

# Social Sciences as Conceptual Resource for Transportation Research

SAMUEL Z. KLAUSNER, University of Pennsylvania

My assignment is to brief members of the conference on potential contributions of the social sciences to transportation research. This assignment could be approached inductively from the bottom up, as it were. That would involve a case approach, commenting on the way social science theory and method might improve the accuracy or scope of application of specific examples of transportation research. Incrementalists, who anticipate that social scientific applications will evolve in transportation research as the sum of small adjustments, might prefer such a case approach.

Conversely, proceeding deductively from the top down, a conceptual map of the social sciences may be used to project some directions for transportation research by proposing alternative statements of transportation problems. The deductive approach, from theory to application, is chosen here for several reasons. Foremost is the fact that current transportation behavioral research is imprisoned by a physicalist frame of reference. This very frame of reference calls for revision. The conceptual frame is not physicalist in the literal sense that transportation systems are conceived as constituted solely by vehicles, motive power, and routes. Rather, the human actors in the system are treated as objects in a fluid medium, which is described by rates of flow in constrained boundaries subject to the action of valves and represented by such metaphors as "trip purposes" and "travel demand." The mathematical models preferred are those of operations research. Some of these models were originally designed to monitor physical flow processes such as inventory control. Others, models of population growth and mobility, are borrowed from demography and human ecology. These are specialized, and useful, forms of societal analysis that imagine a human population to be a set of objects arrayed in a spatial matrix.

Such models have immediate use in analyses of system problems of operating transit agencies. The power of social science, though, is hardly exploited in these applications. Market research in the motor vehicle industry, for instance, tends to break away from these spatial models and begins to draw on economical and psychological theories of consumer behavior. Were behavioral researchers called on to evaluate national transportation policy, to assess the interplay between characteristics of transportation systems and the regional distribution of industries, or to examine transportation in relation to defense strategy and tactics or in relation to health services or its impact on culture and education, the pressure would be to break away from the physicalist model in favor of a wider range of symbolist social science models.

In proceeding from a discussion of the nature of the social sciences to applied problems, we hope to reveal new possibilities for transportation research. Issues not high on the current agenda but of high national significance may be revealed. What resources may the social sciences, and sociology in particular, offer transportation planners and researchers?

As motivation, I begin with a series of comments on the way we think about transportation and offer general caveats (actually advice) about how not to think about transportation as a social phenomenon. In the second part of the paper, I examine problems of social prediction, particularly relevant to plan-

ning. I will close with a systematic, though brief and schematic, statement about the conceptual frameworks current in social science and the contributions to transportation research, particularly for planning and policy, possible within each framework.

## HOW TO THINK AND NOT TO THINK ABOUT TRANSPORTATION

Five fallacies dog our thinking about transportation. They impede our research and planning.

1. Transportation refers to getting people and goods from here to there and in negating the space in between. Land use, contrasted to transportation, refers to a static commitment of territory to particular activities and facilities.

The error is to consider land use or human settlement, on the one hand, and transportation or mobility, on the other, as distinct social events. The basic analytic dimensions of transportation and of land use are similar rather than contrasting.

To specify these dimensions, let us begin with the idea of a social order. A social order consists of interrelated activities. The activities are accomplished by actors, the individual or collective agents of the activities, governed by social rules and goals and facilitated by material means such as technology and symbolic means such as language. A network of such activities constitutes a social structure. These activities may take place at locations distant from one another. This seeming condition of action may be modified by technical intervention.

Add to the idea of a social order the idea of a physical order of society, not to be confused with the physical order of nature. The physical order refers to the net of locations in which the activities reside. Human activity requires the articulation of the social and the physical orders. Transportation is itself a social activity, having both a social and a physical order among its components.

The function of transportation is to articulate the social and physical orders of the society. By mapping one on the other, society is transformed from a latent potential to an enacted reality. Transit between locations is one device by which social and spatial relations are articulated. Social interaction becomes possible despite physical separation. Speed is a mechanism that reduces the social significance of distance toward nothingness.

The social and spatial order may also be articulated by arranging activities within a limited set of locations. This we call land use. Land use is a way of ordering activities that does not negate space but makes creative use of it. The more-limited space becomes a stage for social action. The military, for instance, arranges fire power with respect to characteristics of a battleground, an element in tactics. Battleground characteristics are not passive but enter into the social, specifically the military, activity.

Transportation and land use are two ways of dealing with the same social problem, the patterning of human activities in space. Transportation might be distinguished from land use according to the distance between locations. The critical distance varies with the type of interaction and technology. The interaction of a net of satellite-tracking stations is a form of land use; the logistical support of those stations is a transportation problem.

2. The measure of the social benefit of a transportation system is the rate at which it processes people or goods through the system.

Why is this common assertion misguided? The benefit of a transportation system is its contribution to the ordering (i.e., articulating the social and physical orders) of other social institutions. A transportation system succeeds to the degree to which it facilitates the political, economic, or religious, among other, relations of a society. The measure is the extent to which it enhances the work of educational organizations or the functioning of hospitals, of medical services, or of manufacturing industry in American life.

These measures of effectiveness may be, but not necessarily, related to the economic efficiency of transportation itself. Striving for economic efficiency within the transportation system may reduce its ability to serve other social institutions. The proper evaluation of transportation is not based on its internal balance sheet alone but also on its contribution to the broader social system. The societal balance sheet may show profit for the transportation company and a deficit for social welfare, or vice versa.

### 3. Transportation is an industry.

Ways of thinking about manufacturing industries have been applied uncritically in thinking about transportation. Both transportation companies and manufacturing companies are profit-oriented firms. Both organize to accomplish their objectives through formally constituted bureaucracies. An industry, however, is a self-justifying social activity. Manufacturing, for example, involves the application of skill or craftsmanship in the production of a good or the offering of a service. Industries produce for consumption. Steel or rubber industries are characterized by the material resources around which their employees and activities are organized. Transportation is not an end in itself and its product is not a final item of consumption. Its role is infrastructural. We speak loosely of a health industry but stop short of speaking of a religion industry. Both of these are infrastructural services. The social role of transportation in facilitating other institutions of society is comparable with that of religion, health, and banking. None of these are ends in themselves. Banking facilitates exchange of labor and capital between households and industries. Trucking can be recognized as part of the social infrastructure because it takes on the meaning of the activities it facilitates. Trucking service to deliver groceries to sustain households is part of the social link between the family and the economy. Railroad cartage of coal is part of the coal industry, especially when the mining corporation owns the cars.

This semantic generalization from an industry to an infrastructure would not matter much for practical purposes but for the fact that policy tends to be generalized as a result. Economic policies for manufacturing industries are not equally valid for infrastructural services. Oligopoly controlling infrastructural service or, on the contrary, disorganized segmentation of control in that sector would be more of an impediment to society than either oligopoly or segmentation would be in manufacturing. A well-known historical example of such a lynch-pin role is the limitation that toll roads in 17th-century Europe or in the 19th-century Near East imposed on travel, cartage, and trade.

4. The enterprise of transportation is properly corporately proprietary.

Society's need for transportation is as intense as its need for the activities that transportation facilitates. The social contribution of transportation is not a product but is an increment of social order--in cybernetic terms, negative entropy. Governmental regulation emerges to chide the transportation system when it threatens to become selfish or behaves as if it were an end in itself. Competition among infrastructural organizations may not evoke Adam Smith's invisible hand as a source of social order. The invisible hand works in an economic free market. The less the direct economic relevance of social activities, the less likely is the invisible hand to emerge to govern them. The infrastructural organizations support numerous social activities that are not primarily market activities. They are familial, religious, etc.

Financial profitability for the individual transportation unit is desirable but not crucial for the existence of transportation as a system. It is a consequence of the way we finance transportation within our market system that, in practice, general profitability is accepted as a controlling norm. It is less important that profits show on the ledger of a specific company than that profits show on society's ledger. The shipper and the receiver are not the sole beneficiaries and therefore the only ones who need pay for the service. To hold this to be the case is again to treat an infrastructural service as if it were an industry. The fate of social organizations not primarily economic, such as small towns, should not hinge on economic exchanges between the trucking company and its shippers and receivers. Like health care and religion, transportation should resist total economic rationalization if it is to optimize its contribution to society.

Transportation ratemaking, for example, may be discussed as a choice between market and administered prices. All prices are administered to some extent. Every price may be negotiable in a Middle Eastern bazaar but not where prices are fixed by company policy. The issues are who administers the prices, the government or the board of a corporation; what criteria are considered; and what weight is given to each criterion. The so-called market price results from the decision of sellers to emphasize a revenue function based on cost functions and supply-and-demand relationships over, for example, political or military considerations.

Government responsibility for the general welfare is a license to administer prices for infrastructural services. Price administration may serve a variety of policies including population distribution, resource exploitation, sovereignty over territory, and military defense. Since government decisions are political, its policy also reflects constituent interests. This is a natural outcome of the fact that transportation is not an end in itself but designed to facilitate policy goals of other societal sectors.

5. Transportation is, in itself, politically and culturally neutral.

To say that transportation is neutral is to say that its influence on the shape of society does not derive from its intrinsic characteristics. It influences politics when it is exploited as a tool by the socially powerful. Indeed, political control of transportation influences the distribution of power among interest groups, ethnic groups, and regions. One reason governments have tended to nationalize

and operate transportation systems is that strategic control may be exercised through them. Labor-management power struggles within transportation organizations are, for such reasons, of intense concern to the public. The reverse is also true. The distribution of social power affects transportation planning and programs, the establishing of routes, the acquisition of equipment, and the nature of service.

However, the social impact of transportation is not limited to its exploitation as a tool of the powerful. Transportation for reasons intrinsic to its character affects the balance of cultural power in the society. In this sense, it is not a neutral facility. Transportation strengthens economic and political institutions at the expense of other social institutions such as family and religion. This shift of institutional power changes the fundamental character of the society. Families, submerged in industrial society, increasingly incorporate norms and values that properly govern political and economic activities. This is in part what is meant by speaking of industrializing society as becoming modern and as becoming secular.

The cultural change occurs in part because of the nature of transportation technology and the way in which it serves society through an economic market. Transportation centers around complex technology and high energy. It is particularly promotive of those social activities based on the technical division of labor, the specialized occupations of production. Social activities aimed at acquiring and allocating resources and at shaping the physical environment and imposing the will of society on its members are aided by a powerful transportation system. Modern transportation does not promote to the same degree the more intimate and expressive social relationships in family, community, and religion.

#### SOCIOLOGICAL SCHEMAS

##### What Sociology Offers and What Is Missing from That Offer

The above fallacies do not occur simply because of insufficient rigor and precision in our thinking. They become apparent when transportation is conceived as institutionalized social activity functioning in a milieu of social organizations. General social science concepts have been brought to bear to achieve an understanding of the social system of transportation. This advantage must be balanced by a recognition of the limits of social scientific analysis, especially with reference to social planning in general and to transportation planning in particular. For illustrative purposes, the following discussion will deal with sociological knowledge rather than with all of the social sciences. A similar case may be made with respect to the knowledge produced through psychology, anthropology, economics, political science, the other generalizing social sciences, and history, a particularizing form of social scholarship.

Sociology, and even the social sciences taken together, offers some necessary but not sufficient knowledge for planning the empirical social system of transportation. The social sciences offer a narrow, specific, and perspective knowledge, a way of thinking about society that uses abstract general concepts. These concepts assemble seemingly disparate concrete events in an attribute "space." The coordinates assign to the events measures of the degrees to which they manifest the attributes defined by the spatial axes. Thus, the event may be living in a small town as compared with living in an urban center and the attributes may be distances

traveled to school or proportion of households at various stages in the family life cycle.

Most American social science follows the positivist school of scientific philosophy. Taking a cue from the success of the physical and biological sciences, the method of choice derives from thinkers such as David Hume, Thomas Hobbes, Jeremy Bentham, or, more recently, Rudolf Carnap and Karl Wittgenstein. Approaches, no less scientific, derived from German idealism--the empiricism of Karl Marx, the economic sociology of Werner Sombart, and the comparative sociology of Max Weber--are less typical. The positivistic thrust implies the measurement of external variables to arrive at statements about social process from which a reconstruction of real events is attempted. To believe that the real, palpable world can be reconstituted from a collection of abstractions is a delusion.

As a result, four types of knowledge needed by planners are not provided by sociology. First, sociological knowledge is not technical knowledge. It is not knowledge designed for the manipulation of the social world. To draw an analogy, a sociologist is more like a physicist than like an engineer. Concern with particular concrete situations is rare. The establishment of probabilist or statistical relationships relating to a universalized process is the typical way of working. The practitioner needs statements relating to concrete means translatable into instrumental instructions for the social craftsman or engineer. The political scientist is not a politician. Politicians draw on political science but must know more about their specific constituencies than they could infer from generalizations about, say, social class and voting propensities. Social science provides some background for understanding instrumental knowledge. Theory offers an environment for the practitioners' understanding, perhaps reducing the likelihood of vain effort or sheer foolishness.

Second, sociology is not moral or religious knowledge. It provides no statement of the "oughts" or the "shoulds" of the world. Its descriptions, existential statements, are factual and carry no intrinsic implications for acting one way or the other. The moral actor, of course, has more of a chance of achieving moral ends when existing facts and possible facts are taken into consideration. The kind of world we would like to realize, given the facts, is defined by our collective moral or religious sensibilities. Philosophical ethics contemplate the options. Religions, or secular social philosophies, implement the values in action.

Third, sociology does not offer aesthetic knowledge, or knowledge of the patterns in which the social world organizes itself into an array of functionally related institutions. The arrangement of organized, competing, and cooperating groups that carry out the world's work manifests such a societal aesthetic. We rarely see the concrete social world. Partly, this is due to our positivistic attempt to infer that world from its secondary qualities, as philosophers call them, or attributes, as scientists term them. Idealist scientists, such as Max Weber, concentrated on the organized "historical individual" such as capitalism or feudalism or the German nation or the Catholic church. These take shape from an aesthetic or an organizational plan. One way to put it together is to go to literature or other more socially synthetic approaches. Such entities might well be our objects of research rather than simply the strategic research sites for measuring varying attributes.

Fourth, sociology is not a source of affective knowledge or emotional involvement in the activities. The social scientist aims for ethical

neutrality, standing outside of the events and not judging them emotionally or morally, at least within the moment of scientific practice. Planners may never be ethically neutral, at least not in their active moments. In the preparatory moments, the planner may delay judgment but ultimately requires a commitment to action. The sociologist cannot provide the commitment, whether defined direction of development or the emotional thrust. At the same time, the sociologist is not alienated from the world. As Renée Fox, a medical sociologist, says in relation to the objectivity of the physician, the proper attitude is detached concern. Sociological work does not reflect the tone of the society. The reports are neither melancholy or slothful nor enthusiastic or triumphant. A social scientist who abandons such emotional and moral asceticism in his or her scholarly roles is not relying solely on the tools of social science.

Social planning is acting in society. It involves the scientific--that is, the cognitive--as well as the technical, the moral, the aesthetic, and the affective elements of action. Or, in the language of Alfred North Whitehead, philosopher of the natural sciences, the objects and entities ingress into, become part of, or qualify the developing concrescence of the real world as it emerges in the process that is reality. This cryptic sentence requires more elaboration than is possible within the confines of this paper. Allow it to stand as a signal that a more fruitful relation between science and policy planning and action may be achieved when both are reconceived within a framework of Whitehead's philosophy of organism.

#### Dilemma of Prediction

A plan delineates decisions for action in the future. Any present action predicates a future state of the system. The problem is that within the positivist scientific framework only "efficient cause," to use Aristotle's word for it, is legitimate. As a result we know only about completed events. We project these by extrapolating from an established mathematical model or by assuming a variety of scenarios. We work as if they were true. This fiction permits action in the present but does not avoid miscalculation.

Social scientists are pressured by agencies of the society to do "futurology." At the present state of the art, a conservative stance about futurological statements is prudent. Some social scientists are more courageous than others. A not-insignificant correlation exists between courage in this respect and being a publicist or a popularizer. Popularization is encouraged by the consumers of sociological knowledge because it offers them some sense of security.

The best predictor is an assessment of the current state of the system and a good theory of how it came to be the way it is. The future is always given in germ in the present, but this germ, and the program for its evolution, can only be recognized through some theory.

The discovery of such seeds and their evolutionary programs are at the heart of their empirical search of idealist social scientists. Thus, Marx' option of the inevitability of the shift from feudalism to capitalism and then to socialism is rooted in his theory of the evolving entities and their laws of change. This approach is not the prisoner of an analysis of the secondary qualities of the entity or the variable. The validity of the projection is not tied to past genetic causal relations. The model includes purposiveness, a sense of final

cause, as part of the defining characteristic of the entity.

In the energy field, for instance, the Arab oil embargo of 1973 is treated as a surprise in energy scenarios based on the extrapolation of abstracted elements of past behavior. The embargo surprised only those who were not reading the purposive character of discussions in OPEC about the politicization of their economic power. Not predictable was the vote to implement that purpose at that particular meeting and in response to the particular political crisis. The decision was in the cards.

One statement, probably true but insufficiently appreciated, is that more general principles about society are known and available in the literature than are tapped by practitioners. In part this is a consequence of the social position of the transportation researchers mentioned in the opening of this paper. Researchers are, by and large, called on for immediate responses to organizationally defined problems. This precludes time for study and reduces the predictive validity of research.

Direct extrapolation on the basis of past data by using abstract variables is perhaps the most common predictive technique. Yet its level of predictive validity is not reassuring. Demographic projections illustrate the case. Census projections are not too inaccurate for computing intradecennial estimates. Like the economist who discovers that the best predictor of the price of gasoline in 1984 is that price lagged one year, so the demographer finds the 1960-1970 rate of change applied to the level of population in 1970 a good indicator of the 1980 population. Misprediction occurs for reasons outside of the demographic schema that do not enter computation of the rate. To extend such extrapolations far into the future is the butt of professional tongue-in-cheek comments. During the 1970s those fearful of world overpopulation could prophesy that by the year 3000 but a square foot per person of earth would remain and by the year 5000 the radius of the earth would be expanding, in flesh, at the speed of light. The exponential expression, untamed by any logistic curve-flattening considerations, dictates such outcomes. In real life, some Malthusian positive or moral check would save some members of the population.

A 1948 prediction of the population of the United States in 1980 is illustrative. In 1948, observing post-World War II fertility rate increases, the Bureau of the Census anticipated a United States population of 165 million for 1980. The population for that year was nearly 230 million, an error of the order of 300 percent in a 32-year projection. Lawrence Klein, founder of Wharton Economic Forecasting, says he is comfortable predicting the next two months or the next quarter.

The Meadows' Limits to Growth perceived "overshoot and collapse" of our physical environment. The Meadows' models occupy the attention of political leaders more than scientific leaders. These models connect a number of exponential functions based on the growth of physical variables. Economists were quick to point out that little attention was given to economic variables that would control the rate of consumption, of production, and so of pollution, for example. Nothing in the models refers to the social institutional context. The original Limits to Growth, about 10 years old now, shows a curve representing the increase of gross national product (GNP) per capita over successive years. That function should be increasing exponentially according to the graph.

Transportation planners certainly must look ahead a few years. In fact, in planning a rapid transit system, estimates of ridership a half-century hence

would be most useful. Responsible projecting from planning requires that one be theoretically informed. The work of William F. Ogburn offers an example of theoretically informed projecting. Ogburn was a sociologist at the University of Chicago in the 1920s and 1930s, the author of the theory of social lag and among the first of the social science fraternity to commute between university and government. Herbert Hoover brought him to Washington along with Charles Merriam, the political scientist, to establish a Commission on Social Trends. At that moment in history social scientists were more prominent than natural scientists in advising government. The Commission's report, *Recent Social Trends*, published in the first year of the Roosevelt administration, contributed to New Deal planning.

William F. Ogburn thought about the impact of technology on society. He erred in some specific technological predictions. For example, he anticipated that in the years following World War II a "roadable" helicopter would become a choice mode of travel. This hybrid helicopter and automobile, demonstrated around 1945, could fold its rotors and proceed along a road or deploy its rotors to fly over to the next road. The roadable helicopter did not become the family car because of the availability of functional alternatives.

A 1948 article by William F. Ogburn from the *New York Times Magazine* was entitled "Who Will Be Who in 1980?" This 34-year-old prediction is, in many respects, an accurate one. He interpreted an excess of marriages in 1947 as postwar deferred marriages. A blip in the fertility rates was anticipated. This demographic fact, in its social context, led him to infer impact on the school system, first an increased need for classrooms and then a drop in that demand. The anticipated pattern pretty much happened.

He observed that women were drawn into the labor force during World War II. To interpret the meaning of this, he refers back to models from 1918 when the proportion of women in the labor force had also increased. He anticipated a stimulation of the women's movement and a change in sexual mores. Very perceptive.

For another prediction, he calculated a future decline in the birth rate following completion of the deferred births. This would not indicate a real change in family styles but would, by itself, produce a shrinkage in certain markets. However, the introduction of new inventions would balance that effect. Businesses would be founded around these new inventions. Among the inventions that would make a difference, he did not mention the roadable helicopter. New businesses, he wrote, will be built on television, the helicopter, the magnetic wire recorder, and the electronic tube. Solid-state electronics and computer chips were not yet obvious to him. The University of Pennsylvania prototype computer at this time was operating on vacuum tubes. He further predicted businesses dealing in facsimile transmission, plastics, alloys, and atomic fission. He erred in his expectations of atomic fission. At a time when leaders spoke of atomic power producing electricity too cheap to meter he did not appreciate some real costs associated with a changeover of nuclear plant construction or waste disposal nor did he grasp the evolving public resistance to atomic development and its effect on the availability of capital to fund nuclear plants.

What enabled Ogburn to score so highly? He could see reality because he did not stay within any of the confined abstract frames of reference. He was a sociologist who was able to look at several components of the picture and to integrate these forces. He was well grounded in social theory.

A last example is taken from the writings of one of the finest institutional economists and sociologists. In 1942, Joseph A. Schumpeter, then a professor at Harvard, wrote *Capitalism, Socialism and Democracy*. Posing the question, "Can capitalism survive?" he responds "No." The breakdown of capitalism will not be due to its economic failure. Marx had predicted the breakdown of capitalism following a series of economic crises, the inevitable capitalist business cycle. Schumpeter predicted that its successes doomed capitalism. Consistent with the German idealist tradition, capitalism is treated as an historical individual with its own developmental laws. It is not characterized in terms of attributes, as in a contemporary econometric analysis. A process of creative destruction is built into the capitalist system. The system tends to mutate with the introduction of associated kinds of technology and their new forms of industrial organization. He predicted corporate concentration not unlike the current merger contest of Bendix and Martin Marietta. Negotiating for someone's stock becomes more profitable than building a new factory.

Schumpeter perceived the role of the entrepreneur, or risk-taking behavior, as a key to capitalist growth. Observing the development of bureaucratic structures, he writes that "everything is becoming routinized." Rationalization will rob us of the entrepreneurs and this will deprive capitalism of its dynamic. The large bureaucratic structures that are a mark of capitalist success will destroy the system. After the problem is presented by the elite that enters government through capitalist success as a routinized bourgeoisie, these persons are not heroic and therefore at a disadvantage in managing international relations.

Schumpeter's success in prediction is due to his ability to move between economic and sociological categories and not become lost in a jungle of abstract variables. Transportation planners need their Ogburn and their Schumpeter.

The last section of this paper suggests some directions in which travel behavior research may escape its physicalist models. The following pages survey the various areas of sociology and suggest issues for transportation research. Beyond travel behavior and problems in the prediction of public bus ridership or of community opposition to thruway construction, social research has a place in proposing and evaluating national transportation policy.

#### MAPPING SOCIOLOGY: ILLUSTRATIVE RESOURCES FOR TRANSPORTATION SOCIAL RESEARCH

##### Roots of Sociologies

The social sciences do not constitute a single discipline nor is the subject matter of any one of them ordered in the logic of a discipline. The reasons are historical. American university departments of sociology were, in some cases, a product of American social welfare practice, established at the turn of the century by sons of Midwestern ministers. In other cases, departments emerged from the more global and ethically neutral thinking of European scholars who migrated here or who influenced American thinkers studying abroad. Sociology reflects a number of traditions.

This section organizes some of the materials of sociology in terms of several frames of reference and suggests questions, especially transportation questions, that may be asked within each framework. The presentational principle will be to move from the conceptually simplest form to the conceptually more complex forms of social science thinking.

A frame of reference refers to background rules, hermeneutic principles, which define the types of concepts and therefore of propositions and theories that are legitimate and the types of interpretation that make sense. Sociology, as our illustrative social science, may be examined as a series of interfaces between sociology and the other sciences. Sociology borrows its styles of thinking from the natural sciences and the humanities as well as from such social sciences as political science, psychology, economics, and anthropology. At each interface sociology uses a definable net of concepts to grasp social reality and tends to select a particular range of substantive problems.

#### Interface with Natural Science

The conceptually simplest sociology borrows its style of thinking from the natural sciences. Following Newtonian physics, the space-time frame of reference is adopted. The real world, now the social world, is taken to consist of objects distributed in a spatial matrix. Demography dominates this kind of study of society. The demographic population, which may be a population of any type of independent units, is to be enumerated. Ordinarily, nondemographic factors establish the boundaries of the population. The basic mathematical models of demography apply as well for measuring the growth of fish in a stream as for human beings. The growth exponential  $Ce^x$ , where  $x$  refers to a rate of change, may be applied to people, to microbes, or to social attitudes. Whatever the units are in their totality is unimportant. Their characterization as objects dispersed in a boundary is abstracted from any other reality they possess.

Three basic concepts are fundamental to the field. These are fertility, mortality, and migration. All the other concepts, such as population ratios and rates, are derivative. Human population studies are reduced to an analogy to the probability that red balls and white balls will be found in an urn. The rate at which balls accrete to the urn (fertility), the rate at which they are removed (mortality), and the rate at which they might move from one urn to another (migration) are the central ideas. The advantage of this approach is remarkable clarity and often highly precise measurement.

Asserting that this is the most abstract form of societal study may seem to be a paradox since enumerated people seem quite visible and concrete. The method abstracts simple existence and the physical location from the total qualities of the subjects. Everything except their movement into locations is ignored. This highly abstract thinking allows analysis of certain kinds of useful questions.

Aside from the obvious question of the number of people within a particular boundary at a particular time or its rate of change over time, demographic data may be used to estimate social data. Demographic data predict social data best when the correlation between the number of people in an area and social activities is governed by some law of nature. Until it is questioned, the constitutional principle for apportioning congressional representatives simulates a law of nature. For every given number of people resident in a particular area (the number having been established following the decennial census), one representative is to be sent to Congress. The demographic facts are less helpful when the law relating them to social events is not quite so specific or binding as a natural law or as a constitutional principle. The use of demographic enumerations to plan school services is an example. When birth rates increase, a need for more schoolrooms may be anticipated. However, the ratio is

conditioned by residential preferences, racial attitudes, the attitude toward education, and so forth. The prediction of transit ridership from demographic data encounters similar difficulties. Good rules of thumb come into use to assist transportation planners under such circumstances.

Demographic data are a good first approximation for Malthusian problems relating population size and resource consumption. Malthus theorized about food supply but his models apply to any natural resource. Purely demographic treatment becomes inaccurate to the extent that the relationship between population and resources is mediated by the organization of the population, its social order, and the technology at its disposal and its location--the physical order. Demographic data are weaker still for market predictions. If baby products are to be marketed, knowledge of birth rates, rates of marriage, family formation, etc., cannot be unhelpful. Yet extrademographic factors affect these rates and the character of the demand.

The field of human ecology also conceives of society in a natural science frame of reference. In this case, the biological organism and biotic communities, rather than Newtonian physics, are the model. Human ecology adds the concept of organization among the units to the basic ideas of demography. The arrangement of a population in a territory or the relationship among communities in several territories may be introduced along with its processes of growth and structuring, such as the social division of labor or its patterning with respect to resource or geographic features. The issue of land use and transportation, as described in the opening section, may now be raised. Questions about transportation demand may be framed with respect to the ecological interdependence of communities. The human ecological format allows one to raise environmental problems such as those around the relationship among human, plant, and animal populations.

Problems of crowding in urban centers can be approached in these terms. However, here again the theory becomes weak. Crowding is not simply a question of physical density of population or even a simple function of the organization of that population. We studied households, for example, that were accepting evacuees from a flood disaster. How crowded the host household appeared to its occupants depended on the organization of that household and whether or not mass feeding was instituted, the kitchen allocated to families on a hourly schedule, or the evacuee family was absorbed into the routine of the host family. Certain forms of social organization could absorb more people with more or less experienced stress.

A society cast as a theory of distributed objects organized in a spatial matrix restricts analysis to external characteristics of the units. Demography and human ecology are concerned with populations and communities. The rule for deriving these from the original objects of observation is arithmetic, the aggregate being the exact sum of the enumerated units. The following paragraphs will suggest additional concepts necessary for accounting for the behavior of the units such as mind, norms, values--i.e., concepts of symbolic processes. However, the image of objects distributed in a spatial matrix will hover over the analysis as a rule for admitting cases to the set to be considered, the selection of units of analysis. A population of attitudes may be studied through a sampling of persons having the attitudes. The units may be conceived as independent of one another and selected by probabilistic methods. The assumption of independence refers to the occurrence of the attribute of a

particular object, not to the distribution of objects. Thus, the likelihood of mortality of a particular unit may depend on prior mortalities. This is handled by conditional probabilities. In the case of attitudes, each attitude may change the others much as a spot of color on a painting changes the whole picture.

The demographic and human ecological approaches do deal with certain characteristics of the objects. These include the length of time they have been in a particular location in the matrix (age) or whether they are new entrants (birth) to the set. One may take other attributes of the units and treat them under the same assumptions. This draws the natural science approach into the measurement of attributes even when those attributes are not inherently space/time attributes. In the above paragraph, we discussed the occurrence of attitudes. Now, the very content of attitudes may be analyzed with reference to an attribute space. Attitudes may form the axes of such a space and scores or values of the attitude variables may be used to locate a person within the space. Each location, again, may be considered as independent and the distribution of attitude scores treated by probabilistic methods. The common statistical techniques such as correlation and regression or analysis of variance are tied to these types of assumptions.

Most of the social attributes that form the meat of sociological analysis are not directly observable, not in the protocol language, as the philosopher of social science would say. This applies to the idea of the population of Philadelphia as well as to the idea of a religious cult or a militant attitude. Indicators are used to attest to the presence of these attributes. For instance, responses to questions may be taken to indicate underlying attitudes. The questions taken to evoke the response are but a sample of a universe of items that might have been selected to measure the underlying attitude. Here again, the natural science frame of reference holds sway and, again, not in the substance of the concepts but in the methods for manipulating them. The questionnaire items may be considered as distributed in a spatial matrix, located at independent points, and treated as objects for enumeration and measurement of their joint occurrence. Methods of factor analysis and Guttman scaling may be used to affirm that some small number of such items is an adequate sample of the universe of items that might have been used to measure the latent attributes. The method of treating the observation, if not that of establishing the concepts, is that of the natural sciences. This is what Emile Durkheim, the French sociologist, had in mind when he wrote of treating social facts as things.

#### Interface with Economics

To explain social action by using only the concepts of demography and human ecology is to give primary weight to situational factors, changes in the environment. In Darwinian theory, for instance, adaptation to a niche is discussed in terms of established characteristics of a species, including mutants, in the face of environmental conditions. To posit a mind is to allow the objects and internal structure to account for choices in the face of environmental conditions. In social analysis, it is common to observe several people or groups responding in different ways to the same environment. Positing a concept of mind is a way of dealing with these behavioral variations. The simplest concepts of mind allow but one rule of mental functioning, a rational rule. Adam Smith and other 19th-century economists entertained such a concept of choice

based on a rational assessment of pleasure and pain. Some current microeconomic theories of consumer behavior are still of this character, conceiving of a decisionmaker attempting to optimize utility. The economic behavior theories that rest on such a concept of mind presume that it is already in place. To explain the emergence of mind, one would turn to psychological investigations.

Pure market analyses are pursued by using the idea of the rational mind. When the object of the analysis is a capitalist firm, defined as a rational profit-maximizing entity, this assumption is a good approximation of empirical findings. If the object of analysis is a household, the empirical observation of behavior tends to be further from what the model would lead one to expect. The household as an economic unit is not a rational profit maximizer subject to formal rationality but is, in the language of some economists, a budgetary unit subject to substantive rationality. Its aim is to optimize a relation between consumption and cost rather than to maximize profit. This point is important for travel demand studies since most travelers are delegates of households as they engage in work, pleasure, or family visiting trips.

Institutional economics, in reality the sociology of economic organizations, extends simple market analyses to other social institutional factors. The rational decision taken by the firm may be examined in the light of considerations properly called political (as in planning in the face of a trade embargo) or psychological (as in framing a proposal to appeal to the sentiments of the chairman of the board or to navigate its way around two competing vice presidents of the corporation). One may view economic systems in relation to religious institutions, as for instance in Weber's classical analysis in *The Protestant Ethic and the Spirit of Capitalism*. The value context under which a particular economic system can emerge becomes salient. This requires the introduction of yet another class of concepts, those referring to value standards and nonrational rules for the working of the mind. Such added theoretical complexity will be treated below as we discuss the interface between sociology and anthropology.

Economic concepts are borrowed for analyzing behavior in noneconomic settings. This is another aspect of the interface. The family may be studied with respect to the way a transportation system links it to, say, educational or commercial organizations. The travel behavior of the family may be expressed in terms of an exchange model. Traveling to shop is a role delegated by the household that involves a payment in time and effort by the delegate. What, following this model, is the quid pro quo of another member of the family? Family relations are not fully represented in an exchange theory. It is, however, a good way of locating those reciprocities that exist in family life. Families in industrial society approach the exchange model more closely than families in traditional societies.

#### Interface with Political Science

Human ecology deals with the organization of population. The principle of organization, in that framework, is largely organization in space. An interesting borderline case is that of the ecological food chain. Although, true to the frame of reference, the relation of hunter and prey is one of spatial incorporation, as in digestion, the metaphor carries the idea of power, of dominance, of control. At the social level, one population becomes subject to the will of another under threat of coer-

cion. Social dominance requires symbolic social influence. The mediation of social relations by symbolism adds one type of concept to social analysis. Hierarchies of power, based on potential coerciveness, extend to relationships among groups, such as nations. The symbolizing of power presupposes a concept of mind but of a mind that operates by other than rules of rationality. Power involves a nonrational element in social relations.

Power is a central problem of political science. Systems of social stratification may be understood with respect to the idea of power, of classes of people with a common relation to the power hierarchy. Power relationships are routinized in bureaucratic organization. Such an organizational concept of power can be used to study government, industrial or infrastructural planning, and transportation bureaucracies. Questions may emerge, for example, about the relation of formal to informal organization. How does this relation affect organizational output? How does a bureaucracy meet sudden social change? Planning tends to assume surprise-free scenarios.

Informal processes of redistributing power are studied under the heading of collective behavior. Recently, we studied a New York power blackout and the accompanying looting as spontaneous collective behavior. Here one needs not only a concept of power but also one of play. Play, highly symbolic activity, requires concepts referring to a broad range of social meanings, in fact, the cultural meanings of the anthropologist.

#### Interface with Anthropology

We have assumed one-dimensional, rational minds in traditional economics and one-dimensional, social hierarchies based on power in traditional political science. Much of what people do during a day makes sense only if we assume a variety of standards for making decisions. The concept of values meets this need and rescues mind and society from simple rationality, physical coercion, and a single-dimensioned hierarchy. The explanation of religious and artistic behavior, for example, demands such additional conceptual complexity.

Societies may be compared on the basis of broad cultural themes or value patterns, the goals they set, their moral judgments, and their tastes for pleasure and beauty. The theme or spirit of the society conditions all levels of social activity. Militarist Sparta may be compared with civic Athens. One would expect the transportation policy of a military to differ from that of a civic society.

The anthropological notions of culture facilitate analysis of the interaction of social institutions, the relationship between economic and political culture and between family and religious culture, and the interrelation of all these to health and to education and transportation. Ultimately, the study of transportation is the study of linkages among social institutional activities.

The development of a society may be conceptualized as change in its institutional forms, say from traditional to modernizing. Transportation and communication practices are key to processes of inclusion and exclusion with an evolving culture.

#### Interface with Psychology

Mind develops in interaction with society and can be as many sided. The subfield of social psychology asks how the individual becomes a member of society and what the role of the family and of the school is in socialization. From the societal perspective, social psychology, or perhaps psychological soci-

ology, studies recruitment to society's statuses and may trace the displacement of family by community as a socializing agency. The confrontation between these two forms of social organization, community and family, is manifest in current conservative/liberal issues on science and Genesis or prayer in the schools or the changing status of women. These issues arise as the traditional patriarchal family relinquishes control over socialization to the community, a social system transcending the family. The question of the control of transportation may be framed as a matter of the level of society to which it is assigned. At one extreme, households control the private automobile. At the other extreme, governments control nationalized systems. In each event, the controlling institution will use transportation for the attainment of its ends.

The personality basis for social attitudes is another issue arising at the interface of psychology and sociology. In transportation research on attitudes toward attributes of transportation systems, one wants to distinguish the aspects of responses due to personality from those due to attributes of the system. Planners can adjust the latter after a study and still not affect predispositions to travel.

Attitudes are relatively permanent orientations to a set of objects. Opinions are more volatile reactions to particular concrete situations. This distinction, of course, is significant for market research as well as for political mobilization. Intergroup attitudes, prejudice and discrimination, are a meaningful factor in the use of shared public transportation facilities. Does the subway become the turf of a particular sector of society, socially excluding other travelers?

Problems of mental health and mental healing, disturbances of socialization, also arise at this interface. Personality requirements for role performance and studies of worker performance and of man-machine systems are relevant to the behavior of the transportation labor force.

#### Interface with Humanistic Studies

The scientific method is carried into the study of fields usually considered humanistic. The sociology of religion, for example, is closely aligned with the history of religions but tries to offer general statements about religious organizations and religious leadership. Under the influence of the humanities, concern with the substance, the concreteness, and particularity of the subject matter makes it difficult to resist judgments of value and desirability.

The sociology of knowledge, growing out of philosophical epistemology, is another example. The classifications of knowledge are not those of the philosopher but rather those relevant to social ordering. To critique transportation policies in the light of the social attributes of their proponents is an application of the sociology of knowledge. Such ad hominem examination is not relevant to the truth of a position but is relevant to an assessment of which policy will prevail.

Both the sociologies of religion and of knowledge illustrate applied sociology. General sociological concepts are particularized for a designated institutional setting. The general concept of leadership, or executive role, for instance, appears in the sociology of religion as the study of the role of the minister or the priest or the magician.

Sociology may also be a humanistic field aiming for a clarification of values. Such work borders on social philosophy. Unlike social philosophy itself,



this type of humanistic sociology deals with the factual rather than utopian basis for judgments.

Idealist social science is a humanistic study, an empirically based humanism. Its concepts tend to be realistic, that is, to mirror the concrete world instead of merely classifying it in terms of abstract attributes. Marxist praxis and Marxist theory can, for this reason, join in proposing a practical social agenda.

#### Practical Intersect of Sociologies

The realistic symbolism of humanistic sociology relates it to social technique and to the craft of social living. In the framework of positivistic social science, each interface introduces abstract concepts. The sociology of social conduct transcends the abstractions to fix on social problems. A social problem definition does not emerge out of disciplinary questions. It is an interpretation by members of a society of a point of strain in the society.

The study of group relations or race relations is an instance of the sociology of social conduct. The analyst draws on all of the relevant social sciences to understand problems of group formation, group conflict, group competition, and attitudes such as prejudice.

Functional analyses help us appreciate the ordering of groups in relation to the operating of society as a whole. In criminology, although the definition of crime is socially generated, theories concern the emergence of deviant social acts, criminal or not, and the manner in which they may engage the formal judicial system or the informal sanctioning system.

The sociology of a particular organization, the sociology of industry, and the sociology of the military or of religious organizations, as contrasted with religious institutions, mentioned above, are studies of concrete social conduct. Social conduct is particularized. A study of an operating transportation organization, say the Chicago Transit Authority, would have this character. Positivistic social science provides statements probabilistically related to these particular situations. The policymaker may do well with such probabilistic statements.

#### Analytic Intersect of Sociologies

The positivistic social scientist is faced with abstractions of the various social sciences, each offering a perspectival view of society. Reductionist approaches to integrating these several sets of abstract concepts may seek to translate all into the concepts of a single social science. All of life, it may be argued, is reducible to intrapsychic phenomena. Culture is psychic, carried in people's heads, and therefore mental processes are the basic subject of discussion. Orthodox psychoanalysis

would proceed in this way. As soon as two people are together, however, a new emergent level of reality, their relationship, appears with, as Durkheim says, a sui generis existence.

An impediment to the nonreductionist integration of the theories is that different traditions of theorizing have arisen at each of the interfaces. It is difficult to have a social psychology based on concepts of social structure developed in a Marxian frame of reference and the concepts of psychology in a Skinnerian frame of reference. Talcott Parsons' general theory of action meets this problem through a set of generic social science concepts. These are general concepts that are individually specified within psychology, sociology, or anthropology. For example, the concept of performance and sanction expresses the interaction between two actors at a generic level, one initiating an action and the other responding in some way meaningful to the first actor. Reinforcement theory in psychology may have its analog in stimulus and response. Role relations in sociology may be said to involve binary elements of proaction and reaction. The concepts of supply and demand in market economics are a specification of performance and sanction in that context, the demand being the sanction that influences the future rate of production. The social science disciplines, thus, with a common language, examine exchanges among the social, personality, and cultural systems.

Another approach is to argue, as does Charles Morris in his theory of semiotics, that all scientific knowledge is a symbolism. Semiotics is offered as the metalanguage for integrating the sciences.

#### CONCLUSION

Transportation research may be conducted with the concepts proposed at each of the interfaces discussed above. Transportation planning is a problem of the practical intersect of the sciences of man. Studies at any intersect contribute to the understanding needed for planning. The caveats above about what sociology offers and what is missing from that offer should be recalled here.

Transportation research may expand from travel behavior to matters of economic and political national policy. Social science will contribute only the cognitive element to the knowledge. The planner must look elsewhere for moral guidelines and affective commitment to action. The analyst may then introduce the familiar models of operations research, such as linear programming, or of econometrics, such as production functions. These are, by and large, rationalistic models designed to aid us in drawing the implication of what we know. They tend not to be in themselves methods of discovery of new knowledge. New knowledge will become available through the conceptual resources of the social sciences and their associated empirical methods.