

THEORETICAL FOUNDATIONS FOR STUDYING STATEWIDE TRANSPORTATION AND OTHER FUNCTIONAL SYSTEMS

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An attempt has been made to formulate theoretical foundations for studying and planning statewide transportation and other urban functional systems. The examples and sample hypotheses given pertain mainly to transportation, but most propositions regarding the conceptual comprehension framework also pertain to other systems. The conceptual system of urban spaces serves as the framework for comprehending urban systems up to the metropolitan planning level. To comprehend the issues of planning beyond this level, however, requires a more general and broader conceptual framework. Culture, defined as a supersystem that contains numerous functional systems, is a suitable conceptual comprehension framework at state and higher levels of planning. Culture as an analysis framework possesses the potential for integrating knowledge of all sciences that deal with the forms of man's existence and forms of man-made environment.

•GENERAL PLANNING and service systems planning, such as that for transportation, are very recent at the state level. The popular demand for planning has pushed the planning process upward to a new plateau; a plateau at which both the capability to comprehend the issues and the effectiveness of the working tools are inadequate. The science and art of urban planning emerged as a result of the search for cures for ailing cities. The early issues that challenged the new profession pertained to improving the viability of old cities and to conceptualizing about the best form of new towns. Metropolitan planning issues emerged in the postwar decades. Now planners are confronting the issues of statewide planning, and federal planning will soon follow.

Thus, the hierarchy of planning levels is developing, and this trend is challenging the resourcefulness of the profession. New planning tools as well as new perspectives are necessary.

There are inherent problems, however, in the development from lower to higher levels of planning. By specializing in local planning, the planner becomes engrossed in detailed problem solutions. His intellectual orientation is fixed in a short-range view that brings mainly current problems to the observer's focus but not the elements of organizational framework with which such problems can be associated. Planning methods and practices are designed to cope with current issues, and local planning know-how has evolved in confrontation with current events. With each new level of planning, however, the issues change; and this change requires reorientation of both the point of view and the planning strategies. In general, it can be stated that each new level of planning requires broader comprehension and more general solutions.

THE NEED FOR AN EXPLICIT COMPREHENSIVENESS CONCEPT IN PLANNING

Planning transportation or any other functional system differs from engineering and design of isolated projects mainly in the comprehensiveness of the considerations that enter into the process. In both development stages—planning and engineering—we try to make the product optimal for the context of its services. In planning a large trans-

portation system, we assess its impact on other functional systems. By optimizing transportation we also take into account the optimality implications of other activity systems, and thus we enhance the performance of the body to which all such systems pertain.

Thus, in planning transportation, we consider wide implications of the system, i.e., wide optimality. For this reason we may state, quite appropriately, that planning deals with the wide optimality systems. Project planning and design, on the other hand, work within the limits that are specified by the systems plan. The project must meet the system's requirements. Although the designer must also deliver an optimal product, its optimality is evaluated in the light of systems specializations. Hence, we may say that project planning and design work with narrow issues of optimality, or narrow optimality.

In this paper we are interested in planning that deals with wide issues and wide optimality of systems. By moving the planning upward on the hierarchical ladder, we must expand the conceptual framework within which the comprehensiveness of planning solutions is to be considered. In order to remain meaningful, however, the wide optimality considerations cannot be boundless. The conceptual framework must suit the geographical delimitations of the planned area on the one hand and, in its complexity, cannot exceed the capability of the planner's comprehension on the other hand. Plans must be communicated to others and must be understood by those who participate in decisions regarding their implementation.

The optimality issues can be realized and problems properly resolved only by mastering both the model of the conceptual framework and the functional system under consideration. The conceptual framework must provide broad but explicit boundaries within which the comprehensiveness of planning solutions is to be considered.

URBAN SPACE: THE CONCEPTUAL SYSTEM FOR URBAN PLANNING

At the level of local planning, the planner deals with the city or the community; he is preoccupied with problems unique to such urban areas. However, if the solutions of such problems are to benefit the entire population, and if each subsequent planning consideration is to make the urban area more viable, the planner must assess the ramifications of each solution accordingly. For such an evaluation, the planner must visualize the city in the framework of a conceptual system that explains the essential relationships between its elements. From these relations, the planners should see the relevance of current issues to the entire system and, from such an evaluation, should find the proper solution. Even at the lowest level of planning, a conceptual system that generalizes on the urban elements and explains the relationships between them is indispensable.

In urban and community planning we work with the concept of urban space. The urban space is the conceptual framework. It is three dimensional and possesses a definable form. Planners know the history of this form, the rationale behind its formation, and also factors that tend to change it in time. If the planner understands the urban space in depth, the conceptual framework of urban space can serve as a conceptual model and a "master plan" for individual small-scale planning solutions.

In metropolitan planning we stretch the concept of urban space further. At this level of planning we work with aggregations of urban spaces. Metropolitan aggregation possesses its own form. Accordingly, we extend the conceptual system of urban space to a system of urban spaces. We visualize cities within systems of cities. We generalize on such systems, understand the history of their development, and attempt to comprehend the interactions of the city system. From this knowledge, we are able to make judgments that would reoptimize the entire city system now and in the future.

At the metropolitan level of planning, however, urban space as the conceptual framework has been stretched to the limits; its powers of explanation have been exhausted. The next higher level of planning, such as the state, may involve an arbitrary assembly of such spaces. The state may have been defined by chance events in history rather than by functional considerations. Even so, in a given state, the urban spaces are linked together in various ways; this linkage may not be characteristic to all states, and it may extend to include several states. For the level of state planning, we need another con-

ceptual framework, a concept that transcends not only the urban spaces but even the states themselves.

CULTURE: A CONCEPTUAL SYSTEM FOR STATE AND HIGHER LEVELS OF PLANNING

Higher levels of planning may embrace numerous urban spaces, rural districts, and undeveloped tracts. Within the boundaries of the state, the location pattern of urban spaces may not be functional. A state is an administrative space, not a functional space. These two types of spaces have a radically different evolution, and it would be an error of judgment to force the conceptual planning framework of functional spaces on a space that is obviously of a different kind.

In discussing local planning, we realized that even at this level the conceptual system lends comprehensiveness to the solutions of problems that are unique to individual urban areas. Contrary to local planning, the state and higher levels of planning deal with issues that are common, rather than unique, to all localities. Optimal solutions at such levels of planning, more than at preceding levels, depend on a comprehension of a complex system, and the comprehension grows in importance with each level of planning. Higher levels of planning, therefore, differ from local planning in concept and in method. Systems at such levels are broader in scope, and their optimality must be considered within a wider framework.

The concerns of lower levels of planning tend to be narrow and limit the planner's point of view and may even inhibit his seeking perspectives of a higher level. For this reason the development of a new level of planning practice is a slow process. Because it focuses mainly on current events, a lower level of planning cannot produce the means of comprehension required for a higher level of planning. However, a lower level of planning may uncover fragments of knowledge that are relevant to the higher level. These fragments remain to be put together, but, when integrated, a new body of knowledge is likely to emerge. Once developed, this knowledge would benefit all levels of planning. As a result of this general perception of higher order systems, all planning activities could attain broader comprehensiveness.

For such an all-inclusive systems construct, the most suitable concept is culture. The word has numerous meanings, depending on which aspect of human existence is stressed. It is used even with lower forms of life, such as bacteria. In planning we will view culture as a conceptual supersystem consisting of a specified number of functional systems. For the boundaries of such a set of systems we will consider, on the one hand, the population and its distribution forms and, on the other hand, the geography of the state. Systems within these boundaries are to represent the various attributes of the population, organized activities, and service facilities. In a given culture, population attributes and service systems establish a peculiar balance. This balance is manifested in the forms of living and in the patterns of statewide distribution of facility systems.

The planner would consider in depth only those systems within a given culture that are relevant to his task. No matter what systems the planner would deal with, however, he would work within the context of culture. In other words, higher levels of planning, such as at the state level, would entail planning the various service systems to fit the cultural context. In order to do this, culture as a conceptual system would have to be defined generally, and some basic principles that integrate the constituent systems into such a single supersystem would have to be identified. This approach will provide planning with a certain point of view. Any planning undertaking, if conceived and executed in this light, will contribute to the enrichment of knowledge and strengthen the point of view itself.

The propositions that follow are fragments of knowledge gained from past planning practice but supplemented with the logical suppositions that were required to connect these fragments into a plausible body of knowledge. The propositions are structured so as to reveal the circumstances that give rise to culture, the systems that structure culture, and the factors underlying cultural change. The set of propositions is to serve as a source for hypotheses, which, in turn, can be grouped into various research and planning projects.

Knowledge breeds knowledge. The set of propositions is bound to be revised by research findings. In the long run, the propositions are bound to coalesce into a theory that provides a comprehensive explanation about the man-made systems world; the world that man creates but that, in turn, influences man's further evolution.

PROPOSITIONS REVEALING THE RUDIMENTS OF SYSTEMS THAT CHARACTERIZE A GIVEN CULTURE

The propositions that follow provide the minimal foundations for the growth of a theory. Such a theory is necessary for explaining the structure of culture in a way that could assist the planning of large aggregates such as states and regions. A given culture can be studied from a number of viewpoints. The objectives of a given study influence the choice of the viewpoint.

The theory, which we anticipate to emerge, will explain the structural systems of culture. In order to become more aware of the implications of his work, the planner must know how the supersystem—called culture—is put together, how it functions as a unit, and what is behind its change. He must know the skeleton on which are hung other adornments of culture, because by changing the skeleton other cultural attributes also change. Radical technological innovations tend to modify the cultural skeleton, and, in our age of rapid transformations, a broader and deeper comprehension of the entire cultural phenomenon is becoming indispensable.

A natural system, which takes shape in time without the intervention of an identifiable designer, is constrained by the effects of one or more invariants. In a general sense, an invariant is something that does not change. Invariants can be environmental factors that retain nearly the same characteristics over time, or they may be internal elements of the system. Regarding the development of culture, the former kind of invariant is the behavior of the planet Earth in the solar system. It is strictly periodical. The environmental cycles, due to the Earth's rotation, have a profound effect on the development of systems on the surface of this planet. The latter kind of invariant is to be found in the biopsychological nature of man himself. The basic needs of man, which pertain to his survival and development, essentially do not change. The ways of satisfying the needs have varied in time and different places but not the needs themselves. Man has always needed food, shelter, medical care, mental development, communication, and some forms of recreation. Each culture at different points in time provided for these necessities in a way that was considered to be "best", and differences in these ways distinguish one culture from the other. The environmental invariants and the invariants inherent in the nature of man, however, underlie the structural similarities of all cultures.

A theory attempting to explain a system must reveal its three major aspects: history or evolution, structure, and factors through which the system changes. The propositions in this essay are structured accordingly. However, some propositions contain elements of all three systems aspects. The inclusion of such propositions under one of the three headings means that it relates to that topic more directly than to the others. The grouping of the propositions is primarily to serve as a guide in the formulation of analysis programs and planning projects.

The title associates the essay with transportation planning. In comprehensive planning, however, such as is envisioned by the introduction of culture as a conceptual framework, the analysis of transportation systems would become part of the general analysis of cultural structure. Specific conclusions of such analysis would be directed to travel and transport and thus would lead to transportation systems planning. Each proposition ends with several hypotheses. These hypotheses are only a few of the numerous possibilities for approaching the analysis of statewide systems. The given hypotheses are transportation oriented. Hypotheses for other function systems could be drawn in a similar manner.

Activity Patterning and Rise of Culture

Culture is characterized by numerous patterns manifested in everyday existence of an aggregation of individuals. The reasons for the emergence of patterns might be numerous. At this point we are interested mainly in the fact that such patterns exist and in the causes that underlie the patterning of all cultures.

Fundamentally, nature itself has conditioned man for a patterned existence. From without, nature has imposed a time limitation of a 24-hour day. From within, in order for man to function normally, a series of needs have to be met during that time period. These are invariants of nature and they transpire all cultures at any time. Man's life is a cycle, creating different needs at different stages. All these needs can be met in a variety of ways, but in all cultures they have been protruding as necessities that require solution. Even if these necessities were ignored, they existed nonetheless. The aggregation of households into settlements is a long-run consequence of pressures of the common necessities of man. Thus, the invariants of nature from without and the invariants of man's nature from within underlie the skeletal structure of all cultures.

Proposition 1—Aggregation of households into settlements led to patterning of activities and to the development of culture.

Aggregation of households into settlements is an evolutionary consequence. Settlements grew into cities, cities into city-states, and city-states into city-empires. In our cultural context, settlements have retained a hierarchy of sizes. Metropolitan areas, cities, towns, and villages provide the contemporary variety of choices for household locations.

The degree of intrinsic and extrinsic orientation of activities characterizes a given culture. It affects the patterning of activities in two ways: Extrinsic orientation not only makes the activity patterns more distinct but also tends to make the pattern structure more elaborate and complete. Everything becomes organized, and human activities fall into the organizational pattern. Intrinsic orientation tends to minimize the organization and, thus, the patterning of activities.

Aggregation of smaller activity units into a larger one is associated with the transferring of some activities and functions from smaller to larger units. If a household exists in isolation, the activities of its members must take place within the household—the activities are intrinsically oriented. On placing the household into a settlement, some of its activities are transferred to the settlement. The activities and also the responsibility for providing vital services become the function of the settlement. Aggregation of households into settlements marks the beginning of urban culture.

Hypotheses:

1. As the distance from the city center increases and population density decreases, a smaller percentage of the population earns income from institutionalized employment (full-time employment in an organized establishment). The decentralization of industry may have changed this pattern but not appreciably. In such locations most travel is not work-oriented.
2. The set of daily activities varies for similar classes of households in different development densities. This variation affects the travel demand.
3. Contacts with neighboring establishments increase as density increases. With increasing densities, pedestrian travel replaces vehicular travel.
4. There exists a possibility for establishing an intrinsic-extrinsic activity orientation ratio. This ratio could be effective in predicting change in travel demand.

Proposition 2—Activity patterning is also caused by the invariants of nature.

The origin of pattern-making, to a degree, is rooted in the invariants of nature. The 24-hour day is the main invariant. Anything that is necessary for securing subsistence and for attending to other human daily needs must be scheduled within the 24-hour time span. The organized way of life in a given cultural setting tends to standardize the ways of satisfying basic needs. Organizations abide by the time constraints in a fairly uniform manner—hence, the origin of pattern-making.

Another natural invariant is the day-and-night cycle. This cycle creates two radically different environments for daily activities. It tends to confine various classes of activities to a still narrower time span. It is optimal to schedule some activities during

the daytime, others at night. As a result of the two invariants of nature, a number of activities are patterned on the 24-hour time scale.

The third invariant of nature is to be found in the basic needs of man—those needs that are common to all individuals. One set of needs pertains to biological survival and represents necessities such as food, shelter, clothing, and health care. Security against inside and outside dangers, security against consequences of inability to earn subsistence in old age, and other welfare needs constitute another set of man's natural wants. Settlements and organized existence are the outgrowth of the first two types of needs, but the forms of organized living create further necessities: those of self-governance and settlement organization. In settlements and cities, man becomes an element of larger systems. Such a systematization, however, is a universal phenomenon. To a degree it has also been instituted by other biological creatures.

Hypotheses:

1. All activity and artifact systems can be classified in accordance with the categories of essential human needs. Such a functional classification basis would be valid for all cultures and at all times. Travel and transportation is a typical function system.
2. There is a relationship between the evolution of transportation systems and the evolution of other cultural characteristics.
3. Of the increasing total volume of travel, night travel increases more than proportionately. Night travel is especially favored if the possibilities of sleeping while traveling exist without additional expense.

Activity Structure: A Cultural Characteristic

The daily rhythm of man's existence, consisting of rest, work, and leisure time, tends to group all activities accordingly. This grouping produces three distinct activity classes. Each class is structured further, and this structuring reflects cultural characteristics.

While the reasons for similar activities to occur at about the same time of the day might be the same in all cultures, in technologically advanced cultures these reasons are more overt. For instance, it is more optimal to both the business establishments and the individuals to schedule work periods at about the same time of day. Such scheduling facilitates intercommunication among organizations and contributes to the efficiency of their operations. There are also advantages for individuals in such scheduling. If services are required from organizations, one can be certain to get satisfaction even if such services involve more than one establishment.

Scheduling work and rest periods at the same time of the day benefits individuals still further. Most individuals enjoy their free time concurrently, social intercourse becomes possible, and a variety of facilities can be established in response to the demands that arise from free-time activities. In fact, one cannot state with certainty whether the demands stimulate the rise of new enterprises or whether innovative enterprises shape the demand. Most likely this process follows the laws of the evolutionary process.

When the variety of opportunities for utilizing time becomes great, individuals and households must make the "best" selection of alternative choices. The need and the general tendency to economize time lead in the long run, to the establishment of time-allocation patterns. If the opportunities for spending time productively prevail and if there is a variety of activity choices that attracts most individuals to do so, culture attains a high level of welfare. Cultures are characterized by time-allocation patterns.

Travel is one of the time-consuming activities. While travel is desirable to most individuals for recreation, travel to work and other activities consume resources and time. If travel could be avoided, individuals could use these resources for other purposes. In their time scheduling, households rationalize on this type of travel. They tend to maintain the daily travel time within "reasonable" bounds.

Location patterning results from the tendency to economize in time and other resources for intercommunication. According to the information available to the individuals involved in the decisions and their ability to utilize such information, all types of establishments and residences tend to minimize the social cost of intercommunication

and to maximize the extent of intercommunication itself. In the matrix of such spatial patterning, the patterning of activities leads to the patterning of time allocation, and this patterning, in turn, leads to urban spatial patterning. The parameters of all such patterns, to a considerable extent, are determined by the performance of the transportation system.

Proposition 3—The three phases of the day—sleep, work, and leisure time—provide the basic structure to activity patterns.

In our geographic and cultural setting, the day is divided into three approximately equal parts: 8 hours for sleep, 8 hours for work, and 8 hours for leisure-time activities, such as travel, rest, recreation, dining, entertainment, and education. A majority of individuals sleep at night; most working hours are scheduled between 8 a. m. and 5 p. m. The remaining hours constitute leisure time. A number of cultural characteristics could be defined by studying how this free time is utilized by different groups of individuals and how this utilization changes with the increasing level of welfare of technological sophistication.

There are elements of optimality in scheduling work hours at about the same period of the day. Such scheduling facilitates the intercommunication among establishments during the working period, and social intercourse becomes possible during the leisure period. Such structuring and patterning of activities are requisites for the development of culture and make it possible for an ever-greater variety of abilities and talents to attain realization. The activity structure characterizes a given culture.

Hypotheses:

1. In a given culture, different groups of individuals develop patterns for utilizing leisure time. These patterns vary among age groups. Each generation changes somewhat the pattern of using leisure time. Travel is considered in the leisure-time allocation.
2. For most activities there are advantages in scheduling work periods at the same time. The optimality of such scheduling can be identified and evaluated. The advantages outweigh the disadvantages of peak-hour congestion.
3. There is a unique assortment of enterprises that cater to off-hour activities in each culture. Minimal population densities are required to support a given mixture of such enterprises. Concentration of off-hour activities creates demands for transportation facilities.

Proposition 4—The time-allocation pattern is a cultural trait.

Each culture is characterized by commonly accepted time-allocation schedules. Such schedules normally emerge as the "best" use of time from the existing variety of all possible time uses. A preferred assortment of time uses dominates the culture. Innovations in the means of mass communication, such as the invention of television, inject new elements in the prevailing variety of choices. Depending on the strength of public acceptance, a new element may change the prevailing time-allocation schedule.

Increasing productivity per man-hour changes the activity structure. Gains in income and leisure time increase the household resources. Foreseeing the assortment of future off-hour activities is rather difficult. However, it is possible to find out which of the current favored activities have a tendency to gain additional time allocation. This can be researched by preference surveys. New activities require either technological innovations or new events in the realm of ideas. In order to change the time schedule, both would have to be accepted by a sizable portion of the population.

In the past, daily travel time was not the greatest beneficiary in the rescheduling of leisure-time gains. The speed and distances of travel have increased, but the total daily travel time has changed only insignificantly in recent decades. The current complaint about travel to work is that it is too slow—it takes too much time. If there is an increase in the total daily travel time, such an increase is associated with the increasing

number of activities that require travel, rather than with the increased time required per trip.

Cultural change is to be associated with the changing variety in activities. Each assortment of activities possesses its time-allocation schedule.

Hypotheses:

1. Different population classes in a given culture possess typical time-allocation schedules. Culture is characterized by such schedules.
2. Preference surveys for more free time for some activities would indicate the trends for changes in the future use of leisure time. New travel demands could be deduced from these indications.
3. The past trend in the allocation of time for travel can be researched. Moreover, the research could reveal which forms of travel will be preferred in the future.

Proposition 5—Journeying to work is the most time-demanding, single-purpose daily travel. It affects the time-allocation schedule.

Going to and from work accounts for a major portion of daily travel; for this reason, travel to work is given special attention by households. The average person is willing to devote only a limited amount of time for this purpose. Travel to work tends not only to extend the work period, but also to reduce the sleeping period in the morning hours and the off-hour activities in the evening. There is a natural resistance by individuals to such a sacrifice.

Individuals tend to dispose of their time in the manner that pleases them most. The total available time is invariant; therefore, to retain the approximate time allocation and the choice of activities that is customary for a given culture, the time allotted for travel to work cannot vary extensively. Those individuals who reside long distances from their places of employment must travel faster. On the other hand, city residents, living in the proximity of their places of employment, tend to be tolerant about the inconvenience of traffic congestion.

Journeying to work from suburban locations to downtown destinations consists of both high-and low-speed segments. How to keep the travel time within reasonable limits challenges the planner's imagination.

Hypotheses:

1. The time spent for travel to work is a fairly constant quantity, especially if choices of travel modes exist. A wide dispersion around a mean value would indicate that there are serious inadequacies in the transportation system.
2. There is a correlation between travel-demand intensities and travel speed. This relationship can be explained by the economics of transportation facilities.
3. In a given culture, there exists an optimal radius of gyration of population distribution. The length of this radius depends on the population size in the core city.

Proposition 6—The limitations of time and the variations of travel speed lead to a three-way spatial patterning of interactions. The utilization of resources is controlled by locating origins and destinations at reasonable distances and by designing transportation facilities for proper speeds.

The earlier premises lead to a visualization of the rationale for a three-way spatial patterning. First, concentrations of jobs and activities, such as office buildings, tend to be located centrally to be accessible from all parts of the urban area. Second, within the available range of choices, households tend to locate their residences so that, for their habits of interactions, the travel would not be too time-demanding. Third, the resulting travel demand tends to induce the arrangement of transportation facility networks so that the average travel time per day can be maintained by residences located in different parts of the urban area.

Hypotheses:

1. Job concentrations and the variety of jobs are morphologically interrelated with population concentrations.
2. A morphological relationship exists between the availability of transportation facilities and measures of population potential.
3. There are morphological relationships between subsystems of transportation facilities. These subsystems tend to equalize the travel time per average daily trip.

Factors Behind the Shaping and Changing of Cultural Forms

Planning that pertains to large systems takes into account those cultural forms that can be defined and generalized on. The activity structure is of primary interest to planners. The variety of cultural forms that emanate from the systems of activities and that give texture to culture would require additional inquiry. Such knowledge would be relevant to project designs. In this respect, planners would expect contributions from the appropriate social sciences.

The overall well-being within a given culture is represented by a cultural milieu. The milieu can be defined by the service standards of all function systems. For instance, in our cultural context, the service standard of the urban vehicular transportation system is approximately 20 min per trip; the average trip amounts to about 6 miles; and the daily activity pattern requires about 2.5 trips per day per person. This performance standard of the transportation system is an integral part of our culture. Its performance parameters are established by the urban spatial order, activity location, household's daily assortment of activities, extent of utilization of communication means other than travel, and performance and economy of transportation systems. Other function systems perform in a similar manner, and their service standards are also measurable. The entirety of all service standards of all function systems represent the cultural milieu.

Thus, the level of cultural milieu is established by the optimality levels of function systems. An examination of how the transportation service parameters are established clearly shows that the level of service standards of individual function systems are dependent not only on the efficiency of its facilities but also on the spatial arrangement of residences and on the location of activity concentrations. The activity structure that characterizes the given culture also plays a significant role in determining the service standards. The predilection of households to optimize the affairs of their realm, the information that the households use for this purpose, and the quality of information that underlies major organized branches of culture are the major factors in shaping and changing the forms of a given culture.

Households optimize their realm within the limits of three major constraints—time, energy, and income. The cultural milieu sets the limits for these factors. By reoptimizing their realms, households become better off within the available limits of these three resources. When the majority of households attains a higher level of welfare, the cultural milieu also rises. The gains, however, must result in more and better information by which more output can be attained from available resources and additional natural resources can be channeled into the general welfare.

Distance is another important factor in shaping the forms of culture. Physical distance can become social distance, which is commonly understood as the lack of communication between individuals. Social distance may also be created by disharmony caused by numerous factors. Social distance resulting from physical distance requires resources to be overcome. Social distance reduces the possibilities for information flow within a given culture and reduces the chances for attaining higher optimality by households and by systems serving them.

Planning is also a factor in shaping cultural forms. Planning pertains to the seeking and incorporating of better information in the optimization process. Planning represents knowledge of how to utilize the available information. Planning attempts to place the time, energy, and income resources of individuals and organizations to their best advantage, and thus planning influences the forms of a given culture.

Proposition 7—Physical distance is also a social distance. Resources are necessary to overcome it. Distance tends to inversely affect the population potential.

In locations where residences are spaced far apart and where interactions require a considerable amount of time, energy, and income, households have three choices. The first choice for such households is not to interact; another possibility is to interact at any cost; and the third choice is to limit interactions to an extent that is optimal for a given household.

Under the first possibility—no interaction—all activities of household members would be confined within the household, and the estate would have to provide for all resident needs. The activities would be intrinsically confined. Under such conditions, individuals could utilize their abilities and talents only as much as opportunities for their utilization are provided by the estate. Within an isolated estate, the variety of opportunities for developing the potential can be only limited.

Under the second option, a maximum of interaction at any cost, the householders will not be better off than under the first one. Time, energy, and resources would be consumed for long-distance travel, and the variety of other activity choices would be reduced to a minimum. Even though there would be some gains from interacting and from common production, most of these gains would be lost in the effort required for interactions.

The third option would be the rational choice. It is a limited interaction with the best utilization of the fruits gained. In such a case, the individual could attain a potential that corresponds to the social distance in a given cultural context.

The distinction between physical and social distance may be characterized by the means and resources that a given culture possesses for overcoming the physical distance. The same physical distance under a low standard of living represents a long social distance; and under a high standard, a short social distance.

The interaction implications that were discussed for households are also valid for settlements. Because dispersed small settlements cannot interact, they develop more sophisticated service systems. Political constraints and disharmony tend to increase the social distance between settlements—in a similar manner as they do between individuals—and prevent the development of a more refined culture.

Hypotheses:

1. Potential population surfaces may be computed for a state and region. Such surfaces characterize the potential for interactions in a given setting of population distribution. Potential surfaces also indicate the potential for travel.
2. In addition to interaction at a distance, potential surfaces may be used for explaining social differences among population groups. Such explanations could be utilized in assessing the variation in travel demand.
3. If the actual interaction friction with respect to both the geographical constraints and resource needs were used in computing potential surfaces, a map of social distances may be developed. It could reveal the deficiencies and inconsistencies of the present transportation network.

Proposition 8—Travel parameters, such as the annual travel mileage, travel speeds, and the daily allocation of time for travel, are characteristic of a given culture.

An average individual, in a given culture, travels a certain number of miles a year, depending on the technology of the dominant mode of transportation. In this country each automobile travels about 10,000 miles a year. This figure has remained constant for decades. At the time when a horse and carriage was the dominant mode of transportation, the annual travel mileage was less. In areas of high population densities the annual travel per car is somewhat less, and in areas of low densities annual travel is more. Obviously, regardless of his spatial location, the average man balances the amount of interaction within a similar set of constraints. The variety of interaction needed by individuals is matched by the variety of available residential locations in urbanized areas. This balancing enables the households to keep travel needs in harmony with other necessities.

Travel speed is limited by the transportation technology and by the economic characteristics of transportation facilities. Although our cars can attain speeds up to 120 mph

we cannot use such speed. The economics of road construction radically curtails this technological advantage. To change the prevailing speed would require more than just additional resources. New designs of transportation facilities would also change other cultural characteristics.

Hypotheses:

1. The average annual travel mileage per year per household has changed in time. This change can be associated with new transportation technology. Other cultural characteristics, however, change concurrently.
2. Historically, the increase in travel speed has had a profound effect on the interactions of different cultures. It tends to change the barriers isolating cultures from one another. International cooperation expands as a result of gains in travel speeds.
3. Increasing travel speed changes the spatial order of urbanized areas and industrial location patterns.

Proposition 9—The major constraints in delimiting cultural characteristics are time, energy, and income factors.

To traverse a distance, one requires time, energy, and income. Of the three, income is the most elastic factor. In low-income cultures where walking is the most common means of traversing a distance, hardly any income is used for the purpose of travel. In technologically advanced cultures, income is necessary to pay for the service of mechanized transportation. Income may substituted for time and energy but only to a degree. Performance characteristics of transportation technology essentially limit the range of travel. A prosperous rancher may own a plane. The performance of the plane and ground facilities, in comparison with slower modes, determines the substitutability of time, energy, and income factors. Regardless of how prosperous the rancher might be, there is no faster means of transportation in this culture than the plane. However, should rockets someday become part of our culture, the substitutability of time-energy-income factors would be extended further. The new speed, however, would also change other cultural characteristics.

Only high-income cultures possess sophisticated transportation technology. For this reason low-density living can be organized in such cultures with little or no additional cost in time. High-speed facilities call for sophisticated and costly designs to be fast but also safe and comfortable. Thus, innovative designs go hand in hand with increasing income. The existing state of income in a given culture delimits cultural characteristics.

Hypotheses:

1. To a degree, income can substitute time and energy requirements for travel. This substitutability can be determined.
2. A relationship can be established between energy and time utilization for travel at different income levels.
3. A functional relationship may be established that considers time, energy, and income factors in maintaining the allocation pattern for travel time in a given culture.

Proposition 10—Man's predilection for seeking higher optimality for his private and public realms of affairs is the vehicle of cultural change.

Optimizing in this context means ordering the affairs, which are under the individual's control, in the best way. However, information is necessary for such organizing, and it is always limited. Therefore, the optimality level is never final, and in most instances it can be raised. To do this, new and better information is necessary. Thus, the reoptimization process entails obtaining and injecting new information in processes that sustain the culture.

The realm of an individual's affairs is delimited by cultural factors. Some of these factors have already been identified. The culture as a whole provides a variety of choices for the individual. By making choices that he considers to be "right", man

optimizes his affairs. The available variety of choices represents the degrees of freedom offered to individuals in optimizing their realm.

Innovative and high-quality (tested to be valid) information is crucial in the optimization process. This holds true in the reoptimization of both the private and public realms. Extrinsicly organized activities are normally instituted on more objective information than that of intrinsicly oriented activities. A wide consensus is necessary about the validity of information that underlies publicly organized institutions. Individual dictates, on the other hand, can govern intrinsicly oriented activities.

Hypotheses:

1. The realm of individual and household activities in a given culture is definable. The information by which the realm is optimized may also be identified. Travel demand is likely to change if such information changes.

2. The variety of choices of major activity and service classes that are available for a household in a given culture may be defined. Such a study would indicate the degree of relative convergence of tastes on the one hand and constraints in the service organizations on the other hand. Travel demand is influenced by the variety of choices.

3. Historically it may be demonstrated that organized activities and major technological inventions changed the intuitively conceived information as to what is "good" for people. Technological inventions even changed religious practices.

Proposition 11—In a given culture all service and productive systems operate at a certain level of optimality. Changes in these optimality levels underlie the cultural change.

At the turn of the century, railroad transportation dominated the passenger and freight movement. The optimality of the entire transportation system was characterized by its speed, cost, convenience, and flexibility. The motor vehicle became dominant in the twenties and introduced new optimality characteristics for passenger travel and for moving certain classes of goods. With the introduction of the automobile, the transportation system was reoptimized. Further reoptimization of this system took place as a result of the initiation of air travel. Thus, the transportation system extended its speed and range by means of the airplane, attained new flexibility with the automobile, and also set a new travel cost. As a result of these changes, the city took a new form. Better transportation made interactions possible that were not possible before, and the ramifications of these interactions pervade contemporary cultural characteristics.

A similar reoptimization process can be traced for the school system. In a relatively short time span, single-room school houses have grown upward to educational plants and centers. Changes took place not only in the form of structures but also in the educational process itself. The scope of educational activity vastly expanded and changed the cultural characteristics in a number of ways.

Hypotheses:

1. The history of reoptimization of transportation systems may be studied. Such a study could reveal the cultural environment that invited reoptimization on the one hand and the changes in the environment that the innovation caused on the other hand.

2. By studying the current trends of technological advances, predictions can be made about the future reoptimization of transportation systems.

3. It can be shown that a lag in one function system's development tends to restrain the reoptimization process in others.

Proposition 12—The cumulative result of optimality characteristics of all service and production systems (which can be classified into function systems) represent the cultural milieu.

In a general sense, the cultural milieu can be defined by studying how individuals utilize their time, energy, and income. Because an individual's welfare in a given culture depends on the service and production (function) systems, the operating characteristics of these systems claim an individual's resources in a specific way. More optimally

organized systems render more benefits for a given amount of an individual's resources, and less optimal systems, in this sense, are more costly. In optimizing his affairs, the individual makes choices from the variety of services offered by the several function systems. For instance, if the individual is considering a vacation trip, he must make a choice from the service types that the present transportation system offers. Only cultures that have attained a high milieu can sustain transportation systems that provide a great variety of choices with respect to time, energy, and income utilization.

Previous propositions have associated the individual's time scheduling with the culture. Energy has received less attention. It cannot be dealt with as explicitly as time. By mechanized production processes, man's energy is substituted with the energy drawn from nature. In his routine work, man is naturally inclined to preserve his energy and utilize it for pursuits of his liking, i. e., those activities in which he utilizes his talents and abilities best. Psychological factors have a bearing on the energy preservation and utilization.

In the cultural milieu concept, the income level indicates the productivity of function systems. It represents the potential for satisfying the individual's needs in exchange for the individual's contribution. Mechanization and the amount of natural resources utilized per capita work in favor of the individual. If the income is high, an individual can utilize it for conserving his time and energy. For example, we may consider an individual who possesses the ability to write. If the individual can subsist by working just a few hours a day, he can use the remaining time and energy for writing. However, if the cultural milieu requires him to work at other tasks 10 hours a day for subsistence alone, the chances for the development of man's abilities are slim. A low cultural milieu represents low optimality of function systems, drains man's resources, and tends to leave human abilities undeveloped.

Hypotheses:

1. The explanation of the cultural milieu may be attained by defining the standards of service of the various function systems.
2. Uplifting of the cultural milieu depends on the flexibility of a function system in offering the variety of choices that is required to optimize the private and public realms and the ability to seek and institutionalize new information in the function system.

CONCLUSIONS

The set of 12 propositions represents a sketch depicting a coarse cultural structure for the purpose of analysis of major function systems at the state level.

The structure is neither complete nor accurate. It is only a reference framework for building knowledge. The framework is used to stimulate research hypotheses. By giving rise to hypotheses, the framework will also tend to integrate the research findings. Thus, the proposed framework could lead to the understanding of the integration of various function systems into a given culture and of the relative roles of function systems in enhancing the welfare of the population at a given time.

The essay emphasizes transportation systems, but the propositions apply to other function systems as well. If other propositions that are related to another function system were injected into the proposed framework, the explanation could be oriented in the direction of that system. Jointly, function systems constitute cultures, and, therefore, all cultures possess a common theoretical framework.

The framework itself is bound to change as a result of further factual evidence. Such a process, however, is in keeping with the growth of knowledge.

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REFERENCES

1. Appleton, J. H. A Morphological Approach to the Geography of Transport. Univ. of Hull, England, Paper 3, 1965.
2. Automobile Facts and Figures. Automobile Manufacturers Assn., Detroit, Mich.
3. Balkus, K. Metropolitan Highway System in the Framework of Social Welfare Decisions. Regional Science Assn. Papers, European Congress, Vol. 22, Budapest, 1969, pp. 39-64.
4. Balkus, K. Toward the Theory of Urbanology: The Science of Man-Made Environment. Presented to the American Institute of Planners Conf., Minneapolis, 1970.
5. Campbell, N. What Is Science? Dover Publications, New York, 1952.
6. Garner, W. R. Uncertainty and Structure as Psychological Concepts. John Wiley and Sons, New York, 1962.
7. Kansky, K. Structure of Transportation Networks: Relationships Between Network Geometry and Regional Characteristics. Dept. of Geography, Univ. of Chicago, Research Paper 84, 1963.
8. Lansing, J. B., and Blood, D. M. The Changing Travel Market. Institute for Social Research, Univ. of Michigan, Ann Arbor, 1964.
9. Levi-Strauss, C. Structural Anthropology. Doubleday and Co., New York, 1967.
10. Oi, W. Y., and Shuldiner, P. W. An Analysis of Urban Travel Demands. Northwestern Univ. Press, 1962.
11. White, L. A. The Science of Culture: A Study of Man and Civilization. Farras Straus, New York, 1958.
12. Wilbur Smith and Associates. Future Highways and Urban Growth. Automobile Manufacturers Assn., 1961.