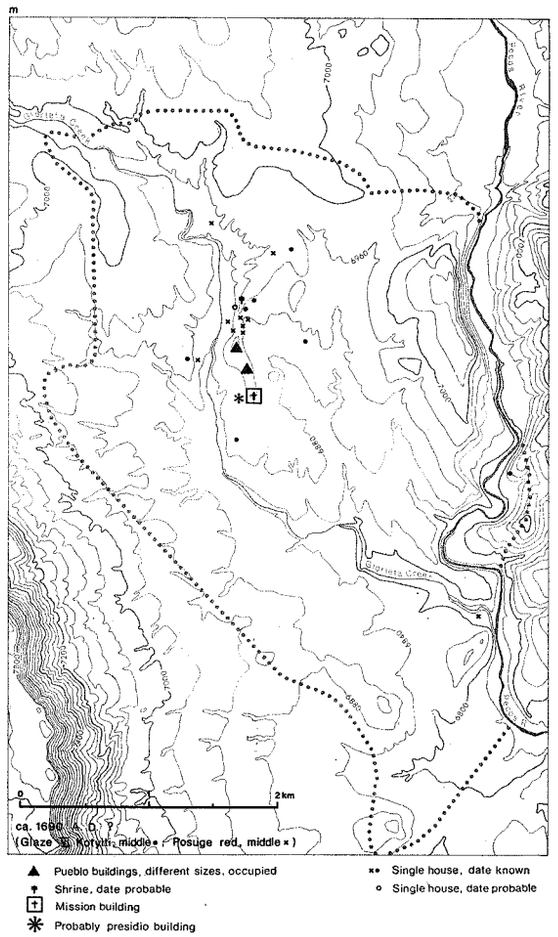
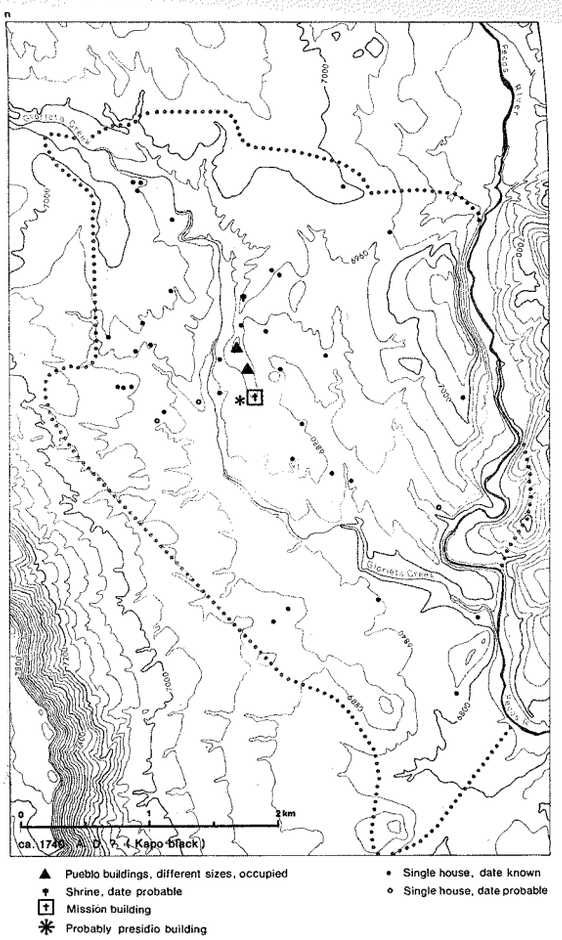


Fig. 6 (i-l): Pueblo Pecos, village settlements and single houses, ca. 1530 - ca. 1650 (?)





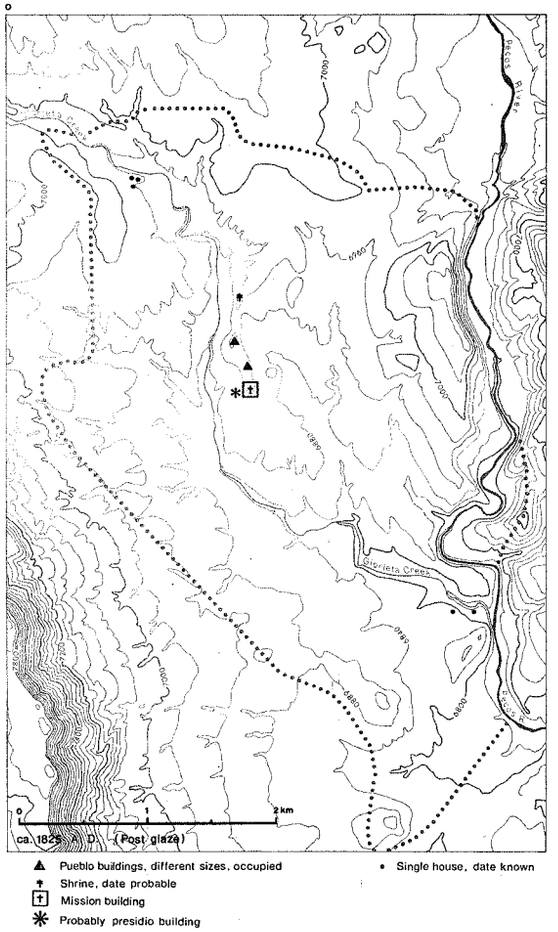


Fig. 6 (m-o): Pueblo Pecos, village settlements and single houses, ca. 1690 - ca. 1825.

change the cultural landscape, e.g. by clearing woodland, building roads etc. Thus, the living space is shaped according to the requirements of the system. While the structure-changing processes are going on, the structure-conserving processes also continue; e.g., while the woodland around some communities was being cleared, the fields were still being cultivated, so that the change in the amount of land cultivation could be adapted to the demand. Thus, enough land was successively cleared until it could provide sufficient amounts of food. Due to feedback, the structure-changing process is prevented from pursuing its course and the structure-conserving processes, i.e. production, become stabilized at about the same level (cf. section 2.7.1.).

If the structure does not change, the system nucleus (or population) and the environment are as a rule in a state of equilibrium in this task-category, while structure-changing processes indicate disparities between the system nucleus and the environment. The state of equilibrium finds formal expression in the economic models of equilibrium for example (cf. section 3.5.2.1.), or in the ecosystemic models (cf. section 2.3.1.). Structure-changing processes signalize continuing development and progress, growth or concentration. System-disturbing unrest (K. JETTMAR, 1973, p. 86) initiates historic processes and social change. The structure-changing processes cause the system nuclei, i.e. the populations, to open up towards the horizontal environment. Structure-conserving and structure-changing processes can either be induction or reaction processes (cf. section 2.7.2.

2.6.2. Entropy, media (mobile artefacts)

The Pecos example shows that the population had encountered the limits of its carrying capacity and had tried to procure more energy by two different means, 1) by increasing the intensity of cultivation and 2) by trading.

To 1): we can say that the traces of soil erosion (cf. section 2.5.2.) indicate that the population had reached the limit of the ecosystem's capacity in the living space by attempting to increase the agricultural yield. In general, it can be said that the yield obtained from cultivating the living

space does not rise linear to the input; while with a further constant raising of the input the yield begins to increase at a slower pace after a certain point has been reached, and finally even sinks. In this, the "law of diminishing returns" is manifested (for plant production, E.A. MITSCHERLICH, 1909, p. 545f; E. BOSERUP, 1965, p. 35f). The prerequisite condition is that no other changes take place.

So, when this point has been reached, an additional energy requirement comes about. This can be interpreted as a consequence of entropy. This term, taken from thermodynamics, has been in use in systems theory for some time. It serves the purpose of measuring the uncontrolled dissipation of energy within the system, manifesting itself structurally in the form of disorder. Entropy is always found to result if, due to its structure, the system's performance is inefficient or fruitless. This may be within the scope of communication; for if information only incompletely reaches the receiver, the sequence of processes based on this information will also be incomplete. The same is true if faulty products are made, inspite of high energy input.

The mere conserving of a population's structure and of a system in general requires processes and a supply of energy (cf. section 2.6.1.). Systems that are closed on all sides, towards all environments (cf. section 1.2.) would disintegrate. Disorder is the most probable condition caused by entropy and the processes are irreversible from an energetic point of view. If they are to be repeated, more energy has to be supplied.

With regard to 2), we can say that if the number of inhabitants keeps on increasing beyond the critical point at which the population and the environment still remain balanced, additional ways must be found to obtain energy without straining the environment and to counteract the increase in entropy. The example of trade of the Pecos population with other tribes shows that different activities can replace one another as far as the energy requirement is concerned. Thus, the division of labour is rendered possible and meaningful (cf. section 2.2.2.). For human populations the desire to replace human work-energy provides the drive to find new sources of energy or ways of better utilizing existing energy. By the division of labour, i.e., differentiation, the population provides a higher state of order for itself and thus reduces entropy. In this way it is able to survive with the aid of additional energy drawn from the living space. Thus, the dynamic equilibrium is maintained under the same work load (per person) on the system nucleus and without over-straining the ecosystems of the living space.

These efforts based on intelligence save energy and reduce entropy. We refer to them as negentropy. Thus, a method of counteracting an increase in entropy is indicated; without additional human work-energy it is possible to draw a different form of energy, previously unobtainable, from the living space. This additonal energy supply may be of animal or mineral origin.

This requires technical perfection, e.g. inventions and the development of new tools or - generally speaking, media (mobile artefacts). They provide the means for applying energy in a precise and controlled manner (M. E.E. HURST, 1972, p. 58), so that here again, entropy is reduced in relation to the effect (cf. also J. SCHMITHÜSEN, 1976, p. 179f).

The term media refers to equipment, for instance, that simplifies cultivation, or instruments enabling a doctor's activities, vehicles rendering transportation more efficient, television receivers that transmit information, furniture that permits an optimal use of space, weapons serving defence, clothing that protects the body, machines facilitating and speeding up work. All media go to aid processes and the rational control of the environment.

Furthermore, there are the earthbound artefacts mentioned earlier on (cf. section 2.4.1.). Media (e.g., a locomotive) and earthbound artefacts (e.g., railway lines) are coordinated; they can also be identical (e.g., an oil refinery). They are constructs, intended to influence the processes with regard to direction and intensity in such a way that the adaptation between the population and the living space is facilitated and energy is saved. In order to produce media, there must be trade and industry, having detached itself from domestic work by the division of labour and having become extremely differentiated in itself (cf. section 3.5.1.1.1.).

While resistance as a consequence of saturation stops the adoption of the innovation or structure-changing process (cf. below, section 2.6.5.) the rise of entropy stimulates the process. The inferior systems in which a

specific task has to be completed are not able to adjust to this new situation, so that the structural conservation of the superior system appears endangered. The inferior systems have to change their structure, by adopting the innovations. Thus, entropy in the superior systems can be reduced.

2.6.3. Process sequence

The individuals frequently change their position within the population hierarchy during the course of the day. They take their place in a number of consecutive processes and systems, they work in enterprises serving the economy, go shopping in stores, use transport vehicles, have to deal with administrative authorities, return to their homes in the evening, i.e., they are active participants for a time and then consumers. In their respective activities, they are bound by certain roles, and engaged in process-sequences, and are thus working for a variety of systems (cf. section 2.2.1.). Every activity requires another activity to have been completed be forehand (possibly by other persons) and forms the basis for further activities (cf. Time Geography; T. HÄGERSTRAND, 1975; TIMING SPACE, 1978).

In order to find the modus operandi for an assessment of the process-sequences, we can regard the structure of the actions. The individuals play their parts, and their activities are the fundamental units building up the processes or changes in an historical geographic order of magnitude. Therefore, the interest shown by a number of historians in a thorough understanding of the actions is comprehensible (e.g., A. HEUSS, 1973, p. 183f).

We are taken a step further by the statement that individual activities can be regarded as temporally reduced copies of controlled processes. Individuals can be regarded as system nuclei in the same way as populations can in the light of the theoretical statements made above (cf. section 2.3.1.); both are trying to hold their own and both interact with their environment. Fundamentally, the shape of the information-fields within the various orders of magnitude is the same. T. HÄGERSTRAND (1966/70, p. 372) successfully attempted to transfer a model of information processing developed

in a local frame to an order of magnitude of continental dimensions. The mechanisms proved to be of the same kind. Thus, he was able to simulate the diffusion of innovations.

This could be an approach for a comparison between actions and controlled processes (e.g. induction processes: cf. section 2.7.2.). In the sociological theory of actions, these questions are pursued further in more detail and related to group behaviour and social structures. Whereas T. PARSONS, (1951a, b) had not yet elaborated a detailed sequence, but worked on the basis of an equilibrium in the social system, other authors describe a series of actions, e.g. H.G. FRANK (1969, p. 23): goal setting - program development (planning) - logical assignation of control-actions to instructions - physical work-performance - influencing the environment). If actions are seen as parts of a sequence achieving an equilibrium, stabilization marks the last stage (cf. below).

An example shall show the sequence of stages which form an action: Throwing the ball in a basket ball game (D. FLIEDNER, 1980, p. 16):

1. The player receives the ball (input in the individual system)
2. Decision, e.g., that the ball should be passed to another player
3. Planning the action, e.g., the shot
4. Getting into the right position for throwing
5. Concentrating the body's energy in order to throw
6. Throwing (as "production")
7. Taking back the ball by the team (output of the indvidual system). The player returns into a new position in the team, ready for the next action.

Earlier on we tried to show (cf. section 1.1.) that the populations have an hierarchical order. Actions are carried out by the individuals forming the basis of the hierarchy. Thus, processes can be thought of as actions of a higher order. Investigations of innovations showed that different stages in the course of the process could be distinguished too: awareness stage - interest stage - evaluation stage - trial stage - adoption stage; or, seen as a decision process: knowledge - persuasion - decision - confirmation (E.M. ROGERS, 1962, p. 81; E.M. ROGERS and F.F. SHOEMAKER, 1971, p. 100f). In this we can regard the processes as appertaining to the populations in the same way as actions go with indivi-

duals. It suggests itself to go back to our deliberations on the task-categories at this point (cf. section 2.2.1.), to define the course taken by the processes.

We can demonstrate this using the establishment of an industrial plant as an example (D. FLIEDNER, 1979b):

1. An industrial syndicate infers from the economic situation on the market that there is a demand for certain products: perception
2. Deciding on the development of a plant: determination
3. Planning the operational steps and priorities: regulation
4. Planning the locality and the dimensions of the building: organization
5. Procuring material for building the plant (investment): dynamization
6. Building the plant: kinetization
7. Taking possession of the plant by the industrial syndicate: stabilization.

Another example:
In the 16th and 17th centuries, New Mexico was conquered by the Spanish (H.H. BANCROFT, 1888; R.E. TWITCHELL, 1922; G.P. HAMMOND and A. REY, 1953; A.H. SCHROEDER, 1972; D. FLIEDNER, 1975, 1979a). Several stages can be distinguished in this process. First of all, a need for valuable minerals in Mexico and Spain had to be established, and a directive given to missionize the heathen Indians. With Cabeza de Baca (1536) and Coronado (1540/41), it was recognized that it was basically possible to take possession of New Mexico. The process of conquest itself reveals various stages:

1. Purposive reconnaissance expeditions from about the 1580's (Chamiscado-Rodriguez, 1581/82; Espejo, 1582): perception
2. The decision to colonize and fixing the objective: search for gold, mission; ca. 1585: determination
3. a) A first fruitless attempt by Castaño de Sosa (1590/91)
   b) Organizing a new expedition group by Oñate, before 1598, setting and allocation of tasks. The group consisted of priests, soldiers and the accompanying horses, waggons and herds: regulation
4. Migration from Mexico to New Mexico, i.e. overcoming distance. Preliminary settlement in St. Gabriel, 1598. First planning of transportation links (foot or bridlepaths) and settlements: organization
5. Building of settlements, missionary stations (about 1600 to 1635), Santa Fe as the new capital (1609/10). Thus investment in earthbound artefacts: dynamization
6. Production: the search for gold and silver, which was, however, fruitless: forcing the Indians into service; missionary work (e.g., Benavides, 1630 and 1634): kinetization

7. Reporting success or failure to the viceroy in Mexico; conclusions drawn for the continued existence of the population; establishment of haciendas (ca. 1635-1680): stabilization

In an abstract form, a process can be divided into the following partial stages (D. FLIEDNER, 1979b):

Perception: due to the demand, process stimulation and thus, general orientation by the superior system (information input)

Determination: decision, task-setting, process specification

Regulation: planning, transfer to inferior, and thus controlled systems or elements (information output)

Organization: arranging the (three-dimensional) spatial order of the process between the elements (of the same order of magnitude)

Dynamization: absorbing energy from the inferior, thus controlled, systems, and energy transfer, so that production can take place (input of raw materials and raw products)

Kinetization: production (in accordance with determination)

Stabilization: products are passed on and taken up by the demanding superior system (output). (This stimulates the adjustment of the system to the new production volume in the reaction-process; cf. section 2.7.2.).

The cogency of this sequence is obvious. The sequence reveals the irreversible nature of every action and process carried out by individuals resp. populations. This is a consequence of the second law of thermodynamics. There is, however, an extensive temporal overlapping of the process stages. Moreover many processes are not completed. Process stages that were not successfully brought to completion are usually repeated, whenever this is possible.

2.6.4. Control loop and process hierarchy; main and derived processes

A control loop adapted to the goal-oriented system (Fig. 7) leads from a variable or level which characterizes a state, e.g. of a population with a definite need in one task category, over the process, back to the initial variable.

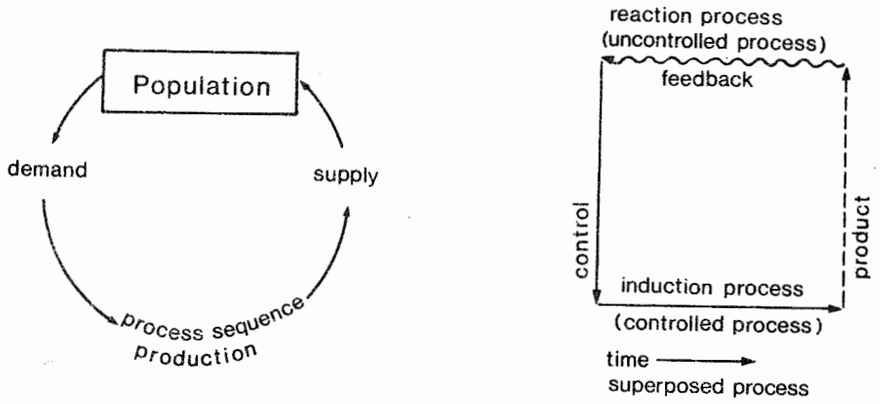


Fig. 7: Control and production loop of a goal-oriented system (cf. text).

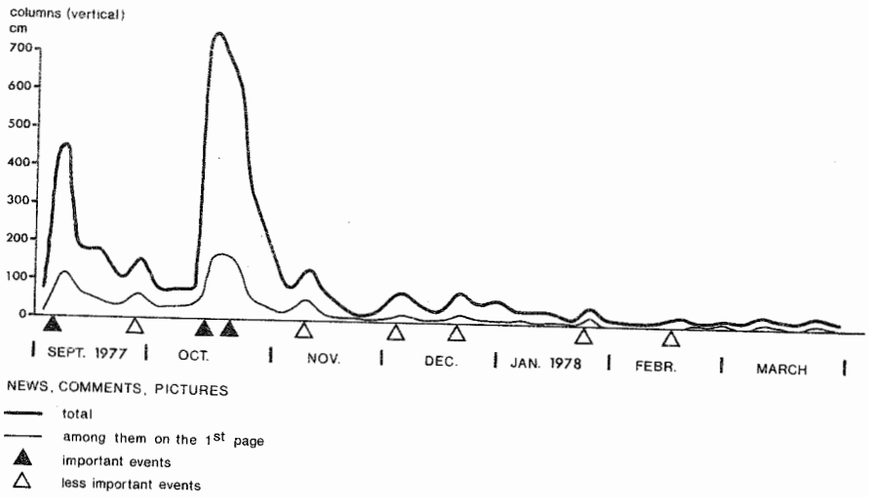


Fig. 8: Treatment of important events in the newspaper as the expression of temporal long-term effect.

At every stage in a process, new populations are stimulated, in two ways: on the one hand the populations induce populations of the same kind to go into production along these lines as well (diffusion), thus causing competition ("horizontal environment"; cf. section 2.3.2.). On the other hand, the populations make demands on their "vertical environment" (supply of raw materials, labour, the conveying of information etc.). All the while these claims are being made on the environment, the process is carried over into the other task-categories within the process-sequence, as described above. The superior populations create a need, thereby stimulating the inferior populations to produce. However, this does not happen to all these populations at once, but rather the innovations are borne to the other, competing populations (cf. organisates) of the same level, in the form of a diffusion (cf. below, section 2.6.5.).

In this way, the controlled process is continued down the hierarchy starting from the top. Each link in the process-sequence serving the superior population is, on a lower level, a complete process in itself. The product created by the inferior populations in their stages of kinetization is (during their stabilization phase) given to the superior population, where it defines dynamization. In this connection, a second fact emerges; the processes serving to conserve the structure of the superior populations must be considered on the level of the inferior processes, as changing the structure of the populations involved (cf. above, section 2.6.1.).

> The Spanish colonization in New Mexico shall again serve as an illustrative example: when the Spanish arrived in the land of the Pueblo Indians in 1598, the Pueblo Indians' life changed completely. The Spanish introduced new economic methods, forced the Indians into service and to pay tributes, and tried to reshape the religious life in the villages along the lines of Christianity. This structural change affected the entire cultural region of the Pueblo Indians, going through the tribal and settlement populations right down to the family. Conversely, this process, seen in the order of magnitude of the Mexican ethnic group, of the Spanish people and its area of expansion, or even of the European cultural population, provided the opportunity of conserving the structure of these superposed populations. In this light, the colonization process served the purpose of covering a demand. Depending on the order of magnitude then, the same process can be regarded as structure-changing or structure-conserving.

It remains to be shown (cf. section 3., in the chapters about the controlling populations), that each type of population on the same level in the

hierarchy (cf. section 1.1.) has to complete a specific task in the process-sequence for conserving mankind as the uppermost population (e.g., the state population: regulation). These processes may be called main processes. The remaining tasks that need to be completed in this connection, thus conserving the resp. populations themselves as a structure (e.g., taxes as dynamization; administration as a part of kinetization in the state populations;cf. section 3.3.1.1.), can be regarded as derived processes. The institutions assignable to them will be discussed in connection with the task-categories (section 3 and 4).

2.6.5. Innovation diffusion

Innovation implies the introduction of an information, rousing local forces and stimulating them into action. The acceptance of an innovation can be described as adoption. Only things that are registered by the senses are perceptible, i.e., the innovation is not adopted and does not become effective, until it comes into the material stages (dynamization, kinetization, stabilization) of the structure-changing process. This also applies to processes aimed at changing perception, determiniation, regulation or organization. For instance, the introduction of the Reformation into southern Germany (M. HANNEMANN, 1975) meant a denominational change, and as such, therefore, a change in an informational and not a material situation. However, the process did not become effective until people had been made aware of it through their senses, by people preaching and being listened to, distributing pamphlets that could be read, converts professing the new doctrine, etc. Every process, no matter which determination it may have, must find e xpression in a perceptible and material form.

While the process is going on, the populations involved are linked to the superior populations, whose demand is to be met by the process (cf. sections 2.3.1., 2.6.4.). In the course of the process-sequence, the processes are controlled by the respective superior populations, via the input. The process is determined. For the controlled system, it is thus not clear at the beginning whether the task taken on will be completed, but only that the previous conditions are to be improved, so that for instance the capacity is increased, certain economic problems are resolved, etc.

The population competes with other populations and selection decides which method is the most suitable in the course of the process-sequence. Controlled systems are passive as elements in aggregates, selectively oriented towards a goal, so that the course of the process is continually being selectively corrected. Only the sequence of task-categories is determined, and not which population with which institutions will hold its own. Thus, the tasks are predictable, the institutions and the way in which the tasks are completed, are not.

Through feedback, indications are provided via the output as to whether the process can be continued and diffusion carried on. As long as the products of the inferior populations are accepted by the demanding population, the process continues. More inferior populations are drawn into the process. Meanwhile the demanding population changes its own structure, thus perhaps triggering further increases in the demand etc. This kind of thing can frequently be observed and we can interpret historic processes along these lines. Thus, K.V. FLANNERY (1968/71) attempted to explain the great cultural innovations in ancient Mexico, on the agricultural sector (the cultivation of maize, irrigation etc.), by interpreting them in connection with the population development; cultural change and population development mutually influenced one another in a positive way.

Processes such as these that strengthen one another are normally characteristic of the initial phase and the phase with the fastest spreading of an innovation. We refer to positive or cumulative feedback, though it must be recognized that not only feedback is involved, but also control via determination, i.e., coming from the input. This is the effect known as the "principle of self-reinforcement", which was given attention in physical geography quite early on (W. BEHRMANN, 1919). The multiplier effect of economics (J.M. KEYNES 1936; P.E. LLOYD and P. DICKEN 1972, p. 164f) should also be seen in this light.

Strictly speaking the population-structure comes into play. The information that precedes the actual adoption jumps from one population to the next one of the same order of magnitude; within the populations it is passed from the respective initial populations to the remaining populations of the same hierarchical order, etc. (e.g., D. BARTELS, 1970a, p. 288ff; L.A. BROWN and K.R. COX, 1971; G. BAHRENBERG and J. LOBODA, 1973, p. 167ff, 177;

D. DENECKE, 1976a). However, the principle of long-range effect is also recognizable in the course of the process. The intensity decreases in the course of time, beginning at the information stage. An example of a temporal decrease in intensity of this kind, e.g., of an information process, is given by news coverage of important events in the newspaper (Fig. 8).

If over a long period of time the feedback-signals remain positive, the innovation-process keeps on going. During diffusion, the extent of the expansion area and at the same time the number of populations adopting the innovation may grow according to an exponential function (cf. section 5.3.).

On the other hand, a converse tendency asserts itself the further the process proceeds along its course. For instance, a wave of colonization can be triggered by overpressure developing within a population and by rising food prices. In the course of colonization, new cultivation areas are opened up, the production of food increases faster than the number of people. Finally, the production of food covers the demand and prices go down. The market acts as a feedback mechanism. The populations and individuals involved in the colonization have trouble in finding a market for their goods. This in turn brings about a reduction in productivity, as the input costs increase, profits sink, returns diminish and finally, even the yield itself goes down. Resistance has grown to such an extent that colonization stops. Feedback is negative. While entropy (cf. section 2.6.2.) stimulates, resistance in adopting breaks the process. While entropy is caused by problems on the side of the inferior populations, resistance is caused by problems on the side of the superior populations.

The upward growth-curve is replaced by the logistic curve (cf. section 5.3.). This means that the speed of diffusion drops after a phase of fastest expansion and that finally stagnation sets in. The logistic curve can be divided into further partial sections, so that in fact a subdivision of the diffusion is effected (cf. e.g., T. HÄGERSTRAND, 1952, p. 16ff).

The task the process had to accomplish is completed. No additional energy is spent on carrying out this task. The production rate is kept at an approximately constant level. The solution of the next task problem in the process-sequence follows. This goes on in the same way until the whole process-sequence is completed.

2.7. ADOPTION AND STEADYING

2.7.1. Oscillation

We have already referred to the fact that in an uncontrolled structure-changing process the decision on whether the process is to continue or not does not come until the population triggering the process has adopted the product, following output. During the kinetization phase, production is carried on and the volume of production depends on the amount of products passed on. But many populations competing with one another and making decisions independently from one another are involved in production in the same way. As every process takes time, the process does not come to a halt as soon as the additional requirements of the superior population are met. This is because before the involved inferior populations have all perceived that the market is saturated, new investments have been made. In the case of colonization for instance, more land has been cleared than is necessary for supplying the population (cf. below; according to E. M. ROGERS and F.F. SHOEMAKER, 1971, p. 164ff: "overadoption"). Thus there results an overproduction ("overshot"). In consequence the organisates are under-utilized. Resistance grows, and a part of the organisates (or other populations) involved give up, production decreases.

In the meantime, however, the demand in the population from which the process emanates has also changed, because simultaneously with the efforts made to expand the production, the demand started to go back, due to the fact that the population for its part had readjusted in accordance with the insufficient supply, and had cut the demand.

Basically, systems always show delayed reaction to demand. Thus the start of production is also deferred because the process-sequence needs to be run through starting from perception, over decision-making to organization and dynamization. This delay is known as the response period or relaxation time (G. CARLSSON, 1967/68; J. LANGTON, 1972, p. 138ff). The cultural lag (W. OGBURN, 1922, quoted in 1957) belongs to this area of meaning too. Due to the delay, supply does not exactly meet the demand because no precise coordination is achieved. By this means, the processes are periodically stimulated afresh in the same task-categories, while the kind of production involved receives new accents every time according to the progress made in the interval. We speak of oscillations.

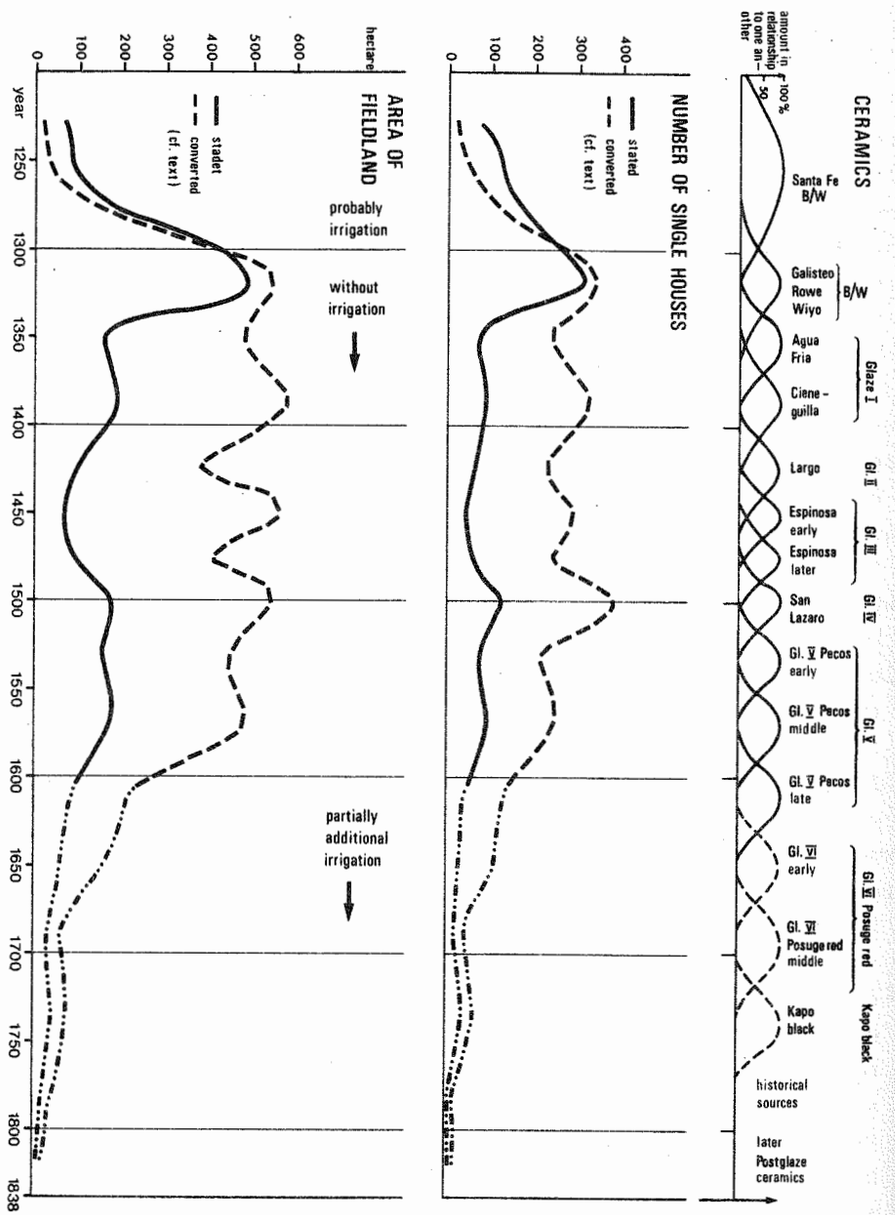


Fig. 9: Pueblo Pecos, development of field-size.

Let us illustrate this point again by using an example from the development of Pueblo Pecos. The populations became established, as far as we know in the beginning of the 13th century. At the time, a small settlement (Forked Lightning Pueblo) was founded in a marginal position to the superposed cultural population. In the course of the 13th century, this settlement was enlarged. In the 1st half of the 14th century, several pueblos were established in the surrounding basin, as mentioned above (section 2.6.1.; C.E. GUTHE, 1917; J. HOLDEN, 1955; A.V. KIDDER, 1958; files at the Laboratory of Anthropology, Santa Fe; cf. Fig. 6b). Maybe these pueblos were founded by Indians coming from the mother settlement or, more likely, by immigrant groups from other pueblos of the cultural population. The neighbouring regions, even those farther to the east and southeast were colonized as well (for the complex of questions concerning this aspect as seen in a wider setting, cf. R. FORD, A.H. SCHROEDER and St.L. PECKHAM, 1972, p. 25). At that time, Pueblo Pecos was also established; probably only a short time after this the first settlement was abandoned. The population density was relatively high, possibly too high, so that the ecosystems in the living space were excessively loaded. The number of inhabitants must have dropped rapidly over the ensuing decades, as all the pueblo buildings, except for Pueblo Pecos were abandoned (Figs. 6c-e). During this desertion period the remaining Indians seemed to have been concentrated at Pecos, because the site was enlarged at this time.

There are therefore three recognizable stages:
1. a small population took possession of a new space,
2. strong increase in numbers,
3. great drop in numbers, connected with desertion-phenomena.

In this case there does appear to have been an overshot as far as the utilization of the living space is concerned. Probably excessive expansion and subsequent strong contraction can be assessed as an expression of adjustment; during this time information on the capacity of the ecosystems was gathered before a steady state, an equilibrium between the population and the living space could be achieved in the Pecos basin. In the course of the following era of cultivation lasting about 2 centuries, the agricultural area in the economic territory was extended and reduced several times; this is revealed by the mapping of the single houses and their classification into periods (cf. section 2.5.2.; Fig. 9). One could speak of a pretty regular oscillation of the system of the Pecos population. An interpretation of the material admits the inference that the detached houses within an approx. 1-1,5 km wide zone served the purpose of shelters for families engaged in cultivating the land for certain periods, and at other times were used by groups of pueblo inhabitants engaged in hunting (cf. section 2.5.2.). Agriculture and hunting alternated in this zone four times between 1400 and 1600, before the Spanish occupied the pueblo area. Each phase lasted, on an average, 60-70 years. Investigations also revealed that the intensity of exploitation, measured by the number of sherds found (cf. section 2.5.2.), was not greater during the periods of contraction of the cultivated area than during times of expansion. Thus it can be assumed that not only the cultivated land but also the yield of cropping fluctuated.

In the remaining pueblo area too, some of these processes of contrac-

tion and expansion, desertion or colonization can be recognized. Thus, there is evidence of contractions around 1350 (Glaze I Agua Fria) and 1430 (Glaze II Largo), expansion occurred around 1300 (Galisteo, Rowe and Wiyo Black on White), 1370 (Glaze I Cieneguilla) and 1500 (Glaze IV San Lazaro) (cf. amongst others, H.P. MERA, 1934; 1940; M.F. LAMBERT, 1954; analysis of the data in the Laboratory of Anthropology, Santa Fe).

As can be inferred from the traces of earlier soil erosion recognizable at various points (cf. below, section 2.7.3.), the ecosystems were strained to the limits of their capacity. The development of population numbers is significant in this connection. In the last two centuries of the pueblo's existence (we only have censuses and estimations for this period of time) corresponding phases of oscillation are recognizable. Every maxima of population numbers appears displaced by several decades compared with those of the cultivation area (Fig. 10).

If we combine the observations made, we come to the following conclusions (Fig. 11):

1st stage: population numbers drop due to the lack of food. Meanwhile more land is cleared in order to increase the yield;

2nd stage: population numbers and agricultural yield increase;

3rd stage: food supply exceeds demand; the cultivated area decreases. After a certain delay the trend in the development of population numbers also passes through its maximum;

4th stage: population numbers drop, the cultivated acreage reaches its minimum.

The oscillations occur at the limit of the carrying capacity (cf. section 4.7.1.). Production by the society (adaptation) and biotic reproduction constitute, within the frame of maximum load capacity of the ecosystems (cf. section 2.5.2.), the decisive processes which interact with one another.

The two kinds of production have only an indirect influence on each other (D. FLIEDNER, 1979b); the population with its individuals interpolates. The individuals are the producers and consumers. As producers, they participate in the processes with their activities, so that they play specific roles. On the other hand, they have a specific requirement as consumers that has to be covered to enable them to exist and to accomplish their tasks for the population as the carrier system of the processes.

Assuming this interpretation to be accurate, this shows to what extent the

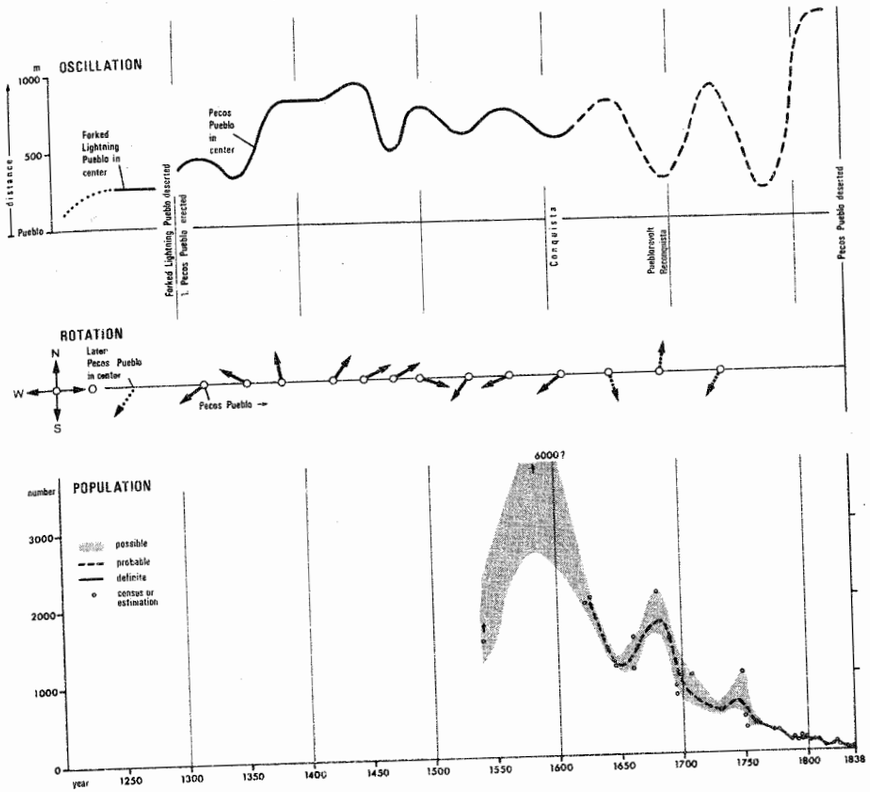


Fig. 10: Pueblo Pecos, oscillation and rotation in field exploitation.

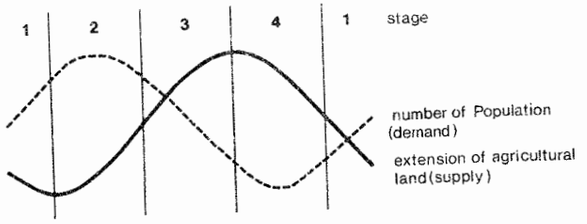


Fig. 11: Mutual influence exercised by the supply (according to the harvest yield) and demand (according to the population numbers) of food in an autonomous (or almost autonomous) population. Explanatory sketch (cf. text).

processes are related to one another in the different task-categories and how much they support or hinder each other (positive or negative feedback). Thus, the population tries to keep itself in a kind of equilibrium with its environment.

Oscillations are characteristic for any process in living systems. They have been observed and studied in the different scientific disciplines e.g., in ecology (R.H. Mc ARHUR and J.H. CONNELL; 1966; H.L. MARGULIS, 1977), in anthropology (R.A. RAPPAPORT, 1967; St.B. SHANTZIS and W.W. BEHRENS, 1973) and in economics (cf. section 3.7.2.2.). In general it can be stated that the oscillations contribute greatly to the course of history. Thus - as seen from the viewpoint of a natural scientist - we have next to electromagnetic and mechanic oscillations, the biosocial oscillations (D. FLIEDNER, 1980; 1981).

As still remains to be demonstrated (cf. sections 3 and 4 and in particular the chapters about the structure-changing processes), the processes and thus the innovations too, are brought into temporal order by the rhythm of the oscillations. Each phase signifies a new link in the process sequence. Frequently, of course, several oscillation-periods are required to complete one task in the sequence, while conversely, several processes, i.e. the solving of several tasks, may be squeezed into one period. In the latter case therefore, the development is particularly fast.

The equilibrium between population and environment can be disturbed by influence from outside.

> The arrival of the Spaniards in Pecos in around 1600 brought great unrest to the population living in a state of equilibrium with the environment. Through their mission work, the Spanish changed the religious foundation (determination; cf. section 3.2.1.1.1.). People lost their vital energy, diseases came on the scene, population numbers dropped. This process of acculturation disturbed the rhythm of oscillation. A phase that had lasted on average 60 to 70 years before the arrival of the Spanish, now lasted ca. 70 to 90 years. From this we can infer that the ability to hold their own was badly affected.
>
> Furthermore, the Pecos population was having trouble with the other Indians in the area, living as hunters and gatherers. Evidently the population numbers required to survive against the hostile neighbouring populations had sunk below the necessary level (e.g., the number of warriors). The last hundred years of the Pecos population clearly reflect the way in which the system lost its internal cohesion and drifted towards dissolution. In 1776, we are informed (Father Dominguez; E. ADAMS and A. CHAVEZ, 1956) that the Indians cultivated their fields only in the close proximity of the pueblo. Later on however, probably around 1800, groups of inhabited houses were constructed a long distance away from the pueblo (Fig. 6 o), whose inhabitants appear to have communicated hardly at all with the few remaining inhabitants of the pueblo. Central control of the population is no longer recognizable. The system ended its oscillations with extreme deflections. In 1838 the last remaining survivors migrated to Pueblo Jemez, about 200 km away, where their language was spoken (e.g., H.H. ROBERTS, 1932; J.L. KESSELL, 1975, p. 556ff).

2.7.2. Induction and reaction process

The oscillations of the Pecos system show that social (adaptation) and biotic (reproduction) processes (cf. sections 1.2. and 2.2.1.) are related to one another. Both processes show oscillations within the same frequency; but the phases are deferred. Both processes are performed in the same population, the community; probably this population as a controlled unit initiated the adaptation processes, whereas the families in this community were the units of reproduction. So the community was on the one hand a population, on the other hand an aggregate of small populations and individuals. The individuals performed the labour and consumed the products.

This observation shall serve as the basis for further statements. With increasing differentation which, as stated above, arises from adopting the innovations, the structure of the population changes (cf. sections 1.1.; 2.2.2.). The rhythms of the processes are taken over into each of the different task categories or process stages. The resp. adaptative and reproductive processes remain related to one another, so that the individuals can - to satisfy the biotic processes - consume the products of the social processes. Thus the structural adjustment of the biotic processes as the superposed processes (the demand arises here; cf. section 2.6.4.) to the social processes (they offer the products) emanates from the individuals as the consumers. It is a new process. Let us consider the details:

We distinguished structure-conserving from structure-changing processes (cf. section 2.6.1.). Theoretically, the quantity of products has to cover

merely the amount required to maintain the demanding party, i.e. enough to enable the biotic processes to unfold. But demand and supply are not exactly adjusted to one another since the processes cause a delay. Thus stimulation and resistance trigger resp. brake the production. Control is effected by positive and negative feedback (cf. sections 2.3.1.; 2.6.4.). The oscillations can occur within a certain load capacity without changing the structure of the system.

However, if the demand should increase beyond the load capacity, i.e. if the inferior producing populations (e.g. organisates) are not able to satisfy the demand, entropy becomes visible. An innovation of new techniques is necessary, i.e. a structure-changing process (cf. section 2.6.2.).

The innovation process follows a course according to the process sequence from perception to stabilization (cf. section 2.6.3.). Thus, by adopting the innovation, negentropy increases, the living space with its advantages and disadvantages can be better exploited. The production increases (positive feedback), but only as long as the demand continues. If the demand decreases, resistance arises - at the boundary of the superior environment - until saturation is reached (negative feedback) (cf. sections 2.6.5.; 2.7.1.). Thus every process swings between the boundaries of the system's capacity to the inferior resp. the superior environments. Entropy and resistance make these boundaries visible.

Resistance causes a new process to be triggered within the population which checks the innovation process until it stops. This counter process proceeds into the opposite direction to that used by the innovation processes, like the retroaction resulting when traffic is congested (D. FLIEDNER, 1980). Thus it first influences stabilization and leads back until perception is reached. So the structure, which is changed by the innovation process, can be fixed.

The first kind of process can be called induction process; the population receives information for changing the structure (innovation). Moreover it receives energy, refines it, and passes the products on to the individuals of the demanding system. The second process can be called reaction process, emanating from the consuming individuals as the system's elements. The elements receive their positions according to their capabilities with

the aid of selection mechanisms, so that the system is provided with a lasting structure, or order. Reaction processes fix the structure which constitutes the basis for the future induction processes. Thus the population structure is stable until the induction process is finished. The terms persistence (H.D. de VRIES REILINGH, 1968: consistence) and tradition (S. ICHII, 1970; E. WIRTH, 1976) belong in this context.

Every innovation also changes the quantity of production, because innovations are always embedded in production. In fact, usually it is easiest to indicate an innovation by a change in production (cf. section 3., chapters about structure-changing processes). Thus the induction process embraces innovation and production. Accordingly this stands for the reaction process it embraces the feedback and the fixing of the structural change. On the level of the individuals, work is the induction process, consumption and digestion by the body and mind the reaction process.

During the stabilization period of the process sequence the induction process ends and the reaction process begins; at the same time the perception period of the next process sequence opens a new induction process and stops the reaction process of the preceding process sequence. Thus consumption resp. adoption indicate the first stages of the subsequent reaction processes.

2.7.3. Rotation

Corresponding with the oscillation phases, spatial displacements give the processes their temporal differentiation. These displacements, which can be summed up under the heading rotation, also require for their explanation the interrelations between the system-nucleus, with the process emanating from it, and the adopting environment.

> This shall be demonstrated using Pueblo Pecos as an example again. As was previously indicated, ecological reactions interfere with the oscillations in the economic territory. To maintain crop yield on a long-term basis, the Indians were obliged to keep changing the cultivation areas in the outer regions during their woodland-clearing activities. Every radial displacement (oscillation) simultaneously called forth a tangential one, i.e., the main cultivation area was

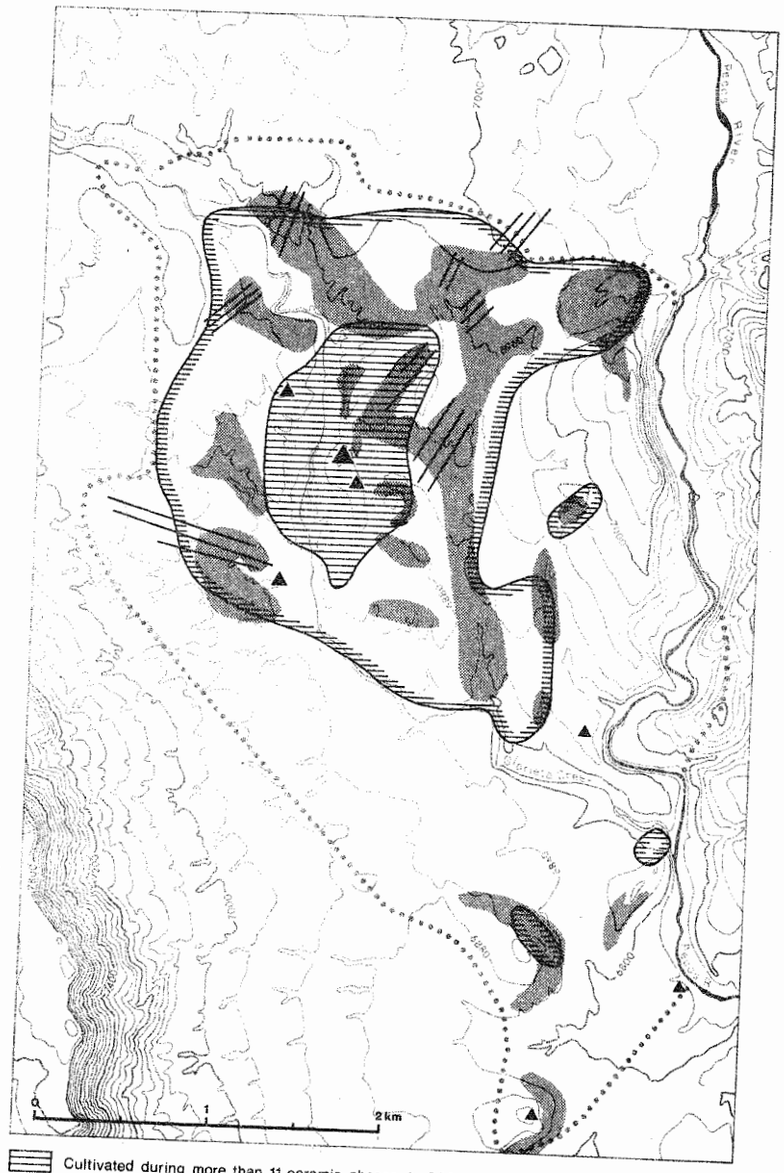


Fig. 12: Pueblo Pecos, duration of field exploitation and extent of damage caused by soil erosion.

laterally displaced. This tangential displacement always resulted in one direction (before the Spanish arrived), i.e., clockwise (Fig. 10). Due to soil erosion, the previously exploited and then abandoned space had not quite recuperated, so that the adjoining land seemed more attractive. This means that not only oscillation, but rotation too, belonged to the compensatory movements of the Pecos population in their environment. Thus, the system closely approached the limit of its capacity. Locally it was even gone beyond. This is revealed by the fact that the previously exploited areas of cultivation show evidence of soil erosion of varying intensity (cf. section 2.5.3.).
It was indicated above that following a regular rhythm, a concentric strip at the fringe of the field area was alternately used for cultivation and for hunting. It is striking that this 1-1,5 km wide zone was particularly strongly affected by soil erosion, more than the zone used for hunting in the outer region, and more even than the inner portion of land that had been used as agricultural land only (Fig. 12). This would indicate that though this border region of fieldland was cultivated during the times of greatest expansion only, it was not properly cared for. Work-input in relation to output served the purpose of increasing the yield to a much greater extent than in the inner regions of the agricultural land where soil conservation was also important. Due to soil erosion, we can assume that the yield always deteriorated after a few decades use, so that new areas had to be selected in the respective clearing phases.

Displacements of the fieldland such as these have often been described in connection with arid areas (e.g. M. BORN, 1965, p. 143f; E. BOSERUP, 1965: long fallow and short fallow systems).

There are more general rules underlying this. The economic territory, as part of the living space, belongs to the environment into which the process of cultivation was carried by woodland clearing and cultivation. Due to exploitation and the accompanying depletion of the soil, the fields in that part of the economic territory became less suitable for the subsequent processes, so that the neighbouring area was given preference. Accordingly, there is a recognizable regular displacement of the cleared areas in one direction. Reduced to a common denominator, this means that the diffusion of innovations avoids unsuited areas. Instead other areas are given preference.

Any kind of innovation demands an additional effort or investment. The given structure of the environment responds in a number of different ways. This also holds true for the earthbound artefacts belonging to the living space and in fact for any adopting inferior populations as elements of the process. They can impede innovations, i.e., new structure-changing processes because they demand further investments be made in order to bring about a reorganization. Thus, the new structure-changing processes in the same task category are more likely to be adopted in different, possibly adjacent areas that had previously not taken up innovations.

3. MANKIND AS SOCIETY (ADAPTATION)

3.0. INTRODUCTION

In evolution, adaptation and thus the ability to exploit the environment is a decisive step in the species-selection process (W. ZIMMERMANN, 1967/74, I, p. 138ff; E.O. WILSON, 1975, p. 3f). Seen in terms of the energy supply of the earth, all processes within mankind serving the purpose of obtaining energy and reducing entropy are conceived of under the general heading of adaptation. Thus, adaptation is, in the superposed biotic process-sequence (cf. section 4.), identical with the task of dynamization. The product is usable energy. In a deterministic simplification, L. WHITE (1943) already perceived culture as a mechanism for saving energy (cf. also M. HARRIS, 1968, p. 635ff; and even earlier, in a similar vane, W. OSTWALD, 1909, and again, more recently, H. HASS, 1970).

Adaptation and reproduction must be distinguished from one another, for the "product" of the latter is the human being. Reproduction guarantees man's own existence as a species. By the adaptation processes mankind becomes supplied with energy, which causes the reproduction process to receive positive or negative impulses, depending on whether sufficient or insufficient energy was obtained. As a result, population numbers go either up or down correspondingly; this in turn establishes the energy requirement and thus influences the adaptation process. Within the frame of this treatise we shall only deal with the reproduction processes as far as they are influenced by the adaptation processes, as their reaction processes (cf. section 2.7.2.). We will call them socio-reproduction processes. In the process of evolution, the human species has proved to be particularly sucessful, owing to the human beings' ability to adapt and to adjust his reproduction processes to the adaptation processes.

Thus mankind has to be regarded issuing from both the social and the socio-reproductive processes, from induction and reaction processes. Our treatise is subdivided accordingly. Adaptation will be treated first. By society, the system of mankind linked via information and interactions, and qualitatively stabilized mainly by selfdeveloped institutions ("culture") is meant.

It should be recalled (cf. sections 2.3.; 2.6.; 2.7.) that processes

1) have a task to complete for the population
2) either conserve or change the structure.

The tasks can be assigned to categories, and the processes assigned to them correspondingly in the order of the process sequence. In order to complete the tasks in the frame of adaptation, an induction process is started, led by an institution using special media. The assigning of the institutions to the tasks and processes, and their incorporation into the control loops can often be seen to be hindered by the lack of definite criteria. Every single case has to be weighed up carefully. Unless the institutions are assigned to the processes and their interrelations recognized, there can be no certainty. Thus, and this must be stated quite clearly, many of the conclusions presented here remain open to discussion.

The main processes are initiated by mankind as a whole. The processes serving these main processes are subordinated. Some of these derived processes (cf. section 2.6.4.) are treated in separate sections. The structure-conserving processes are distinguished from the structure-changing processes. In the structure-changing processes, the institutions or certain of their traits are propagated by diffusion. Special attention should be given to spatial extension and temporal progression. When these processes are stabilized, both oscillation and rotation become recognizable. The oscillation periods must be emphasized in particular.

3.1. PERCEPTION

3.1.1. Structure-conserving processes

3.1.1.1. Main processes

3.1.1.1.1. Magic and science as institutions

Perception is the prerequisite condition for the ability of individuals and populations to become oriented in their environment and to adjust their behaviour to it. Thus the aim of perception is the obtention and evaluation of information by the population in order to provide a basis for decision-making (determination) with regard to the performance of the processes. In a temporal sense then, perception represents the initial period for the processes (cf. sections 2.2.1.; 2.6.2.; 2.6.3.).

All human beings have the same senses, organs for taking up, processing, evaluating and storing information. This means that acquiring knowledge must be seen as a controlled process, attributable to mankind.

The most important activities of perception, therefore, take place on the border surface between mankind and the environment, particularly the global ecosystem, but also the inferior populations. Specific perceptual abilities enabled mankind to assess its own environment better than the other species. For instance, the potential suitability (J. SCHMITHÜSEN, 1976, p. 214) for economic exploitation of a space can be tested. Science is fundamentally rooted in the need to acquire new knowledge from the environment. It produces the conditions prerequisite for an ever improving exploitation of the living space and for reducing the dependence on the imponderable factors of the ecosystems of the living space. This allows mankind on principle to fill its ecological niche and to exploit the environment to its own advantage. Science must be seen as an institution permitting controlled perception. The basically similar biotic disposition enables mankind to evaluate experiences not only individually, but to build up on those made by others, so that environmental facts can be investigated objectively in all cultural populations; the conclusions are transferable.

In little differentiated populations, magic can be regarded as a first stage. It is an attempt to understand the environment and the reciprocal relations (S. MOWINCKEL, 1953, p. 15). On this level inanimate and animate, organic and inorganic, imaginary and real, cannot yet be distinguished. Magic tries to manipulate chains of cause and effect, which according to our experience and knowledge, do not exist (R.M. KEESING and F.M. KEESING, 1971, p. 303ff).

3.1.1.1.2. Art as an institution

Perception of the evironment seems also to be institutionalized by art. According to K. ALSLEBEN (1973, p. 355), art could be defined as the "ultimate formulation of experienced perceptions". H.P. BAHRDT (1974) also speaks of "esthetic perception" and communication in this context.

Anyone perceiving a work of art is encouraged to enter into intellectual activity, into "productive perception", though human behaviour is not itself directly shaped by works of art.

Thus, art mediates beween the artist and the environment in two different directions: the artist receives impulses and becomes stimulated, and he makes his formulations recognizable to others (cf. also D. FREY, 1946, p. 30ff). A work of art can be regarded as a medium, which tries to render the environment conceivable by means of symbols (D. FREY, 1958/76, p. 84; 1976). A work of art provides information for the populations' determination.

The displays common in the animal kingdom may be understood as a preliminary stage to art, indicating a certain esthetic sensibility. They are genetically fixed. This may also be the case for certain basic patterns of esthetic feeling in the human being (E.O. WILSON, 1975, p. 564).

All human beings, as we have already emphasized, are provided with the same biotic conditions for perception. However, there are vast differences in art. The less differentiated the social structure of the population, and the more dependent on the environment the population is, the smaller the range of variation of the means of expressing style, and the kinds of expression are (except for representations based on eidetic seeing; E.R. JAENSCH, 1925). Thus socalled primitive art as well as folk art can be seen in this context.

> Numerous primitive drawings were discovered on stones and potsherds during excavation work in Pecos, and also in areas surrounding the location, on rock-faces (petroglyphs). Furthermore, small figurines made of wood, clay or stone (A.V. KIDDER, 1931) were found. Pictured are either human beings, in part certainly, with symbolic character, or stars, lightning and other signs of the unexplained and transcendental. These representations must as a rule have served ritual purposes, i.e., determination. They were supposed to transmit messages to, or from the transcendental, in the same way as music and dancing.

In more differentiated societies, art is strongly influenced by the determination of the populations to which the artists belong (for this complex of questions, cf. TH.W. ADORNO, 1970/73, p. 61). As individuals, the artists

are involved in the determination, for instance in the religion, of the cultural populations concerned. The important works of art appealing to large populations require special technical skills that have to be acquired. Thus, workshops and schools developed. The geography of art tries to work out regionally bound basic attitudes and the fundamental interactions behind this phenomenon (for a geographic viewpoint, cf. H. LEHMANN, 1961; seen through the eyes of the history of art, cf. D. FREY, 1955/76; R. HAUSSHERR, 1965). The important art styles are peculiar to the cultural populations (e.g., Gothic); amongst the peoples variants developed (e.g., German gothic). Whithin the different peoples too, there are recognizable differentiations (e.g., Brick gothic, Weser renaissance; for Westphalia, cf. P. PIEPER, 1964). In folk art regional differences are even more evident, as not professional artists were involved, but rather craftsmen or laymen working with symbols and elements of style rooted solidly in local traditions.

3.1.1.2. Derived processes

As all processes must begin with perception, there are a great many institutions dedicated to this task.

We have already briefly dealt with the geographically particularly important procedure of spatial perception (cf. section 2.1.). This procedure is decisive for the organization of the populations in space.

In the economy, finding new resources, observing the market and taking up new ideas are important (e.g., J. WOLPERT, 1964/68). Every organisate must establish and cultivate contacts with the environment. The individuals check the situation and conditions before entering into any activity, in order to be able to decide on the way it is to be carried out.

3.1.2. Structure-changing processes

3.1.2.1. Periodization

3.1.2.1.1. Science

So far, not very much can be said about the temporal sequence and periodization of scientific development, as there has been too little research into this.

In the first approximation (arrived at by evaluating data and a number of reports; e.g. by W.C. DAMPIER, 1948/52 and W. STEIN, 1946/70) it can be seen that after several decades new scientific questions come to the fore. Thus in 1750 there was an accumulation of important discoveries in the natural sciences (above all botany, physics, geographical expeditions), then around 1810 (above all geography, agronomics), 1850 (chiefly physics, chemistry) and in 1910 (mainly nuclear physics) (cf. Fig. 25). There seems to be a similar periodization in physiology (K.E. ROTHSCHUH, 1969, p. 157f, 170f).

We must also mention the considerable accumulation of scientific discoveries in the Renaissance und during the last 100 years while less attention was evidently paid to science in the centuries inbetween. The scientific unveiling of the earth by means of geographical discoveries took place in an exponential progression, mostly in Modern Times until the present (W. BEHRMANN, 1948; 1949). It is too early to infer a periodization from these few data however.

3.1.2.1.2. Art

The products of the processes of perception are taken up in different ways. Some populations take them over more completely than others, and in addition, more are adopted at certain times than at others. The styles of art are dominant only for a certain period; after a time the works of art are considered no longer up-to-date, thus reflecting a change in the mode of perceiving.

The Pueblo Indians changed the colour combination of the symbolic

or ornamental patterns on their pottery several times, making it possible today to identify the date of origin. In Pueblo Pecos, the patterns, and the design of the rim of the bowls and jars changed about every 30 years between 1300 and 1800 (Fig. 9; H.P. MERA, 1933; 1934; 1939; A.V. KIDDER and CH.A. AMSDEN, 1931; A.V. KIDDER and A.O. SHEPARD, 1936; EIGHTH SOUTH WESTERN CERAMIC SEMINAR, 1966; D.H. SNOW and H. WARREN, w.d.; F.H. HARLOW, 1973). Every second phase of pottery style in Pecos can be related to expansion resp. contraction of the population within the process sequence (cf. section 2.7.1.).

This "decennial rhythm" can also be shown to exist in the development of art in Europe (cf. Fig. 13). Since 1700, poetry has reflected the Enlightenment, Realism and Individualism. The development of architecture and painting finds expression in the art styles of the Baroque and Classic periods, the Romantic Movement, Impressionism and Modern Art (literature cf. annex 2, Fig. 13). The decennial rhythm fits into a superior "centennial rhythm", based on periods spanning several centuries. This rhythm can be recognized by the developments in the history of art in the European cultural population. Byzantine-Carolingian art, the art of the High Middle Ages as well as the art of Modern Times are the great periods (e.g., K. BAUCH, 1952, p. 91ff, 116ff, 173ff; W. PINDER, 1952/53, I., p. 106ff; II, p. 81ff), beginning around 400, 900 resp. 1350 A.D.

The way in which art is represented demonstrates a specific experience of the environment. For instance, starting with the Romanic period and the Othonic art-style, the living space was consciously given shape by means of architectural substance. However, in medieval times, three-dimensional space could not yet be represented on a surface, such as a painting for instance. In science too, a different understanding of space can be found to have existed (A. NITSCHKE, 1973, p. 130). Not until the Renaissance, when perspective became comprehensible, could three-dimensional space be represented on the surface of paintings. In the present decades there seems to be a new change coming about (H. SEDLMAYR, 1955a and b; D. WELLERSHOFF, 1976). Natural science is trying to introduce time into our world of conception, as the fourth dimension (Space-time-continuum; A. EINSTEIN, 1916/73).

Research into the history of art has attempted to interpret the rhythmic changes inherent in art. According to W. PINDER (1928/49, p. 145ff), a change in the generation sequence must be particularly stressed. PINDER

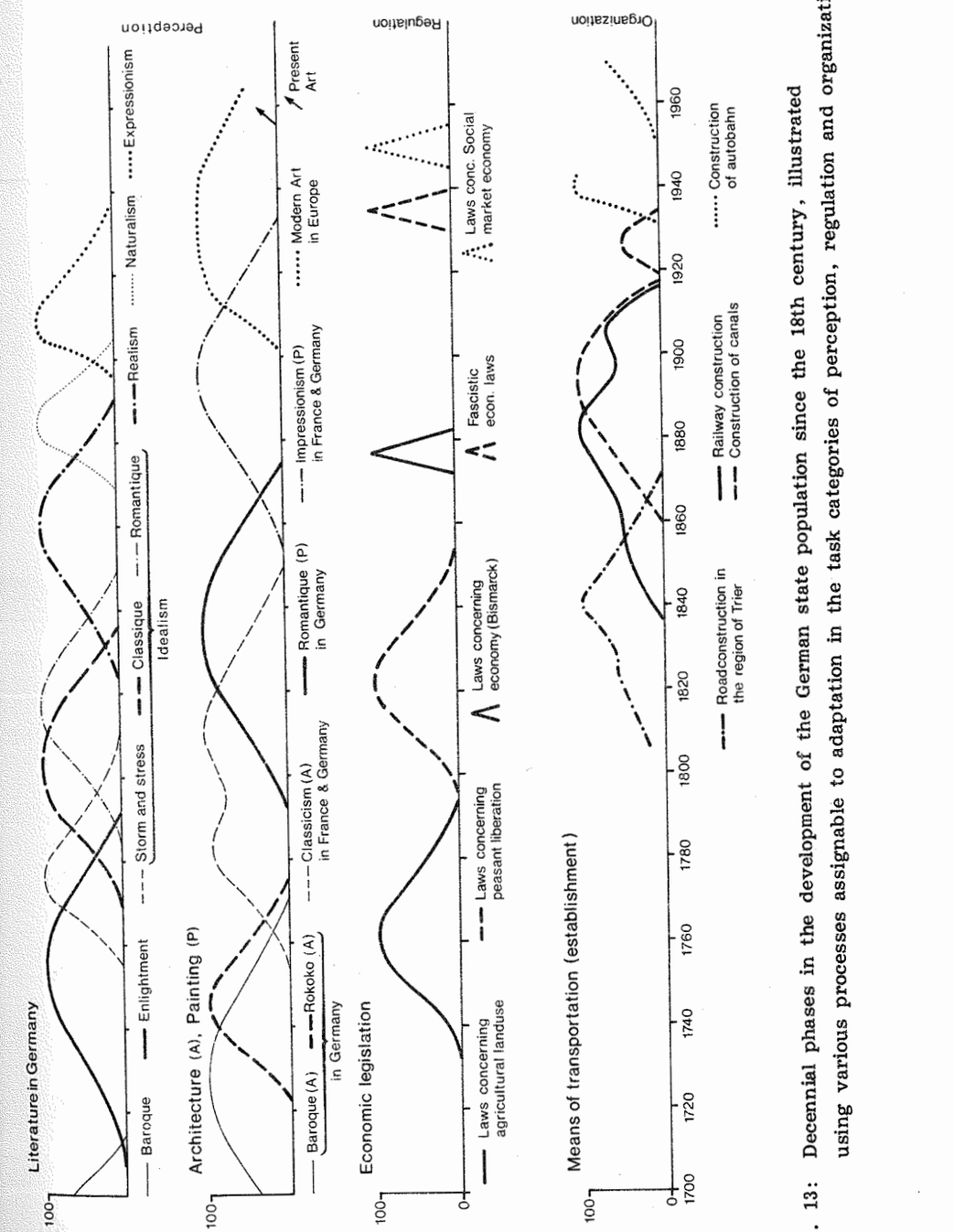


Fig. 13: Decennial phases in the development of the German state population since the 18th century, illustrated using various processes assignable to adaptation in the task categories of perception, regulation and organization.

states that there exist groups of decisive dates of birth, and intervals lasting about a human lifetime (25-30 years). The really great masters are supposed to come within temporal "birth-strata". Two generations would equal a decennial phase. D. FREY (1946, p.50) considered the synthetic synopsis a possible means of advancing towards an understanding of the structure of the temporal, social or biological units. This surely is the way, which, quite in our way of thinking, takes into consideration that there are interactions beween forms of artistic expression and institutions in other task categories, finding expression in oscillations and the process sequence.

The fact that the great periods of art in the case of the Pueblo-population as well as the European cultural population, lasted several centuries in each case, during which the art-styles were diffused from tribe to tribe, or from nation to nation, in periods that normally only lasted a few decades, indicates that the centennial rhythms must be attributed to the cultural populations and the decennial rhythms to the tribal populations or peoples. The populations involved in rotation during these times confirm this conception.

3.1.2.2. Rotation (art)

The centres of artistic innovations moved around several times within the cultural populations. In the Pueblo cultural population, these initial populations at the same time represent the centres of dense population, which appear to have shifted from tribe to tribe in a decennial rhythm (cf. section 4.7.2.2.). The pueblo buildings of the preceding populations are characterized by their particular perfection (H.M. WORMINGTON, 1947/68, p. 76ff). In addition, there is the pottery, the stylistic variety and the skilled craftsmanship.

It is harder to define the artistic and scientific centres in the cultural populations of Europe.

The most important European art innovation-centre was Italy (Renaissance, Baroque style; K. BAUCH, 1952, p. 161ff; J. BIALOSTOCKI, 1972, p. 66ff;

G. KAUFFMANN, 1970; E. HUBALA, 1970, H. KELLER, 1971), but Germany (e.g., music in the 18th and 19th centuries) and the Netherlands (painting, 17th century; E. HUBALA, 1970, p. 44ff), had a leading position in Europe for a time as well. The closer we approach the present, the more differentiated the artistic form of expression becomes and the more difficult the interpretation. The qualitative comparison of the countries required in order to answer these questions is a delicate subject whichever way one looks at it, and the necessary impartiality almost unattainable yet. The increasing differentiation of society in the European cultural population established the basis for the pluralistic development of the peoples, each with individual ways of feeling and presenting art. Maybe in the future it will be possible to make clearer statements when new methods have been elaborated.

3.2. DETERMINATION

3.2.1. Structure-conserving processes

3.2.1.1. Main processes

3.2.1.1.1. Religion as an institution

Determination means, first of all, making decisions based on perceived information, with regard to future behaviour. It thus determines the task of the system within its environment - according to the task-categories mentioned above (cf. section 2.2.1.). By determination, the desired, though not always attainable, output is stipulated and the processes are given their orientation, their significance (L. MISES, 1933, p. 122f; N. LUHMANN, 1971). The main instrument is institutionalization, it constitutes the culture of populations (B. MALINOWSKI, 1944). This is plainly conveyed to the environment. Determination enables the identification of the system, distinguishing it from others, which is an important condition for interaction.

Mankind as a population is given an identity compared with other species, by his specific kind of perception in particular (cf. section 3.1.1.). Cultural populations are representative of a specific way of life ("genre de vie"), of specific values and standards. One could call them "life-form" groups of the highest order. Despite the fact that we can interpret every

population as being a life-form group and every population as having a meaning of its own (cf. section 2.2.1.), determination only provides the cultural population with an essential reason for existing. Coherence is guaranteed by religion. Religion provides the aim in life (W. KELLER, 1971, p. 140/41). R.M. KEESING and F.M. KEESING (1971, p. 308ff) emphasized that religion motivates and regulates social relations.

According to N. LUHMANN (1977, p. 10ff), religion does not always and as a matter of principle play a system-integrating role (indeed, this would come under the task category of regulation; cf. section 2.3.1.), and on the other hand, does not only have an interpreting "function" either (as this would mean that it was assignable to perception). "With religion we are concerned with the transformation of undefinable complexity into definable complexity" (p. 20). In other words, religion provides the system with an orientation, a designation. In a similar way, and in a systems-theoretical context, J.W. FORRESTER (cited according to R.W. BURHOE, 1973, p. 178) regarded religion as an institution, providing society with the "long-term values" it needs to survive, BURHOE (p. 184) supplemented this by stating that cultural information on the significance of life must replace genetic information.

Religion has three distinguishing aspects: myth (the essence of faith, doctrine), ethics (the mode of living, morals) and cult (the worship of God). They are manifestations of the same thing (S. MOWINCKEL, 1953, p.7), but they require different activities and earthbound artefacts (buildings, field shrines, holy places etc.).

> In the Pueblo Indian area, for instance, the kivas are buildings consisting of round rooms sunk below the surface of the ground, that served the various religious societies of the Pueblo communities as meeting places, mainly for mythical activities. The societies were dedicated to problems such as fertility, hunting, agriculture, healing (F.H. ELLIS, 1964). The ethic aspect is revealed in this. The actions required for the self-conservation of the population can be seen to emerge, while on the other hand the environment with its encouraging and disturbing influences becomes manifest. Perception and determination were not yet separated by means of a division of labour. Furthermore, cultic events, particularly the ritual dances on the Pueblo plaza, sometimes together with field processions, are related to the population's tasks and are thus connected with the work schedule of the Indians (R.J. FORD, 1972; cf. in general, S. MOWINCKEL, 1953, p. 58). The feedback of ritual activities on work operations in the other task categories is still immediate with the Pueblo Indians. Outside the village artificial markings (shrines) of different kinds were placed within the living space, and were intended to document the sacred character of these areas. Prominent hills, waterfalls, caves and other significant points within the Indians' living space, frequently outside the actual economic territory, were then, and still are, considered sacred.

Much the same as the kiva and plaza, temples, mosques and church buildings give evidence of places of ritual activity and religious territories, in higher differentiated cultural populations.

3.2.1.1.2. Church and social control as controlling media

Control in the chief higher religions is achieved through the Churches, represented by their organisates right down to the level of settlement populations and reaching every member by means of their ritual activities at important events in life (e.g., baptism, marriage, burial). The Churches provide for continuity and guide activities. They represent binding moral standards for the coexistence of the populations and individuals, giving the general behaviour and the chief activities of the believers a specific style. Thus the cultures are bracketed together. Moreover, many populations bound by a religion are aligned to clerical centres (cf. Rome).
The beginnings of a formation of centres can also be seen in less differentiated cultural populations, such as the Pueblo Indians (e.g., the Sun templ in the region of the Mesa Verde Population; H.M. WORMINGTON, 1947/68, p. 94) or the Hohokam Indians (e.g., Casa Grande; P.S. MARTIN and F. PLOG, 1973, p. 313), though the significance of these buildings has not been established beyond a doubt yet. In these small and easily surveyed cultural populations, control was exercised by priests, religious societies or by means of "social control".

Social control also has an important part to play in higher differentiated societies (G.C. HOMANS, 1950), with regard to the observance of determination throughout the whole process-sequence. It also reaches, for instance, those members of the cultural population who have severed their ties with the Church.

3.2.1.1.3. The cultural population as the controlling population

Presumably, the major races in little differentiated societies (particularly game-hunting groups), represented the original populations with uniform determination in their environment (cf. section 1.1.). Today the cultural populations should be interpreted as representative of determination. Many attempts have been made to typify these large life-form groups, e.g., by A. HETTNER (1929), H. SCHMITTHENNER (1938/51), E. BANSE etc. (1914/23), H. BOBEK (1959) and A. KOLB (1962).

A typoligical classification of the different life-form groups on a tribal or ethnic level is often tied up with an attempt to bring the types into some kind of development sequence (K. MARX, cf. G. KISS, 1972/75; I, p. 146f; B. HILDEBRAND, 1864/1971; K. BÜCHER, 1926; H. BOBEK, 1959). As a decisive criterion the differing degrees of division of labour are placed in the foreground.

Religion influences other processes; this has been dealt with in a variety of ways, e.g., by the geographers H. HAHN (1950; 1958a), H.-G. ZIMPEL (1963) and E. WIRTH (1965), who illustrate the strong influence of religion on history, social structure, the economy and the psyche, using central European or Oriental examples. In particular the famous article by M. WEBER (1920) must be cited here, in which he postulates a connection between religion and the economy, and more precisely, between Protestantism and Capitalism. The success of the Western cultural population in the history of man compared with the Orient, China or India is, according to M. WEBER, attributable to the evaluation of work since the Reformation, especially by the Calvinists. Work was regarded in a positive way, as the ultimate life fulfillment. This new orientation of determination facilitated the uncoupling of the economy from religion, enabling the unfolding of free growth and development.

3.2.1.2. Derived processes

The determination of populations other than cultural populations is controlled by other institutions, e.g., state populations provide their own specific determination within the cultural population by means of a constitution. The settlement population's determination allows us to typify the settlements by means of a selection of data, whose importance has been established (e.g. size, economic orientation etc.). To the geographer, typology is an important step forward in understanding (A. HETTNER, 1902; CITY CLASSIFICATION, 1972; M. BORN, 1979). Determination becomes especially obvious in organisates, as public proclamation of their task (advertising) is essential for most of them within the aggregate of rival organisates, in order to secure output.

3.2.2. Structure-changing processes

3.2.2.1. Innovation: acculturation

Basically, determination remains true to itself in the course of the process ("tradition"). Small deviations result from the adjustment to other processes and the correction of imperfections. In time, determination can become established as rigid doctrine or degenerate to an unattainable ideal. When this happens, or when the process-sequence comes to an end, determination is changed, and an innovation takes place, beginning a new period. In this way the periods can be recorded in a typological and qualitative way.

Religious innovations are acculturation processes (D.E. SOPHER, 1967, p. 89ff).

> When the Spanish penetrated into the Pueblo Indians' country ("Conquista", cf. section 2.6.3.) in 1598, the soldiers wanted to acquire riches. The priests who accompanied them on the other hand, wished to convert "heathens". They built missionary stations and churches in nearly every village (for Pecos, cf. A.V. KIDDER, 1958; A.C. HAYES, 1974; J.L. KESSELL, 1975). The Indians had to submit to the Christian faith, thousands were baptized. Many priests strongly opposed the traditional ritual dances, they considered them the work of the devil, and looked on the meetings of the secret male societies in the kivas with mistrust. Therefore, constant conflicts were unavoidable. Furthermore, soldiers and administrative officials abused the Indians and exploited their working power (encomienda system). The population numbers of the Indians went back considerably at this time; out of more than 90 villages in 1600, only 43 remained in 1643. We have reports of diseases, though the enforced acculturation that made the vital energy wane will have been the true cause (A.H. SCHROEDER, 1972, p. 51ff).

> Then resistance grew. In 1680 the Indians had realigned; a revolt involved nearly all the tribes. Many of the Spanish priests were killed and the Spanish had to withdraw (CH.W. HACKETT and C.C. SHELBY, 1942). They did not come back until 12 years later, with instructions to dispense as far as possible with exploiting the Indians. The church in particular changed its approach. It dispensed with the suppression of the dances and meetings of the male societies and was a good deal more careful in its methods of conversion than before the revolt. From this time on, church services were held in the church and the dances were carried out on the plaza as well, with Christian elements appearing woven in with them. For many representations still serving hunting, agriculture, healing etc., an altar was now set up in the plaza and the priest himself participated.
>
> We can see from these events that the traditional form of religious activities, i.e., giving the structure-conserving activities determination, had not lost their meaning in the Indian culture, because social life and economic activities remained nearly the same. The Christian religion, adjusted to a system with a completely different structure of society could not replace it.

By acculturation therefore, the adoption of institutions of superposed or neighbouring populations by individual persons or populations is meant. This procedure can also include language, or the economic system, or state organization etc. (cf. also R.C. THURNWALD, 1932/66; A.I. HALLOWELL, 1955, p. 310ff; G. BALANDIER, 1960; section 1.2.).

The conquest of the Pueblo Indians took place within the diffusion of Christianity over the earth. The spread of religion has affected the history of man to an extraordinary extent. The rise of the high religions also meant the origin of the chief cultural populations, China, India, the Islamic Orient and Europe (H. SCHMITTHENNER, 1938/51; J.B. NOSS, 1949/74).

As mentioned above, the message of religion must remain unchanged over a long period of time, in compliance with the task that was set. In this respect, the Church sees itself in the role of the custodian of tradition. On the other hand, it is precisely this need for a long-term representation of values that carries the inherent danger of rigidity. Particularly in marginal areas, some populations may be confronted with other problems in dealing with the tasks of life in the environment. This may have contributed to the fact that the different religions split up several times and new ideas could enter locally as innovations. The chief Churches could not all adjust to the changing situations, particularly with regard to scientific

findings or even economic situations. Small religious associations developed next to them, coming into being for reasons of presumed better insight or because of local needs, often having particularly strict moral standards.

3.2.2.2. Periodization

Quantitative investigations into the periodization of the development of religion have not been made so far. Historians differentiate between the Early and the High Middle Ages, and Modern Times. These periods were initiated by important religious changes.

Modern-day determination in Europe began with the Reformation and Catholic Reform shortly after 1500 (K. BRANDI, 1927/60). The High Middle Ages represented a period similar to Modern Times, with determination being set into motion by the Cluniac Reform and the Investiture Struggle (2nd half of the 11th century to 1st half of the 12th century). This formed part of a much wider spiritual movement (H. MITTEIS, 1940/59, p. 185ff; J. LE GOFF, 1964; W. WEISBACH, 1945, p. 15ff; K. BOSL, 1970/75, p. 182ff). The introduction of Christianity in Franconia after 496 (F. STEINBACH and F. PETRY, 1939; K. BOSL, 1970/75, p. 64ff) and the reform of monasticism by Saint Benedict (T. LING, 1968/71, p. 349ff; R. TSCHUDY, 1960, p. 80f) can be considered in the same light. A rhythm encompassing about 5 centuries could be ascertained (centennial rhythm; Fig. 23). The innovations embraced the entire European cultural population. So this rhythm seems to emanate from the cultural populations.

Shorter periods in the task category of determination appear to be even more difficult to recognize. As far as the institution of religion is concerned no statements can be made at this point. An investigation such as this undoubtedly requires specialized knowledge.

3.3. REGULATION

3.3.1. Structure-conserving processes

3.3.1.1. Main processes

3.3.1.1.1. Government and power as institutions

A division of labour is only conceivable if information and decisions can be passed on. Work is divided, and coordination is achieved by the exchange of information. If the coherence of a population is to remain intact despite this differentiation, there must be regulation. A plus in the division of labour requires a plus in regulation. These considerations include the fact that the exchange of information must be controlled, i.e., the transmitting and receiving of instructions must be guaranteed. Supervised regulation is referred to as control. The transfer of information must take place a good deal faster than the actual material transport required for the processes themselves. In this way the decisions necessary for the run of the processes can become effective for the benefit of the system more rapidly.

Thus, regulation must make use of communication. Communication means that instructions given in the course of determination in the form of previously made decisions, are passed on and received. A temporal postposition is equivalent to hierarchical subposition.

In addition, control means that compliance with instructions is guaranteed, as otherwise, the process might not be completed. If the processes are to be controlled, institutions must be created that ensure that communication becomes established, as only then actions can be put together into processes (cf. section 2.6.3.).

The institution we are concerned with here is government. It is the characteristic trait of a system (M. HENNE and W.-U. PRIGGE, 1977, p. 10ff), i.e., of a population. Authority, on the other hand, is the characteristic trait of a person, inconceivable without government, while government is equally inconceivable without authority.

By means of government, the division of labour is made possible in so far as instructions (orders), the receiving of instructions and finally carrying them out (obedience) are controlled.

Whereas the conditions for authority are understanding, legitimation and respect during the inter-relations between the superior and subordinate person (M. HENNE and W.-U. PRIGGE, 1977, p. 21ff), power enables orders to be enforced even in the face of opposition (M. WEBER, 1921/72, p. 28/29; M. HENNE and W.-U. PRIGGE, 1977, p. 27ff).

In pre-Spanish times, the pueblos were governed by priests, elected for a certain length of time. An aristocracy did not exist yet, i.e., a group or family who could pass on these institutions by inheritance. In higher developed societies, where the division of labour becomes more pronounced, various privileges appear to have become concentrated in the hands of the controlling person or family. Thus power increased. Particularly, the right of disposal over land owned as property and, in this connection, also the potential inheritance of material assets, seems to have brought about the securing of the privilege of control by one family. Private property in earthbound artefacts or possession of portions of the living space have a stabilizing effect on power. The connection between practising power and controlling the means of production was established by K. MARX (1867/90/1965). However, further power-stabilizing factors can appear on the scene, such as ritual worship, privileges in receiving tributes or in jurisdiction.

3.3.1.1.2. Information-conveying media and administration as controlling media

The controlled transfer of information is carried out via different media. It makes use of transportation, or rather of the organisates taking care of the transportation in the system. By means of the hierarchy, the processes can be controlled and there is the guarantee that the partner will receive the instructions. Obviously, control of the flow of information can only be carried out in delimitable systems. The populations are geo-quanta with regard to control within their determination. By means of a personal conversation, instructions by letter or telephone, controlled communication is made possible. Reaction and feedback of reception guarantee that the information has arrived, enabling the instructions to be followed.

Human language is the most important medium of communication. Perhaps

the fact that the human being could coordinate actions played an important part in the very successful development of mankind. Thus it must have been important that whilst out hunting several persons could communicate about what was going on by calling to one another (K.J. NARR, 1973, p. 29ff).

In higher differentiated populations where government has developed a specific administration as an organisate of its own, quite a large region with numerous settlement populations can be controlled from one spot. The spoken word has to be supplemented by written instructions. For this reason the development of writing can be seen in connection with administrative needs (A. HEUSS, 1973, p. 180).

Furthermore, a large state with a population embracing millions of inhabitants does not only require writing as a medium of control but also media with which the individual can be reached directly. The so-called mass-media, newspapers, books, radio and television transmit the information from a central point to a wide public.

3.3.1.1.3. The state population as the controlling population

Government has to make sure that the entire system of communication (instruction, transmission, reception, observance) is controlled. In smaller populations, e.g., communities or tribes, the authority or legitimation of the directing person (e.g., a tribal chief) is sufficient for exercising government. In highly differentiated populations, on the other hand, the state has emerged as centrally regulated institution on the level of peoples, provided with a comprehensive mechanism of administration. Frequently, several peoples become merged into a state, usually due to the power expansion of one population or to external influences, or a people becoming divided into several states. Therefore, the state population as secondary population must be distinguished from a people as a primary population (cf. also O. MAULL, 1925/56, p. 100ff; M. SCHWIND, 1972, p. 192).

State control is hierarchically organized. The government gives the instructions, the administration passes them on and supervises their execution right down to community level. The administrative organisates are bound by instructions, and thus controlled. Spatial organization of state finds expression in the territorial arrangement of the state area into administrative units.

The state territory, much the same as any administrative unit, is surrounded by clearly defined boundaries that are watched over and protected (J.R.V. PRESCOTT, 1972; M. SCHWIND, 1972, p. 104ff; an exception: the nomad states in Central Asia, e.g., the Mongolians in the 13th to 15th centuries, had only vaguely defined borders; L. KRADER, 1968, p. 26). The clear nature of the boundaries between the populations or organisates is supposed to guarantee a communication free of disturbance (avoidance of "noise") and thus the undisturbed run of structure-conserving processes. Borders are therefore to be distinguished from frontiers (L.K.D. KRISTOF, 1959/69), which emerge with structure-changing processes.

3.3.1.2. Derived processes

Rural self-administration must be mentioned as an institution of regulation in populations other than state-populations. It is adjusted to operations on the economic sector. For instance every medieval German village can be seen to have had many rules governing the agricultural use of land (e.g., K.S. BADER, 1957/62/73; especially volume 2).

A further example is the regulation of the organisates. Within the organisates, control receives its structural frame by the course and goal of production. In larger enterprises, the different steps of production are carefully tuned to one another by a specific administration, which may have moved into a building of its own, separate from the actual production plant.

3.3.2. Structure-changing processes

3.3.2.1. Periodization

In the European/North American cultural population, the type of controlled regulation seems to change within a period of about 500 years (centennial rhythm; Early Middle Ages, High Middle Ages,Modern Times). We can assume that the formation of states - after the decline of the Roman Empire - reached its peak in the Early Middle Ages in the 8th century (Carolingian Kingdom, Charles Martel, Charlemagne), in the High Middle Ages in the 12th century (Staufer Kingdom, Frederick Barbarossa) and in Modern Times in the age of absolutism (France, 17th century, Louis XIV). During these periods, the central power of state was most pronounced (K. HAMPE, 1908/49, p. 104f; H. MITTEIS, 1940/59, p. 63ff; HANDBUCH DER EUROPÄISCHEN GESCHICHTE, vol. 4, 1968; W. HUBATSCH, 1970). The processes were directed by state, right down to settlement level (H.-J. NITZ, 1961; 1963; D. FLIEDNER, 1969; K. FILIPP, 1971). Of course more criteria are required in order to corroborate this statement better.

A rhythm lasting about fifty years (decennial rhythm) can be found for example, in the efforts made by the states to carry out the necessary work according to the position in the superior process-sequence. For instance, the European cultural population was going through its dynamization phase (in the centennial rhythm, Fig. 23) in Modern Times (cf. section 5.2.) In the course of this period covering approx. 500 years, the process-sequence was passed through in the decennial rhythm. In Germany, each regulation phase can perhaps best be recognized by considering the enacting of the laws concerning the economy within the state (Fig. 13). For instance, the laws regarding the cultivation, distribution and reclamation of land ("Landeskulturgesetze", culminating ca. 1760) and the laws for the liberation of the peasants ("Bauernbefreiung", around 1820) and the economic and social laws (around 1870) can be considered the most important state contribution to economic welfare in Germany during the 18th and 19th centuries (F. LÜTGE, 1952; 1963; W. ABEL, 1962; H. HAUSHOFER, 1963; F.-W. HENNING, 1973/76). In other countries administration activities and legislature are of a different kind, though probably within the same rhythm. The decennial rhythm is peculiar to the state populations and peoples.

3.3.2.2. Rotation

Within the European/North American cultural population, the political regulation centres changed place several times. The decennial rhythm seems to be revealed here. In the historical literature the terms "great or super or leading power" are employed. Here too, of course, the problem is finding suitable criteria. Thus, only with reservations can we claim that until about 1770 Prussia, until 1810 France, until 1860 England, until 1915 Germany and from then on the USA and Soviet Union represented the most important states (particularly as the spheres of interest towards continental Europe or overseas were different). Thus, even though these indications are open to attack, there seems to be no doubt as to the existence of a rotation in the hierarchy of the peoples as such within the cultural population.

3.4. ORGANIZATION

3.4.1. Structure-conserving processes (main processes)

3.4.1.1.1. Traffic as an institution

The earthbound artefacts and the populations with their processes require space. On the earth's surface the three-dimensional allocation has to be turned into an incomplete, two-dimensional juxtaposition.

Organization is aimed at optimizing the processes with regard to their spatial arrangement. It strives to find the most favourable spatial conversion for the hierarchy of processes and populations taken over as input from regulation. This is made possible by traffic. It consists in the conveying of people, energy, goods and information to those points in the system, where they are necessary for the run of the structure-conserving processes. Conversely it can be seen that traffic conserves or creates populations and systems in their spatial structure, i.e., it enables controlled organization.

Traffic connects homogeneous populations on the one hand, and heterogenous ones on the other (F. VON RICHTHOFEN and O. SCHLÜTER, 1908,

p. 201ff). Homogeneous spaces are aggregates consisting of organisates with tasks of the same kind to accomplish. However, traffic also interconnects elements of a heterogeneous nature, at the service of the superior population. It counteracts the disadvantage of substantiality and space requirement of system and processes and permits a division of labour.

Basically, traffic consists in a back and forth movement (H. HETTNER and H. SCHMITTHENNER, 1951, p. 5). Certain products are brought from one point to another (energy, information, goods), while the conveyer and the vehicle used return again. Thus, the structure of the system or the population is conserved. However, one-way transportation, such as colonization or military campaigns entail structural changes (cf. sections 4.3.2.1.2.; 4.7.2.3.).

Different kinds of traffic can be distinguished, as can be shown in the case of the little differentiated Pueblo-population:

> The pre-Spanish settlements of these populations have a clearly defined traffic network (D. FLIEDNER, 1974a). It brings together populations and earthbound artefacts of the same kind as well as those of a different kind. In the village itself, the plaza was the square where the village people met in order to communicate. It was the central place of communication, at which communal events took place; economic transport was centred here and individual communication brought the families into contact. The flat roofs of the dwelling houses and the ladders were a public area of traffic as well. This internal traffic in the village was then, and still is, diffuse today. On the other hand, the village was the central point of a network of footpaths leading into the economic territory. Investigations in the Jemez area (D. FLIEDNER, 1974a) showed that they went to the single houses mentioned earlier on (cf. section 2.5.2.), from where the surrounding land was cultivated. From these houses (as far as we know, they were used by small families during the warm season), paths led to springs and permanently flowing rivers. They thus served the purpose of supplying the family with water.
>
> A number of paths led past the houses and can thus be interpreted as by-passes. They went to the single houses or field areas situated further away from the pueblo, and to the outlying areas reserved mainly for hunting and gathering. However, relics of paths could only occasionally be found in places where single houses had been built for hunters or gatherers as protective huts.
>
> This network of paths opening up the economic territory, was at the same time also used by the traffic serving security and religion. Observation huts and field shrines were connected to the main network by paths ending at their destination.

> Only one path led to the neighbouring settlements in each case, structured in a similar way and leading from village to village. Apart from this, the economic areas were not directly connected. Probably only a small amount of goods was transported on these paths between the villages. However, they enabled traffic to come about and thus bracketed the superior population, the tribe, together. But single paths also linked up the traffic networks that belonged to the tribes, probably within the entire living space of the Pueblo population. The first conquistador, Juan Oñate followed them during the conquest of New Mexico in 1598 and the subsequent years. It is not clear whether there were further paths between the pueblo populations on the one hand and other populations not belonging to them (e.g., hunters and gatherers) on the other hand, for instance from Pecos to the east into the Plains and from other pueblos to the west and south. Certain traffic links must have existed, as the exchange of goods between the populations shows (cf. section 3.7.1.1.1.).

Thus the arrangement of the paths throws some light on the populations' organization. The smallest unit of traffic served to supply the families within the settlement, within the village between the dwellings, as well as between dwelling and economic territory with its single houses. This constitutes local traffic. Between the tribal villages, short- and long-distance traffic can be found to have existed. A frequent back and forth movement is important for short-distance traffic, e.g., visits by relatives on village festive occasions. Some of the tribal areas spread out so far that several days had to be calculated to get from one village to another and back again. This is all the more true for the long-distance transport linking up the various tribal areas within the cultural population, and particularly between the cultural populations (Mexico, Pueblo, Mississippi, etc.).

Control of population organization is effected by traffic because no structure-conserving processes can take place, no organisate can produce, if information, people or products cannot be conveyed to other places, to the consumers in the system, or brought to the place of production. In some cases, the traffic costs stimulate a spatial differentiation, for seen from the consumer's point of view as the taker of the products, the costs of transporation have to be added to the costs of production, so that the organisates situated in closer proximity have the advantage (A. LÖSCH, 1943).

The costs vary according to the means of transportation and the goods to be conveyed. The transfer of information must be effected as quickly as possible, because information must run ahead of any other activity (cf.

3.3.1.1.2.). The transfer of information however, requires the least effort. On the other hand, the transport of bulk articles usually does not depend so much on speed, but a lot more on moderately priced transportation. Human beings, energy and piece-goods are normally somewhere between these extremes.

The city-umland traffic is particularly important. The supply of the city with fresh perishable goods from the umland nearby is dealt with by short-distance traffic, and conversely, a good portion of the shopping traffic from the umland as well. Moreover the commuter traffic is part of the city-umland traffic. The city-umland population is controlled by short-distance traffic and the size of the settlement by the local traffic. A change in the structure of traffic would cause corresponding changes in the size and structure of the populations to come about.

3.4.1.1.2. Means of transportation as controlling media

Every act of transport and communication is introduced into the environment by individuals or populations. If in the course of the division of labour this central-peripheral arrangement becomes institutionalized, e.g., in city-umlands, traffic too must be given stable persistence by earthbound artefacts. This is done by means of laying out the transportation network 1) according to the potential incline from the centre to the periphery and 2) according to the hierarchic grading of the populations with their central places, from one point of intersection to the next linking up the networks of different stages with one another (cf. below, section 4.4.1.2.). Because of the hierarchy of the networks, their lines become intertwined and influence one another.

3.4.1.1.3. The city-umland population as the controlling population

Organisates and individuals can only attain the spatially most favourable position between the sources of input and the consumers within the state population resp. their living spaces, for they are regulated in them (cf.

section 3.3.1.1.3.). On the other hand, other space structural constraints emanate from the living space with its natural resources, for these resources are not movable, and their exploitation is governed by specific rules (adjustment to the peculiarities of the relief, the climate, the soil, etc.). As these problems are dealt with in the communities (cf. section 3.5.1.1.3.), the range of free action of organization lies in the hierarchy of the populations between the state population and the community, i.e., in the ethnic group. As a secondary population the city-umland population has developed in this order of magnitude.

The more labour is divided within the population, the more the organisates that are particularly dependent on contacts, can push to the centre. Thus the spatial differentiation - as a reaction process - becomes more pronounced. In societies with a clearly recognizable division of labour extending beyond the family, central places or cities develop. As the central places gain in importance, the ethnic groups thus break up and are replaced by the secondary city-umland populations (P. SCHÖLLER, 1953b).

The development of the city-umland population is, like any other population development, a reaction process. The internal structure, the ring-structure of these secondary populations will therefore be treated further on (cf. section 4.4.1.2.).

3.4.2. Structure-changing processes

Changes in organization are identical with changes in the structure of traffic. The introduction of new means of transport and forms of spatial organization took place in distinct innovation periods corresponding to different rhythms.

The development of cities has the same meaning as the development of city-umland populations. It goes back to a time around 3000 B.C. (V.G. CHILDE, 1936/51, p. 114f; 1950; R.M. ADAMS, 1966; 1972). Starting from Mesopotamia the city spread over the earth. Thus "urban revolution" can be compared to the "neolithic revolution" approx. 5000 years earlier and the "industrial revolution" in the 18th/19th century. As a precondition for the de-

velopment of city-umland populations and central places during the urban revolution, cattle was domesticized, perhaps at first merely as working animals for carrying goods, as the sledge, yoke and cart were invented at this time too (E. ISAAC, 1962/71, p. 455). Not until the 19th century was the carriage superseded as chief means of transport by the introduction of the railway, the automobile, and then the aeroplane. Thus, a completely different spatial structuring was made possible, with conurbations as the central places of extensive umlands. Here therefore, radical change can be recognized in intervals of about 5000 years, seen in relation to the history of mankind. We refer to this rhythm which also occurs in other task categories, as the millennial rhythm.

The centennial rhythm also seems to be reflected in the history of transport. In the 9th and 10th centuries many traffic settlements were founded, particularly along the North Sea coast and its hinterland ("wikorte"; H. PLANITZ, 1954, p. 54f; H. PIRENNE, 1933/76, p. 44; W. HAARNAGEL, 1955).

Investigations into the city-umland relations in the High Middle Ages in some parts of Northern Germany (D. FLIEDNER, 1974b) and Bavaria (K. FEHN, 1970, e.g. p. 250f) allow us to conclude that the trade in bulk goods, especially grain, carried on in the early 14th century probably consisted almost entirely of an exchange between a city and its umland. Thus every city was the focal point of an economic cell which was largely autonomous in this respect. As far as long-distance trading was concerned, an hierarchy of central places had already developed. During this period the city system was flourishing, finding direct expression in numerous new cities being established after 1150, as well as in the growth of those already existing (H. STOOB, 1956, p. 23f; E. KEYSER, 1958, p. 106f; C. HAASE, 1960/65; on the city and its umland in the late Middle Ages, cf. H. AMMANN, 1963).

In the late 14th and 15th centuries the structure changed. High sea navigation began (invention of the compass; H. PIRENNE, 1933). New, large ships were built (e.g., the cog; S. FLIEDNER, without date; 1969) the road network became most important (F. BRUNS and H. WECZERKA, 1962/67; H. KELLENBENZ, 1963). From this time we have reports of grain being supplied by the territories in the eastern part of Central Europe previously

colonized by the Germans. The Hanseatic League developed, also due to the expansion of the grain trade between the east and west (A. von BRANDT, 1963, p. 21f; P. JOHANSON, 1963, p. 48f). The preceding cellular structure of the economy obviously collapsed and the peripheral regions of Germany that were overproducing were incorporated into the whole economy of Central Europe.

Similarly drastic changes in the transport system did not come about again until the 19th and 20th centuries. The introduction of the railway as a mass means of fast transport, steamships, the automobile and air travel completely changed the transport situation and steered organization on to a new course. These trends were helped along by new means of communication. Just before the turn of the century the telephone and wireless telegraphy entered on the scene, followed by the radio and television as mass media. They took up position next to book and newspaper printing.

The decennial rhythm is also recognizable. Constant improvements in the transport links in the last 2 centuries changed the spatial organization. In the final stages of the era of absolutism, particularly in the second half of the 18th century, the old network of earth tracks was supplemented in France (Routes Nationales; H. HITZER, 1971, p. 221f), and going on from there into other European countries (for Britain, A. BIRD, 1969, p. 50f), by a network of gravel roads and highways, connecting up the cities.

At about the same time the transporting of bulk goods (e.g., ore, coal, grain) began to play a much more important role with the rise of industrialization in Britain, as well as in France and Germany, here also following inland colonization (cf. also section 4.7.2.3.). A network of canals was soon set up between the bigger industrial and mining centres (E.C.R. HADFIELD, 1971).

Around 1830, the railway was introduced (Fig. 13) as inland shipping was no longer able to satisfy the speed requirements and the traditional overland transport could no longer deal with the task set by mass transportation. Until around 1870, the large central places and mining areas were interconnected (HUNDERT JAHRE DEUTSCHE EISENBAHN, 1935, p. 31f, map; B. STUMPF, 1960, p. 38; for Britain, C.H. ELLIS, 1954/59, I).

After 1910/20 the scene changed again. In the nuclear areas of the modern European and American living spaces all cities and larger towns were connected by rail, the innovation was complete. Meanwhile the motor vehicle had succeded in the USA (J.J. FLINK, 1970) and went on to do the same in European industrialized countries as well. Motorized traffic opened up space, so that the horse and carriage was almost completely supplanted by it. Deglomeration tendencies can be observed in the cities due to the motor vehicle and modern means of communication, though, from the point of view of the superior system, concentration continues.

Amongst the shorter rhythms, the yearly rhythm stands out in particular. It has an important part to play in the traffic activities related to agriculture, e.g., in nomadism, transhumance or seasonal work, and to tourism. In the industrialized countries peak loads come about in the summer resp. winter seasons due to holiday traffic. Long distance commercial transport shows the smallest seasonal fluctuations, though they are by no means non-existent, as shipping demonstrates (A.D. COUPER, 1972, p. 93).

There are many signs of the weekly production rhythm, e.g., with shopping traffic (W. MESCHEDE, 1974; G. HEINRITZ, 1977). The daily rhythm is connected with short-distance traffic (e.g. commuters, transport of commodities between the city and its umland). Amplitudes are generally far greater than in the yearly traffic rhythms.

It is not possible yet to state which kind of rhythm is peculiar to the city-umland population and the organization process. If we extrapolate (cf. sections 3.1.2.1.; 3.2.2.2.; 3.3.2.1.) we can assume that phases lasting about 5 years are involved here (Fig. 17). But this ought to be investigated.

3.5. DYNAMIZATION

3.5.1. Structure-conserving processes (main processes)

3.5.1.1.1. Economy as an institution: input and investment

Every process requires energy and must, furthermore, end with products

that can be accepted by the demanding population. In the process sequence this means dynamization, kinetization and stabilization. The economy is devoted to these tasks. Dynamization comprises input and investment; the production itself or the refining of the energy on the other hand can be assigned to kinetization, and trade and consumption to stabilization.

Traditionally the economy is divided into the primary, the secondary and the tertiary sectors. The primary sector (agriculture, forestry, fishing, and mining) extracts raw materials from the ecosystems, thus providing food for human beings and raw materials for the processing industry. The secondary sector processes the products of the primary (and the secondary) sector. Raw materials are turned into usable foodstuffs and media (e.g. instruments, equipment), etc., if primary production has not already done so. The production within the primary sector is not included here. As in any economic activity, obviously input and investment, as well as production, are involved in both sectors. (For the tertiary sector cf. sections 3.1.; 3.2.; 3.3. and 3.4.; trade cf. section 3.7.1.1.1.).

The population develops a specific infrastructure, due to its knowledge of the different possible ways of exploiting the environment, its orientation and its hierarchic and spatial order. The infrastructure can be regarded as a potential in negentropy, with the help of which it can obtain energy from the environment (cf. section 2.6.2.). The better these preceding activities are carried out, the more carefully the resources can be exploited so that the environment is not overstrained in spite of greater efficiency. The intensity of the processes depends on the amount of energy supplied, i.e., the degree of exploitation of the living space with regard to the production of food or other raw materials. Thus the more negentropy a population produces, the higher the possible intensity of the processes, the greater the amount of energy obtained, and the higher the carrying capacity. Dynamization provides the opportunity for effecting production, i.e., input and investment in a broad sense.

The organisates reflect this. Within the economy they can be combined into classes, depending on their claim to negentropy. This claim to negentropy at the same time indicates the demand for a suitable infrastructure, as the basis for successful production.

With agriculture a typification of organisates according to the classes of negentropy is identical with a typification according to intensity; for the higher the intensity the environment can reasonably be burdened with, i.e., the input per acreage, the greater the knowledge and the clearer the orientation (possibly specialization) have to be, and the better the spatial location, which includes the accessibility of the market or population centre (cf. section 4.4.1.2.). The more negentropy is produced, the more intensively the land can be used (seen per unit of space and according to the supply of resources), the greater the possible input of factors (B. ANDREAE, 1964, p. 50f; H. SPITZER, 1975, p. 51).

Thus a sequence becomes manifest, starting from a gathering economy, through shifting-cultivation (with land lying fallow for different lengths of time; E. BOSERUP, 1965), and going on to fieldgrass and field cultivation, and finally to horticulture (W. MÜLLER-WILLE, 1941; E. OTREMBA, 1953/76, p. 171f; B. ANDREAE, 1964, p. 93f; 1972). Similar sequences can be established for the economic utilization of animals, extending from hunting over nomadic herding, commercial grazing and dairy farming, as far as pure stall feeding (B. ANDREAE, 1964, p. 138f; A. BEUERMANN, 1967).

Similar classes of different levels of intensity can be elaborated for forest culture (H.-W. WINDHORST, 1972, p. 361), for fishing (F. BARTZ, 1964/74; J.R. COULL, 1972, p. 89f) or mining.

The dependence of manufacturing on the infrastructure is even more evident. The higher the production of negentropy, the greater the volume of production can be, as can be seen on a small scale already (cf. J.M. GILMOUR, 1972; he investigated the industrialization of south Ontario). In general, as a first approximation, four types of industrial organisates can be distinguished, adapted to populations producing different amounts of negentropy and requiring different infrastructures.

The first group of factories produces relatively simple products in limited amounts despite the input of much labour. The textile industry is an example of this. Today factories of this kind can be found in many developing countries; in the industrialized countries they are situated outside the conurbations with their high wages. The second group includes the industries which produce iron and steel plate and rails (heavy industry),

simple machines, railway coaches etc. They make greater demands on the infrastructure, e.g., with regard to fossil energy, traffic connections, a skilled labour force. Their favourite locations are regions with mineral coal or ore mining, in industrial countries with few raw materials, often ports. They are becoming more and more frequent in advanced developing countries too. The industries that produce more complex machines, motor vehicles, aircraft, electrical articles, chemical products etc., constitute a third group. Factories of this kind are tied to conurbations and large central places with a good infrastructure and populations with a high technical know-how. A wide supply on the tertiary sector, a large labour force and good traffic connections are a precondition. The cities in the manufacturing belt of the USA and the industrial countries around the southern part of the North Sea in Europe fall into this category.
These industries today still constitute the economic backbone of the industrial countries. The fourth and last group is characterized by a particularly large amount of research or by a high degree of automation. These concerns require the manifold stimuli and technological opportunities provided by big cities, and communication with scientific institutes. In the USA we can name the cities in the east, such as New York and Boston. In Europe we can find these establishments in cities like Frankfurt, Paris and London.

3.5.1.1.2. Earthbound artefacts as controlling media

Without the existence of substance, energy cannot become effective. As a cultural achievement the forming of substance into earthbound artefacts - buildings, transport lines, defense facilities, agricultural fields etc. - signifies a fixing of the given negentropy. Thus the processes are provided with an infrastructure which allows the flow of energy to be canalized (cf. also section 2.4.1.).

Thus primary production is channelled to follow a certain course. For instance, the farmers strive to adjust the localization and shaping of the fields to their knowledge concerning the yield of the soil (choice of areas in the natural environment), to the intended use (as pastureland, for grain crops, etc.), to the hierarchic structure of their population (e.g., the

arrangement in strips seems especially suited to a co-operative social structure) and to the distance from the centre of the community (gardens near farmsteads, fields at a medium distance, pastures outside). In other words, agricultural land-use, that is, the structure-conserving processes of agrarian primary production, is controlled by the pattern of the fields as the earthbound artefacts. Similarly, the farm buildings are adjusted to a specific task. The same is true for the position, shape and size of pits for extracting mining products.

It is much the same with processing. The shape and size of the establishments where processing takes place are adjusted to determination, i.e., the task of the manufacturing plant; inasmuch it can often be seen at a glance which line of production the industrial plant is engaged in. The size is also adjusted to the volume of production; the position in the superior system is governed by organization (cf. section 4.4.1.2.). The earthbound artefacts thus control the extraction and flow of energy from the input side.

3.5.1.1.3. The community as the controlling population

We have already shown above (cf. section 3.5.1.2.) that the earthbound artefacts enable the extraction and flow of energy to be controlled. In the settlements they are organized in such a way that they are arranged optimally with regard to the process sequence so that as little energy as possible is lost (on a similar note, H. JÄGER, 1977). Settlements can be considered mosaiques of uniformly used areas and spaces, e.g. houses, squares, fields, woods intended for certain activities; these are the topes, e.g., agrotope (H.-J. NITZ, 1970, p. 85; H.-W. WINDHORST, 1974, p. 274). They are clearly delimited and the activities carried on in them are thus controllable. The allocation to one another of these topes is dealt with by organization in rural settlements. Mostly the fields are arranged in a way which shows an intended optimal adjustment to the natural environment, especially to the quality of the soils. Thus the materials, foodstuffs and energy can be processed further with the least possible loss of energy and can reach the consumer. This also goes for the inner pattern of towns, which are characterized even more by the way the architectural substance is handled (W. MÜLLER etc.

1970). The layout of roads, the height of the houses, the establishment of recreational areas, all these in accordance with the topographical possibilities, constitute typical urban, communal tasks.

The geography of settlement, as one of the best developed branches of geography, has elaborated a wealth of material and has recognized and explained a large number of different forms. (For reference, see G. SCHWARZ, 1966; P. SCHÖLLER, 1967; M. BORN, 1977; from an archaeological viewpoint, B.G. TRIGGER, 1968, and H. JANKUHN, 1977).

3.5.2. Structure-changing processes

3.5.2.1. Economic growth

Economic growth means an increase in the flow of energy in the system. The precondition for this is the intake of more energy from the environment and/or a reducing of entropy, making a greater output possible, and enabling the production to be increased. Economic growth depends on the adoption of innovations in the system. It manifests itself in more investments being made. For arriving at a realistic explanation of the economy, a state of equilibrium (a basic assumption of the "equilibrium theories" e.g., E. BÖVENTER, 1962) may not be considered of long duration. On the other hand, conceptions of equilibrium must not simply be considered incorrect; for the desire of the superior systems to find a state of equilibrium can hardly be denied (cf. section 2.3.1.).

The populations require energy to perform the processes that maintain them, and furthermore, innovations that enable growth to come about. J.A. SCHUMPETER (1939/61; cf. section 3.7.2.2.1.) had already recognized a connection between innovations and economic growth. Economic innovations depend above all on technological progress. They diffuse from the initial location or system nucleus into the umland, mostly via the hierarchy of the inferior systems as we have emphasized (cf. section 2.6.5.). The non-economic processes precede dynamization in the process sequence. Industrialization can be considered a particularly striking example of this. In a poignant journalistic way W.W. ROSTOW (1960) termed this kind of dynamization "take-off".

Because of the diffusion process, the innovation centre has a development lead. Economic growth takes place more quickly. Local growth must be regarded as a special case occuring in diffusion processes (B.J.L. BERRY, 1972, p. 136). In this way links can be established to the theory of growth poles (F. PERROUX, 1961/69, especially p. 159f; J. FRIEDMANN, 1972; J. FRIEDMANN and R. WULFF, 1976). According to this theory, innovation centres, once formed, constitute growth poles for economic and, more especially, for industrial development, on account of their better infrastructure. Due to the growth poles, the disequilibrium between the centre and the periphery of the system increases (cf. section 3.7.1.2.).

3.5.2.2. Periodization

Innovations within the scope of dynamization encompassing the whole of mankind are for instance land cultivation and keeping domestic animals, i.e., the transition from a gathering and hunting economy to the calculated rational exploitation of the plant and animal world (cf. section 3.1.2.). As far as we know today this "neolithic revolution" (V.G. CHILDE, 1936/51, p. 59f) took place in the "fertile crescent", taking in Palestine, Lebanon, northern Syria, South-Anatolia, northeast and east Iraq and southwest Persia during the era 9000/7000 B.C. (CH. REED, 1962/71; K.W. BUTZER, 1964/71; K.V. FLANNERY, 1969/71; F. HOLE, 1966/74, p. 270f; K.J. NARR, 1973, p. 46f).

In the centuries following this era, agriculture was intensified and around 5000 B.C. irrigation farming was probably introduced in Mesopotamia and Iran (K.V. FLANNERY, 1969/71, p. 70f; F. HOLE, K.V. FLANNERY and J.A. NEELY, 1969/71, p. 308f). An even more important innovation came about with the splitting off of non-farming economic activities; this was probably connected with the rise of towns, ca. 3000 B.C. (V.G. CHILDE, 1936/51, p. 115, 133f; F. HOLE, 1966/74, p. 273; K.V. FLANNERY, 1969/71). From this time on the plough seems to have been in use (E. ISAAC, 1962/71, p. 455). The innovation of towns is comparable to industrialization ("industrial revolution") in the 18th and 19th centuries A.D. If we were to disregard the introduction of irrigation farming, which - compared with the other "revolutions" - seems to be of less importance, there would be

about 5000 years between each of these innovations (millenial rhythm). The farming techniques, crops and domestic animals spread out all over the earth from the area of origin (e.g., C.O. SAUER, 1952, who recognized several centres of agricultural innovations).

The periods before these "revolutions" bringing about particularly fast economic development are characterized by a considerable increase in population numbers. Thus the centuries before 3000 B.C. are characterized by very fast growth (e.g., in Iran, F. HOLE, K.V. FLANNERY and J.A. NEELY, 1969/71, p. 309), and similarly in Europe in the late 18th and 19th centuries before industrialization (J. SCHMID, 1976, p. 111f). Pressure from population numbers seems to have particularly encouraged innovations and economic efforts, as E. BOSERUP (1965, p. 11f) had basically already recognized.

The centennial rhythm can be inferred from a number of different criteria. Information about the Early Middle Ages is still too vague. Though clearance of woodland and the introduction of longstrip farming in Central Europe could be seen together with the development of non-agrarian settlements, there are certainly other reasons to be taken into consideration as well (H.-J. NITZ, 1961). Reliable information is not available until the High Middle Ages. During the 13th and early 14th centuries a large amount of land was cleared, not only in the course of colonization but also around the already existing settlements.

Similar increases in the growth rate probably did not reappear until the 19th century when agriculture entered into a new phase with the introduction of new techniques and methods of fertilization (H.W. FINCK V. FINCKENSTEIN, 1960; H. HAUSHOFER, 1963).

Parallel to this, the non-farming economy developed, as in the High Middle Ages, particularly the crafts in the 13th century (H. PIRENNE, 1933; F. LÜTGE, 1952, p. 113; H. PLANITZ, 1954, p. 161f; 205f; C. HAASE, 1960/65). In the late 18th and 19th centuries, industrialization came on the scene, causing such an increase in economic production and acting as such a contrast with its novel aspects, that it must be considered as belonging to the millennial rhythm as well (cf. above).

Industrialization itself came about in separate intermittent innovations, in a decennial rhythm, with the different peoples emerging as the adopting units (R. RUBBERDT, 1972; F.W. HENNING, 1973/76). In Great Britain it began in the 18th century. The development of industrial mass production and the extension of the living space by means of colonization influenced each other in a positive sense (E.J. HOBSBAWM, 1968/76). From here industrialization spread out over Central Europe and the USA, and later on over the rest of Europe and to the other continents during the 19th and 20th centuries (cf. in particular, W.W. ROSTOW, 1960, p. 14, 22f). Several phases can be distinguished, during which one of the four types of industry with certain infrastructural requirements was diffused (cf. above, section 3.5.1.1.1.). Before industrialization crafts, cottage crafts and early manufacturing were characteristic; then the setting up of establishments for the mass production of simple products became typical for Great Britain between 1760 and 1830, with water as the supplier of energy, followed by coal (TH.S. ASHTON, 1948); this innovation came to Central Europe between 1830 and 1880 (H. MOTTEK, 1960; H. BLUMBERG, 1965; K. BORCHARDT, 1972). The textile industry is the prototype. Between 1870 and 1910/20 the mining of mineral coal, iron and the production of steel, as well as the construction of simple machines, had central importance (F.-W. HENNING, 1973/76, p. 217). In the third phase of industrial development plants were set up especially to produce more complex equipment, machines and vehicles, often with the aid of assembly lines. Examples are: machine and motor vehicle production, the electrical industry, the chemical industry (W. HUPPERT, 1957, p. 16f; L.F. HABER, 1971; J. BRITTAIN, 1974). This phase started in around 1919/20 and is ending at the present time. In the course of this phase the production sites of simpler goods, e.g., the textile industry, were pushed into more distant fringe areas, including developing countries. After the Second World War the fourth phase began; industrial branches in which people with high qualifications and creativity play an important part are typical for this, e.g., technicians and scientists in research departments (prototypes: the electronic and pharmaceutic industries). Now automation is at the same time growing in the chief industrial countries and the industries created in the previous phases have spread out into the countries that up until now have been less industrialized. These industries enter into competition with the industries of the respective same type in the innovation centre countries. Here a stagnation and finally a decline or a moderni-

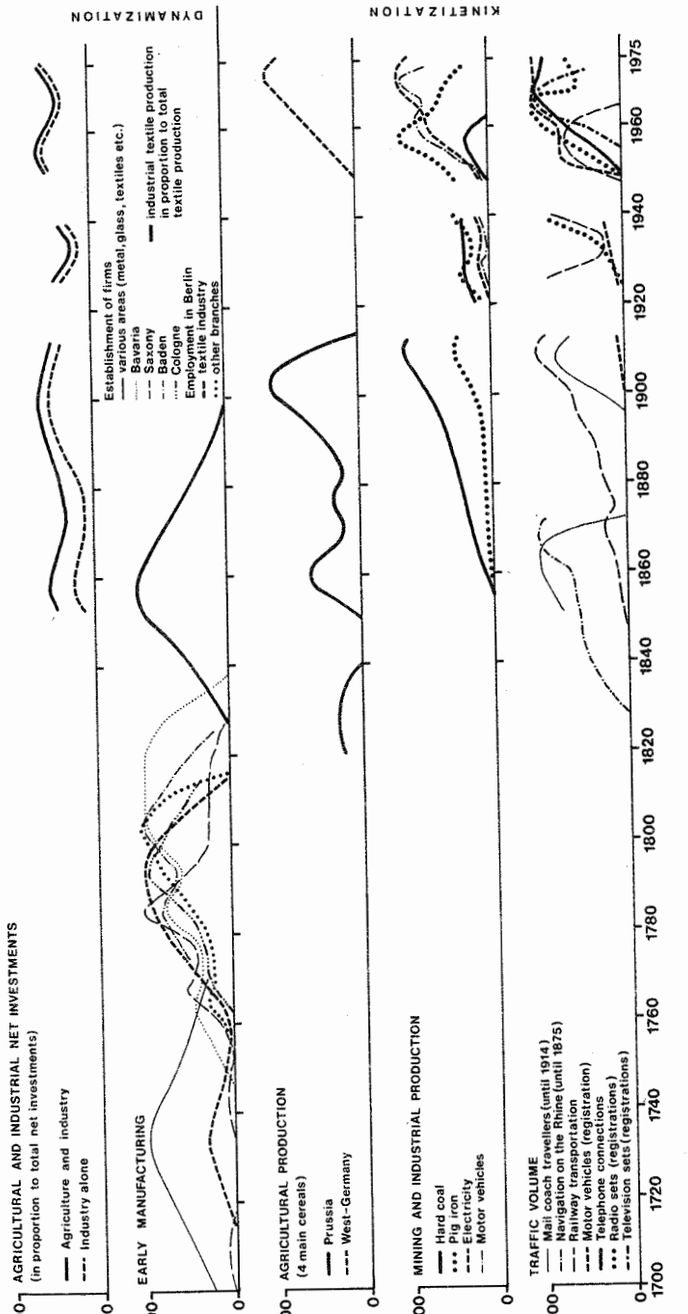


Fig. 14: Decennial phases in the development of the German state population since the 18th century, illustrated using different processes assignable to adaptation in the task categories of dynamization and kinetization.

zation (automation) are observable, connected with an extension of the tertiary sector.

Fig. 14 shows the decennial rhythms in the development of manufacturing in Germany.

The economic year in particular should be mentioned to illustrate a shorter rhythm; it has received much attention in the past. Agriculture is ruled by a yearly climatic cycle; it is directly dependent on the rhythmic growth of vegetation to which work in rural settlements becomes adjusted (G. JENSCH, 1957; E. OTREMBA, 1953/76, p. 148f). Particularly obvious seasonal fluctuations occur in nomadism and transhumance (M. BORN, 1965; A. BEUERMANN, 1967; J. BEAUJEU-GARNIER, 1967). The yearly rhythm also affects industrial production and the building industry, though fluctuations are less pronounced here. The oscillations of unemployment reflect this rhythm (Fig. 15). It can be assigned to dynamization, and thus to the community, which is responsible for dynamization (cf. above, section 3.5.1.1.3.).

3.5.2.3. Rotation

In the European/North-American cultural population, a rotation of the economic innovational centres is becoming manifest. Thus in 1800 Great Britain was plainly the economic innovation centre, in 1900 it seems to have been Germany, around 1950 it was the USA. More precise investigations, e.g., using growth rates in the respective countries, would enable us to make more detailed statements in this connection.

3.6. KINETIZATION

3.6.1. Structure-conserving processes (main processes)

3.6.1.1.1. Economy as an institution: production

In the phase of kinetization, the previously programmed and dynamized process is carried out. The institution controlling this task is production. It consists of a large number of single activities.

Production depends on a plan. The factor requirement (input) and the result or the amount of products (output) can be calculated. The capacity depends on the investments previously made; it determines the volume and the speed of production.

In a more strict economic sense, economic production is referred to here. However, in a wider sense, all processes can be included, as long as they serve organization (e.g., the amount of traffic), determination (e.g., the amount of missionary work), regulation (e.g., administrative work) etc.

The productivity per working person depends on the personal ability of the working people as well as on the mechanical aids, the allocation and adjustment to the superior process. That is why media that enable or facilitate a controlled production are necessary as well as organisates in which the activities of the different working people are suitably distributed and adjusted to one another in a meaningful way.

3.6.1.1.2. Mobile artefacts (technics) as controlling media

Control is exercised with the aid of the media, i.e. technics (cf. section 2.6.2.). In the course of economic labour tools and machines bring about precise working operations and guarantee constant control during the activities. Due to them, energy is used sparingly, and human labour in particular is saved at the expense of the non-human energy potential. The media in all task categories can basically be interpreted in the same way, as instruments that control activities or production, taking as examples weapons for offensive or defensive purposes, motor vehicles for traffic. The media are adjusted to the earthbound artefacts; conversely, the earth-

bound artefacts should be set up in such a way as to allow the media to be optimally applied.

3.6.1.1.3. The organisate as the controlling population

In societies that are not very differentiated (gatherers, hunters, agrarian societies, nomads), production becomes determined, regulated, organized and dynamized within the families. Women and men play their specific roles. For instance in the Pueblo population the women were responsible for making pottery, baskets and clothing, and for preparing the food, while weapon making and hunting were taken care of by the men. Land cultivation and house-construction were - and still are today - tasks to be dealt with by members of both sexes together.

As the division of labour progressed, the organisate came into being (cf. section 2.2.2.) to take over these tasks. For the small family as a primary population reproduction remains the main task. Being a secondary population, the organisate also attempts to maintain itself. That is why all tasks must be adequately completed in it.

Most research work has been carried out into economic organisates (cf. e. g. G. WÖHE, 1960/76). The size of these establishments is determined by the amount of production, which in turn depends on the intensity of the umland relations on the input and output side. At the lowest limit are the small firms (particularly the crafts; TH. BECKERMANN, 1965; W. WERNET, 1970).

The medium and large firms take up position above these and finally there are the large enterprises of the modern economy which have a complex but clear-cut structure from an organizational point of view, such as commercial, mining and industrial concerns. They appear to be the most important carriers of economic growth and social decision-making at the present time (J.K. GALBRAITH, 1967/74). In each case we are looking at organisates, defined as working units. Similarly, the organisates within the non-economic task categories should be described as places in which activities are controlled. Examples are churches, offices, bureaus, transport offices, army barracks, hotels and shops.

3.6.2. Structure-changing processes

Structure-changing processes in the task category of kinetization signify an increase or decrease in production in the economy, while dynamization is mainly characterized by investment, and the taking on of innovations, as described above (cf. sections 3.5.2.1.; 3.5.2.2.).

Changes in economic production can be observed in the German people, e. g., in the decennial rhythm (Fig. 14). Shorter rhythms taking in several (four, five, seven) years can be observed with regard to work resp. unemployment (e.g., for Canada, P.E. LLOYD and P. DICKEN, 1972, p. 213), as well as the yearly rhythm.

Production time has been divided into weeks since the 3rd century A.D. (Babylon) in the ancient Oriental and later in the European cultural population. In other cultural populations, different divisions were customary in some cases, e.g., six days, a month etc. One or two days are kept for resting from work. In ancient Mexico a month consisting of twenty days was usual (W. KRICKEBERG, 1956, p. 258f; V. SCHLENTHER, 1965, p. 57). These rhythms are peculiar to economic production and organisates resp. families.

The term production can be amplified to cover the kinetization of the processes in all task categories, as we have established above (section 3.6.1.1.1.), so that the structure-changing processes already mentioned in previous chapters could also be included here. There is no need to go into this in any more detail at this point however.

3.7. STABILIZATION

3.7.1. Structure-conserving-processes

3.7.1.1. Main processes

3.7.1.1.1. Exchange and trade as institutions

The stabilization of the population comes about by the interconnection of production and consumption. The goods produced by society, food, tools and energy in particular, reach the consumer via trade. Although in societies that are only slightly or not at all differentiated (e.g. hunting people, agrarian societies) there are no organisates to handle trade yet, there still exists exchange, the act of delivering resp. receiving between producers and consumers as a primitive kind of trade. The amount of produced goods or energy and the amount in demand are not adjusted to each other. Rather, over-production or a shortage are frequent, in turn having an effect on the economy and (in higher differentiated societies by the price configuration) also on the production. Exchange and trade should be interpreted as institutions for the transfer of products.

In a differentiated society with an extensively divided production sequence, there are different kinds of trade with special organisates in each case.

The retail trade conveys goods and energy straight to the individuals and families. The goods are obtained from wholesalers who in turn serve wider areas, e.g., city-umlands (cf. section 4.4.1.2.). Only large retail shops, e.g., department stores, can obtain their goods directly from the manufacturer in the same way as wholesalers. Depending on the requirements for spatial organization this applies to the capitalist economy (e.g., B.J.L. BERRY, 1967; J.E. VANCE, 1970) as well as the socialist economy (K. ILLGEN, 1969, p. 62f, 110f). International trade can be superposed to the wholesale business, providing the wholesaler or the manufacturer, i.e., the commercial organisate in the different state populations, with finished products and raw materials respectively (A. LÖSCH, 1939/75; E. OTREMBA, 1957/78; H.R. HELLER, 1968/75).

Trade as an institution with special organisates, and particularly wholesale business and international trade are only conceivable in a society with division of labour, in which production and consumption are in different hands. It should not merely balance out supply and demand but also facilitate the production process. By this means it provides the conditions for an orderly transfer of energy and materials.

Reverting once again to the example of Pecos:

> As we have indicated above (cf. section 2.5.2.), the Pueblo-populations in Pecos kept up some trade with other Pueblo-populations in the west (pottery, material for pottery and stone tools) and with the Indian gatherers and hunters in the east (above all the bartering of vegetable products in exchange for animal products).
>
> At first sight the exchange of goods does not seem vitally important for the Pueblo population, as the economic territory of the Pecos Indians would have provided plenty enough energy and materials for the survival of the populations. However, other populations were able to procure certain products easier or better due to their specialization (collecting or hunting people) or because of the presence of other, more suitable resources in the living space. Thus it was probably useful to have a part in the economic advantages of the other populations, and to emphazise the activities for which the living space or the population was better suited even if this meant putting more effort into transport. If a simplification in the method of production resulted, the capacity could ultimately be increased (E. BOSERUP, 1965, p. 11f).

3.7.1.1.2. Money as a controlling medium

Trade is only conceivable if the amount of produced and consumed goods can be clearly defined. Thus measurement and figures are the controlling media of stabilization. In higher differentiated societies money was introduced and the various products produced in the different branches thus were given a comparable basis for measurement. In this way money came to be the standard of value by which the importance of the different products for the population as consumer finds expression (cf. e.g., G. OBST and O. HINTNER, 1963, p. 6f).

Thus the products processed in the various task categories can be acquired. Not only goods and energy as products of the economy, but services too. For instance, the value of a product depends not only on the costs of production, but also on how far away from the consumer it is. With the aid of currency it is possible to compare and add the costs of the product and of the transport service.

The use of money or at least of certain products as a standard of value appears to be as old as the division of labour, social prestige and worship (W. GERLOFF, 1940/47, p. 178f; 1952, p. 30f). However, money has probably only been a regionally accepted and comprehensive unit of measure for economic goods, as a social remuneration for work, since the development of cities in ancient Mesopotamia (beginning of the 3rd millennium A.D.). At that time a regular trading of goods first started up between the communities, i.e., between the city and the umland and also between the city-umland populations that must also be seen as political units (M.A. COPELAND, 1974, p. 6f).

3.7.1.1.3. The individual as the controlling authority

The objective of production resp. of the process sequence is to satisfy the requirements of the individuals. However, the producers themselves are individuals too. Production on the level of the individual is work. Production and consumption can only be combined in a controlled manner by the individual, as only in his case are they governed by one common volition. He controls all actions, productive or consumptive. In this way he is in a position to adapt consumption to his own requirements. In contrast, the populations are in a position to make certain efforts to facilitate or to check these processes. However, consumer and producer always remain two separate actors making their own decisions. Consumption and work have to be dealt with in temporal terms by the individual. The time required can be added up and brought into any given frame (time budget). For the individuals the need for sleep, which can be biologically accounted for, sets the rhythm of the course of the day. This rhythm which is also reflected in the physical capacity (J. STEGEMANN, 1971; G. HILDEBRANDT, 1976; P. G. KÖCK, 1976) makes the individual adjust his other activities to it. The spatial range of many activities ("activity space") also depends on it, varying in the different types of life forms (cf. sections 4.2.1.2.; 4.5.1.2.) (F.ST. CHAPIN, 1968; A. BUTTIMER, 1969; F.E. HORTON and D.R. REYNOLDS, 1971; H. DÜRR, 1972; J. MAIER, 1976; E. WIRTH, 1979).

Another important geographical approach to the role of the individuals as a controlling authority is the "time-geography" of T. HÄGERSTRAND (cf. K. ELLEGARD, T. HÄGERSTRAND and B. LENNTORP, 1977; TIMING SPACE, 1978). It bases on the fact that "each and every one of the actions and events which in sequence compose the individual's existence has both temporal and spatial attributes" (A. PRED, 1977, p. 208). The individuals' changing needs and constraints, their activities, time budget, and contact fields are investigated at the daily, yearly, or lifetime scales of observation. Thus, time geography builds up the understanding of the population systems from below, i.e. the individual's level. Perhaps "time geography" can be connected with the process theory presented in our treatise by bringing the needs and constraints, the spatial fields and time budgets into connection with the population structure and process sequence.

3.7.1.2. Derived processes; the rise of the contrast poverty/wealth (developing countries and distressed regions)

As we have already established, work and consumption can only be adjusted to each other in a controlled way by individuals. On the other hand the adjustment of supply and demand on the level of populations must be considered as derived; these are uncontrolled processes. The demand for the products depends on the sum of the requirements of the individuals making up the population. Conversely, the products are brought to the population to varying degrees, depending on the performance of the social systems.

In this way the contrast poverty/wealth, or put another way, the standard of living, can be provided with its theoretical consolidation. In an undifferentiated society (e.g., gathering and hunting peoples) these terms are nearly synonimous with hunger or satiation, while in higher differentiated societies the products of the organisates can also pass into the possession of individuals, e.g., power, goods or energy, but particularly money. By this means products can be accumulated to different degrees, as K. MARX had already recognized (1867/90/1965, I, p. 589f). This must be taken into consideration when dealing with the question of carrying capacity. Carrying capacity means no more in the first instance than the ability of a region with its infrastructure or its ecosystems to feed a number of people, according to its resources. The energy requirement per person is approxi-

mately represented by a constant value which can be expressed in calories, i.e., the demand for this energy that can be used by the human organism, particularly food, is proportional to the number of individuals in the population (cf. section 2.5.1.). Thus the problem of rich and poor, of the standard of living, must be kept apart from the question of carrying capacity. The first problem concerns the stabilization of the society in the biotically conceived population. The question of carrying capacity on the other hand must be seen in the context of the population's entire environment, also including the ecosystems; in this case the population is conceived of as a biotic, socio-reproductive unit (cf. section 4.6.1.2.).

The contrast between wealth and poverty manifests itself according to the hierarchic positioning of the populations or regions at two different levels (cf. also B.E. COATES, R.J. JOHNSTON and P.L. KNOX, 1977, p. 23f); more precisely in:

1. the cultural population (contrast industry/developing countries)
2. the state population (contrast prospering regions/distressed regions, active/passive regions).

These questions have been dealt with from various sides, and numerous inductive explorations and theories constitute an attempt to explain the differences. We cannot deal with them at this point, though a few basic observations shall be made.

Some observations on the contrasting aspects of industrial/developing countries (K. SCHILLER, 1964; B. HIGGINS, 1972; J. GALTUNG, 1972b; G. MYRDAL, 1971; D. SENGHAAS, 1972a; 1976): the original process was started by europeanization, i.e., the colonization of the earth going out from Europe. The colonies or countries with a semi-colonial status, that varied greatly in their social differentiation, were incorporated into a ring structure with its focal point in Europe as its innovation centre (cf. section 4.4.1.2.). In the centre, economic operations were intensive, in the outer regions they were extensive; i.e., it was possible for this system to have a high population density on the inside, and a low density on the periphery. Inbetween there were intermediate stages according to the existing differences in the infrastructure and the spatial position in relation to the centre formed by Europe. Europe served as a growth pole (cf.

section 3.5.2.1.). Thus the European economy had been able to expand considerably at the time and especially in the 19th century.

This economic correlation has also been maintained in this century even though the former colonies have made themselves politically independent.

In the meantime, in most countries outside Europe there had been changes in the generative behaviour, emanating from Europe like an innovation. The population numbers increased exponentially (cf. section 4.7.2.1.), so that high population pressure and unemployment resulted. Thus the problem of the developing countries started. In the industrialized countries the economy was able to expand a good deal, for the developing countries were now obliged to become more closely associated with the international economic system. In order to take the pressure off the labour market and to obtain foreign exchange, industry was allowed to enter and primary production was increased. Low wages and cheap raw materials were a further aid to the industrialized countries, while immense social and economic problems began to trouble the developing countries. This was because the society and the market of these countries were not yet in a position to adjust themselves in the same way ("dualism"). Adjustment takes time, for a process sequence must first be passed through, i.e., the level of learning (perception), intellectual orientation (determination), the structure of government (regulation) and the traffic network (including a hierarchy of central places: organization) have to accommodate to the new developments.

The problem of the contrast between prosperous regions and distressed areas is basically similar within Europe as the core of the cultural population (H.M. BRONNY, etc., 1972; A. HAMMERSCHMIDT and G. STIENS, 1976) and within the state populations (G. VOPPEL, 1961; R.L. MORRILL and E.H. WOHLENBERG, 1971; D.M. SMITH, 1973). Here too the peripheral areas are at a disadvantage compared with the innovative central regions. They are overpopulated in relation to their restricted economic possibilities and remain too strongly attached to their traditional forms of economic practices.

3.7.2. Structure-changing processes

3.7.2.1. Business cycles

Innovations in the various task categories become arranged in periods within the scope of the process sequence and show a rhythmic character. This is caused by oscillations which are for their part based on the incomplete adjustment of production to consumption, as we pointed out earlier on.
The processes are thus stimulated or checked in their progress (cf. section 2.7.1.). Oscillations indicate that the population resp. the process is becoming incorporated in the superior aggregate which can also be called equilibrium-system or stimulance-response-system (cf. section 2.3.1.).

The oscillations occurring in the social processes at the contact surfaces between population as society and population as biotic unit are known as business or trade cycles, though they are not only conceivable in an economic light.

Here the flow of information and energy remains constant within a certain range of fluctuations. The populations as elements of these aggregates compete with one another on an equal hierarchical level. The equilibrium between production and consumption should thus be evaluated as a special state of goal orientated systems, and the arrangement into the superior aggregate as a stage, the final stage in the development of the process sequence.

3.7.2.2. Periodization

3.7.2.2.1. Oscillations in the decennial rhythm (Kondratieff-cycle)

Oscillations in the task category of stabilization can be observed at various levels of population and process hierarchy. Of course, there is as yet still too little data on the millennial and centennial rhythms. The oscillations in a decennial rhythm, in a rhythm of several years, of one year, of weeks and days, are more easily registered.

Business cycles have already been studied in some detail by economists (G. SCHMÖLDERS, 1955/65). If we look at them more closely they emerge as

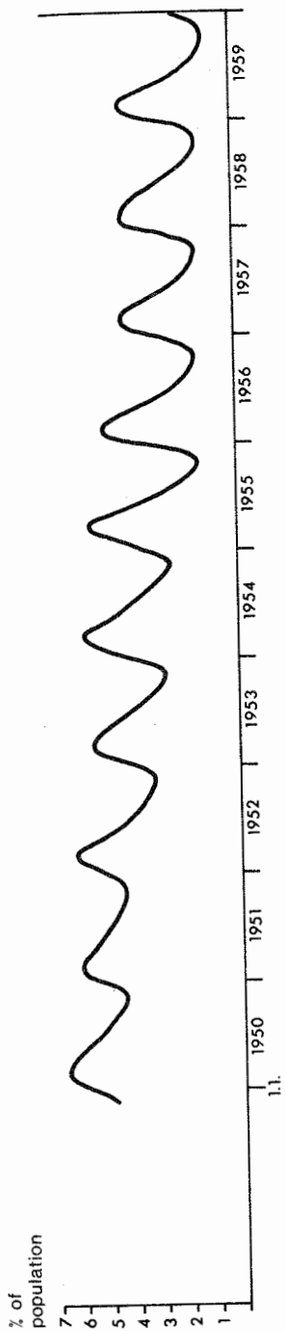


Fig. 15: Yearly cycle: unemployed in Lower Saxony.

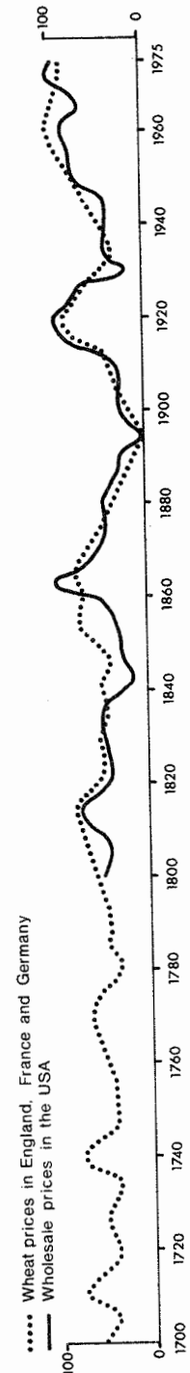


Fig. 16: Decennial cycles: Business cycles in the European/North American cultural population as the expression of stabilization in the scope of adaptation.

price cycles, reflecting the relationship between supply and demand. They affect the production of the organisates in the different task categories.

In pre-industrial times, cycles in a decennial rhythm can be recognized in the development of the price of grain. They are approximately synchronized in the different countries of the European cultural population (W. ABEL, 1935/66, e.g., p. 114). Even though there are plainly differences between them, we certainly cannot state in general terms that synchronous cyclical movements have only existed since the industrial revolution, as A. PREDÖHL (1962, p. 36; 1964, p. 162f) holds. J.A. SCHUMPETER (1939/61, I, p. 261) too, indicated that the Kondratieff cycle, encompassing about 50 years (N.D. KONDRATIEFF, 1928), has existed longer, though in his opinion it has become very much stronger since the industrial revolution.

The grain-price cycles in this order of magnitude probably came about due to the interaction between grain production and the amount of biotic reproduction. Even though detailed figures on the development of population numbers in pre-industrial times in Europe are lacking, we can find clues in this connection from the development of colonization, i.e., the expansion of the areas of cultivation. First of all, a comparison (Fig. 16, 20) reveals that the graphs for colonization resp. grain-prices are nearly countercurrent; during increasing population numbers a rapid expansion of the cultivated land is answered by a downward trend in the grain-prices, while in times of relative stagnation of the colonization processes the prices rise. Basically, W. ABEL (1935/66, p. 191f) for instance, had already seen a connection between the price of grain and the satisfaction of a demand by extending the agricultural acreage.

It is much more difficult to find a satisfactory explanation for the oscillations becoming more and more apparent in the production of todays highly differentiated industrial society, for two reasons in particular: first, a large number of processes has to be taken into account due to the division of labour, and second, the European cultural population system has spread out successively over the entire earth, so that we are not in a position to shed any light on the interactions until extensive investigations and comparisons have been made. At this point we can only give a few indications based on the reflections made so far. The graphs of 19th century grain-prices

coincide with the Kondratieff business cycles. Characteristic features of every phase of these cycles is a mean increase of prices for products at first, then a maximum is exceeded after about 25 years, followed by a falling tendency, until after another approx. 25 years a new minimum is reached. In order to find an interpretation for this we can refer to the observations and reflections already made. Supply and demand are, as we have stressed above, the two quantities that are required to become adjusted to each other. The demand does not only depend on the population numbers, but also on their consumer habits which in turn are influenced by the level of development (cf. above, section 3.7.1.2.).

However, production is also differentiated in itself. We have above (cf. section 3.5.1.1.1.) referred to different kinds of production, such as primary production and industry, in particular, due to their need for an infrastructure. The countries of the world resp. the populations living in them belong to different stages of infra-structural development (cf. above, section 3.7.1.2.) that can be put together into a scale. The question of development must be seen in relation to these stages.

In order to be able to satisfy the demand for goods of all kinds, for foodstuffs because of the growing population numbers, for industrial goods because of a growing prosperity of the inhabitants and the increasingly complex technology in the organisates of the industrial countries, and further due to an increasing claim for consumer goods in developing countries, more and more investments are made. Because at first investments are made in the higher differentiated, developed countries, and new organisates develop, wages go up faster there than in the less differentiated countries. Finally however, these also become attractive because of their low wage level, and organisates are then set up in these too, depending on the capacity of their infrastructure. The population explosion taking place here (cf. section 4.7.2.1.) forces these states to become industrialized, particularly on account of the labour market situation (cf. above, section 3.7.1.2.).

Thus in the kinetization phase of the process sequence of the European/North American cultural population the establishments that can be assigned to the different kinds of industry become diffused, and new raw materials are sought and exploited in the outer areas of the system.

J.A. SCHUMPETER (1939/61, I, p. 94f, 146f) already saw the connection between the course taken by the economy and the effect of economic innovations (a recent study, G. MENSCH, 1975). The spatial aspect, i.e., the diffusion of innovations was recognized as being of major importance by A. PREDÖHL (1962, p. 84f).

The innovations of primary production seem to reach the least developed countries as well, while the different types of industry become distributed in the more developed countries, according to their infrastructural situation. In the countries that are furthest developed, in the industrialized countries, the tertiary sector grows disproportionally during this time (cf. J. FOURASTIE, 1949), so that this is already being referred to as a post-industrial era (D. BELL, 1973).

The diffusion of these innovations is not planned however. Thus we have the situation coming about that an increase in industrial capacity may take place quicker than the rise in demand for the products. A time-span of several years always has to be calculated between the start of investments and the beginning of the organisates' production. However, the developing countries can only absorb the products they produce to a limited extent, for a portion of the population as potential consumers still practices traditional market systems. Due to the rapid expansion of industry, excess capacities come about. In the developing countries production is cheaper on account of the low factor-input (particularly wages) so that strong competition results in the establishments involved in the main industrialized countries. As production and thus supply exceeds the respective demand, prices drop. Presumably the order of sequence of the different types of economic production are manifested by this. Thus in the last 20 years a step by step falling tendency could be observed in agriculture, mining, the textile industry (industrial type 1; cf. section 3.5.1.1.1.) and the iron and steel producing industry (industrial type 2). The development of trade seems previously to have taken place in a similar order of sequence (K. DORNER, 1974, p. 7f; D. SENGHAAS, 1976, p. 47). Perhaps a downward tendency will prevail in present times with the industry of the 3rd kind (above all, machine-production, transport equipment industry, chemical industry) and, maybe, with the tertiary sector, especially the banks as the last link in the chain, before a new boom sets in.

The constraints coming about during these developments force the developing countries - of different grades in the scale of differentiation - as well as the industrialized countries, to start restructuring (cf. also J. FOURASTIE, 1949). If the economic developments, if dynamization and kinetization are to be given an upward movement, the infrastructure and the markets must previously be developed according to the process sequence. This means that after the perception phase, in which, due to the level of education ("bildung"), the opportunities for adopting and commanding new technologies are provided, determination must be changed (religious orientation, economic mentality, etc.), regulation must be adjusted to modern government practices and organization must be brought about (by extending the traffic networks and the hierarchy of central places etc.), so that dynamization can take place ("take-off stage", according to W.W. ROSTOW, 1960, p. 22f; cf. section 3.5.2.1.).

It becomes quite plain at this stage that the major business cycles can only become conceivable by including the non-economic facts occurring during the process sequence and the spatial mechanisms of expansion. Reflections in this context must not be restricted to economic processes and dependent relations (as in the case of J.M. KEYNES, 1936; N.J. MASS, 1975, who however only studied economic cycles covering shorter time-spans). J.A. SCHUMPETER (1939/61, p. 714f, 739) had already expressed ideas along these general lines.

These few reflections merely enabled us to indicate some possible connections. Yet even so, they will have shown that the policies of aid for the developing countries on the part of the industrialized countries cannot be conceived widely enough and that, moreover, they must be closely linked to the economic policies - in these countries' own interests as well - in order to help reduce the times of stagnation in world-economic development.

3.7.2.2.2. Shorter oscillation rhythms

The Kondratieff cycle manifests itself as an oscillation in the decennial rhythm within the entire cultural population. It initates resp. stops

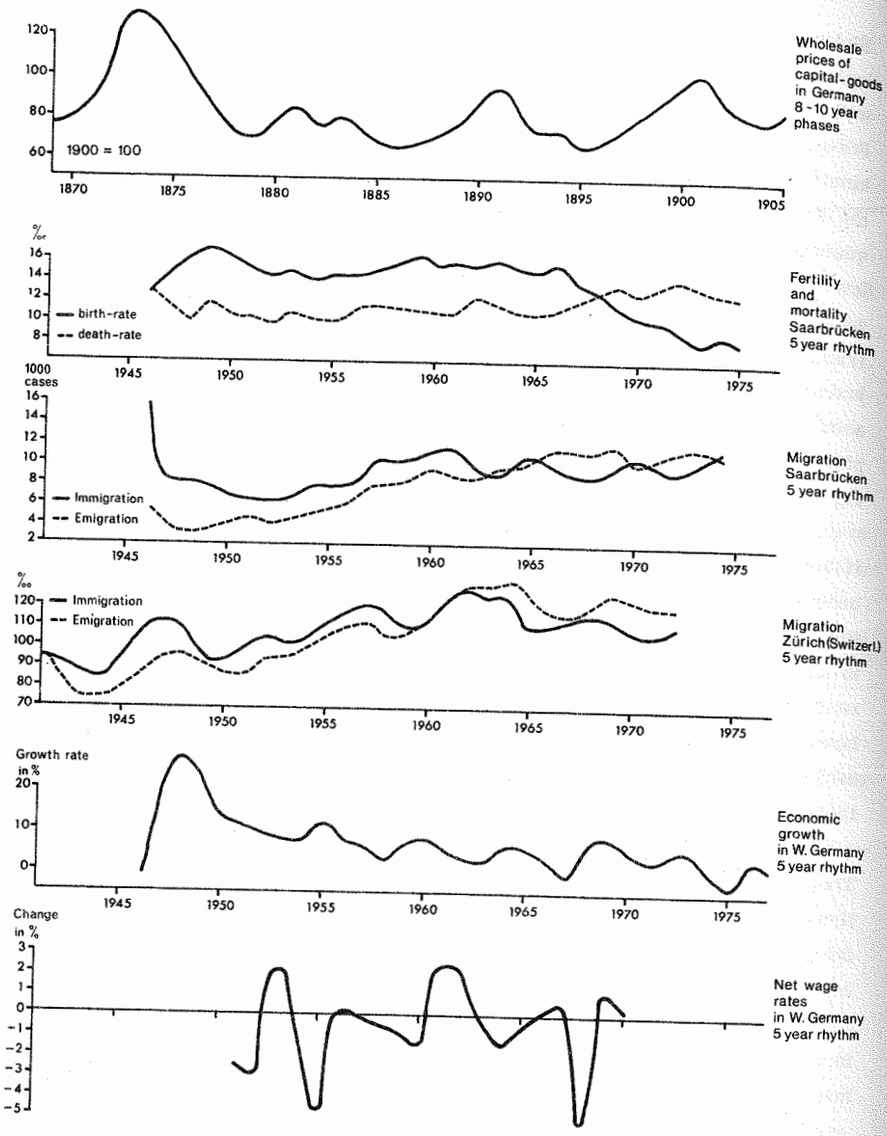


Fig. 17: Cycles of several years. Examples from Central Europe.

structure-changing processes within the involved state populations. It can probably be assumed that the shorter economic cycles, particularly those lasting 4 or 7 years can be related to the changes on the level of city-umland populations. It seems as if changes are coming about here; e.g., before the First World War a "Juglar-cycle" lasting 8-11 years and a "Kitchen-cycle" lasting 40 months played an important part (A. JACOBS and H. RICHTER, 1935, p. 48f; J.A. SCHUMPETER, 1939/61; G. SCHMÖLDERS, 1955/65, p. 42; A. PREDÖHL, 1962, p. 20f). Today they are hardly recognizable any more; instead a cycle lasting 4-6 years has become established (Fig. 17). Investigations ought to be made into the extent to which changes in the hierarchy of central places resp. in the structuring of city-umland populations can be considered significant. This would have to be studied together with the development of growth poles and the expansion or shrinking of backward regions within the states (cf. section 3.5.2.1.). Cycles lasting several years can be observed in country to town migration for instance, as can be seen in the diagram.

3.7.2.3. Rotation (selection)

The oscillations produce structural changes in the inferior populations. A selection takes place. This can be observed in all task categories resp. the populations assignable to them, and particularly obviously so between the competing economic organisates. As we have briefly shown already (cf. above, section 3.7.2.1.), the process leads into an aggregate, an equilibrium system. During the upward trend in the individual phases of the oscillation rhythm the products are put on offer, investments are made according to the existing infrastructure. During each downward trend the competition of the producing populations comes to the fore more plainly due to the falling consumption in relation to the demand. Then selection results. Only the most favourable products on offer are accepted by the population. This selection thus is advantageous for the superior population making its demand known. By means of selection the better populations are supposed to be filtered out, whereby the superior population for its part is more likely to survive the competition battle with populations of its own kind. The fact that this cannot be thoroughly accomplished in every way is another matter (cf. section 2.1.). During the following upward trend

the remaining populations take over the production and the innovations. The populations that turn out to be best because of their previous efficiency then carry the developments; among them are the innovation centres. For instance, in the cultural populations, a tribal or state population emerges as the most powerful and leads the cultural population according to the position in the process sequence. The rest of the populations follows (cf. section 3.3.2.2.).

Stabilization of the population in the social system complex thus means stabilization in the vertical and horizontal environment, i.e., in the course of the transfer of products and in competition with the populations engaged in the same matter. Oscillation and rotation belong together, they bring about selection, which in turn is the expression of a striving by the superior populations to become stabilized. If we transfer these reflections to the worldwide expansion of the European/North American cultural population and to the contrast between industrialized and developing countries brought about by this, we can assume that mankind as a population also strives to become stabilized. Now, it can be seen that looking at the fringe position of the developing countries already mentioned above (cf. above, section 3.7.1.2.) that only have extensive agriculture and thus only require low population density, and on the other hand at the increasing population concentration in several of these countries, one cannot fail but see that the innovation centre of mankind will have to change its place in one of the coming decennial phases, if all human beings are to partake of the fruits of society's production to the same extent. Here, states with high population numbers will come to the fore more strongly as innovation centres (=super-powers) in the future, after having produced a suitable infrastructure in their own region. From this viewpoint alone, great long-term changes in the regional distribution of poverty and wealth seem predictable.

4. MANKIND AS A BIOTIC UNIT (SOCIO-REPRODUCTION)

4.0. INTRODUCTION

In the previous section 3 the social processes were set down in detail. Ultimately, the product of these processes is consumable energy. The precondition for this is the ability to adapt as much as possible to the living space and the energy flow, chiefly controlled by human intellect in general and more particularly, oriented by institutions and controlled by media. The task of mankind as a biotic unit on the other hand is reproduction, the "product" is the human being. As pointed out earlier (cf. sections 2.7.2.; 3.0.) reproduction joins adaptation. The results are the socio-reproductive processes as reaction processes. So the populations adjust their structure in every task category to the necessities of the induction processes. In the course of the division of labour primary and then secondary populations emerge.

While the adaptation process affects human beings only in their role-behaviour, the socio-reproduction process concerns the human being as a whole, as a personality. The reaction processes basically emanate from the individuals and lead up to the controlling population, thus structuring it. As in the induction processes, we distinguish structure-conserving processes and structure-changing processes. The main structure-conserving reaction processes react to the main structure-conserving induction processes. The following section is an attempt to explain the processes and the structure within the resp. populations. Significant single examples are used to illustrate the structure-changing processes, mostly derived processes which emanate not from the individuals but from inferior populations as elements.

Of course, the statements made in this chapter are open to further discussion.

4.1. PERCEPTION

Within the scope of adaptation, knowledge was interpreted as a result of perception. The senses and the intellect are used by man in such a

way that the actions of perception can assist in adjusting to the system in the best possible way. The respective induction processes are magic, science and art (cf. sections 3.1.1.1.1.; 3.1.1.1.2.).

Resulting from the controlled efforts to acquire knowledge, mankind disposes of knowledge or of an "image" that can be introduced into the subsequent processes as input. It is gradually adopted by the individuals by learning as a reaction process. The processes of passing on and adopting knowledge, experience and abilities is roughly described by the term education in the sense of "bildung". This term must be distinguished from education in the sense of "erziehung", which has the function of bringing children to maturity by means of the influence of persons of the environment (parents, teachers, other children), and of introducing them to a way of living (cf. section 4.2.1.1.). "Bildung" is conveyed particularly by schools and universities.

Even though education (as "bildung") thus constitutes something peculiar to mankind as a whole, the means of acquiring the knowledge and the standard of teaching still vary a great deal amongst the populations and the individuals, e.g. the states attempt to exercise their influence by supervising the school system.

In a general sense learning means understanding the environment on the part of the individuals. This implies contacts with the environment, especially with other human beings as the elements of mankind as a system. Contact, relations and interaction may constitute basic attributes of mankind as a society. We cannot go into these problems in detail (cf. T. PARSONS, 1951c; G.C. HOMANS, 1950; N. LUHMANN, 1971, 1970/75; summed up by R. DAHRENDORF, 1963; G. KISS, 1972/75; W. SIEBEL, 1974).

In a concrete sense, this means on a small scale the existence of more or less short-lived encounter groups (e.g., ego-alter-dyad). The theories of behaviour and of learning attempt to illuminate the individual steps in more detail (R.F. BALES, 1950/68; P.R. HOFSTÄTTER, 1957; K.-D. OPP, 1972; L.-M. ALISCH and L. RÖSSNER, 1977).

It is not yet possible to identify structure-changing reaction processes within these task categories. Further investigations are necessary.

4.2. DETERMINATION

4.2.1. Structure-conserving processes

4.2.1.1. Main processes: gaining an attitude to life, division of labour, education ("erziehung")

Religion provides the populations with a frame for their orientation. In a broader sense and as a consequence of religion as the most important institution of the main induction process we may consider the basic attitude to life and to living together with other people as the main reaction process. The evaluation of the environment, and freedom of decision, provide the individuals within the given framework with a variety of ways of behaving with regard to their role in the systems and their way of life. By this means, the choice of profession is established, and this must be regarded as determination by the individuals as elements of the populations. It provides the condition for the division of labour issuing from the individuals (cf. section 2.2.2.).

By education (erziehung) the individuals are formed, provided with a conception of the world in the widest sense of the word, and are introduced to a form of life, while formal education (bildung) is chiefly concerned with providing knowledge and skills (as a part of perception; cf. section 4.1.).

Erziehung can be practiced for a whole lifetime, though it is concentrated mainly on childhood in preparation for growing up (cf. for this complex of questions, H.H. GROOTHOFF, 1964; J. DOLCH, 1967). The embryonic phase in growing human beings up to birth, as against childhood, i.e., to the period of education (erziehung) is short in comparison with animals (A. PORTMANN, 1956, p. 49f; A. MITSCHERLICH, 1963, p. 19; W.J. GOODE, 1949), a fact that emphasizes the importance of education (erziehung) of children and juveniles. Formal education (bildung) is mainly provided in schools and universities, while erziehung is still mainly confined to the home. Erziehung is aimed at introducing children into their own environment, into the population, and subconsciously there is the intention of conserving the peculiarities of the population. Inasmuch, it produces "kulturähnlichkeit" (cultural similarity) (W.J. GOODE, 1949; cf. also, W. FLITNER, 1958, p. 30f).

4.2.1.2. Population structure: groupings with distinctive characters

Consequently, a variety of groupings with distinctive characters, different types of life-forms or modes of living come about (cf. section 1.1.). The differences between them are marked by the individuals' behaviour and their ability to hold their own in the environment. P. VIDAL DE LA BLACHE (1911, p. 195) spoke of the "genre de vie". E. SPRANGER's conception (1914/66) of life-forms took in the different forms of value-orientation in a society, with the cultural performances and goods assignable to them, that can be typologically registered. In ethology, groupings of living creatures with the same survival strategy are subsumed under this term (I. EIBL-EIBELSFELDT, 1976, p. 260). In the cultural populations this constitutes a conception of the world. In undifferentiated populations, for instance the Pueblo population, religion and the conception of the world may have been more closely linked. In the European cultural population however, both exist separately as induction and reaction processes.

People with certain life-forms need not necessarily live spatially concentrated, forming aggregated life-form groups or even populations. This kind of grouping does not become characteristic until later stages in population development have been reached (cf. sections 4.5.; 4.6.; 4.7.;). On the other hand groupings as units also assume a specific character and a specific attitude towards the environment that can be perceived by outsiders as a characteristic trait of the grouping. Cultural populations can be distinguished clearly, but national identity and national character can also be listed here (cf. for reference on this subject, J.O.M. BROEK, 1967). The accounts presented by G. GORER (1948; cf. also R. DAHRENDORF, 1963) about the Americans, by D.F. ABERLE (1967) on the Hopi Indians or by SH.M. EISENSTADT (1967) on the Israelis provide examples of investigations into this.

4.2.2. Structure-changing processes

Transformations within the scope of the determination of socio-reproduction can be reflected in changes in the conception of the world in the larger populations, e.g., peoples. They can be initiated in a variety of ways. Generally, literature prepares the way. The Encyclopedists before the

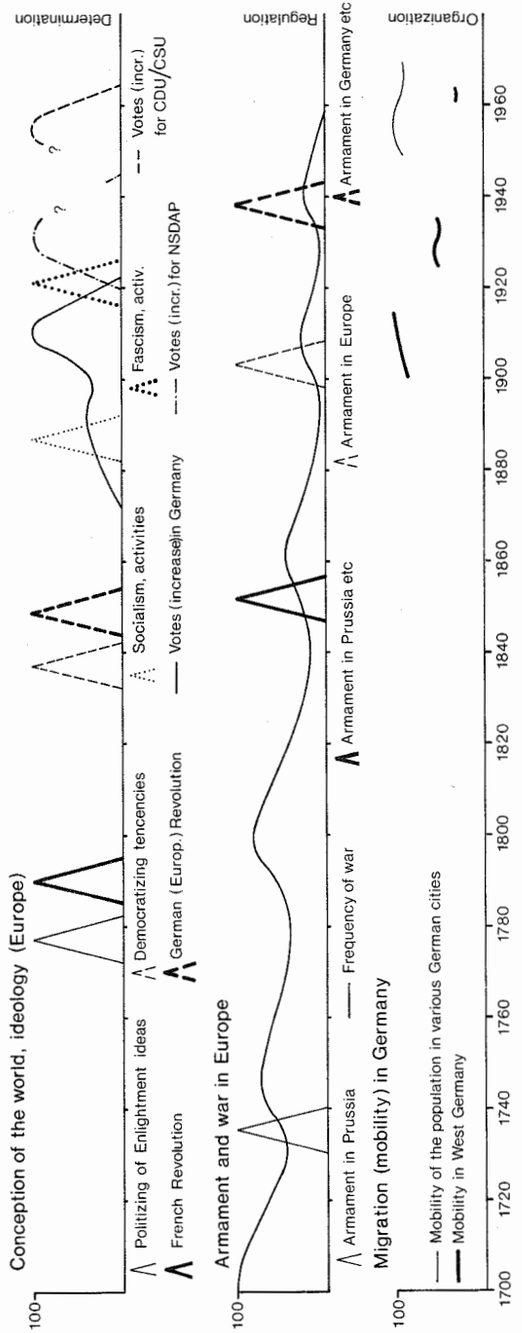


Fig. 18: Decennial phases in the development of European state populations since the 18th century, represented using various processes assignable to socio-reproduction in the task categories of determination, regulation and organization.

French Revolution are relevant in this connection. In Germany a large number of democratic and liberal publications appeared before the European Revolution of 1848. The activities of Marx and Engels are equally well-known, as is the establishment of socialist parties in the second half of the last century, preparing the ground for adopting the socialistic conception of the world.

Taking on an ideological conception of the world can come about slowly and within the existing form of government, e.g., within the scope of democracy. It can however, take a dramatic, revolutionary form. Major revolutions are always borne by changes in the ideological conception of the world. Examples for this are the French Revolution of 1789, the European Revolution of 1848 and the Russian Revolution of 1917. The ruling power was generally regarded as the keeper of the traditional conception of the world and, inasmuch, was also made the target of attack. Revolutions begin at the basis. Changes in the conception of the world under a form of government carried by political parties emerged in Germany for instance, when the elections between 1870 and 1910 indicated the growth of Socialism or between 1920 and 1933, when National Socialism became established (Fig. 18).

4.3. REGULATION

4.3.1. Structure-conserving processes

4.3.1.1. Main processes: social movement

While discussing regulation within the scope of adaptation, it was shown that controlled regulation requires an hierarchy and a definite assignation, so that communication can take place undisturbed. The responsible institution for the induction process is the government.

The search by the individuals for a position in the hierarchy, i.e., the vertical movement within the population, may be considered a reaction process. The individuals have to make their own way in the hierarchy. The position in the hierarchy cannot be interpreted from the role of the individuals alone because every individual is affiliated with populations and roles of all hierarchical grades. Rather, esteem and prestige are due to the individuals as well. Profession serves as a filter. It marks the dominant role the individual himself has decided to play. Persons having professions from task categories that precede in order within the process sequence and serve the procuring, transmitting and processing of information ("white-collar-occupations") appear to be endowed with privileges compared with the material categories ("blue-collar-occupations"), for the processes preceding in sequence or controlled by superposed populations are given a higher rating within the populations than the later, or inferior processes.

4.3.1.2. Population structure: social stratification

Within the state populations a vertical structure of society, a social stratification or inequality, is characteristic. The functionalistic theory (K. DAVIS and W.E. MOORE, 1945) is not sufficient to explain the hierarchy within the society (R. MAYNTZ, 1969/72; K.M. BOLTE, D. KNAPPE and F. NEIDHARDT, 1975, p. 11ff). Individual esteem and prestige, besides profession, income and education are important standards of values.

However, the subject-matter involves rather confusing aspects. Several theories try to explain social stratification - our treatise cannot describe them all. Basically, it should be remembered (cf. section 3.3.1.1.) that communication, necessary for reasons of the transmitter/receiver relationship, implies an instruction/compliance relationship in the individual activities, i.e., a temporary hierarchy. This can be said for all instruction/compliance relationships in general. The division of labour alone does not bring about social inequality as G. SCHMOLLER (1890/1968) held (cf. R. DAHRENDORF, 1961, p. 15ff). But communication is always tied up with it, so that in this respect, the populations have their own hierarchy. A perpetuation of communication in the population similarly also signifies perpetuation of the hierarchy, and with it of the supply of roles. By this means, a scale of assessment specific to populations is produced, based on the meaning of the role in the structure-conserving processes (measured according to the position in the hierarchy). This is expressed in the prestige of the roles.

The seven task categories and their interlacing within the process sequence could indicate that every society strives to divide into seven social strata. This should be examined.

The populations, as derived processes, are also arranged in a hierarchy, e.g. the city-umland-populations (central-place-hierarchy, cf. section 4.4.1.2.) or the peoples (or state populations) within the cultural populations.

4.3.2. Structure-changing processes

4.3.2.1. Changes in social stratification

The adoption of new kinds of regulation is often connected with a change in the social structure. PARETO (cited according to G. KISS, 1972/75, II, p. 118ff) developed the thesis that the history of human society is marked by frequent changes in the élites. T.B. BOTTOMORE (1966/69, p. 47ff, 114ff) doubted whether there exists an effective circulation of élites as, except for the hypothetical "classless society", social stratification prevents a vertical exchange from coming about. Rather, such processes depend on changes in the hierarchy of whole classes. With these processes of course, new élites are formed who take over leading roles. Changing the stratification is a structure-changing process, developing as a consequence of the adoption of new ideas or ideologies. The members of the lower placed strata of the population may undermine the hierarchical order. This can lead to revolution, especially if the determination is changed at the same time (cf. section 4.2.2.). A prerequisite condition for this is that the upper classes in the traditional hierarchic order of the society delay innovations which are essential for the determination and thus for the development of the population. Behind these processes lie hidden very complex social processes.

4.3.2.2. Wars

Changes in the hierarchy of the populations may be considered derived processes, especially on the level of peoples or state populations. Although

the hierarchization of state populations within a cultural population may be necessary, it bears the inherent danger of conflicts. The tribes, peoples or state populations are in competition with one another within the cultural population for leadership and the positions of the cultural centres. These positions shift, as we have already established (cf. section 3.3.2.2.), by means of rotation, so that conflicts can result. This is basically the background of most wars. All individuals are involved, i.e., the population as a biotic unit. This is what makes these processes dangerous.

Rotation can be accompanied by wars, but not necessarily of course. Peace at the level of cultural populations means a state of equilibrium between the tribes, peoples resp. state populations. It is maintained by diplomacy, so that the processes, including the structure-changing processes, can take place within the scope of regulation in the cultural populations. Wars must be seen on the same level, they delimit periods of diplomatic communication and should be interpreted as processes that change the structure of the superior cultural population in a specific way. C.v. CLAUSEWITZ (1832/37/1943, p. 32, 580) had already described war as a "political act", and moreover, as a "mere continuation of politics by other means". After two world wars, of course, we can see how much his words depended on the conditions of the time in which the book was written; on the other hand, we can agree inasmuch as diplomacy and war must be seen as belonging to the same category.

During a war, diplomatic communication turns into material interaction. A. MITSCHERLICH (1969,p.121) stated that aggression turns into destruction when excitement has reached a pitch from where there is no return. The organisates resp. populations that work in the state population become more and more involved. The resulting high expenditure slowly takes in the entire state population as the technological effort increases (A. BUCHAN, 1968, p. 124f), until all the inferior systems are within a short time set to overwhelming the enemy ("total war").

"Autistic" isolation and selfcentredness go to form the precondition; they disturb international communication. Behaviour of this kind is typical for conflict situations (D. SENGHAAS, 1972b, p. 46). It is rooted in an "ethnocentric philosophy of life" (W.E. MÜHLMANN, 1962, p.219f), causing a sharp delimitation to be made between the population and the strangers.

In our context it is not important whether we take war to be due chiefly to an inborn instinct of aggression, as ethologists and psychologists would have it (R. ARDREY, 1966, p. 289; I. EIBL-EIBESFELDT, 1967/78, p. 622; A. MITSCHERLICH, 1969, p. 107f), or whether we see it as an invention, as some anthropologists hold (M. MEAD, 1940/68, p. 273; B. MALINOWSKI, 1941/68, p. 249, 260).

History, the philosophy of history, as well as peace and conflict research, dealt with mainly by political scientists and sociologists, endeavour to shed some light into the events and factors responsible for this process. History concentrates more on the concrete developments (P. SCHMITT-HENNER, 1930) or on single periods of time (e.g., the Thirty Years War, M. RITTER, 1889/1908; G. FRANZ, 1943/61; the 1870/71 War and the 1st World War, G. RITTER, 1954/68), whereas the philosophy of history or peace and conflict research attempt to find out the underlying conditions and laws, thus proceeding in a normative way (e.g., A.J. TOYNBEE, 1950; L.F. RICHARDSON, 1960; A. ETZIONI, 1967/68; J. GALTUNG, 1972a; J.D. SINGER, 1971; D. SENGHAAS, 1972b).

Within our context, two different kinds of war must be distinguished (though transitional stages are possible):

1. the wars between state populations within the cultural population ("central system and major power wars"; J.D. SINGER and M. SMALL, 1972, p. 31),
2. the colonial wars between populations belonging to different cultural populations, or in the colonial area outside the living space of the cultural population ("extra-systemic" or "imperial and colonial wars"; J.D. SINGER and M. SMALL, 1972, p. 31f).

Within state or tribal populations there are revolutions, civil wars and revolts (Intra-systemic or Inter-state wars; J.D. SINGER and M. SMALL, 1972, p. 31), aimed at forcefully changing the determination or social stratification. These are not relevant here (cf. sections 4.2.2.; 4.3.2.1.). Imperialist wars are characteristic on the fringe of the cultural populations and should be seen in connection with the formation of colonial empires.

The wars between the peoples within the cultural populations can also be classified according to different types, depending on their motives. The classification made by A.J. TOYNBEE (1950, p. 4f) establishing wars of religion (16th and 17th centuries), wars as sport of kings (17th and 18th centuries), and wars of nationality (since the 18th century) gives an indication of this. J.U. NEF (1968, p. 228, 263, 357f) provided a similar classification, though he saw stronger economic motives in the foreground for the middle group, and called the wars of the most recent phase total wars. Of course, such classifications can only register partial aspects; this the authors themselves recognized.

4.3.2.3. Periodization (wars)

In the foregoing, we established that there are different types of war. If however, the attempt is made to picture wars in a time sequence, difficulties resulting from the methods of comparing the values are encountered. These can be reduced by making limitations. Thus a limited space (a cultural population), a certain type (wars between state populations) and a homogeneous period as far as the development of the cultural populations is concerned, should be chosen. This is how the frequency of wars between state populations within Europe during the most recent period of Modern Times has been depicted (Fig. 18). In the Middle Ages there appear to have been wars of a different kind (B.L. MONTGOMERY OF ALAMEIN, 1968). However, due to the Cold War and the introduction of guerilla warfare it is not easy at present to decide whether there is a state of war or peace. At the same time it must be recognized that the spatial frame of reference has now changed very much, for today we can no longer merely pick out conflicts within Europe alone as being of consequence for that continent, rather every situation of conflict on the earth is important for security in Europe on account of the expansion of the spheres of interest of the superpowers (J.D. SINGER, 1971).

The diagram shows the decennial rhythm (also referred to by J.D. SINGER and M. SMALL, 1972, p. 205f, who however selected too brief a period of time between 1815 and 1965 for their investigations and did not take into account enough the different types of war). Apparently the frequency of

war reached its peak whenever the populations changed from one phase in the development of regulation to another, i.e. when the supremacy within the cultural population shifted from one state to another (cf. section 3.3.2.2.). There are, of course, considerable deviations from this rhythm - like the 2nd World War. This shows that we must caution against drawing very far-reaching conclusions for the future, for the European/North American cultural population is even now going through structural changes (in a centennial and perhaps also in a millennial rhythm; Fig. 23), which are not leaving this rhythm undisturbed.

4.4. ORGANIZATION

4.4.1. Structure-conserving processes

4.4.1.1. Main processes: migration

Traffic is the main institution of spatial organisation; it connects the organisates and individuals involved in the different task categories. In the city-umland-population spatial organisation should be optimized (cf. sections 3.4.1.1.3.; 4.4.1.2.). In reaction, a spatial differentiation of the population arises. During the organization phase the roles and processes are spatially adjusted to the system, a regional distribution of the population itself takes place, mainly by migration.

The individuals as working and consuming persons are subject to the restraints of superposed locational advantages and disadvantages which are perceived and require decisions to be made. In the decision process we can distinguish between the actual motives and the marginal conditions (M. VANBERG, 1975, p. 9ff). The general background of migration is formed by the subjective target of an improved environmental situation compared with the present one (G. IBLHER, 1973, p. 3).

The marginal conditions take effect, as far as possible, in the choice of a dwelling place in the new surroundings. The aim of these migrations is, therefore, to find a place situated in a pleasing living environment, with respect also to the migrants' quality of life, and from where the organisate offering work can be reached within tolerable limits of expenditure of time and money (F.ST. CHAPIN, 1968).

In deciding whether a move is finally to be effected, it is of some importance whether the umland with which the individuals have come into regular contact in a daily or weekly rhythm has to be changed or not (C.C. ROSEMAN, 1971). If the distance between the place of dwelling and the new place of work is too great, which frequently happens when the two are in different settlements, people move. In this way family life and reproduction still remain possible. Without going any further we have the double aspect of migration emerging here - the individual migrates as a member of society and as part of the population as a biotic unit. Accordingly, two basic patterns can be recognized: the socio-economical and the individual one (L. NEUNDÖRFER, 1959, p. 499ff).

The migrations resulting from socio-economic motives (in West-Germany these constitute about half of all cases of migration; R.G. WIETING and J. HÜBSCHLE, 1968, p. 90ff) are related to the organization of the systems. The moves are undertaken (in the light of the system and the minimization of its organization) because the migrants are bearers of certain professions. To be exact, the roles are brought into position. Migration enables the spatio-structural tensions in the system to be compensated. It brings about a balance on the labour sector if regional disequilibria occur (cf. section 3.7.1.2.).

The basic fields of migration are formed by city-umland-systems. In the city-umland system, the birth-rate is usually, though not always (cf. G. MACKENROTH, 1953, p. 269ff), higher in the umland than in the city (K. SCHWARZ, 1964, p. 72; 1975, p. 107; G. MÜLLER, 1968, p. 202ff). In the city, on the other hand, labour is needed. This kind of disequilibrium is caused mainly by regional differences in the birth-rate resp. death-rate between the centre and the periphery of the system. Migrations equalize this and thus contribute to maintaining the population. Moreover, structure-changing processes in the other task categories (technological innovation, economic growth, political transition etc.), also bring about radially oriented migration (A. SAUVY, 1966/69, p. 468ff; H.-J. HOFFMANN-NOVOTNY, 1970; J. FRIEDMANN and R. WULFF, 1976).

Horizontal and vertical mobility (cf. section 4.3.1.1.) are thus often related. Conversely, this means that the probability of moving increases with the chances of advancement to be expected (for West Germany, cf. H. ZIMMERMANN etc. 1973, p. 189; for Austria, A. KAUFMANN, 1972/74, p. 284ff). On the other hand the expectations do not necessarily have to come true. In reality, there is a feedback in every migration process, as in any other process; i.e., the expectations that do not come true cause a flagging of incentives and, possibly, migration will slow down (cf. for instance, for city-umland migration in developing countries, A.L. MABOGUNJE, 1970/72, p. 195).

The size of the systems emerges from the distances covered by the migration. First essential for this is the size of the information field, which in turn depends on the type of perception. With this the desirability of the location becomes assessable for the potential migrant. The information triggers the stress required for the decision (J.WOLPERT, 1966/73). T. HÄGERSTRAND (1957, esp. p. 132ff) in particular, established the importance of information for the decision to migrate (cf. also P.H. ROSSI, 1955, p. 159ff; S. DAHL, 1957). Individual contacts play a decisive role in this. A large part of the "passive" migrants follow other "active" migrants who have already investigated the prospects. The negative connection between distance and intensity of migration that can be observed everywhere is probably not caused by the cost of moving but by the diminishing information resources (cf. also P.G. JANSEN, 1969, p. 158; I. KÜHNE, 1974, p. 196ff).

As derived processes, the migrations often extend beyond the state boundaries. This is the case if the population numbers of the peripheral populations within a cultural population are too high in relation to the carrying capacity (cf. sections 4.7.1.2., 4.7.2.). In that case a balancing of the labour force can be attempted. We can include in this the migration of workers in south-east Asia (K.J. PELZER, 1935), as well as the moves effected in the early phase of industrialization (e.g., in the large European industrial zones; G. IPSEN, 1933, p. 437ff; W. BREPOHL, 1948; W. KÖLLMANN, 1974) and the migration of the "gastarbeiter" in Europe (H. SCHRETTENBRUNNER, 1971; G. SCHILLER, 1972; H. HARBACH, 1976; C. LIENAU, 1977).

The "individual" migrations (after NEUNDÖRFER, cf. above) are caused by changes in the personal life cycle and thus serve reproduction in particular. This is particularly the case with the setting up of families, but also generally with adjustments of the size of a home to changed requirements, possibly because the family has increased in size or because the children have grown up and left home (e.g., B.T. ROBSON, 1973b; research in the USA, P.H. ROSSI, 1955, p. 77f; in West Germany, F. SCHAFFER, 1970, p. 62f; H. BÖHM, F.-J. KEMPER and W. KULS, 1975, p. 46f).

Moves motivated in this way lead away from the dwelling connections, though they usually take place within the settlement (R.G. WIETING and J. HÜBSCHLE, 1968, p. 89f; for Zürich, G. IBLHER, 1973). However, migrations between different settlements also take place if relatives decide to live together (e.g. in Italy, I. KÜHNE, 1974, p. 200f; 228f).

Migrations in connection with choosing a partner are especially important for the reproduction of the population. In little-differentiated societies (e.g., agrarian societies), marriage fields are virtually restricted to the neighbouring families and neighbouring villages. In more differentiated societies they are much wider due to the secondary formation of the system of central places (according to the size of the information fields; e.g., R. L. MORILL and R.F. PITTS, 1967).

4.4.1.2. Population structure: concentration and city-umland-structure

In a little-differentiated, e.g., agrarian society, the dwelling places are in the immediate vicinity of the place of work and can be reached quickly, as in the case of fields. They can even be identical with the workshop, as in the household, where clothes and tools were made as well.

In medieval European towns too, the dwelling place was generally close to the workshop; in the case of craftsmen and traders it was in the same house. However, the further dividing up of tasks brought about a separation of work from the dwelling place, particularly in our modern society with its labour-intensive industries, the large commercial and administra-

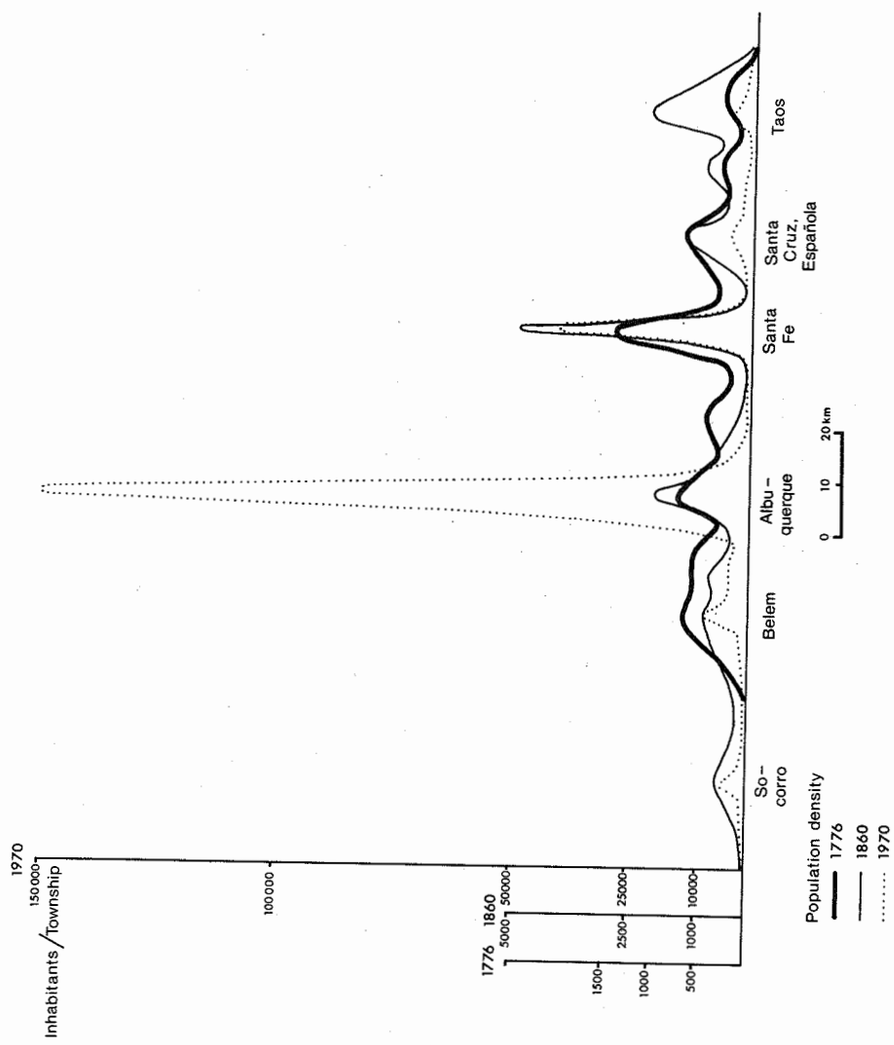


Fig. 19: Changing shape of a population with growing differentiation. Profile of the population density along the main settlement axis of New Mexico 1776, 1860 and 1970.

tive concerns.

Due to this separation, the distribution pattern of the residential population changed. In a city umland system a model of population density (e.g. measured by the average length of time per day individuals spend in one place) therefore takes on a completely different shape compared with an ethnic group with no, or only minor differentiation (e.g., an agrarian society). While for the latter the bell-profile with only moderately rising flanks is characteristic (cf. section 2.4.3.), for the former it is a cone that starts out quite flat in the umland but rises steeply upwards from the periphery to the centre of the city. The proportion of the concave part of the curve in cross-section is by far the greatest. A delimitation of the umland on the outside is quite hard to achieve, as a wide transitional area leads over to the neighbouring system (Fig. 19). The sifting procedure, and with it the spatial arrangement, have different rates of progress. With increasing division of labour and traffic development, the principle of long range effect becomes more apparent in the distribution of the population.

The size of the umland and the attractiveness of the central place correlate in a positive way (W. CHRISTALLER, 1933). The accessibility of the central facilities or of the places of work becomes the factor limiting the umland (equifinality, cf. section 2.4.2.).

If the model conceptions already elaborated of the structure of a city (E. W. BURGESS, 1925/68; BABCOCK, quoted according to B. GOODALL, 1972 p. 111; H. HOYT, 1939; CH.D. HARRIS and E.L. ULLMANN, 1945/69), of the city umland and the city region (A. LÖSCH, 1943; O. BOUSTEDT, 1970a, b), of the ring structure of the umland (J.H.v. THÜNEN, 1826/75/1966) as well as of the hierarchy of central places (W. CHRISTALLER, 1933; W. ISARD, 1956) are combined with the process behaviour of the populations, particularly in the process-sequence (cf. section 2.6.3.), a comprehensive framework of spatial structure can be achieved.

By means of the division of labour, it became possible to distribute the production processes amongst different organisates. All organisates endeavour to find the most favourable means of access to the centre of the population. The centre is on average the easiest to reach for all

members of the population and localization there particularly favourable. Thus the individuals and organisates, seen from the city-umland population, take their position uncontrolled. Consumer behaviour and locational decisions come into view. The main facts are known. Seen within the frame of process theory and task categories we may add these statements:

1. The system has to complete all 7 tasks in order to be successful (cf. section 2.6.3.).
2. The process leads from the top to the bottom in the hierarchy (cf. sec. 2.6.4.), from the population as a whole to its elements.
3. Thus the individuals and organisates which are engaged in previous tasks in the course of the process sequence have to serve a larger umland than those which follow in line.
4. Organisates which require a larger umland for their existence are more dependent on receiving a favourable central position in the system than those which require a smaller umland.

As a result of the controlled and uncontrolled processes, the prevalent processes and institutions with their organisates in the city-umland population are arranged in a spatial sequence, going out from the centre to the umland, and forming a ring structure, according to the process sequence:

The organisates, being contact places between the producers and the consumers resp. the whole system, are particularly bent on finding the positions in space that are most accessible for the population. This is the point at which the population perceives. The institution is commerce, and more particularly, the retail trade. Here the products are taken on, so that the producing organisates obtain their information on the further development of their production. In a simple ring structure model, in which the centre of a city emerges as the most accessible point (abstracted from all differentiations caused by traffic), the main shopping street of the town centre would therefore be the area in which the organisates dealing with PERCEPTION were situated.

The next step in the sequence of the processes is DETERMINATION. In the model therefore, the organisates responsible for decisions regarding production in large areas of the population must be referred to. They

are accomodated in offices. This is demonstrated in a particularly impressive way by the headquarters of the concerns and banks (J.B. GODDARD, 1975; P.W. DANIELS, 1975, p. 106ff), though numerous other administrative offices and practices, etc., must be mentioned in this context.

Towards the outside, REGULATION, meaning primarily public administration joins on; it is also established in offices. As different to the organisates of the retail trade, the offices serving determination and regulation can make use of the upper storeys of the buildings as well. This encourages the erecting of multi-storeyed buildings. Spatial separation is achieved mainly via the real estate prices.

The processes performing perception, determination and (as a rule) regulation together shape the central business district (E. KANT, 1962; R.E. MURPHY, 1971).

The dwelling place is a locality in which, and emanating from which, many activities from all task categories are carried out, amongst other things consumption and reproduction. The households with their personal spatial needs are in areal competition with the other organisates (B.T. ROBSON, 1975). In highly differentiated industrial societies the greater part of the population lives in the residential area round the town-centre and out towards the periphery. This part of the population has become incorporated in the organization process by migration (cf. also L.S. BOURNE, 1968/71) and marks the ORGANIZATION zone in the city-umland model. This means the households, whose occupants must be conceived of in the role of working people as well as consumers, represent the task category of organization in the process-sequence with their input-output connections.

The organisates, serving the processing of the products of primary production (DYNAMIZATION), are located mainly on the urban fringe. When the cities expand, the residential areas grow up around them, so that the old peripheries can often be recognized by the former industrial plants (H. LOUIS, 1936 for Berlin).

Because of the spatial separation, especially of primary production and processing, a particularly high tension of transport results. Short-distance

traffic tries to compensate for this (e.g., commuter traffic, P. SCHÖLLER, 1956). This is the KINETIZATION zone, for in the task category of organization, traffic means production or kinetization (cf. section 3.4.1.1.1.).

Towards the outside, expenditure for transport increases and after a certain distance (subject to the effectiveness of the means of transport), transport becomes unprofitable, depending on the material being transported. Here, smaller central places of a lower order take on the task of supplying the utilities for which the central place of a higher order is too far away, and the transport investment in relation to the value of the utilities too great (W. CHRISTALLER, 1933, p. 65; P. SCHÖLLER, 1957/72). Here the system is stabilized against the neighbouring populations, so that this zone can be called the STABILIZATION zone. The small central places relieve the centre of the population of some of the tasks, thus being the centres of smaller spatial work units. This can be observed in very different orders of magnitude. A hierarchy of central places emerges, because the central places of a lower order also have their stabilization zones. Also, the agricultural land use here demonstrates a stabilizing of the population against the natural environment, the living space. The orientation of production becomes adjusted to the local conditions.

The control loops of the city-umland system are revealed in the traffic flow. An idealized view shows the transport of information starting from the nucleus of the population, the central business district. Here the system is linked to the superior system. The goods produced by the population are transported mainly in the opposite direction to the centre of the system, to be offered to the consumers.

A central-peripheral arrangement corresponding to the city-umland populations is also (as a result of derived processes) recognizable in cultural populations. There are differences in the intensity of agricultural land use (cf. E. OBST, 1926/69; W. FISCHER, 1928; L. WAIBEL, 1933), but also in the degree of differentiation in peoples resp. state populations between the centre and the periphery of the cultural populations (cf. section 3.7.1.2.).

The state populations are also structured in a central-peripheral way, though the differences between the nucleus and the fringe are less pronounced because the states normally try to reduce the differences. Yet, here too, it can be seen that the economically more intensively used regions are more frequent in the central areas (H. SPITZER, 1975, p. 54f; 178f; cf. section 3.7.1.2.).

The settlements also reveal a definite central-peripheral structure. This is the case for little differentiated agrarian societies (e.g., Pecos; cf. section 2.5.2.), as well as rural settlements in highly differentiated industrial societies (cf. section 1.2.; moreover W. MÜLLER-WILLE, 1936, p. 89; M. CHISHOLM, 1962, p. 50). The spatial organization of communities, however, means above all the structuring of settlements as earthbound artefacts (cf. section 3.5.1.1.3.).

4.4.2. Structure-changing processes

The migrations can vary in intensity. The decennial rhythm is particularly characteristic. Around the middle of the last century a maximum can be observed, while a second maximum before the First World War, and another in the mid 1950's (Fig. 18) are even plainer. A sequence of shorter periods is manifested by the 5-year rhythm (Fig. 17).

4.5. DYNAMIZATION

4.5.1. Structure-conserving processes

4.5.1.1. Main processes: adaptation (social processes)

The energy requisite for life and reproduction has to be taken from the environment and converted to a form suitable for human consumption. Here, the human beings are confronted with the living space. Seen as a socio-reproductive process, adaptation is uncontrolled. It emerges from the consuming individuals. The ability to adapt in accordance with the given resources is decisive for the success of the population. Mankind has created a position of precedence over other species of living creatures for himself

by the selectively established ability to adapt particularly well to the environment. The amount of energy obtained from the resources present in the living space is the most important factor responsible for the population numbers. For further reference, see the section of this treatise dealing with adaptation (cf. section 3.).

4.5.1.2. Population structure: life-form groups (aggregates)

As pointed out already (cf. section 4.4.1.2.) individuals and organisates try to arrange themselves in a particularly favourable position in the superposed central-peripheral structure of the city-umland population in relation to the input and output. In these locations they are adjacent to other elements of the same kind. Thus zones of elements determined in the same way within the system are formed around the centre, as is expressed in the city-modell of E.W. BURGESS (1925/68) for instance, or in the Thünen Rings (J.H.v. THÜNEN, 1826/75/1966). Within this frame, elements for their part arrange themselves in aggregates. Individuals or organisates of the same kind become concentrated into delimitable spatial formations, despite the fact that they are in competition with one another (in the horizontal environment). Their common task in the superior system produces the need to communicate, but also the need for joint facilities that simplify labour. In rural areas this means adaptation in their natural environment, so the fieldpattern corresponds to a certain degree to the natural areas. The agrarian communities are basically organized in this way (cf. section 3.5.1.1.3.).

A tendency to aggregate into more or less homogeneous districts is recognizable also with organisates in cities (e.g., Mainz:R. KLÜPPER, 1961; Aarhus: W. TAUBMANN, 1969; Austrian towns: E. LICHTENBERGER, 1972a, p. 246f). Thus there are banking districts, shopping districts, industrial areas etc. in towns, as the multinuclei model of Ch.D. HARRIS and E.L. ULLMANN (1945/69) demonstrates.

The term "wirtschaftsformation" (economic formation) has been used for such aggregates in economic geography, although mainly in superposed systems. Within the scope of his study of the agrarian regions of the

Sierra Madre de Chiapas, L. WAIBEL (1928) distinguished regional units formed by organisates that have the same line of production and are economically linked together by additional facilities serving the whole unit (G. PFEIFER, 1958; H. QUASTEN, 1970, 1975; H.-J. NITZ, 1975).

There is also a tendency to form aggregates by migration. Country to city migration (cf. section 4.4.1.1.) ends in another community. In this community, preference is given to districts that harbour individuals and families of the same kind, which facilitates adjustment (G. ALBRECHT, 1972, p. 261f). Thus the migrants become arranged into spatially concentrated life-form groups (as aggregates; cf. as against life-form, section 4.2.1.2.), representing the counterpart to the "wirtschaftsformationen". On close examination, the differentiation of residential districts is the expression of various processes, having for their motive power the satisfaction of personal desires and expectations according to the migrants' social position, life cycle, ethnic belonging and mobility. Each grouping with specific characteristics tends to produce specific spatial patterns of behaviour (D. TIMMS, 1971).

Social stratification (cf. section 4.3.1.2.) appears to have precedence. Therehave always existed different population strata in cities and in the country; in the cities this brought about a certain segregation into specific districts (particularly E. LICHTENBERGER, 1972b; 1973, p. 299f).

In the cities of modern industrial society, the districts of social strata come into evidence particularly if there is a need for protection from members of other life-form groups. In that case ghettos may arise. A special phenomenon is the slum-problem. It is based especially on the grave discrepancies between the newcomers and the surrounding population (level of knowledge and education, inner orientation, possibly racial differences; H. HOYT, 1939; N. KANTROWITZ, 1969; H.M. ROSE, 1970/73; R.L. MORRILL, 1972). In consequence, an hierarchical barrier in the social stratification, together with discrimination, play a major part. This prevents the advancement of the slum inhabitants.

In the wide peripheral areas of the metropoles in developing countries on the other hand, discrimination of this kind plays a minor role (G. SANDNER, 1969; H.J. NICKEL, 1975; W. BRÜCHER and G. MERTINS, 1978).

Here the problem of unemployment can probably be solved by increasing industrialization and thus depends on the solution of the whole complex of problems surrounding developing countries (cf. section 3.7.1.2.).

The aggregation of the individuals and families can be assessed as a means of overcoming the influence exercised by the environment. Joint actions and reactions simplify the task, reduce the effort involved. Alone, the individuals are in danger, or at least a good deal less effective, in an environment that is to be exploited and may be hostile. Aggregation can be assessed as a more or less passive reaction. The next step could be joining together into populations, enabling individuals to actively influence the environment to their own advantage (cf. section 4.6.1.2.).

4.5.2. Structure-changing processes

The changes in production manifested in business cycles should be assessed as structure-changing processes in the scope of the dynamization of socio-reproduction, i.e., of adaptation processes (cf. section 3.7.2.).

4.6. KINETIZATION

4.6.1. Structure-conserving processes

4.6.1.1. Main processes: propagation

Within the scope of reproduction, propagation emerges as "production". It is the concern of the small or nuclear family and is based on individual decisions. Depending on the life expectancy, the reproductive age lasts from 13/18 to 30/65 years (in particular, W.J. GOODE, 1949; A.S. BOUGHEY, 1968, p. 121f; W. PETERSEN, 1961/75, p. 71f). The proportion of the sexes and the age structure of the population, the number of marriages and divorces, medical, economic, psychical and other factors indirectly influence fertility and the birthrate.

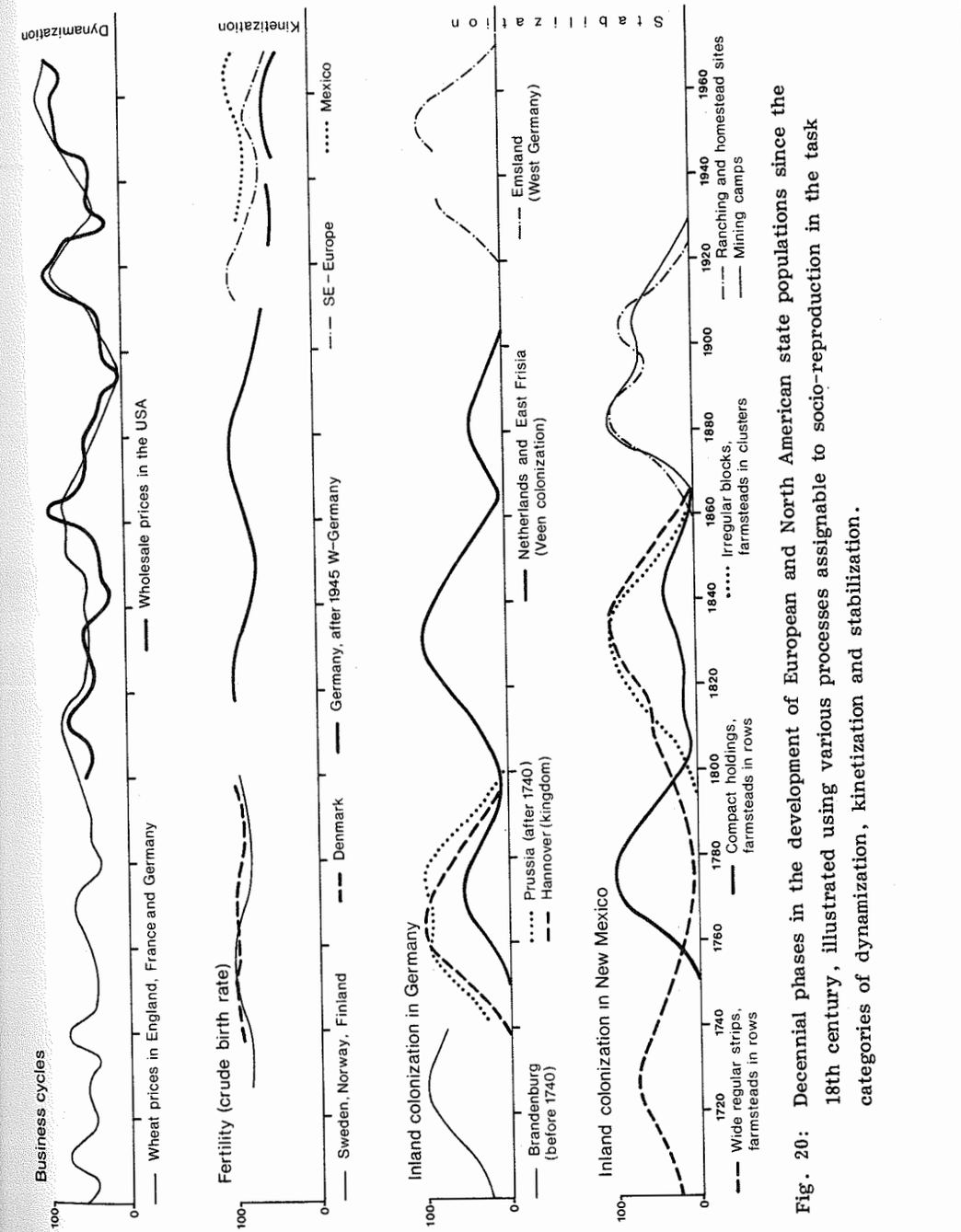


Fig. 20: Decennial phases in the development of European and North American state populations since the 18th century, illustrated using various processes assignable to socio-reproduction in the task categories of dynamization, kinetization and stabilization.

4.6.1.2. The population as a production unit

Propagation induces the individuals to form families as primary populations. Basically, the family as a type of biotic unit does not change in the course of the differentation of society. If the superposed populations change their shape (cf. section 4.4.1.2.) the families have to procure for themselves, by migration in some cases, the spatial position that corresponds to the requirements of the adaptive processes (cf. section 4.4.1.1.). Thus they are able to continue their existence as primary populations. As secondary populations organisates arise on the same level in the hierarchy (cf. section 1.1.).

Basically, and as derived reaction processes, every population comes into existence as a production unit both in adaptation and in socio-reproduction processes, i.e., as a carrier of the process sequences. The production within the scope of the adaptation processes provides the involved groupings with a systemic basis so that they constitute secondary populations. The populations as such only exist as long as they complete the task as elements in the superposed system, i.e. fulfill all seven stages of the process sequence belonging to the task.

As far as the task is concerned, the population is a closed system for the duration of the structure-conserving process, as otherwise the task could not be optimally brought to completion. At the same time the population can be interpreted as an open system by the fact that the individuals assigned to it also belong to other population types.

4.6.2. Structure-changing processes

Changes in the kinetization processes of socio-reproduction become manifest as changes in the birth-rate development. Unfortunately, counts of these values have only been available for the last 200 years, so that the longer periods covering millennia or centennia cannot be identified. In the decennial rhythm a change in fertility can be observed in the European/North American cultural population (Fig. 20). The 1870's and 1880's for instance, are characterized by a falling tendency in the curve diagram of

births registered in Britain and Germany, ending in around 1920/30. In the eastern and south-eastern European countries this was the time when the trend started, coming to an end around 1960/70, when a new downward trend set in in Central Europe (G. MACKENROTH, 1953, p. 56; E. A. WRIGLEY, 1969; J. SCHMID, 1976, p. 287; POPULATION DECLINE IN EUROPE, 1978).

A rhythm of three to seven years also appears to be recognizable in the fertility development (e.g., for Germany, G. MACKENROTH, 1953, p. 56; for the Saarland, cf. Fig. 17). Yearly and weekly rhythms can be observed in the frequency of marriages (L. HENRY, 1976, p. 40f).

4.7. STABILIZATION

4.7.1. Structure-conserving processes

4.7.1.1. Main processes: generative behaviour

Stabilization within the frame of socio-reproduction means bringing the individuals and populations into some kind of equilibrium with their environment. This implies first a stabilizing of the size of the population.

The number of births must be contrasted to the deaths. Both figures determine the size of the population. Mortality, like fertility, varies according to the population. It depends on the position of the population in the process sequence, though it can be influenced by the environment to a considerable extent, by diseases and epidemics for instance. In this context the advance of various epidemics (E. KEYSER, 1954; WELTSEUCHENATLAS, 1952/61) should be noted as an example of the processes carried into the population from the environment. The traffic connections and the practice of hygiene, as well as, indirectly, the will to live and the susceptibility of the people, i.e., the adoption by the population, influence diffusion.

When, in the dynamization phase, the products of society are taken over, the population's behaviour is to determine. If there is enough energy supply, the population has the possibility to continue growing. Is this

not the case however, difficulties ensue. Besides moving away (emigration, colonization) or further improving the infrastructure by new adaptation processes - both kinds of processes are induction processes (cf. sections 3.; 4.7.2.) - the population must shrink. This can be achieved by an increase in the death rate and/or a reduction in the birth rate. This means the population has to change its generative behaviour (cf. for instance, J. SCHMID, 1976, p. 44f; as for the Pecos population cf. Figs. 9-11).

Births and deaths are the expression of the generative behaviour of the people within the population. The generative behaviour ultimately determines the population numbers. It combines numerous single values, such as marriage frequency, family conditions, fertility, age-structuring and so on, i.e., the generative structure (cf. in this context, G. IPSEN, 1933, p. 425f; 458f; G. MACKENROTH, 1953, p. 70f, 110f; H. LINDE, 1959; K.M. BOLTE and D. KAPPE, 1964/67, p. 24f). The generative behaviour is a part of the process sequence of the population and, inasmuch, it is subjected to many influences.

Conversely, the generative behaviour also influences the remaining processes, especially the social (adaptive) processes. Such interactions, complex in themselves, have been depicted in many different ways in the literature (e.g., D. RIESMAN, 1950; W. KÖLLMANN, 1958; G.-R. RÜCKERT and D. SCHMIEDEHAUSEN, 1975, p. 83f; J. SCHMID, 1976, p. 204f). As a rule, they do not take place directly, but via the psyche, and are thus rather difficult to conceive (R.S. PEARL, 1925, p. 178f). They can be detected in particular where structural changes due to processes in one task category produce changes in others. Thus, connections can be seen to exist between generative behaviour and religion (e.g., H. HAHN, 1950). Moral, prestigious or nationalistic reasons may effect an increase in fertility (for the Third World, see J.A. HAUSER, 1974, p. 112). The respective overall situation must be studied however, especially in the passage of time, as drawing premature conclusions can be dangerous. This also applies to the reciprocal influence exercised by generative behaviour and economy (dynamization). On the one hand it can be seen that an increase in population numbers is followed by an economic expansion, as in the High Middle Ages or in early Modern Times; on the other hand, the birth rate sinks with economic progress and is very low today in the industrial countries.

Various attempts have been made to render these complex relationships clearly conceivable in models, for the developing countries for instance (an example is provided by A.J. COALE and E.M. HOOVER, 1958). Systemic models that take into consideration the positive and negative feedback between the different elements were developed by K. DAVIS (1963) and J.J. SPENGLER (1966). These models provide an important insight into the mechanisms and their reciprocal influence, though the meaning and interconnections of the elements still remain very uncertain. It is a very difficult complex of controlled and uncontrolled processes.

A satisfactory long-term solution will not be found until attempts have been made to interpret the processes determining generative behaviour, taking into consideration population hierarchy and process-sequence. In doing so, special importance will have to be given to the theory of demographic transition. Various stages of development can be combined into a sequence. This model, developed by D.O. COWGILL (1949) and D. RIESMAN (1950; also K.M. BOLTE, 1964, p. 266f, H. SCHUBNELL, 1967, p. 37f; 1970, p. 255; J. HAUSER, 1974, p. 130) brings the birth- and death-rates into relation. Every people goes through each of the stages. The present industrial countries, e.g., W. Germany, have taken about 50-60 years (G. MACKENROTH, 1953, p. 56) for this, starting with the initial decrease in the death-rate (around 1870) to the end phase in the birth-rate drop in around 1920/30. The development in the other European countries followed a similar course. Today the industrial countries are entering a phase in which the birth-rate is dropping well below the death-rate, so that population numbers are falling (J. SCHMID, 1976, p. 287f; POPULATION DECLINE IN EUROPE, 1978). These developments can be pursued all over the world by cartographic means (cf. for instance, J.O.M. BROEK and J.W. WEBB, 1968, p. 436f; R. CHUNG, 1970). Though the drop in the death-rate is also a result of medical and hygienic measures, and the birth-rate falling tendency has to do with birth-control, these activities seem to belong to inferior processes; they should not be considered the real reasons for the changes in mortality resp. fertility. Rather, the readiness to use these means or methods by the people permits us to infer a structural change in generative behaviour as the superposed process.

4.7.1.2. Adjustment to the carrying capacity

Human beings as "products" of reproduction must be "adopted" by their environment in order to be able to live. Since this process leads into the living space or the natural environment, it may be considered as an induction process. Thus, the generative behaviour of a population is tied up closely with the carrying capacity of the region. The degree of differentiation is important. In order to maintain the members of a population, energy-material, particularly food, must be obtained from the environement or may also be brought into the living space from outside the boundaries. As a result, the problem of the carrying capacity turns into a problem of the relationship population/environment. We must therefore differentiate between societies that are autonomous and societies that are not. In dealing with the first complex of questions, we are concerned with mankind as a whole or with undifferentiated populations. The second complex of questions involves the different kinds of infrastructure of the populations.
Every population must permanently settle down in its niche in such a way that a dynamic equilibrium can develop and be maintained between the population and the environment. The direct comparison of population density with the potential of the living space contained in the term "carrying capacity" presupposes that the populations are autonomous, i.e., that they have no connections to neighbouring and superposed populations (section 2.5.2.). Inasmuch, the large number of investigations into the problem of global carrying capacity are acceptable (e.g., A. PENCK, 1925; 1941; concisely, K. SCHARLAU, 1953; R.B. LEE, 1966/69; St. BRUSH, 1975; E.B.W. ZUBROW, 1971, 1975). Studies of the Club of Rome: J.W. FORRESTER, 1971; D. MEADOWS, D. MEADOWS, J. RANDERS and W.W. BEHRENS, 1972; M. MESAROVIC and E. PESTEL, 1974).

The carrying capacity depends on the ability of the population to adapt to the conditions of the environment. The fact that the varying degree of differentiation (cf. section 2.2.2.) or rather the variations in production determine the carrying capacity soon became clear to the persons researching this problem. In essence, H. SPENCER (1876/96, part II and E. DURKHEIM, 1893/1922, p. 237f) had already recognized this. Several studies, by American anthropologists particularly, establish the close connection between population pressure resp. carrying capacity and the differentiation of a population (e.g., E. BOSERUP, 1965; D.E. DUMOND; 1965; M.J. HARNER,

1970).

Taking a closer look at the carrying capacity and at social differentiation, various aspects must be taken into consideration. A. SEGRAVES (1974, p. 538f) indicated the connection between the degree of differentiation and the stability in human population systems. This signifies fundamentally, that disturbances from the environment affecting the population can be absorbed more effectively in a differentiated system than in an undifferentiated system. This may be true in part (cf. for instance, the problem of cultural decay, section 4.7.2.3.2.). This does not mean however, that the division of labour came about in order to increase stability. In ecology too, where a similar discussion took place (cf. for example, W. HABER, 1972, p. 295f) attention is called to the fact that ecosystems with few different species can have a high degree of stability (H. ELLENBERG, 1973a, p.24f). It is more important however, that due to the division of labour, i.e. differentiation, human work-energy is saved (cf. section 2.2.2.); the population is able to use the environment better. By this means more human beings can be fed within the same living space again, so that the carrying capacity increases. This affects the generative behaviour of the population.

However, apart from the inhabitants of the earth as a whole, there are now practically no autonomous populations left (cf. section 2.5.2.) so that studies of carrying capacity are only of limited value if the living space alone is regarded as the source of energetic resources. The system opens up according to the amount of differentiation, i.e. the division of labour (J.H. KUNKEL, 1970, p. 195f), while the degree of autonomy is reduced. Due to the opening up of the system according to the differentiation reached, the density of links with the neighbouring populations grows. A. FISCHER (1925) already mentioned a carrying capacity dependent on internal factors and one dependent on external factors. G. ISENBERG (1965; G. ISENBERG and D. KRAFFT, 1970) distinguished between the part of the economy producing for external requirements ("primary population") and the part of the economy producing for internal requirements ("secondary population"). These considerations are based on the theory of export bases and the basic-non-basic conception, according to which the demand determines the economic development of a region from outside (R.B. ANDREWS, 1953/56; D.C. NORTH, 1955; Ch.M. TIEBAUT,

1956). In our context this means that those working for external demand serve the superposed system and thus are in an exchange situation with the environment and accomplish "fundamental" tasks, while those working for internal requirements serve the local system. For the calculations of carrying capacity it must be imputed that they are dependent on those working for external requirements and that their services are "derivative". Thus the considerations on the carrying capacity must also include the social processes.

Moreover, the problem of the environment and its conservation must be seen in this connection. Due to recent discussions against a background of research into ecosystems (H. ELLENBERG, 1973a, b; P. MÜLLER, 1977a, b), into landscape conservation (HANDBUCH FÜR LANDSCHAFTSPFLEGE, 1968/69; K. BUCHWALD, 1972; L. BAUER and H. WEINITSCHKE, 1973), and due to the work of the Club of Rome, mentioned above, a vast collection of literature has made the general public decidedly more aware of the problem of environmental protection in the past few years. The social and socio-cultural processes should be controlled in such a way that the ecosystems are given an opportunity to regenerate (cf. on the ecology of resources, I.G. SIMMONS, 1974). Even so, unintentional side-effects appear (E. NEEF, 1976). The destruction of vegetation and its replacement by cultivated plants in particular has caused wide areas of land to become deserted (using the Thar Desert as an example, C. RATHJENS, 1959; a survey by A.N. STRAHLER and A.H. STRAHLER, 1973; Ch.F. BENNETT, 1975; C. RATHJENS, 1979).

The energy that cannot be re-used is re-introduced into the environment, the living space, as we have emphasized, where it disperses and, in this respect, seen against the very long phases in the oscillation rhythm of inanimate nature, it does no harm. However, as the human populations live in shorter phases, and the order of magnitude is measured in days, years and centuries, the re-introduction of concentrated substance consisting of one-sided material compounds (e.g., chemicals, waste heat, radioactive substances) can produce considerable problems; it can interfere badly with the living space, by obstructing future processes that serve the supply of energy. A re-dispersion of substance facilitates the re-incorporation of the energy into the system that is superposed to mankind and provides the latter's basis for life.

4.7.2. Structure-changing processes

4.7.2.1. Periodization of the development of population numbers

The development in population numbers in mankind as a whole can be seen to have taken a course of exponential growth, perhaps since the birth of Christ, but certainly during the past centuries (J.D. DURAND, 1967/73; in some detail, C. Mc EVEDY and R. JONES, 1978). This has caused a good deal of debating on the carrying capacity of the earth in the past few years (cf. section 4.7.1.2.). Exponential growth is characteristic for a population succeeding in the competition battle in the ecosystem.

Recently, there seem to have been further indications of a slowing down of the growth rate, so that possibly in the long term a stabilization will be aspired to (D.J. BOGUE, 1967/73).

During the High Middle Ages, from the beginning of the 10th to the early 14th century, we can observe a considerable increase in population numbers in terms of the amount of settlement activity in Central, Western and North-West Europe, probably being interrupted in the late 11th century. In the second half of the 14th century on the other hand, the population numbers went back, as can be inferred from the drop in the number of rural settlements (late medieval desertion period, cf. section 4.7.2.2.). In the second half of the 15th century a renewed increase can be noted, continuing into the 1st half of this century, interrupted by a period of stagnation, or rather retrogression in the 17th and 18th centuries (e.g., for Britain, E. A. WRIGLEY, 1969). In Europe the highest point now seems to have been passed and a new phase of stagnation and retrogression has set in (cf. above). Thus two periods can be recognized, each taking in several centuries, initiated by an increase in population numbers and culminating in a decrease or stagnation of population numbers: the High Middle Ages and Modern Times.

This course of population development indicates centennial periods, which are characteristic of cultural populations. Thus the development in the pueblo area was temporally different to that in Europe, while in the Orient there were different trends again (cf. for instance, vast desertion period in Turkey around 1600; W.-D. HÜTTEROTH, 1968, p. 200f). In the population development of China too, the centennial rhythm manifests itself with maximum population numbers around 600, 900, 1200 and 1600 A.D. (accord-

ing to COOK, DURAND, PING-TI, HO and CLARK, cited in R.H. WHITTAKER, 1975, p. 386f).

Today however, the trend peculiar to the European cultural population seems to be becoming prevalent all over the earth. Due in particular to the achievements in medical research since the middle of the last century (in this connection, L. ASCHOFF, P. DIEPGEN and H. GOERKE, 1960, p. 34f; H. SCHIPPERGES, 1970, p. 232f), the hygiene situation, mortality and above all, child mortality, were drastically reduced. Population numbers increased.

This phase of rapid population increase spread out over the countries of the European continent in the form of an innovation wave emanating from Britain, where its presence was felt up to about 1880, and from there on to the less developed overseas countries. In the present decades it seems to be reaching the African countries least touched by European influence. Due to the drastic increase in population numbers, as already noted (cf. section 3.7.1.2.), the problems in the developing countries have become particularly urgent (cf. in the light of this complex of questions, with numerous examples, GEOGRAPHY IN A CROWDING WORLD, 1970; J. CLARKE, 1973, p. 106f; J. HAUSER, 1974). The population in the European countries on the other hand, is stagnating and some peoples are even becoming reduced in numbers (cf. above). However, due to the fact that in the course of the last decades so many countries have been affected by the increase in population numbers at the same time (particularly in East, South-East and Southern Asia, in the Orient and in Latin-America), the total population of the earth is still rapidly increasing. We can assume that this "population explosion" will come to an end when these countries have come out of the phase referred to, i.e., when saturation-point is reached there and the wave spreads out over the comparatively few remaining countries (especially in Africa). As noted above, this is slowly commencing now.

4.7.2.2. Rotation

Rotation processes can be recognized, for instance, in the shifting of the

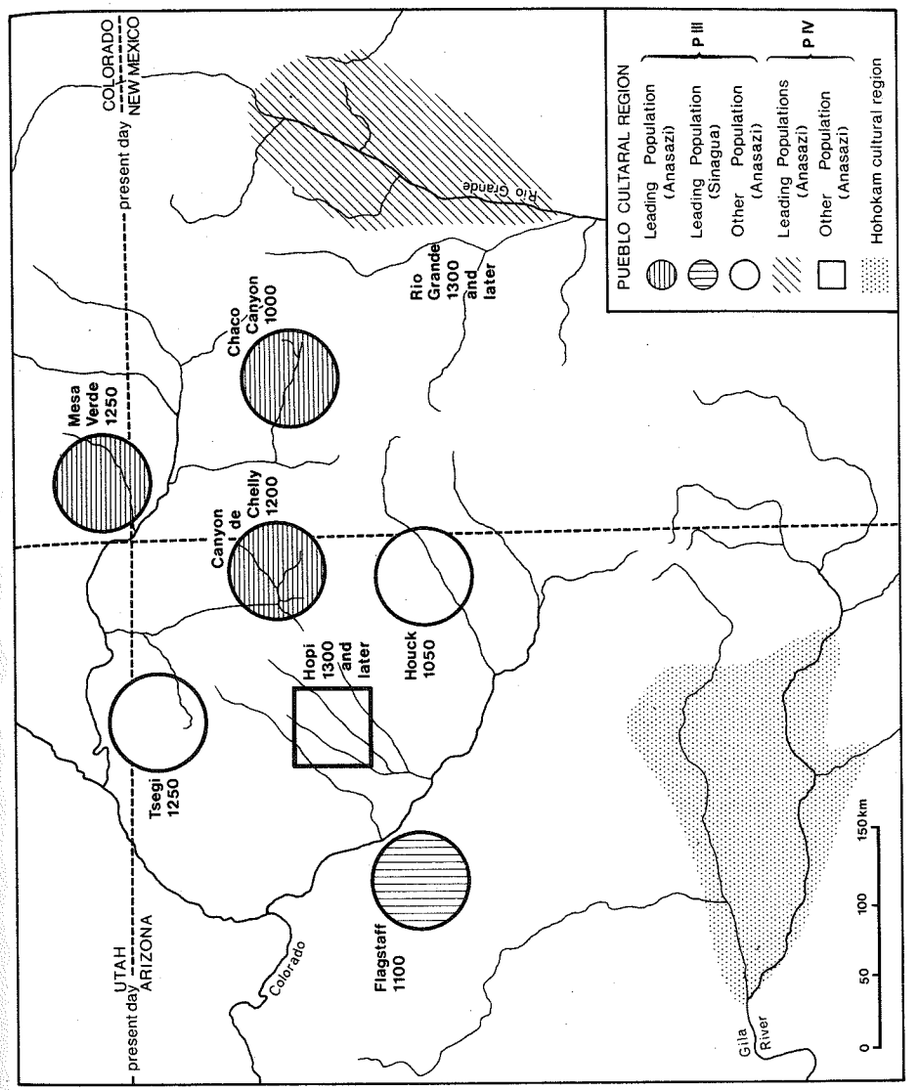


Fig. 21: Population maxima of different Pueblo populations in the P III and P IV periods (approx. 1000 - approx. 1600 A.D.).

innovation and reproduction centres of the Pueblo population between the 10th and 14th centuries (Fig. 21). Despite the fact that doubtlessly research is still incomplete, thorough detailed investigations in the big and conspicuous Pueblo buildings provide a certain justification for drawing conclusions that may lead a step further (S. PLOG, cited according to P.S. MARTIN and F. PLOG, 1973, p. 318f). It can be seen that within the cultural population one tribe enjoyed a particularly strong rise in population numbers at one particular point in time as compared to the others. After reaching a maximum this population dropped back again and another tribe took its place. In this way the centres of highest population density shifted.

Thus the different populations in the Pueblo cultural population one after the other each had their point of highest population numbers with intervals of 50-100 years in a rhythm that becomes more apparent later on in the PIV-period in the Pecos population (decennial rhythm; cf. section 2.7.1.). In other cultural populations too, a rotation of the centres of density can be observed, in the Mexican highlands for instance, before the Spaniards arrived (W.T. SANDERS, 1976). It is difficult to find an explanation for these phenomena.

American archaeologists devoted to the Pueblo cultural region used migrations over long distances to help explain the abandonment of the Colorado plateau settlements and the growth of the population in the Rio Grande area around 1300 (F. WENDORF and E.K. REED, 1955; St. JETT, 1964; F.H. ELLIS, 1967; R.J. FORD, A.H. SCHROEDER and St.L. PECKHAM, 1972), which in turn are supposed to have been caused by changes in the climate, stronger soil erosion due to over-exploitation or by increasing hostility on the part of "nomadic" gatherers and hunters. Ultimately, permanent adaptation was said to have become impossible, so that the populations lost their ecological equilibrium (J. SCHOENWETTER and A.E. DITTERT, JR., 1968; P.S. MARTIN and F. PLOG, 1973, p. 326f). However, the question arises, whether migration really played such an important part. Certainly, many migrations seem well substantiated (e.g. in the Jemez area: F.H. ELLIS, 1956; 1964). Similarities in the pottery style or architecture amongst the regions support this too, but they may also have come about by transfers which could be explained by contacts with small residual groups; these could have journeyed to populations in the Rio Grande region,

as can be substantiated for Pecos for instance at a later date when it was abandoned (cf. section 2.7.1.). In the Rio Grande region there already existed Indian populations who worked the land (e.g., in the Galisteo basin; N.C. NELSON, 1914), and also in the Hopi region (J.T. HACK, 1942, p. 18, 78f).

The decisive process, which caused the shift in the population's centre seems to be rotation, with a reduction in population numbers related to a de-differentiation of society on the one hand, and differentiation and an increase in population numbers on the other. The process of de-differentiation may have temporarily (for as long as the surviving groups were migrating) reached down as far as the level of the gatherers and hunters, even though up until the present, proof of this kind of economy in the Pueblo region could not be provided for the time before the Athapaska tribes (Apaches, Navajos, etc.) arrived in the 15th century (cf. below, section 4.7.2.3.1.; R.J. FORD, A.H. SCHROEDER and St.L. PECKHAM, 1972, p. 30).

In order to explain rotation we can perhaps link up to the observations made in the Pecos economic territory (cf. section 2.7.3.), showing that the chief area of cultivation shifted somewhat in a tangential direction with every oscillation phase. This was explained in particular by the fact that yield conditions in the living space were aggravated by soil erosion, subsequently affecting population numbers. In the course of new expansion, the Indians gave preference to neighbouring areas of ground that had not yet deteriorated. This hypothesis could also be a way of explaining the shift in the centres of reproduction in the Pueblo cultural region, assuming that the soil had been over-exploited due to the strong increase in population numbers (cf. also the elaborations of P.S. MARTIN and F. PLOG, 1973, p. 326f). Indeed traces of soil erosion can be observed in these areas, and have been studied in the region surrounding the Chaco canyon in particular. Presumably, a drop in population numbers would have been the result, which at the same time would have meant the loss of the position of leadership. The neighbouring population that would not yet have occupied a corresponding position in the cultural population, would have been able to take over this function. As these rotation processes came about in the cultural population as a whole however, we have to consider too, that not only soil erosion had an effect; soil erosion alone

could have been compensated for within the settlement or tribe area. Rather, the competitive situation between the tribes must also be taken into considerations; these populations strove to take over the leading position in the cultural population. If a limited area of living space is considered appropriate for the cultural population in accordance with the low degree of differentiation, an upper limit must also be assumed for the population numbers (cf. on the problem of equifinality, section 2.4.2.). As every population has a certain spatial structure (cf. section 4.4.1.2.), the central, leading population too can only reach a certain population density. Presumably, a state of equilibrium, corresponding to the carrying capacity, is achieved or at least aspired to, between the entire population and the living space. If we assume then, that difficulties in reaching and maintaining a state of equilibrium in the tribes with high population density cause a drop in population numbers, it may become understandable that another tribe had to take over and maintain the top social position, in order to conserve the population structure within the cultural population. This tribe had to take on the duty of social leadership within the cultural population, for in societies with such a small degree of differentiation, guiding the social and the biotic, reproductive processes is up to one and the same population. The leadership thus went to a population that had no problems with ecological assimiliation in the living space yet. Under these circumstances, rotation would seem to be in the problem of having to harmonize the maintaining of the superior population and the latter's opportunity of developing fully in its own living space. This seems to show that the top social position within the cultural population can only be held by one tribe or people for a certain period of time, until the increasing population numbers lead to problems with the environment, the carrying capacity. It is plain that, in the absence of special circumstances, there is hardly a population able to maintain it for a long period; after a certain time, there is generally a decline, a sinking to a lower level.

Whatever the case may be, it appears quite obvious that on the basis of the reflections presented so far, it is not possible to understand the development of population numbers without considering the reciprocal influences with processes in the remaining task categories and the course of development of the superior population.

4.7.2.3. Expansion resp. contraction of the living space as induction processes

4.7.2.3.1. Land occupancy and colonization

If the generative behaviour (population numbers) and carrying capacity of a region cannot be adjusted to each other, population density may be too high or too low as a result. Consequently - assuming there is a certain degree of differentiation - this may be compensated by changing the generative behaviour (cf. above, section 4.7.2.1.) or by changing the living space, i.e. land occupancy or colonizing resp. land abandonment or desertion. These processes may be considered structure-changing induction processes because they lead into another area and change its structure (cf. the conquest of New Mexico by the Spaniards, section 2.6.3.). The population encroaches on the umland from its living space, possibly into the living spaces of other populations. When for instance, whatever their reasons, the Teutonic tribes left their native living space during the Migration of Nations, some in complete tribes, others having separated, to settle down again in another part of Europe, after driving out or conquering the previous settlers (e.g., the Celts and Romans), the populations as such remained the same or formed again during the migration (R. WENSKUS, 1961, p. 462f). One living space was abandoned and, following migration, another was occupied. We refer to this as land occupancy. This is conceivable if there exists a certain amount of control, encompassing the whole population. Similar processes can be found all over the earth. Gatherers, hunters and nomads may also occupy land. In the south-west of the present-day United States, the arrival of the Athapaska Indian tribes can be reconstructed, particularly the coming of the Navajos in the 15th and 16th centuries (J.J. HESTER, 1962).

In this order of magnitude the processes of land occupancy generally emanate from almost autonomous, hardly differentiated populations such as gatherers, hunters or agrarian populations. On rare occasions this kind of land occupancy process can also be found in more differentiated societies; the migration of the Mormons to the western parts of the USA and their settling in the Great Salt Lake region can be cited as an example here. This process can only be conceived against the background of the settlement of North America however; a process that should be interpreted as colonization (F.J. TURNER, 1920; R.A. BILLINGTON, 1949, p. 532f).

In contrast to land occupancy therefore, we refer to the settling down of a mass of people who cannot be defined as a population, as colonization. When for instance, in the High Middle Ages, settlers migrated from western Germany to the east in order to settle there, only small populations existed at first - families, religious or political groups -, with hardly any organizational connections. The settlement itself however, had been planned and organized by enterpreneurs, and in the ensuing phases of development and consolidation of the country and the administration, new ethnic groups came into being - the Brandenburgs, Silesians, Pomeranians, etc.

Colonizations can be organized in different ways. The order of magnitude is an important factor in this. In Central Europe during the High Middle Ages or early Modern Times for instance, subsidiary farmsteads or settlements grew up in many places in the common lands (R. MARTINY, 1926; M. BORN, 1974, p. 44f; 77f). If larger areas within the living space of one people were settled, we speak of inland colonization. The settlement of the moors in northern Germany during the era of Absolutism can be seen in this light (A. KRENZLIN, 1952; H.-J. NITZ, 1976b). Thus the biotic over-production of the state population could be partially absorbed within its own living space. On the other hand, new territories outside the living space of the people or tribe are drawn into the power influence or are settled. These colonizations can have different aims (trade, power, economy, settlement; A. HETTNER, 1915). In the course of settlement colonization the settlement forms are developed further. They join up into a series of forms (first recognized by A. SCHULTZE, 1962; elaborated by W. CZAJKA, 1964; R. KRÜGER, 1967; D. FLIEDNER, 1969; H.-J. NITZ, 1976a; D. DENECKE, 1976b; M. BORN, 1977). In the beginning there are usually irregular forms or forms developed out of others. In the next stage they receive their specific shape. This formation phase develops into the phase of greatest extension in which the "peak form" becomes multiplied. During the last phase of colonization, only impoverished forms tend to be established. These series of forms and their configuration become conceivable by their succession.

If a region is settled by means of colonization, this does not mean that a population comes into being immediately. Not until a sequence of induction and reaction processes has taken place, does a marginal mass of people become a population. Colonization normally comes about in close accordance

with the natural resources of the living space, e.g., linked to water supply soil quality etc. (for the Peace-River-Valley, cf. E. EHLERS, 1965), facilitating the adaptation to the living space, though other trends later also appear on the scene. This process is accompanied by a re-structuring of the earthbound artefacts of the cultural landscape. High population numbers a great distance from the mother population, as well as a rich and varied furnishing of the living space and natural barriers on the boundaries, e.g. mountains and desert areas, all go to encourage the formation of new populations, for they hamper outside control by the mother populations. The fina phase reveals a tribal or ethnic population within the living space, wanting to determine itself (e.g., by means of a constitution), and to regulate and organize itself (becoming politically independent and administering itself). The states of North or South America are examples of this. This stag is often not attained however. For instance, in the course of the Spanish colonization in New Mexico after approx. 1600 (cf. section 2.6.3.) and the ensuing establishment of a self-regulated economic region, only an ethnic group developed when in the middle of the 19th century the US Americans took over the area. At this time a people came into being in Mexico (D. FLIEDNER, 1975). Within the newly formed population, smaller populations remain in existence for some time as ethnic minorities within large inhomogeneous masses of immigrants, e.g., in the case of the colonization of North America. Others, for instance religious groups, become organized at the colonization frontier out of a need for protection (BILLINGTON, 1949, p. 89f, 532f).

4.7.2.3.2. Land abandonment and desertion

Land occupancy can be related to the abandonment of land. A migration takes place between the giving up and the taking possession of land. The era of the Migration of Nations was characterized by numerous processes of this kind (R. WENSKUS, 1961). We know very little about these migrations covering decades or even centuries, or about the structure of the populations at the time. The circumstances surrounding the processes of land abandonment are similarly obscure. In the past, researchers have dealt more with the occupancy of land and the increasing differentiation of the population, as the settlements and other earthbound artefacts can

be studied better in this light.

In many cases tribal migration can be substantiated. However, it cannot always be assumed that every large area of ruins was connected with emigration of some kind. In many cases it is more likely that land abandonment, a drop in population numbers and the decay of the organizational forms were more closely related, i.e. that the population became de-differentiated. For instance the Hohokam Indians had developed an advanced irrigation culture between approx. 900 and 1400 A.D. with several large villages in the south of what today is taken up by Arizona (O.A. TURNEY, 1929; P.S. MARTIN and F. PLOG, 1973, p. 286f), so that we can speak of a small cultural population. However, as far as we know the population numbers then dropped, leaving enough space at their disposal. The population was no longer motivated to keep up intensive irrigation farming, and thus changed to rain farming. Supposing this to be the correct interpretation of events, this would constitute a de-differentiation process (cf. section 2.2.2.), i.e., an institution, in this case intensive irrigation farming, was given up and regulation and organization were transferred to hierarchically lower placed populations. This means that cultivation was again controlled by the settlement populations alone.

Looking closer at this, it is necessary to imagine that for intensive irrigation a good deal of work-time is required per person in order to keep the irrigation going, i.e., to maintain the ditches, control the distribution of water and the communal administration etc.; in fact for maintenance activities not assignable directly to primary production. If there are not enough consumers to take the foodstuffs, production is cut down. At the same time however, less work-time is required accordingly for maintenance activities in order to keep irrigation going, than for activities devoted directly to field cultivation. In comparison therefore, this kind of work becomes more important. Ultimately the point is reached, when only field-work remains, and the system of ditches, on the other hand, falls to ruin (for a general survey, E. BOSERUP, 1965, p. 65f). Thus when the Europeans arrived in the 18th century they found rain-cultivation in the south of present-day Arizona. The Pima Indians living there can be considered descendants of the Hohokam Indians (P.H. EZELL, 1963).

The rise and fall of the cultural populations was referred to by R.C. THURN-

WALD (1936/37/66, p. 384f) as cultural rhythm. A.J. TOYNBEE (1950/54, p. 241f; 355f) incorporated the decline and decay of cultures as "social bodies" into his historical considerations (cf. also I. SCHWIDETZKY, 1954, p. 80f). Whatever the case may be, the generative behaviour changed (cf. sections 4.7.1.1.; 4.7.2.2.). Often the processes take up position in the course of rotation processes of the superposed populations (cultural population, mankind; cf. section 4.7.2.2.).

Desertions are often linked to colonizations. As we have pointed out (cf. for instance, section 2.6.5.), a settlement colonization can be triggered by growing food scarcity in the superposed population. When the moment indicating satiation has been reached, the colonization and grain production still go on increasing. The grain prices sink, the colonists receive less money for the same effort. With colonization processes this not only has a checking effect, but also often causes the retraction of the colonization front, to be interpreted as over-compensation ("overshot"; cf. section 2.7.1.). Thus desertion processes can also be conceived as manifestations of the processes at the colonization front on the fringes of the superposed population.

Thus colonization and desertion processes give evidence of a striving for stabilization by the superposed population. Extension and contraction of the living space are a result of the interrelations between the population on the one hand, and its living space and the neighbouring populations in the system umland on the other; the processes become stimulated resp. checked or even cancelled by positive and negative feedback. The rhythmic way in which the processes take place (cf. below, section 4.7.2.3.3.) can be interpreted as the system's means of finding its own level in the environment. Populations develop and decline in a rhythm and as a consequence of the oscillation coming from the superposed populations.

4.7.2.3.3. Periodization of colonization and desertion processes

The expansion of the European cultural population over the earth, or Europeanization as it is called, took place in Modern Times starting in the 15th century and going on into the early 20th century. It constituted a large

and many-faceted colonization period, which equalled the Early Medieval and High Medieval periods of expansion. All these constitute centennial phases in the development of the European cultural population, with different motives coming to the fore in each case, depending on the stage within the process-sequence (cf. section 5.2.).

Within these periods of expansion there are certain recognizable phases of a lower order (in the decennial rhythm), in which inland colonization played a major part. A large number of rural settlements and towns were established and re-organized in them. In Modern Times the mercantilistic colonization period in the 2nd half of the 18th century deserves mention, in which thousands of villages, many towns and transport lines came into being (U. FROESE, 1938; A. KRENZLIN; 1952; cf. Fig. 20). This period of new settlement can be set against the woodland clearing period in the High Middle Ages, particularly in the 12th and 13th centuries, when, in the course of the German colonization of eastern Central-European areas (e.g., R. KÖTZSCHKE, 1937; 1953), connected with inland colonization in West Germany (H. JÄGER, 1958; H.-J. NITZ, 1972b) the land became covered with rural settlements. In France and England similar periods are recognizable (M. BERESFORD, 1967, p. 319f, 339f, 348f). A corresponding period may already have existed in the 8th or even the 7th century, this being the period of Franconian state colonization (H.-J. NITZ, 1961; 1963; 1971; M. BORN, 1974, p. 32; cf. also section 5.2.).

These colonization phases alternated with stagnation or desertion phases. A present decline in settlements joins on to the great period of colonization, taking in several centuries, of Modern Times. Population numbers within the cultural population increased or - as at the present moment - stagnated, so that the cause of the desertion phenomena cannot be sought here. Rather, spatial concentration trends, together with urbanization and industrialization had a part to play (cf. section 4.4.1.2.).

With other desertion processes that can be substantiated historically, however, a certain drop in population numbers seems to have played a part as well, though to a quite different extent. With the great period of desertion in the late Middle Ages in Central Europe, this is quite apparent (W. ABEL, 1943/76). It came after the period of woodland clearing and colonization in the High Middle Ages and was succeeded by the land development

resp. Europeanization of the earth in Modern Times. Thus the desertion period separates the Middle Ages from Modern Times, the great periods of population and economic development of the European cultural population covering several centuries respectively. However, this desertion period was at the same time also accompanied by a re-structuring of society and the economy, causally related to it (cf. section 3.4.2.).

These great periods of colonization and desertion peculiar to the development of the European cultural population, reveal a centennial rhythm. Smaller phases of inland colonization, and organizational alterations within the various states can be brought into a decennial rhythm (Fig. 20). This periodicity, agreeing in most details, except for some regional variations (e.g., the abrogation of the Edict of Nantes in 1685 influenced the colonization of the Huegenottes; the revolt of the Indians in New Mexico in 1680 had an effect on the Spanish colonization, etc.), shows that we should interpret the colonizations as the expression of the oscillation of the superposed cultural population (cf. section 5.2.).

5. SYSTEMS AND PROCESSES; SUMMARY AND FINAL CONSIDERATIONS

5.1. MANKIND AS A SOCIO-BIOTIC UNIT

Mankind as a society must accomplish a number of tasks in order to survive. The process is adaptation. The social processes as induction processes (a) shall now be briefly indicated, with reference in each case to the most important institutions (b), the responsible populations (c) and the duration of the process (oscillation period) (d). Mankind as a biotic unit reacts by differentiating its reproduction processes. Thus the main reaction processes (e) will be pointed out as well as the resulting population structure (f) (cf. also table 2).

Perception:

a) Following on to the preceding process, finding out the requirements and assessing the environment. The products are knowledge or the image.
b) Chief institutions are magic, science and art.
c) Due to mankind's specific aptitudes (sensory organs and the ability to store what has been learnt by experience and to put this knowledge to rational use), it is responsible as a whole.
d) Duration of the process: about 5000 years (millennial rhythm).
e) Main reaction processes are education ("bildung") and learning.
f) Short-lived encounter groups develop uncontrolled.

Determination:

a) Instructions as to the activities required for survival (the setting of tasks). Steadying the processes by means of institutions ("culture").
b) The chief institution is religion.
c) The cultural population provides the organizational frame. The primary population accompanying it is presumably race.
d) Duration of the process: about 500 years (centennial rhythm).
e) Main reaction processes are gaining an attitude to life and education ("erziehung").
f) Character groups develop uncontrolled, due to the division of labour.

Regulation:

a) Control is exercised by a systemic structure with feedback mechanisms

processes resp. populations / task categories		perception	determination	regulation	organization	dynamization	kinetization	stabilization
social processes (adaptation)	main institutions	magic, science, art	religion	govern-ment	traffic	economy (investment)	economy (production)	exchange, trade
	main controlling media	senses	Church, social control	information, conveying media, admin.	means of transportation	earthbound artefacts	mobile artefacts (technics)	money
socio-biotic processes (socio-reproduction)	main reaction processes	learning	gaining an attitude to life	social movement	migration	adaptation	propagation	generative behaviour
	population structure	encounter groups	groupings distinctive characterist.	social strata	ring structures	aggregates	populations	popul. in their environments
oscillation	duration of periods	ca. 5000 years	ca. 500 years	ca. 50 years	ca. 5 years	ca. 1 year	ca. 1 month or week	ca. 1 day
performing resp. emerging populations	primary population	mankind	race?	tribe, people	ethnic group	local group	family	individual
	secondary population		cultural population	state population	city-umland population	community	organisate	

Table 2: Important processes, institutions and populations maintaining mankind

(communication).

b) The chief institution is government.

c) The responsible populations are tribes, peoples and state populations.

d) Duration of the process: about 50 years (decennial rhythm).

e) Main reaction process is social movement.

f) Hierarchization and social stratification take place uncontrolled.

Organization:

a) Society establishes the spatial order for the processes.

b) The chief institution is traffic.

c) The framework in which this controlled process takes place is formed by the ethnic group (primary population) or the city-umland population (secondary population).

d) Duration of the process: probably about 5 years.

e) Main reaction process is migration.

f) Ring structures develop uncontrolled, tapering steeply in the centre and sweeping out at the edges.

Dynamization:

a) Taking up energy (products of the inferior populations); in point of fact, economic investments and factor input. By creating earthbound artefacts, the flow of energy becomes fixed.

b) The chief institution is the economy (investments).

c) The responsible primary resp. secondary populations are the local group, the community or the settlement population.

d) Duration of the process: about 1 year.

e) Main reaction processes are adaptation (social) processes.

f) Homogeneous groupings, aggregates ("wirtschaftsformationen", life form groups) develop uncontrolled within the ring structures. The inferior populations within these aggregates compete with one another.

Kinetization:

a) The task is production. Media control the processes.

b) The chief institution is the economy (production).

c) Families and organisates are the responsible units.

d) Duration of the process: about one week or one month.

e) Main reaction process is propagation.

f) The population emerges uncontrolled as production unit and as carrier

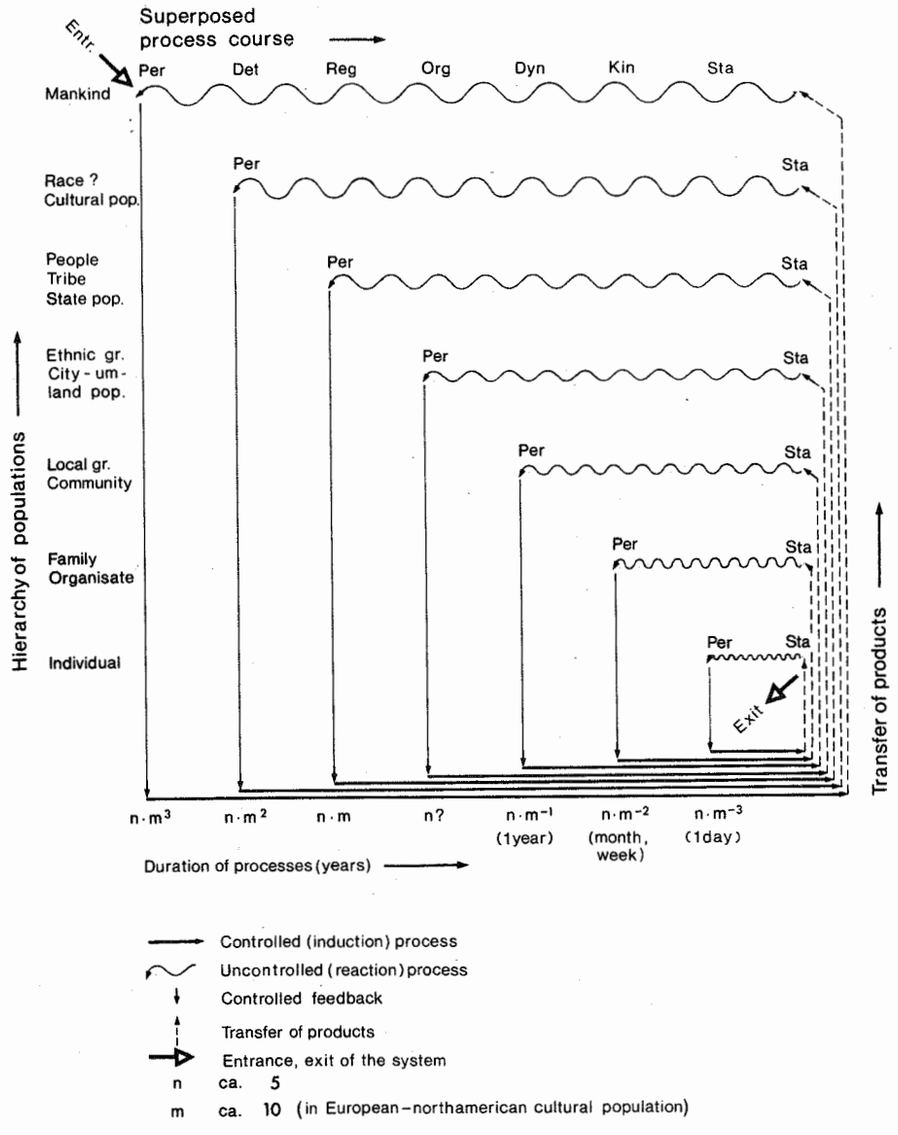


Fig. 22: Mankind as a society and as a socio-reproductive unit. Structural model of population hierarchy and process-sequence (cf. text).

of the process sequences.

Stabilization:

a) The products of society are taken on by the population as a biotic unit.
b) The chief institution is trade.
c) Only the individual can combine workand consumption in a controlled manner.
d) Duration of the process: about one day.
e) Main reaction process is generative behaviour.
f) Adjustment of individuals and populations to their environment, i.e., gaining the carrying capacity may be considered an uncontrolled process.

Fig. 22 is an attempt to sum up the processes and populations that make up mankind as a society and as a socio-biotic unit and to relate them to one another. The seven major control loops are shown linked together and fixed by the population type (left), the task category (top) and the duration of the process respectively (=phase duration of the oscillations, bottom). For instance mankind as a population, perception as the task category and $n \cdot m^3$ years process duration constitute a related unit; similarly, the local group or community as a population, dynamization as the task category and one year process duration. Any inferior population resp. subsequent process appears on the right hand side underneath the respective superposed population resp. preceding process.

Each of the seven control loops emanates from the respective population and its requirements, i.e., from the top left hand corner, and ends again in the population at the top right. The time passing as the process takes its course travels from left to right in the diagram. The course of the process runs according to the process sequence (perception to stabilization), with each respective inferior population following in a 10 times shorter oscillation phase (shown logarithmically shortened in the diagram). For instance, determination is carried out by the cultural population; the latter needs about one tenth of the time required by mankind for its particular process sequence ($n \cdot m^2$ as against $n \cdot m^3$). For the cultural population this phase is a structure-changing process, while during the following nine tenths of the time the same determination is on the whole retained (possibly varying a

little, however, as soon as a further tenth of the time has passed). Regulation ensues on average in the third tenth of the oscillation phase of mankind, dealt with by the tribes, peoples or states, etc. Within 10 oscillation phases for the one process sequence, the 7 single processes of this sequence have to be completed. At the bottom, the controlled processes (induction processes) are represented. The production volume is adjusted to the requirement by means of feedback, because the population structure and the respective reproductive processes at the same time become adjusted to the adaptation processes uncontrolled (reaction process). Oscillations arise. This is shown at the top of the diagram.

During the course of the process, alterations in the amount and the kind of demand come about. At the end of the process sequence, if it is reached, the processes are thus given a different direction, and determination has to be changed again.

Each process is in itself complete, if it is successful. Thus a basically simple interlinking of the populations and processes becomes extremely complex and interlaced looked at more closely.

5.2. THE COURSE OF THE PROCESSES

Social and biotic processes interact together. This is even manifested by the little differentiated population of the Pecos Indians. Adaptation as induction and socio-reproduction as reaction processes succeed one another with a temporal delay. This produces oscillations. In the highly differentiated European/North American cultural population the process sequences are pronounced, i.e., the single tasks follow one after the other starting from perception through to stabilization. Innovations in the institutions make this apparent.

On the basis of these reflections, we shall attempt - with every care - to make apparent some process sequences by taking a look at the course followed by innovations. The fact that any conclusions ought to be substantiated

by further innovations analyses must be plainly established at this point. Although the recognizable historical events and processes should be interpreted as expressions of process sequences, their interpretation cannot always be completely unquestionable. However, it is precisely this interpretation that is needed to thoroughly understand the meaning of the processes.

We shall consider here only the millennial, the centennial and decennial rhythms. As stated above, a population does not exist for itself, but for the role or task it is supposed to accomplish; it must complete certain processes in order to solve these tasks. First of all then, the superior processes emerge, as they govern the inferior ones. This means that we have to go down the process hierarchy starting from the top to find out which processes have which meaning. As the smaller processes take on the results arrived at by the superior, preceding processes as input, it is easier to interpret the superior processes.

Thus it is relatively easy to identify, for instance, the organization phase in the MILLENNIAL RHYTHM, for it has to be determined by the development of the city and its distribution, as was shown by earlier statements (section 3.4.2.). With the "urban revolution", a phase was initiated in which cities spread out over the earth.

The formation of cities is above all an achievement of organization. The "industrial revolution" on the other hand seems to be initiating an economic phase (dynamization). This means that in our present time a transition from the phase of organization to that of dynamization is taking place.

It is more difficult to interpret the preceding phase ushered in by the "neolithic revolution". At that time the tribes became settled, agriculture started with rain cultivation at first and going on to irrigation cultivation later. However, no economic organisates separate from the families came into being; probably more important in this phase was the development of government and later on of state as separate institutions. Irrigation cannot be regarded as a technical question alone, as the tools remained the same as those used for rain cultivation, but rather as a question of regulation (K.A. WITTFOGEL, 1955). The operation of complex systems of irrigation requires a social hierarchy, a certain form of government. And in fact, in

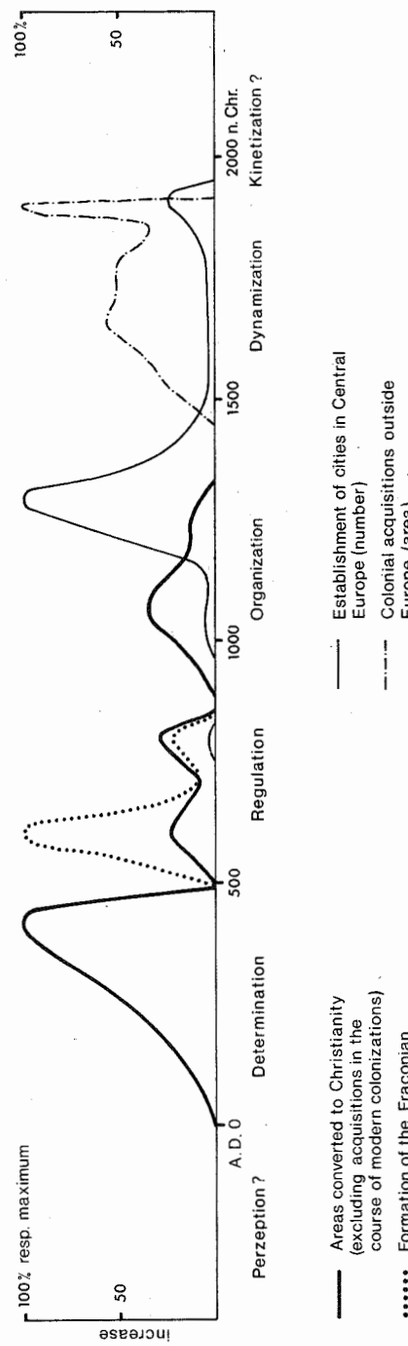


Fig. 23: Centennial phases in the development of the European/North American cultural population.

this period the first states were being founded in the Orient. On the other hand, similarly complex (much later) systems of irrigation in the south-west of the present-day USA (Hohokam; O.A. TURNEY, 1929; H. S. GLADWIN, E.W. HAURY, E.B. SAYLES and N. GLADWIN, 1938/75; R. M. HERSKOVITZ, 1974) were not constructed within the scope of states, but were probably built within populations with a governmental structure (P.S. MARTIN and F. PLOG, 1973, p. 313). Basically in the scope of the adaptation of mankind, settling and cultivation of land can be seen to be linked up closely to government. In the development of society the innovation of settling and cultivation is perhaps the decisive step on the way to a controlled utilization of the natural environment. If so, the "neolithic revolution" would have provided mankind with government as a precondition for State above all else, and would thus have served regulation. Then it could be inferred from this that a process sequence emerged revealing the three elements: regulation(?), organization and dynamization.

Within these long phases we can observe the CENTENNIAL RHYTHM, e.g. in the development of Europe. It took place in the second half of the phase of organization in the millennial rhythm in particular, as can be reconstructed from major innovations (Fig. 23). The perception phase can be assumed to have been in classical antiquity when a specific view of life began to take on shape in philosophy, science and art. At the same time this will probably have been the final phase in the development of the cultural population of the ancient Orient. The spread of Christianity throughout the Roman Empire marks the determination phase. The formation of states, especially of Franconia, in the second half of the first thousand years signalizes the phase of regulation, the main phase in the formation of towns in the High Middle Ages also means the organization of the cultural population in this context, while the colonization of the earth can be assessed as an extension of the economic foundation, i.e. to be thought of as dynamization, ending with industrialization. At the moment we are probably entering the phase of kinetization.

We can take these phases to be more or less plausible in their meaning, as they are relatively easy to substantiate. Nevertheless a clearer and more definite establishment of the meaning is required.

This applies all the more to the subdivisions of the centennial rhythm. The

most recent phase of the centennial rhythm, Modern Times, is probably the easiest to classify. It serves dynamization and its product is thus a multiplication of energy production, an increase in the carrying capacity. Of course, we can here give only a rough representation of the development. Every major innovation that is conform to the system means a greater increase in the division of labour (cf. section 2.2.2.), i.e., the splitting off of the processes that are supposed to solve the task-problems resulting in the process sequence, so that amongst other things special organisates are formed. As processes that encourage the dynamization of the population are meant here, the main question to ask could be something like:

By which process of differentiation was dynamization in Modern Times given most stimulation,

a) within the scope of science (perception)?
   The Renaissance will be hit upon, for at that time science developed, severing its ties with the Church;
b) within the scope of religion (determination)?
   The Reformation led to a new attitude towards work and economic success by becoming separated from the Church in the traditional sense (cf. section 3.2.1.1.3.);
c) within the scope of government (regulation)?
   During the time of Absolutism, the government was separated from the old estates, thus initiating a change in the old social order. In Great Britain a similar development took place in the 17th/18th centuries, though they did not follow the course of Absolutism (G.M. TREVELYAN, 1944);
d) within the scope of traffic (organization)?
   The construction of canals, later on of railways and big freight ships, were the most important innovations. By this means the transport of mass freight, e.g. of coal or peat could be optimized according to the requirements of the means of transport;
e) within the scope of providing an energy basis for the economy (dynamization)?
   Mining particularly profited from the new opportunities of organization in the countries, forming special new focal points which were no longer directly dependent on the traditional hierarchy of central places. Conurbations arose. Moreover the imperialistic phase of the colonization of the

earth was determined in particular by economic interests (extension of the raw material basis);

f) within the scope of production (kinetization)?
Industrialization was able to unfold to its full extent; in the 19th and 20th centuries this kind of economoy became spread out over Europe.

Accordingly, industrialization would not only have initiated the phase of dynamization in a millennial rhythm (assignable to mankind), but could also be interpreted as the phase of kinetization of dynamization in a centennial rhythm (assignable to the European cultural population). The cultural population would have completed its task in the stabilization phase, while at the same time a new process sequence in a centennial rhythm would have begun. In actual fact it can be observed that the European population in its original size, i.e., covering Europe as it really is, is only one population amongst several others and that the leading powers are already outside the traditional living space of the cultural population. The European cultural population has taken on world-wide dimensions: it is now the European/North American cultural population and is striving to become identical with mankind while the peoples and states of Europe are trying to form a state population. The present expansion of science would correspond to the phase of perception under this interpretation; its end is now in sight however (D.J.d.S. PRICE, 1961). Perhaps the phase of determination will now set in in a decennial rhythm, possibly finding expression in a restructuring of the religious system of the cultural population. We could proceed in much the same way for the High and Early Middle Ages, although of course the data-situation is not nearly as good. We shall not go into this any further at this point.

A first approach to finding a subdivision of the last DECENNIAL PHASES is revealed when the course of innovations presumably connected with the development of the German people (Fig. 13, 14, 16) is studied. Thus we could find a frame for the 5-year-rhythm. For this the innovations indicating perception and determination have not yet been able to be identified. Furthermore, the other innovations should only be regarded as being preliminary. But even so it can be seen that in principle, process sequences can be reconstructed. We should like to emphasize that these interpretations will have to be substantiated by means of historical-geographic inductive investigations. Future research will have to deal with completing and rendering more precise the catalogue of criteria permitting a definite classification of processes and events.

However, it must always be kept in mind that not the institutions, innovations and events themselves are determined in the sequence, but rather that these are merely meant to serve perception, determination, regulation etc. The results of these processes prove the extent to which they are suitable for carrying on the development for the purposes of the sequence (cf. section 2.6.3.).

Figs. 24 and 25 synoptically represent important processes in a decennial rhythm in the European/North American cultural population after 1700 for the social and socio-biotic processes as induction and reaction processes. It must be emphasized however, that the single processes usually belong to different sequences. Only because within the cultural population homogeneous processes follow courses in approximately synchronous rhythms - as can be seen from the survey of the colonization phases in Fig. 20 - can statements be made on the grounds of a representation such as this.

In the first instance, the phasing rhythmics can be recognized quite plainly in the different task categories. The reaction processes follow on to the induction processes (without the 50-year rhythm) after about 20 years.

If we compare the social or induction processes and the socio-reproductive or reaction processes (as far as they are available in detail at present) in the various task categories, i.e. if we read the two diagrams (Figs. 24 and 25) from the top to the bottom, it becomes recognizable that the single phases succeed one another in the different task categories. For instance, in the case of adaptation (maxima of innovations or processes in each case; cf. also the sequence of basic inventions and innovations from G. MENSCH, 1975, p. 251): Perception 1815, Determination ?, Regulation 1825, Organisation 1840, Dynamization 1855, Kinetization 1860, Stabilization 1865;
or with the socio-reproductive processes:
Perception ?, Determination 1835, Regulation 1860, Organization ?, Dynamization 1865, Kinetization 1875, Stabilization 1895.

The last phase of the sequence (stabilization) corresponds temporally approximately with the first in the following sequence (perception). Irregular-

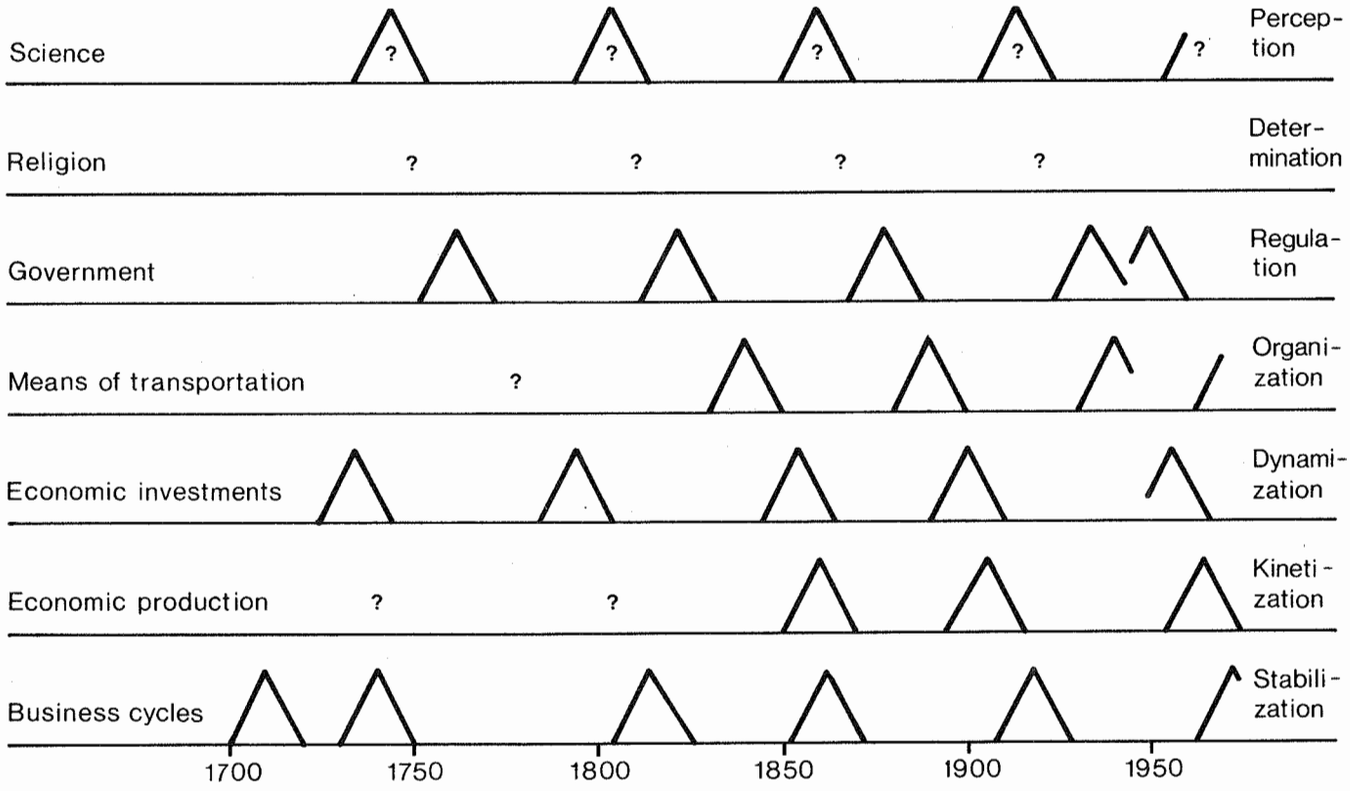


Fig. 24: Decennial phases in the development of European state populations since the 18th century. Simplified survey of different adaptation processes presented in the treatise.

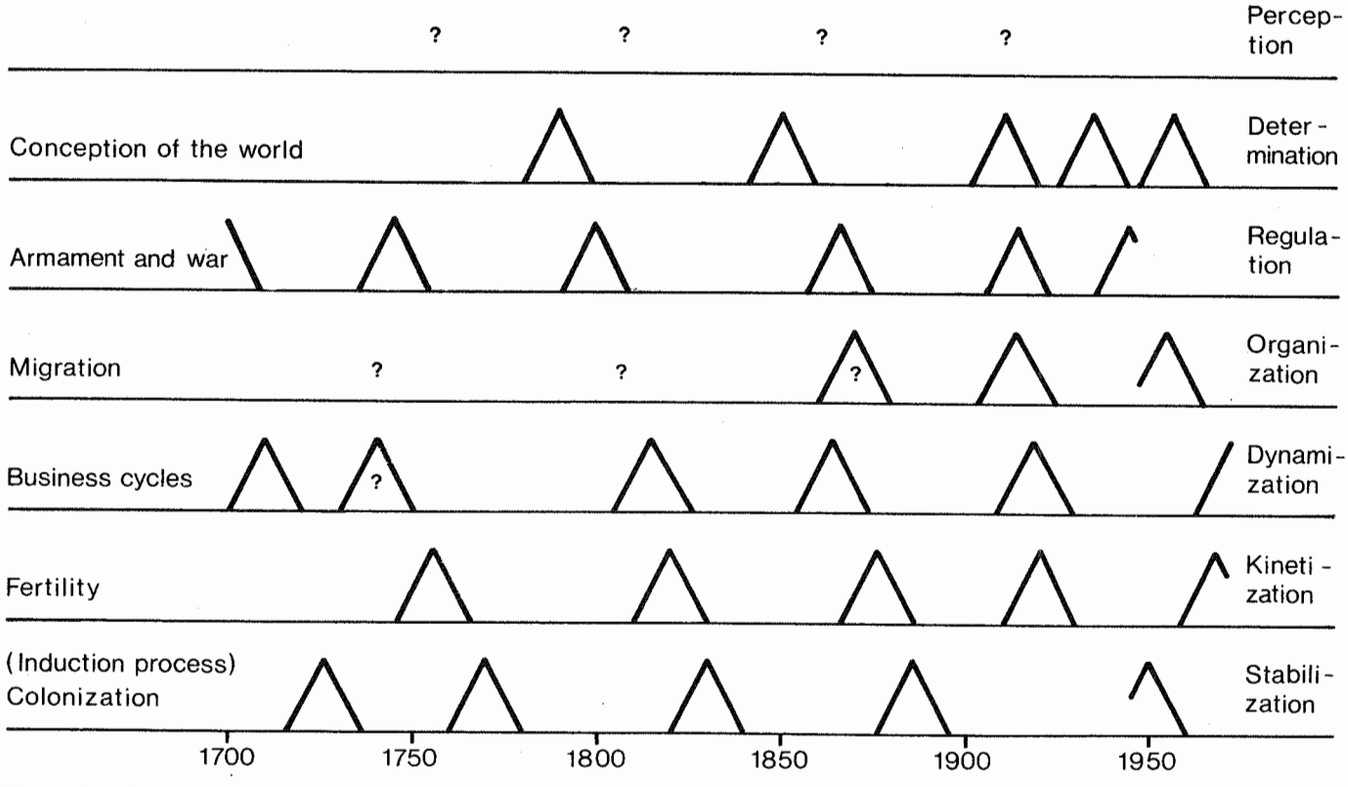


Fig. 25: Decennial phases in the development of European and North American state populations since the 18th century. Simplified survey of different socio-reproduction processes presented in the treatise.

ities appear around 1920 to 1940 due to the development of Fascism and the outbreak of the 2nd World War. An interpretation within the scope of this treatise is not possible yet. In this connection we must emphasize again (cf. above) that the series of phases shown here can only be considered in part as elements of sequences. Moreover, a number of different processes cannot be interpreted yet (e.g., the periods in the history of art). Precise studies are required in every respect.

The thoughts set down here can be represented in a model (Fig. 26) which includes the respective changes in state. These may be interpreted as transformations or, briefly, as progress in society.

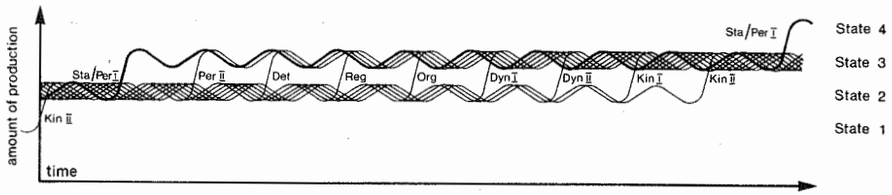


Fig. 26: Process sequence and change of state. Schematic drawing (cf. text)

5.3. A PRELIMINARY ACCOUNT REGARDING A MATHEMATICAL FORMULATION OF THE PROCESS THEORY

A formalization of the process theory presented in this treatise must present the facts within a set of functions. The written word must be transposed into the more precise language of mathematics. The following shall be an introductory attempt to indicate the lines along which a solution might be found.

In the treatise we distinguished between structure-conserving and structure-changing processes (section 2.6.1.), and furthermore between induction and reaction processes (section 2.7.2.). Here we intend showing how, from an impulse, from a triggering information, a structure-changing process is set in motion. This means that the goal values of the producing system's production (induction process) or the receiving system's adoption (reaction process) change. In this, it is assumed that any process, including the social one, must be considered as being an expression of four-dimensional space (D. FLIEDNER, 1980; 1981).

Information literally means "bringing in shape". From the view-point of four-dimensional space this means that any information must provide exact particulars on the value that the product of the process is to have in the different dimensions. Thus, not only matter, but information, too, must be dealt with in terms of a four-dimensional structure. Thus, the new goal value information becomes introduced into the system, i.e. the population, on four levels (four lines in table 3, resp. Fig. 27), until the intended values are obtained. This, again, is performed in four stages (four columns in table 3, resp. Fig. 27). The information comes from a demanding system (cf. section 2.6.4.). The goal values become adjusted to the adoption capacity of the demanding system at the beginning of the process. The information is introduced into the system, during the stages perception to organization and taken out in the form of produced matter, during the stages organization to stabilization, to be offered to the demanding system (D. FLIEDNER, 1980, p. 14f; 1981, p. 397f).

The intake of energy benefits the system and can therefore be valued positive in a mathematical sense. Output, on the other hand, emerges as a negative value. In systems of coordinates, therefore, the stages of infor-

system properties \ process stages	.1 Perception	.2 Determination	.3 Regulation	.4 Organization
1. consistence	$x_x = X_X - \frac{X_X - x_{(x)o}}{i_x^n}$	$x_t = x_{(t)o} + n \cdot i_t$ (upper limit X_t)	$x_y = x_{(y)o} \cdot i_y^n$ (upper limit X_Y)	$x_z = x_{(z)o}^{a_{(z)x}^n} \cdot i_z^{\frac{a_{(z)x}^n - 1}{a_{(z)x} - 1}}$ (upper limit X_Z)
2. duration	$t_x = t_{(x)o} + \frac{T_X - t_{(x)o}}{j_x} \cdot n$	$t_t = t_{(t)o} + \frac{T_t - t_{(t)o}}{j_t} \cdot n$	$t_y = t_{(y)o} + \frac{T_y - t_{(y)o}}{j_y} \cdot n$	$t_z = t_{(z)o} + \frac{T_z - t_{(z)o}}{j_z} \cdot n$
3. quantity	$y_x = \frac{1}{2}\left(Y_x - \frac{Y_x - y_{(x)o}}{k_x^n} + y_{(x)o} \cdot k_x^n\right)$	$y_t = y_{(t)o} + \frac{Y_t - y_{(t)o}}{k_t} \cdot n$	$y_y = \frac{Y_y}{1 + \left(Y_y - y_{(y)o}\right) \cdot k_y^{-n}}$	$y_z = y_{(z)o}^{a_{(z)y}^n} \cdot k_z^{\frac{a_{(z)y}^n - 1}{a_{(z)y} - 1}}$ (upper limit $Y_z = k_z^{\frac{1}{1 - a_{(z)y}}}$)
4. [3]space (distance)	$z_x = Z_x \cdot \sin(\omega_x \cdot n - \varphi_x)$	$z_t = z_{(t)o} + \frac{Z_t - z_{(t)o}}{l_t} \cdot n$	$z_y = Z_y \cdot \sin(\omega_y \cdot n - \varphi_y)$	$z_z = Z_z \cdot \cos(a_{(z)z} \cdot s - \omega_z n - \varphi_z)$

variables		goal values	initial values	inherent constants		oscillation and wave constants	
$n = 1, 2...$	abscissa values	$X_{x,t,y,z} > x_{(x,t,y,z)o} > 0$		$i_{x,y,z} > 1$	$k_{x,y,z} > 1$	$\omega_{x,y,z}$	circular frequencies
$s = 1, 2...$		$T_{x,t,y,z} > t_{(x,t,y,z)o} > 0$		$i_t > 0$	$k_t > 0$	$\varphi_{x,y,z}$	phase displacements
$x_{x,t,y,z}$	ordinate values	$Y_{x,t,y,z} > y_{(x,t,y,z)o} > 0$		$j_{x,t,y,z} > 0$	$l_x > 0$	$Z_{x,y,z}$	amplitudes
$t_{x,t,y,z}$		$Z_t > z_{(t)o} > 0$			$a_{(z)x} > 1$	$a_{(z)z}$	wave value
$y_{x,t,y,z}$					$0 < a_{(z)y} < 1$		
$z_{x,t,y,z}$							

Table 3: Mathematic description of the information stages of the induction processes. Basis equations.

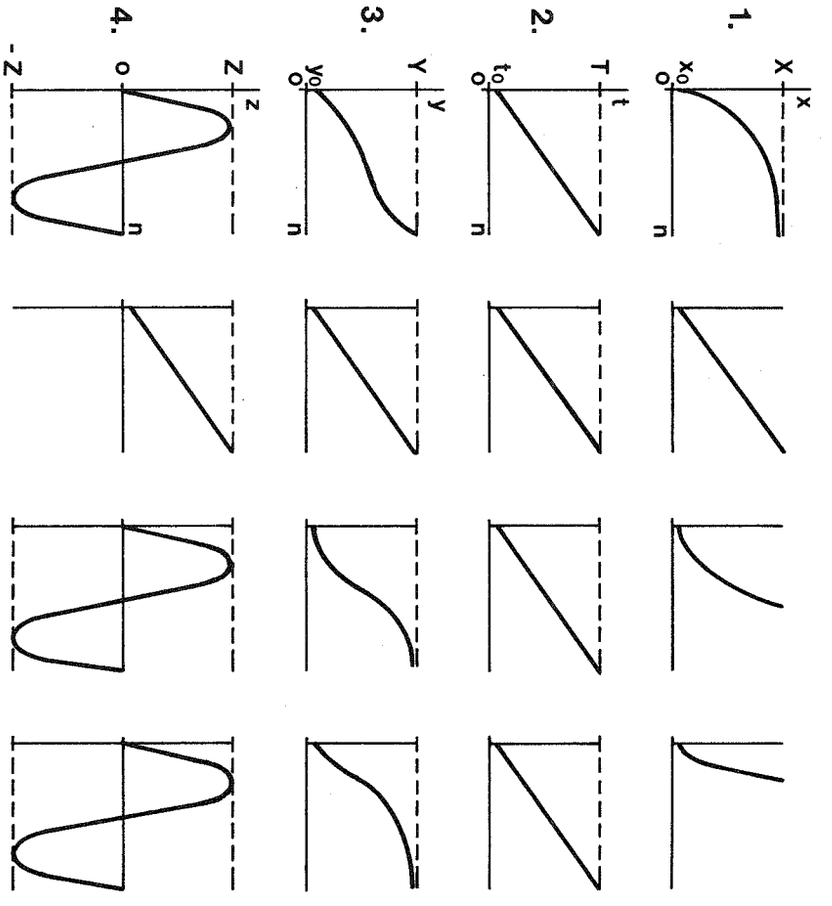


Fig. 27: Mathematic description of the information stages of the induction process. Basic graphs (cf. text).

mation (perception - organization) of an induction process should be placed above, and the material stages (organization - stabilization) below the horizontal n-axis.

Let us begin by looking at the information stages (perception to organization) of the induction process, i.e., within the offering system (table 3 and Fig. 27). The formulae are presented in their respective basic forms only. n constitutes the abscissa variable, i.e. the number of temporal steps; x, t, y and z are the ordinate variables, x_o, t_o, y_o and z_o provide the initial condition (at n=o), ω the circular frequency and φ the phase displacements (cf. oscillation and wave equations). X, T, Y and Z are the constants constituting the goal values of the process; i, j, k, l and a constants within the system. All constants are valid for the individual formulae in each case.

The four horizontal lines of the table resp. diagram 1., 2., 3. and 4. show, from top to bottom, the different ways of coupling the information onto the preexisting (material) system. In the first line the course of the process is only dependent on the consistence of the adopting system, one constant, owing to which the process is slowed down or accelerated. For example, the standard of knowledge of the population facilitates or complicates the absorption and diffusion of the information. In the second line the course of the process is also dependent on the adopting system in a temporal sense. The formulae in the third line, moreover, take into account the limits to the quantity of information taken on by the adopting system and the fourth line, in addition, the available (three-dimensional) space. In other words, the functions of the different lines express the changes in the information relations of the system with a) the vertically superposed, b) the temporally preposed resp. postposed, c) the vertically subposed and d) the horizontally juxtaposed environment (cf. section 1.2.; D. FLIEDNER, 1980, p. 19f). In the graphs the respective goal values of the processes appear as constants (X, T, Y, Z).

In the columns (.1, .2, .3 and .4) of the table resp. diagram the stages succeeding one another in the course of the process (perception, determination, regulation, organization) emerge. In terms of fact this means that the intake of information (about the intended change of production) into the system can be described in the first column, the transmission of the

perceived information into directive information to the producing system (codification) in the second column, the diffusion of the information (directions) into the system (number of the potential subposed elements) in the third column and the demands made on (three-dimensional) space (distance from the centre) in the fourth column.

Line 1 (Eqs 1.1 to 1.4): The population as producing, offering system receives information from the demanding, super-posed population (the market) which triggers a change in the consistence. The information becomes incorporated into the system in the course of the process in all four stages, only influenced by the consistence of the adopting system, i.e., the functions characterize from a systems-theoretical viewpoint (J. W. FORRESTER, 1968, sec. 2.1.; R. RÖHLER, 1973, p. 51f) feedback systems of the first order. There exists only one level (state or condition) of the system, which becomes changed by a rate. They become interlinked by a feedback loop.

1.1. (Perception): briefly introduced information (delta-function) indicates the goal value X. It is gradually taken in by the population. The velocity depends on the consistence (e.g. differentiation) of the system resp. population. The differential equation

$$\frac{dx}{dn} = c\ (X-x)$$

in which c is a constant inherent in the system, has a negative exponential relationship for solution. In systems theory, this is a system with a negative feedback loop. This equation describes also the function of impulse reaction used in kybernetics (R. RÖHLER, 1973, p. 46), or the function of limited growth used in ecology (R. DE SAPIO, 1976, p. 405f), or the physical function giving the change in velocity when an object falls through a viscous medium. The information value might be characterized by the information content of a message (cf. Information Theory, e.g., J. YOUNG, 1975).

1.2. (Determination): transposing the content of the signal into the system (as a direction) requires the process to progress step by step, for every process must pass through all the stages (perception to stabilization). The determination stage acts as a filter between the demanding and the produc-

ing systems, or like a transmitter into the producing inner system. The information put in gradually becomes absorbed in the course of time by a fixed partial amount

$$\frac{dx}{dn} = c$$

and accumulated. The feedback loop has no significance, the equation describes an arithmetic progression.

1.3. (Regulation): the propagation of the signal to the hierarchically subposed elements in the population takes place in a positive exponential manner, as was to be expected, after the differential equation

$$\frac{dx}{dn} = c \cdot x.$$

The factor is again determined by the inner state of the system. This function, too, is well-known in kybernetics, demography, ecology and other sciences, as the function of unrestricted growth resp. of ramifications (positive feedback loop, geometric progression).

1.4. (Organization): the space surrounding the elements is accounted for by a fixed exponent a. If the information is diffused, only dependent on the consistence, the value of a is greater than 1, corresponding to the equation $a = 1 + f/100$ (where $f > 0$ is a factor). This means, starting with x_o, the first step is $x_o^{\,a} \cdot k$, the second step $(x_o^{\,a} \cdot k)^a \cdot k$, etc. In this way information is diffused from the centre into the city-umland population. The variable x defines the distance. (This function replaces the assumption in my earlier papers (1980, Fig. 7, table 4; 1981, Fig. 5, table 4) that growth is purely exponential).

Line 2 (Eqs 2.1 to 2.4): the equations in the 2nd to 4th lines of these considerations are characterized by the greater functional proximity of the adopting system (or the consuming population). From a systems-theoretical viewpoint there are now two levels to be considered in each case. In line 2, the process-duration T of the producing (offering) system is adjusted to that of the adopting (consuming) system. As in equation 1.2, therefore, a time filter is involved here, which must be taken into account in all four stages. Reception of the information by each adoptor - as well as its transmission - can only take place by degrees and generally takes (the same

time as or) longer than it took to send the information. Thus two measures of time are brought into relation with one another (j:T). The exponential growth as indicated in line one is thus accompanied by a linear growth in the equations of the second line; arithmetic progressions are formed. From a systems-theoretical viewpoint, 2 levels become interconnected by a fixed rate. There are no feedback loops.

Line three (Eqs 3.1 to 3.4): here the quantity of diffusing information impulses becomes additionally influenced by the goal value Y. Thus the functions 1.1 - 1.4 are provided with equal counterparts. From a systems-theoretical angle this means the coupling of a positive with a negative feedback loop. In this way non-linear systems also come about.

3.1. (Perception): the reception of information characterized by formula 1.1 is limited by both the producing and the adopting systems' inherent capacities. As time passes, the influence of the producing system decreases, while the influence of the adopting system increases. Two tendencies must therefore be added together. An additive combination (divided by two) of the formulae 1.1 and 1.3 seems appropriate here.

3.2. (Determination): the temporal incorporation of the information and the transposing into directions must here, as in function 1.2, also take place in a linear manner. Knowledge summation is additive, the goal value Y is given.

3.3. (Regulation): the quantity of information impulses becomes diffused to the subposed elements of the system, the process on the other hand is slowed down by the increasing influence of the upper limit of the adopting system. This is the logistic equation known in innovation research, mentioned earlier (section 2.6.5.). The differential equation

$$\frac{dy}{dn} = c \cdot y\ (Y-y)$$

can be obtained from the probability calculus (G. BAHRENBERG and J. LOBODA, 1973; G. BAHRENBERG and E. GIESE, 1975, p. 85). For some time now this function has also served well in demography and ecology (R. DE SAPIO, 1976, p. 439f). A bell-shaped graph emerges as the derivative

$$y' = \frac{(Y-y_o)\cdot Y\cdot k^n\cdot \ln k}{(Y-y_o+k^n)^2}$$

and must be distinguished from normal distribution for one, and from the resonance curve for another (cf. also, the treatment of formula 4.2). This derivative of the innovation curve is shown in several diagrams in the treatise (e.g., Figs. 13, 14).

3.4. (Organization): the (three-dimensional) spatial diffusion of information also becomes directed to a new goal value (distance from the centre). It spreads into a limited space

$$Y_z = k^{\frac{1}{1-a}},$$

i.e., the still uninvolved space becomes smaller with every step, or conversely, less and less space units are added. The exponent a is smaller than 1 by the amount

$$f = (\log k)/(\log Y_z).$$

Line 4 (Eqs 4.1 to 4.4): in the three preceding lines the processes leading to the goal values X (consistence), T (time) and Y (quantity) are defined. Here it shall be shown that additionally the producing system develops towards the goal value Z which represents the (three-dimensional) spatial capacity of the adopting system. If, as is demonstrated here, an additional quantity of information is introduced into a specific system, an increased (three-dimensional) space requirement also results. If the system has no way of expanding, overpressure develops, metaphorically speaking, which has to be reduced within the time-span T. So the information must be converted into production within a given time-span T and then taken out of the system again (stabilization stage). The surplus of the producing system is taken on by the adopting system. Thus the producing and the adopting systems become interdependent and thus mutually effect one another. As time passes, changes are therefore brought about in both systems. Because of the time lag between production and adoption, a direct compensation is prevented, oscillations result, as demonstrated in the Pecos example (cf. section 2.7.1., Fig. 11). The producing and adopting systems become oscillators. The intake of information into the producing system and the output of products going to the adopting system take place intermittently, discretely. The result is a non-linear system, defined for instance, by the

differential equations

$$\frac{dz_1}{dn} = A\cdot b_1\cdot z_1 - d_1\cdot z_1\cdot z_2$$

and

$$\frac{dz_2}{dn} = b_2\cdot z_1\cdot z_2 - d_2\cdot z_2.$$

Here z_1 and z_2 are the variables of the producing resp. adopting system, b_1 and b_2 resp. d_1 and d_2 are constants, individual rates that represent the velocity of entering (b = birth) and leaving (d = death) the two systems. A is a factor characterizing the resources for the material stages of production. These equations have been demonstrated in ecology by LOTKA and VOLTERRA (A.J. LOTKA, 1956, p. 88; E.O. WILSON and W.H. BOSSERT, 1971, p. 117f; W. NÖBAUER and W. TIMISCHL, p. 110f; I. PRIGOGINE, 1979).

These studies already included the material stages of the processes. However, to continue with the informative stages: the individual stages are of course also complete processes of a lower order (cf. section 2.6.4.). Thus, here too, there are oscillations (4.1., 4.3., etc.), i.e., the curves plunge into the negative sectors of the coordinate system. Here, therefore, partial material stages of a lower order occur; information too, can only be consumed as matter (section 2.6.5.). On the other hand, if we look at the process as a whole it might suffice to use linear equations to describe the oscillations of the single stages within the producing, offering system. From a systems-theoretical viewpoint, functions are presented in this line that are characterized by a second order negative feedback loop (two levels and two rates) (J.W. FORRESTER, 1968, sec. 2.3. and sec. 10.3.; R. RÜHLER, 1973, p. 56f). Sine and cosine oscillations are characteristic for this kind of system. The period is $T = 2\pi/\omega$; the circular frequency ω depends on the consistence of the system (e.g., degree of knowledge) and the quantitiy Y. Z means the amplitude. Moreover, there is a phase displacement φ, establishing the initial condition in the system.

4.1. (Perception): the intake of information into the producing system takes the shape of a sine or cosine curve, this depends on the initial condition in the simplest case, for the reasons given earlier. This function defines the periodic force stimulating the system interpreted as an oscillator.

4.2. (Determination): the information is introduced into the system stepwise in each respective direction. Here the rules of forced oscillation reign. The efficiency of transposition depends on the phase displacement between the stimulating system (4.1.) and the inherent system (4.3.). Control loops have no significance here (in the case of undamped oscillations). A fixed rate of growth leads to the final condition Z with every information step in the period T. Thus two levels are here made to interrelate, growth is represented by an arithmetic progression. A maximum transmission of information is achieved when the oscillations of the triggering system and the inherent system are displaced by $\pi/2$ (resonance). The absorption is defined by the resonance curve which is proportional to the so-called "Lorentz function" (basic type $z = 1/(1+n^2)$) (cf., e.g., Berkeley Physics Course, Vol. 1). The graph is bell-shaped (cf. above).

4.3. (Regulation): the quantity of information passed on in stage 4.2. is absorbed by the producing population in the form of an oscillation. Several examples of oscillations have been described in the treatise (e.g., Figs. 15-18). The initial condition is established by the phase displacement φ.

4.4. (Organization): the information impulse spreads out from the population in waves over the horizontal environment and triggers individual developments in other populations of the horizontal environment (for examples, cf. section 3.4.2.). The phases of the waves do not only depend on time, but also on the location. The classic wave equation should be used here. The formula (table 3, formula 4.4) can, as in the other functions introduced here, represent the temporal development of the oscillations of a particle at a certain place, in which case n is the abscissa variable and s a constant. The formula can, however, also be considered as capturing the whole wave at a certain moment, in which case s is the abscissa variable and n a constant. If we consider the oscillation period T representing the duration of a process and the wavelength λ corresponding to the diameter of the system (i.e., the population), the speed of the spatially propagating process ($v = \frac{\lambda}{T}$) is approx 10 km per year (in differentiated populations; D. FLIEDNER, 1980, p. 31; 1981, p. 408).

Information consists of well-defined signals from the super-posed environment. They are diffused in the producing system - as the considerations so far have attempted to demonstrate - in accordance with the four dimensions in the process sequence. Mathematically, the informative stages of the induction process can thus be defined by means of growth curves, expressing an expansion. The material stages of the induction process (organization to stabilization) succeed, with a time lag. During these stages substances from the sub-posed environment (e.g. the living space) are put together into well-defined products according to the given information. In the organization stage, the information is diffused outwards, while conversely, the material substances are brought to the centre from the outside (e.g., in the city-umland population; cf. section 4.4.1.2.). In the regulation stage the information is taken down to the sub-posed elements. These for their part are systems in which the information reaches their elements, and so on. Conversely, the hierarchically super-posed systems are reached via the dynamization stage (D. FLIEDNER, 1980, p. 20f; 1981, p. 397f). Similarly, determination and kinetization resp. perception and stabilization are assigned to one another in a complementary fashion. Thus the sequence of formulae resp. graphs of the information stages becomes repeated during the material stage, but in an inverse order. In addition, it is necessary to take into account that the material stages in the induction process lead outside the system, as we have already pointed out above. They must therefore be given a minus sign. Graphically, the functions would thus have to be reflected at the horizontal n-axis of the system of coordinates. Information stages and material stages are linked together in the organization stage.

The super-posed population must be structured in such a way that it is able to pass the information on downwards (during the regulation stage) and take up the products from there (during the dynamization stage), e.g., according to the LOTKA/VOLTERRA equations or by resonance (cf. above). This means that the larger super-posed population must be divided in such a way that its elements become the same size and develop the same oscillation rhythm as the producing, sub-posed populations (cf. section 2.7.2.). For instance, the adopting, receiving population of Pecos (as a biotic unit) is vertically identical with the producing population (a small amount of trade must be taken into account; cf. sections 2.5.2.; 2.6.2.). With higher differentiated populations with a marked exchange of information and products with neighbouring populations, the oscillation phases must be approximately equal in length and phase in order to bring about an exchange of information and products between producing and receiving populations.

That is why, in a cultural population, for instance, the peoples resp. state populations all vibrate in approximately the same rhythm (cf. section 5.2.). The structural adaptation of the super-posed demanding, adopting population in size and rhythm of oscillation to the producing population takes place with the aid of the reaction process. Every induction process is succeeded by a reaction process, starting with the adoption of the products made by the producing system. The last stage (stabilization) of the induction process is contemporaneous with the first stage of the reaction process. During this stage the induction process becomes connected with the reaction process. Reception, as mentioned above, is the negative counterpart to delivery. The value of the actually accepted product is brought back (as a signal and then as a material change) step by step to the point of entry of the producing system, as time proceeds (stoppage effect). The reversal causes the demanding system's structure to change in order to adjust to the actual value of production. If there are no further, shorter control loops, we call this an uncontrolled process (cf. section 2.3.1.). In systems theory, feedback without feedback loop is referred to (R. RÖHLER, 1973, p. 51f).

Generally, it must be added, that the processes can be changed or even brought to a halt by unpredictable influences from the environment. Moreover, it is possible that some stages are repeated. The material stages are furthermore dependent on the resources situation. So prediction is a problematical matter.

The formulae and graphs referred to of course only reproduce certain aspects of the process-models mentioned in the treatise and generally used in geography and the social sciences (innovations, oscillations, etc.). A system of given consistence, time requirement, quantity and (three-dimensional) use of space was looked at within the process sequence. This means the system was developed according to time, n was regarded as a temporal step. It is possible to define n generally as a step within a sequence. Thus also for describing the differences in the consistence, the steps in the hierarchy and the distance intervals in (three-dimensional) space the formulae in table 3 may be used. For instance, the processes 1.1. to 1.4. reveal the basic structures of a system, in that they pass through them step by step; in formula 1.3. the processes follow the hierarchy downwards (amount of elements), in formula 1.4. the distance in a (three-

dimensional) spatial, central-peripheral structure (city-umland population for instance). Perhaps several functions that are still missing could be worked out along these lines, e.g. by combining equations.

However, in four-dimensional space time is just one dimension. Several questions remain unsolved. For instance, all functions mentioned above describe processes resp. structures which are determined, as parts of the inner system (cf. section 2.3.1.). In order to find a solution for such important questions as rotation, coherence, differentiation, concentration and selection, other formulae must be worked out, perhaps partly on the basis of the probability theory; some of these processes resp. structures represent the outer system and are not determined.

It is to be hoped and desired that these points for discussion will stimulate the reader to contribute further criticism and new ideas.

ANNEX 1

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ANNEX 2

ILLUSTRATIONS AND THE CHIEF SOURCE MATERIAL USED

Fig. 1: Pueblo Pecos, ruins of the villages and single houses. A survey.
Source: field work (cf. also Fig. 6)

Elevation in feet
The field shrines are stone rings with a diameter of 5-10 m, possibly serving astronomical observations. Knowledge of the precise course of the seasons was necessary for field cultivation (cf. similar observations made in Chaco Canyon by J.R. MORGAN, 1977, in Wyoming and Saskatchewan by J.A. EDDY, 1977).

Fig. 2: Principle of coherence; intensity and distance (cf. text)
Source: D. FLIEDNER, 1974c

Fig. 3: Principle of long-range effect; intensity and distance (cf. text)
Source: D. FLIEDNER, 1974c

Fig. 4: Pueblo Pecos, duration of field exploitation and area from where hunting was undertaken
Source: field work (cf. Fig. 6)
Elevation in feet

Fig. 5: Density of sherds and stone implements found at various distances from Pueblo Pecos
Source: field work
Only identifiable rim-sherds of the P IV or modern period were taken into consideration, i.e., not Black-on-White or Culinary-Ware, because in the P III period not Pecos (Quadrangle or North-Pueblo) formed the central point, but the Forked-Lightning Pueblo approx. 300 m away. With the stone implements (resp. their fragments) a similar age differentiation could not be attempted. However, considering the small amount of fragments found near the pueblos, it seemed legitimate to neglect this aspect. Zones, each covering a distance of 200 m were set up around Pueblos Pecos and the fragments found in them counted.

Fig. 6: a-o Pueblo Pecos, village settlements and single houses, 13th century - 1838
Sources: field work;
Also: E. ADAMS and A. CHAVEZ, 1956; EIGHTH SOUTHWESTERN CERAMIC SEMINAR, 1966, Rio Grande Glazes; R.J. FORD, A.H. SCHROEDER and St.L. PECKHAM, 1972; J.H. GUNNERSON and D.A. GUNNERSON, 1970; 1971; C.E. GUTHE, 1917; F.H. HARLOW, 1973; A.C. HAYES, 1974; J. HOLDEN, 1955; J.L. KESSELL, 1975; A.V. KIDDER, 1924/62; 1931; 1958; A.V. KIDDER and Ch.A. AMSDEN, 1931; A.V. KIDDER and A.O. SHEPARD, 1936; G. KUBLER, 1940; H.P. MERA, 1933; 1934; 1939; 1940; D.H. SNOW and H. WARREN, without date; St.A. STUBBS, B.T. ELLIS and A.E. DITTERT, 1957; C.L. WOOD, 1973.
Elevation in feet.
For the field shrines cf. explanations to Fig. 1.

Information provided by MRS. SNOW (on the pottery of the 17th and 18th centuries), MR. PECKHAM (he determined sherds of the P III-period), MR. NORDBY, MR. KAYSER and MR. WISEMAN (they aided me in the determining of Glaze-sherds). MR. NORDBY invited me to view his potsherd collection from the Pecos National Monument and provided me with information on recent excavations carried out in the South Pueblo which threw light on the duration of the occupancy. Site files and sample collections of the Laboratory of Anthropology, Sante Fe.
Important criteria for classifying the pottery:
Black-on-White and Glaze I-IV are described in enough detail in the literature indicated, so that a more precise portrayal will not be required here.
Glaze V Pecos (bowl): Usually whitish yellowish slip.
Early: rim approx. 2 cms high, thickened more than Glaze IV items;
Medium: rim approx. 3 cms high, cross section slightly thickened, spindle-shaped;
Late: approx. 2 cms high, very much thickened.
Glaze VI (bowl): no slip, or mainly dark, applied decorative glaze often carelessly applied.
Early: rim approx. 3-5 cms. Slight to moderate thickening;
Late: rim very slightly or not at all thickened, often curved outwards a little with a flattened upper edge.
Kapo black: not clearly delimited against Kapo grey; only unmistakable fragments were taken to be Kapo black as it is described in the literature referred to above.
Later Post-glaze pottery: many different types, previous kinds of pottery do not recur, some china.
Detailed differentiation not possible.
The author unfortunately did not have the opportunity to examine sherds found during excavations for the refuge pueblos that were set up after the revolt of 1680 by the Pueblo Indians and were inhabited for about 10 years. They would have made a precise separation of the pottery in general use before and after this period easier. There was no access to these collections. Thus the author was obliged to revert to the sherds that had been dated and were kept in the sample collections mentioned above, as well as to personal notes made on the occasion of a visit to the refuge pueblo "Atialaqua" situated in the Jemez area (about 9 kms to the north of present-day Pueblo Jemez). The statements made about the time after about 1620 are therefore not as reliable as those about the time before (indicated by dotted lines in the diagrams in Fig. 9 and Fig. 10).
The material and the corresponding lists of sherds were given to the National Park Service and are now in the Pecos National Monument.

Fig. 7: Control and production loop of a goal-oriented system (cf. text)

Fig. 8: Treatment of important events in the newspapers as the expression of temporal long-term effect: The West-German terrorist problem in the daily paper "Saarbrücker Zeitung" (Sept. 1977 to March 1978).
The amount of news, comments and photo reports was measured according to the column-space (centimetres) and then added up. Five-day averages (related to the number of papers appearing in this timespan), not smoothed. Distinctions were made between the items of news on the first page, as the most important, and the other pages.
1. The kidnapping of the chairman of the Employers Association, Mr. Schleyer
2. The kidnapping of a Lufthansa plane
3. The storming of the plane and the murder of Mr. Schleyer in short succession, as well as the suicide of various terrorists

were considered especially serious events.

Fig. 9: Pueblo Pecos, development of field-size
Procedure:
Dating the pottery cf. Fig. 6a-o
Number of single houses: 1) numeration of all datable single houses (solid line)
2) conversion to periods of equal length; by this means the number of fragments was increased in shorter periods (e.g., Glaze III, Espinosa medium and late, around 1470; date: literature, cf. Fig. 6). Furthermore, the amount of sherds of ceramic types of which only the rims could be dated was multiplied by 5 (especially Glaze compared to Black-on-White); this is approximately the relationship between the rim and body sherds of this kind of pottery (including bowls). Obviously only approximate values could be achieved by this means. However, the errors will balance out quite well in the end.
Area covered by fieldland: 1) area ascertained according to the distribution of the field houses that could be dated
2) conversion to periods equal in length, so that the values could be achieved.

Fig. 10: Pueblo Pecos, oscillation and rotation in field exploitation.
Oscillation: single houses at a medium distance from Pueblo Pecos during the different periods
Rotation: 1) average distribution of all single houses around Pueblo Pecos in all directions (16-petalled rose)
2) deviation from the average distribution
3) resultant of the range of vectors
Sources: cf. Fig. 6. For 1776 in particular: E. ADAMS and A. CHAVEZ, 1956; J.L. KESSELL, 1975, especially p. 532.
Population numbers: all available data were noted down.
Source: J.L. KESSELL, 1975

Fig. 11: Mutual influence exercised by the supply (according to the harvest yield) and demand (according to the population numbers) of food in an autonomous (or almost autonomous) population. Explanatory sketch (cf. text).

Fig. 12: Pueblo Pecos, duration of field exploitation and extent of damage caused by soil erosion. Additional damage was caused by former traffic (cf. sunken roads).
Source: field work (cf. Fig. 6), evaluation of aerial photographs.
Elevation in feet.

Fig. 13: Decennial phases in the development of the German state population since the 18th century, illustrated using various processes assignable to adaptation in the task categories of perception, regulation and organization.
General explanation of Figs. 13, 14, 16, 18 and 20:
The choice of the subjects, time intervals and statistical treatment depend above all on the available material; an optimal representation according to the questions being asked was aspired to. For this reason different year averages were used as a basis (5 resp. 10 years) and related in different ways to the adjacent values (usually composed to three, more rarely five parts); sometimes no smoothing was done if it was a matter of showing up important trends and if the short-term fluctuations did not cover them up. The regional basis, if there is no indication to the contrary, is the German Empire (Deutsches Reich) for the time before 1945 (the 1937 borders) and the German Federal Republic after this period. Usually (exceptions are indicated) the values were related to the number of inhabitants. In order to detect and determine the processes, the increase was represented in each case, and not the state (e.g., the increase in production and not the production figures themselves or, in another instance, the amount of settlements established in the course of colonization and not the total amount of settlements). Otherwise logistic graphs would have come about. In order to achieve comparability, the respective maximum values of time, i.e., the greatest rates of growth were made to equal hundred.

a) Perception
Art: The periods were defined using the works of writers, architects resp. painters. The dates of publication resp. production were classed according to decades. Over 3 decades smoothed. Respective maxima = 100.
Sources: Literature
A. ARNOLD, 1966; DEUTSCHE DICHTER DER ROMANTIK, 1971; S. HOEFERT, 1968; G. KAISER, 1966/76; O. MANN, 1964; U. MÜNCHOW, 1968; R. PASCAL, 1963; F. SCHMITT, 1949/52; W. STEIN, 1946/70; F. VOGT and M. KOCH, 1897; ZEITALTER DER AUFKLÄRUNG, 1963
Architecture and painting:
A.E. BRINCKMANN, 1931; H. BÜNEMANN, 1961; J. CASSOU, 1954; G. DEHIO, 1930/34; S. GIEDION, 1922; W. HAFTMANN, 1954/76; W. HAGER, 1942; E. HEMPEL, 1956; W. HERRMANN, 1932/77; W. HOFMANN, 1960/74; H. KIENER, 1935; H. OHFF, 1971; G. PAULI, 1925; W. PINDER, 1955; J. REWALD, 1957; H. SCHRADE, 1967; F. SCHUMACHER, 1955; H. VOGEL, 1937.

b) Regulation
State expenditure, five years averages, not smoothed
Sources: W.G. HOFFMANN, 1965; STATISTISCHES JAHRBUCH FÜR DIE BUNDESREPUBLIK DEUTSCHLAND
Legislation: ten year averages,not smoothed
Sources: W. ABEL, 1962; R. BLUM, 1969; W. DÖNNINGES, 1843/45; 1850; G. FRANZ, 1970; R. GOLKOWSKY, 1966, H. HAUSHOFER, 1963/72; F.-W. HENNING, 1973/76; 1974/78; G.F. KNAPP, 1887; F. LÜTGE, 1952; 1963; F. MAGER, 1955; H. SCHORN, 1963; W. STEIN, 1946/70.

c) Organization
Induction-processes: laying of transport lines, ten year averages, over 3 decades smoothed.
Sources: DIE DEUTSCHEN EISENBAHNEN, 1935; F.-W. HENNING, 1973/76; 1974/78; W.G. HOFFMANN, 1965; K.v. HUGO, 1962; HUNDERT JAHRE DEUTSCHE EISENBAHN, 1935; K.H. REINHARD, 1969; STATISTISCHES JAHRBUCH FÜR DAS DEUTSCHE REICH; STATISTISCHES JAHRBUCH FÜR DIE BUNDESREPUBLIK DEUTSCHLAND

Fig. 14: Decennial phases in the development of the German state population since the 18th century, illustrated using different processes assignabel to adaptation in the task categories of dynamization and kinetization.
Explanations, cf. Fig. 13

a) Dynamization
Agricultural and commercial net investments, in relation to total net investments. Five year averages, over three parts smoothed.
Sources: W.G. HOFFMANN, 1965; STATISTISCHES BUNDESAMT; private Information.
Pre-industrial and early industrial activities, ten year averages, not smoothed.
Sources: H. BLUMBERG, 1960; 1965; K. BRÜNING etc., 1955; W. EVERS etc., 1964; W. FISCHER, 1972; R. FORBERGER, 1958; F. FURGER, 1927; A. HAACK-LÜBBERS, 1951; H. HASSINGER, 1961; F.W. HENNING, 1973/76; 1974/78; W.G. HOFFMANN, 1965; G. HOTOPP, 1958; J. KERMANN, 1972; A. KÖNIG, 1899; H. KRÜGER, 1958; W. LAUER, 1922; C. LIEBICH, 1961; A.v. LIMBERG, 1948; G. MEERWEIN, 1914; H. MICHEL, 1921; H. MILZ, 1962; K. MITTELHÄUSER, 1957; G. SLAWINGER, 1966; E. TACKE, 1943; 1951; O. WIEDFELDT, 1898; W. WITT, 1951.

b) Kinetization
Agricultural production, five year averages, not smoothed. The values were not related to the inhabitants, because with the strong increase in population numbers before the 1st World War, the growth of production would not have become apparent. Thus Prussia and the Federal Republic of Germany had to be presented separately.
Sources: W. ABEL, 1935/66; 1962; H.W. FINCK v. FINCKENSTEIN, 1960; W.G. HOFFMANN, 1965; STATISTISCHES JAHRBUCH FÜR DAS DEUTSCHE REICH; STATISTISCHES JAHRBUCH FÜR DIE BUNDESREPUBLIK DEUTSCHLAND.
Mining and industrial production; five year averages, not smoothed. Related to the number of inhabitants.
Sources: F.-W. HENNING, 1973/76; W.G. HOFFMANN, 1965; STATISTISCHES JAHRBUCH FÜR DAS DEUTSCHE REICH; STATISTISCHES JAHRBUCH FÜR DIE BUNDESREPUBLIK DEUTSCHLAND.
Amount of traffic, five year averages over three parts smoothed. Passengers by mail-coach only until the First World War, as there were different forms of organization and calculation afterwards (introduction of motorized mail transport etc.).

Shipping on the Rhine only until 1875. Railways in relation to the number of inhabitants, German Empire resp. Federal Republic of Germany.
Sources: DEUTSCHE EISENBAHNEN, 1935; W.G. HOFFMANN, 1965; HUNDERT JAHRE DEUTSCHE EISENBAHN, 1935; G. MENSCH, 1975; STATISTISCHES JAHRBUCH FÜR DAS DEUTSCHE REICH; STATISTISCHES JAHRBUCH FÜR DIE BUNDESREPUBLIK DEUTSCHLAND.

Fig. 15: Yearly cycle: unemployed in Lower Saxony
Source: STATISTISCHE MONATSHEFTE FÜR NIEDERSACHSEN.

Fig. 16: Decennial cycles: Business cycles in the European/North American cultural population as the expression of stabilization in the scope of adaptation.
Yearly average, over 7 years smoothed. In order to eliminate the fluctuations covering several centuries, the ten year averages were drawn in addition (after W. ABEL, 1935/66; over 5 decades smoothed) and the trend curve emerging by this means was stretched. The minimum of the curve thus represented is equal to nil, the maximum to one hundred.
Sources: Grain prices: W. ABEL, 1935/66; 1962; H. HAUSER, 1936; W. NAUDE and A. SKALWEIT, 1910; 1931; J.E.T. ROGERS, 1902; Th. TOOKE and W. NEWMARK, 1858, 1859, Vol. 1; Wholesale prices in the USA:N.D. KONDRATIEFF, 1928; DER SPIEGEL, 1975, No. 3; US-WHOLESALE PRICE MOVEMENTS, Bureau of Labor Statistics All Commodity Index (1926=100) 1801 to 1952; US-DEPARTMENT OF COMMERCE, Histor. Statistics of the US 1789 to 1945, pp. 233-234; 1946-1952: Survey of Current Business. L.W. THATSCHER, 1954.
The wholesale prices in the USA are represented. A similar course is followed in Germany, clearly illustrated for the time between 1792 and 1934 in A. JACOBS and H. RICHTER, 1935.

Fig. 17: Cycles of several years. Examples from Central Europe.
a) Wholesale prices for industrial goods in W.-Germany. Yearly averages, not smoothed.
Sources: F.W. HENNING, 1973/76; A. JACOBS and H. RICHTER, 1935; J. KUCZYNSKI 1947; 1951.

b) Birth and death rates Saarbrücken, yearly averages, not smoothed.
Source: STATISTISCHES HANDBUCH DES SAARLANDES; STATISTISCHES JAHRBUCH DER LANDESHAUPTSTADT SAARBRÜCKEN;

c) Migrations, Zürich, yearly averages, not smoothed.
Source: G. IBLHER, 1973;

d) Migrations, Saarbrücken, yearly averages, not smoothed.
Source: STATISTISCHES HANDBUCH DES SAARLANDES; STATISTISCHES JAHRBUCH DER LANDESHAUPTSTADT SAARBRÜCKEN;

e) Economic growth in West-Germany, yearly averages, not smoothed.

Source: F.W. HENNING, 1973/76; 1974/78; DIE ZEIT, No. 36, 1976; STATISTISCHES BUNDESAMT, information in writing.

f) Adjusted net wages rate in W.-Germany, yearly averages, not smoothed. Proportion of total income of employed persons in relation to the national income. Taxes deducted.
Source: FUNKKOLLEG "SOZIALER WANDEL" 1, 1975.

Fig. 18: Decennial phases in the development of European state populations since the 18th century, represented using various processes assignable to socio-reproduction in the task categories of determination, regulation and organization.

a) Determination
Conception of the world and ideology in Europe. Quantitative data are difficult to obtain. The activities towards spreading conceptions of the world, e.g., publications, meetings (e.g., the Encyclopaedists in connection with the French revolution, "Hambacher Fest" and "Göttinger Sieben" in connection with the European revolution), the establishing of political parties (Socialists, Fascists) were taken to be early process stages. Revolutions of European dimensions were considered late process stages, provided they were of an ideological nature (French revolution, 1789; European revolution, 1848) and election results (KPD and SPD; NSDAP; CDU/CSU, decades; averages, not smoothed).
Respective maxima = 100
Sources: W. ANDREAS, 1955; F.L. CARSTEN, 1968; E. EYCK, 1954/56; FRAGEN AN DIE DEUTSCHE GESCHICHTE, w.d.; G. FRANZ, 1957; D. GEYER, 1968; K. GRIEWANK, 1958; E. HALEVY, 1948; HANDBUCH DER EUROPÄISCHEN GESCHICHTE, 1968/73, Vols. 4-7; W. HUBATSCH, 1970; E. NOLTE, 1963; SOZIALISMUS, 1968.

b) Regulation
Armament and war in Europe. Armament efforts must be considered as early process stages, the wars as the chief processes. Periods of particularly intense armament can be noted under Frederic William I of Prussia, Roon and before the 2nd World War (Hitler); they can only vaguely be registered qualitatively. Frequency of war in Europe quantitatively total of war years in decades, over 5 decades smoothed (cf. text).
Sources: E. BRANDENBURG, 1916; G.A. CRAIG, 1960; HANDBUCH DER EUROPÄISCHEN GESCHICHTE, 1968/73; W. HUBATSCH, 1970; G. MENSCH, 1975; C. MISCH, 1952; G. RITTER, 1954/68; P. SCHMITTHENNER, 1930; J.D. SINGER and M. SMALL, 1972; F. SCHNABEL, 1929/37; W. STEIN, 1946/70.

c) Organization:
Migration (mobility) in West-Germany. Official counts for the entire Federal Republic only since 1950. Before: counts of the population's mobility (immigration and emigration) divided by the mean number of inhabitants in cities. 5 years, averages, over 15 years smoothed. Maxima set at 100 in each case. The population's mobility remained low after the 1st World War (cf. mobility of the population in German cities 1961 and 1964).

Sources: R. HEBERLE and F. MEYER, 1937; K. SCHWARZ, 1972; STATISTISCHES JAHRBUCH DER BUNDESREPUBLIK DEUTSCHLAND; STATISTISCHES JAHRBUCH DER STADT BERLIN; information provided by STATISTISCHES BUNDESAMT, Wiesbaden.

Fig. 19: Changing shape of a population with growing differentiation. Profile of the population density along the main settlement axis of New Mexico 1776, 1860 and 1970.
For an easier comparison each profile has been given its own vertical scale. In fact in 1776: 8300; 1860: 33000, 1970: 295000 inhabitants were registered in the diagram. The township (93,24 km^2) was chosen as a basis. In the profile only the width of a township was represented in each case.
Sources: 1776 and 1860 D. FLIEDNER, 1975, further references there. 1970: US-Dep. of Commerce, Bureau of Census; PC (1) - A 33 N. Mex.: 1970, Census of Population, Number of Inhabitants, New Mexico.

Fig. 20: Decennial phases in the development of European and North American state populations since the 18th century, illustrated using various processes assignabel to socio-reproduction in the task categories of dynamization, kinetization and stabilization.

a) Dynamization
Business cycles (cf. Fig. 16)

b) Kinetization
Fertility (crude birth rate)
Exemplary curves of countries with differing generative behaviour are given. Averages of 5 years, over 15 years smoothed.
Sources: DEMOGRAPHIC YEARBOOK (1951, 1952, 1965, 1975); H. HILLE, 1949; G. MACKENROTH, 1953; P.C. MATTHIESSEN, 1972; E. SZABADY, K. TEKSE and R. PRESSAT, 1966; E.A. WRIGLEY, 1969.

c) Stabilization
Inland colonization in Central Europe and New Mexico (number of settlements). Average of 10 years respectively; maximum of the respective curves set at 100.
Sources: Central Europe: J. BÜNSTORF, 1966; D. COLDEWEY, 1967; W. CZAJKA, 1939/64; SH.H. DIKE, 1958/59; H. ERBE, 1937; D. FLIEDNER, 1970; U. FROESE, 1938; HANDBUCH DER HISTORISCHEN STÄTTEN, 1960/74; F. HERZOG, 1953; A. HUGENBERG, 1891; H.J. KEUNING, 1933; 1955; E. KEYSER, 1940/43; W. KUHN, 1955/57; 1971; K. LILIENTHAL, 1931; NEW MEXICO PLACE NAMES, 1965; K. SCHARLAU, 1956; L. SCHNEIDER, 1939; B. SCHULZE, 1939; J.E. SHERMAN and B.H. SHERMAN, 1975; H.H. WÄCHTER, 1959; P. WEBER, 1966; A. WESTERHOFF, 1936; L. ZÖGNER, 1966; INFORMATION BY THE EMSLAND G.m.b.H., MEPPEN.
New Mexico: Spanish settlements, D. FLIEDNER, 1975; dates of the setting up of the ranching homestead and mining sites, as far as can be ascertained from NEW MEXICO PLACE NAMES, 1965; J.E. SHERMAN and B.H. SHERMAN, 1975. The dates often correspond to the dates of the setting up of the respective post offices, though not always (SH.H. DIKE, 1958/59)

Fig. 21: Population maxima of different Pueblo populations in the P III and P IV periods (approx. 1000 - approx. 1600 A.D.).
Sources: R.J. FORD, A.H. SCHROEDER and ST.L. PECKHAM, 1972; J.T. HACK, 1942; M.F. LAMBERT, 1954; P.S. MARTIN and F. PLOG, 1973; J.C. MCGREGOR, 1965; H.P. MERA, 1934; 1940; S. PLOG (cit. in P.S. Martin and F. Plog, 1973); A.H. SCHROEDER, 1960; G. VIVIAN and T.W. MATHEWS, 1966; R.G. VIVIAN, 1970; W.W. WASLEY, 1960; F. WENDORF and E.K. REED, 1955; H.M. WORMINGTON, 1947/68.
Information given by Mr. PECKHAM, Acting Director, Museum of New Mexico, Division of Anthropology, Santa Fe.
Files of the Museum of New Mexico, Laboratory of Anthropology.

Fig. 22: Mankind as a society and as a socio-reproductive unit. Structural model of population hierarchy and process-sequence (cf. text).

Fig. 23: Centennial phases in the development of the European/North American cultural population.
Determination: missionized areas (areal growth).
Modern colonization cf. below, dynamization.
Source: WESTERMANNS ATLAS ZUR WELTGESCHICHTE, 1956.
Regulation: Formation of states in Central and Western Europe (Franconia, Holy Roman Empire. Areal growth).
Sources: DTV ATLAS ZUR WELTGESCHICHTE, 1964/66; GROSSER HISTORISCHER WELTATLAS, 1953/57; HANDBUCH DER EUROPÄISCHEN GESCHICHTE, 1968/73; N. POUNDS, 1973; C.T. SMITH, 1967; WESTERMANNS ATLAS ZUR WELTGESCHICHTE, 1956.
Organization: Emergence of cities in Central Europe.
Sources: DEUTSCHES STÄDTEBUCH, 1939/74; C. HAASE, 1960/65; HANDBUCH DER HISTORISCHEN STÄTTEN, 1960/74; H. STOOB, 1956.
Dynamization: Acquisition of colonies outside Europe. Areal growth. Ten year averages, the maximum of the respective curves equal to hundred. The number of new colonies acquired by political means are represented. Purchase, conquest, construction of military forts on politically foreign ground, taking possession by means of peace treaties etc. The setting up of trading posts is assessed in the same light. The surface area involved was not of major importance for inclusion here; particularly for early centuries the area controlled cannot be established accurately. Moreover, the size of the area under command does not necessarily reflect the importance of the colony (cf. military bases usually only a few square kilometers in size but of great strategic value).
Sources: H. BRUNSCHWIG, 1949; DTV-ATLAS ZUR WELTGESCHICHTE, 1964/66; ST.C. EASTON, 1964; H.E. EGERTON, 1950; J.H. ELLIOT, 1963; D.K. FIELDHOUSE, 1966; W.PH. HALL, R.G. ALBION and J.B. POPE, 1961; GROSSER HISTORISCHER WELTATLAS, 1953/57; W. STEIN, 1946/70; V. VALENTIN, 1915; WESTERMANN ATLAS DER WELTGESCHICHTE, 1956; J.A. WILLIAMSON, 1961.

Fig. 24: Decennial phases in the development of European state populations since the 18th century. Simplified survey of different adaptation processes presented in the treatise.
Sources: Science: F. BECKER, 1947; W.C. DAMPIER, 1952; H. DINGLER, 1932/67; M.v. LAUE, 1950; K.E. ROTHSCHUH, 1969; W. STEIN, 1946/70; P. WALDEN, 1950; others cf. Figs. 13, 14 and 16.
An interpretation of styles of art (Fig. 13) in this connection is not possible yet.

Fig. 25: Decennial phases in the development of European and North American state populations since the 18th century. Simplified survey of different socio-reproduction processes presented in the treatise.
Source: cf. Figs. 16, 18 and 20.

Fig. 26: Process sequence and change of state. Schematic drawing (cf. text).

Fig. 27: Mathematic description of the information stages of the induction process. Basic graphs (cf. text).

ANNEX 3

TABLES

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2. Important processes, institutions and populations maintaining mankind

3. Mathematic description of the information stages of the induction process. Basic equations.

ANNEX 4

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