Transportation 1983: The Minnesota Experimental City

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The purpose of this paper is to consider the social and economic aspects of transportation requirements in a highly technological future city, such as the Minnesota Experimental City. The Minnesota Experimental City project, initiated in 1967, is a unique cooperative venture by the State of Minnesota and its university, the business and industrial community, and the federal government. If a city is viewed as a number of interlocking systems, it is probably fair to say that few systems are more vital for the effective functioning of the whole than transportation. In the absence of rapid, comfortable, convenient, and efficient means for transporting people and goods to and from and especially within the city, other systems are subject to undesirable and, in some cases, intolerable stresses. Before it is possible to conceive and design a transportation system for the Experimental City, it is necessary to understand the problems facing planners in redesigning and reworking transportation systems in existing cities. A comprehensive sociotechnological approach is needed to solve the urban transportation problem now facing our cities—one that considers both human and mechanical systems, is capable of accommodating their mutual interaction, and predicts social, economic, and technological cause-and-effect relationships. Some of these factors are discussed in this paper, with particular emphasis on the Minnesota Experimental City.

•IN 1967, A PROGRAM was initiated to study and conceptualize a completely new city for the United States—the Minnesota Experimental City. The objective of the Minnesota Experimental City is to improve significantly the quality of life by providing a major advance in man's ability to mold his environment (1). The Minnesota Experimental City (MXC) project is a unique cooperative venture between the State of Minnesota and its university, the business and industrial community, and the federal government. The overall guidance for the program, as well as direct participation, is being provided by a steering committee composed of 24 nationally known individuals from a variety of disciplines.

It is almost certain that the MXC can be brought to reality only as an instant, new city in which smoothly coordinated social and physical expertise are brought to bear and the city is created as a living demonstration. The instant aspect of the effort is important lest new technology make the overleap of today no leap at all the day after tomorrow. The 10-year goal, beginning with construction in 1973, is a functioning city with a resident population of a quarter million people. It will be a self-sufficient city, located at least 100 miles from the nearest large metropolitan area. A new city is essential because only there would a total systems experiment be possible. Urban systems

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are complex and interacting; the bits and pieces of experiments possible in existing communities are no substitute for one at full city scale, because both citizens and their institutions are deeply committed to the status quo.

As a necessary early stage of the MXC project, workshops were convened in 14 areas in which both social and technological factors were considered. Participants in the workshops included members of the University of Minnesota faculty, representatives from various government agencies, and experts from industry and academic institutions throughout the nation. The technological development of the MXC as discussed by the workshop participants will proceed in several areas, including city building technology, waste management and pollution control, transportation, energy and energy transmission, and telecommunications. Each of these areas will require innovative developments and experiments, many of them untested at urban scale.

The workshop participants identified 4 reasons why the MXC should be a desirable testing ground for such innovations: (a) People choosing to live in the City would be likely to be receptive to technological innovations; (b) old habits and patterns would be less an impediment if innovations are a part of the City from its inception; (c) experimentation would be easier and cheaper in the City than elsewhere because costly duplication and service disruption would be avoided; and (d) scale economies could be expected from concentrating a number of experiments in one place.

If a city is viewed as a number of interlocking systems, it is probably fair to say that few systems are more vital for the effective functioning of the whole than transportation. In the absence of rapid, comfortable, convenient, and efficient means for transporting people and goods to, from, and especially within the city, other systems are subject to undesirable and, in some cases, intolerable stresses. Before it is possible to conceive and design a transportation system for the Experimental City, it is necessary to understand the problems facing city planners in redesigning and reworking transportation systems in existing cities. Considerable effort is now being expended by the federal government to study the problems of urban transportation and to further the development of new urban public transportation concepts; however, much remains to be done.

The list of new systems that have been advanced as solutions to the urban transportation problem grows daily, and several demonstration systems based on these concepts are now in operation. Because of a lack of proper understanding of current and future urban needs and desires, however, no plans are in existence for immediate implementation of any of these systems. This helps to point out that money and technological talent alone are usually sufficient to develop engineering systems, but considerably more time and effort must be expended to solve the more complicated problem of the relationship between man and his urban environment.

A comprehensive sociotechnological approach is needed to solve the urban transportation problem now facing our cities—one that considers both human and mechanical systems, is capable of accommodating their mutual interaction, and predicts social, economic, and technological cause-and-effect relationships. Some of these factors are discussed in this paper, with particular emphasis on the Minnesota Experimental City.

TRANSPORTATION AND GROWTH OF CITIES

The automobile, as a form of transportation, has been both damned and praised for the conditions now existing in American cities. The automobile has strongly influenced the growth patterns in these cities and played an important role in shaping our present way of life. But in more recent years, it has been blamed for many of the problems plaguing our cities such as traffic congestion, air pollution, and urban sprawl.

The land requirements of urban freeways have degraded the amenities and social unity of city life and have displaced those people who can least afford to be displaced. For those who can afford it, the automobile has provided an adequate means of transportation for most trip purposes. Unfortunately, it does not provide adequately for many of the people most in need of the services it can perform, especially those who cannot drive or are unable to afford automobiles. An evident symptom of the transportation difficulties in metropolitan areas is the difficulty associated with travel between home and work for those who have to drive in congested areas. Traffic congestion during rush hours in many cases reduces the average speed below that which can be maintained by walking and sometimes presents the nearly insurmountable problem of finding a place to park the automobile.

The increasing tendency of industry to move away from the city core, combined with the fact that the underprivileged make up a large proportion of the central city population, has made it extremely difficult for these people to travel to and from work. This problem is compounded by the inadequacies of present urban public transportation systems.

In a study recently carried out by the Twin Cities Metropolitan Transit Commission for the Minneapolis-St. Paul area (2), the following data were obtained:

1. In 1958, only half of the 490,000 jobs in the metropolitan area could be reached in 45 minutes by bus by poverty area residents.
2. By 1985, it is anticipated that only about a third of the projected 1.02 million jobs will be reachable from the same areas within the same time.
3. In a survey of bus riders, 55 percent of them have incomes of under $6,000 a year, and more than 80 percent have incomes less than $10,000.
4. Half the families in the poverty areas were without automobiles in 1960.
5. The number of metropolitan area families with more than 1 worker is increasing, which means that, if the family has only 1 automobile, the other worker will have to use public transportation.

The economic and social welfare of individuals is strongly influenced by the transportation system because it is a key factor in determining the nature and variety of opportunities available in jobs, housing, recreation, shopping, and entertainment. Studies carried out by the McCone Commission (3) after the Watts riot in Los Angeles showed that an important factor contributing to the hostility shown by the people was related to the isolation caused by an inadequate public transportation system in the most motorized city in the country. The possible consequences of overcrowding and the continual inward turning of people's environment is reflected in a threat from a woman living in the Watts area (4). When she heard that city officials might close Cabrillo Beach, which is near Los Angeles and used by over 2 million people every summer, she said, "You box us in and we will have to burn our way out!" In tests with mammals, biologists have found that deer, rats, and rabbits each require a certain amount of living space and freedom of movement. If crowded beyond this minimum lower limit, they resort to destructive behavior, ranging from disruption of reproductive cycles to genocide, suicide, and even death from "shock".

FACTORS AFFECTING URBAN TRAVEL DEMAND IN CURRENT CITIES

During the past 20 years, continuous change has occurred in the composition of the work force, income, job location, shopping patterns, and leisure time. The transportation demand requirements such as the number of trips, time of day for the trips, spatial distribution of the travel demand, and purpose of the trips have been strongly affected by these changes. As use of the automobile increased, demand for public transportation, as reflected by both proportion and absolute number of trips, declined during the past 20 years (5). Therefore, an accurate prediction of transportation needs for urban development requires an understanding of such factors as demand for transportation, characteristics of the people, use of the land, and effect of social, economic, technological, and other factors on these demands both in the past and in the future.

Results of studies (6) carried out at the University of Maryland, Stanford Research Institute, and Michigan's Survey Research Center suggest that 8 factors influence most consumers in making transport decisions. These are listed in order of importance:

1. Reliability of destination achievement, including elements of safety and confidence in the vehicles;
2. Convenience and comfort;
3. Travel time, but with large trip-purpose differences;
4. Cost;

5. State of vehicle, with cleanliness overshadowing newness;
6. Self-esteem and autonomy, with emphasis on independence rather than pride;
7. Traffic and congestion both in and out of the vehicle; and
8. Diversion, including nature of travel companions, availability of radio, and scenery.

Studies to determine and predict transportation demand (7) have been based on land use, socioeconomic, and access factors. Land use is separated into 3 major classifications: residential, commercial, and industrial. Several studies have shown that an inverse relationship exists between residential density and person trips per dwelling. Because increased residential density usually results in increased access to commercial activities, the trip destinations are often within walking distance, and fewer person trips are required; thus, the necessity for making person trips decreases as the distance between place of residence and place of socioeconomic activity decreases. To find meaningful relationships between trip generation and industrial and commercial land densities is more difficult. In a study conducted in San Diego (7), it was found that aircraft manufacturing plants caused the largest number of trip origins, with modern industrial parks being a fairly distant second.

Studies relating level of family income to person trips (5) showed that a strong correlation exists. People in medium- or high-cost housing units account for large proportions of the automobile traffic and generated trips. Access factors also affect trip generation, and studies (7) have shown that, in general, an increasing distance from the central business district leads to an increase in the number of trips per person. Studies have also shown that distance from the central business district is inversely related to density of land use and, to a certain extent, correlates with vehicle ownership. Studies of transportation preferences of various occupational classifications (8) have shown that, in general, industrial employees are most reluctant to accept public transportation. Workers at modern industrial plants are provided free parking and they usually have the physical and financial resources required to drive their own automobiles.

THE DEFINITION AND ESTIMATION OF REQUIREMENTS FOR FUTURE TRANSPORTATION SYSTEMS

The Experimental City is envisioned and intended to be both a city and a crucible for experiments at city scale. As a city, it must serve the needs of the people who live there. As an experiment, it offers unique and wide-ranging opportunities to hypothesize and test social, economic, and technological systems and their interrelationships. For this city to fulfill both roles adequately, a planning effort exceeding any previous effort in scope, in depth, and in application of current and emergent planning tools and techniques will be required.

Transportation Planning in the MXC

The planners of the transportation system for the Minnesota Experimental City must evaluate not only the system's ability to move people and goods but also its performance as a social institution related to the needs of the City's inhabitants. Its effect on the social and economic needs of the people must be considered.

During the early planning period for the Minnesota Experimental City, meaningful dialogue must be established between social scientists, natural scientists, and engineers. They will have to define more precisely the values of economic and social amenities in the City, to determine the interrelationships between transportation and city development, and to develop proper transportation models to simulate the interaction of public policy with known and predicted social and economic forces that will develop in the MXC. The planners and policy makers for the MXC must recognize that the transportation system performance is a function both of the facility design and the extent to which it is used, and simultaneously the system itself will contribute to molding transport activities and, thus, shape future demand. In the evaluation of transportation alternatives for the Experimental City, the first and most important concern will be to define the final development objectives and then ask how a given system will contribute to these objectives.

The basic approach to planning will incorporate analysis and outcome prediction of the interrelations and conflicts among the multitude of social, economic, and physical systems. The planning phase is the time when the real-life conflicts will be simulated with models—mathematical, physical, and social. The outcomes of the simulations will be sorted out to find the optimum balance and aggregation of the many systems. These optimum outcomes will provide the planners with insight and guidelines to integrate the various systems into a vital and vibrant community.

Transportation System Analysis

The transportation system is one of the most essential systems of a city, and the first question to be asked about this system is, What is the proper role of the transportation system? The answer must relate to the total system—the city—and its hierarchy of roles. The city must first serve the needs of the people, and the transportation system should logically provide the inhabitants and transients with the means necessary to transport themselves and their goods. This includes the service, commercial, and industrial inhabitants as well as individuals and their families.

The transportation system, in serving the people, will encounter them as individuals and must be designed to deal with them as such. The implications of this are staggering. People as individuals have problems, and the problems are unique, important, and require immediate attention or solution. The transportation system planning will require a people and people-problem orientation. The simple act of transporting people and goods from one point to another is never really simple. The individual is a complex and independent creature who probably manifests this nature as much or more so in his travel habits than in any other routine matters.

The second vital consideration of the transportation system includes its economic and physical aspects. By testing various concepts that integrate the social, economic, and physical systems (including the necessary trade-offs), the planner can develop a profile of cost-benefit outcomes. The predicted outcome is thereby available when one system is compared with another.

Transportation Models

The ability to test the concepts and to develop predictive models is a prerequisite and reasonable assumption. The effort involved is to be neither minimized nor made to appear an impossible task. Performance characteristics, causal relationships, and reams of data will all be necessary inputs. Historically, urban transportation systems have been fairly long-lived; thus, the implications of transportation policies and decisions and resultant costs and benefits become long-term in character. The transportation models should be dynamic to permit prediction to response to changes in modes, facilities, travel patterns and requirements, and population redistribution (9). The transportation model will simulate the total interaction and outcome environment of which the actual transportation system will be a part. As such, it will recognize and relate the mutual influence one system has on all others and vice versa. In this manner, the requirements, constraints, and options of the MXC transportation system will be identified.

A number of objectives might be anticipated for the transportation component of the Experimental City, many differing little from objectives accepted elsewhere:

1. The transportation system should be flexible enough to serve the variety of needs for both people and goods movement that a diverse population can require.
2. The system should provide comparable service for all people, regardless of their socioeconomic characteristics.
3. Standards of comfort, efficiency, convenience, safety, cost, reliability, aesthetics, and pollution should be established for the system.

Finally, in addition, the system should foster the social and overall goals of the City.

Future Transportation Concepts

In defining and estimating the transportation requirement of the MXC, we must have a good understanding of conditions that will be existing in the city after it is built. Spilhaus (10) predicts that all air-burning and service vehicles, as well as all vehicles from outside the city, will travel through underground throughways. The surface will be free for other pursuits, and air pollution will be reduced. Seifert (11) makes some interesting speculations on the status of transportation in the year 1993. He recognizes that a new city should be designed as a total system so that an efficient and desirable environment can be created in which to live and work. He suggests also that transportation systems for both intracity and intercity travel should be included as a part of the city design. He predicts that several new cities will be built during the late 1970's that will use a broad systems approach. He foresees that the major part of the transportation system will be built underneath the city. He predicts an automated guideway system along with a conventional street system on which cars and trucks can be driven manually and with ample space for parking. The ground level will be kept free for malls, shops, and a specialized low-speed passenger transportation system.

Doxiadis (12) presents an interesting discussion on optimum city size and the necessity for having transportation systems underground to free the surface for man's use and enjoyment. With underground transportation systems, the obtainable speeds can increase with a corresponding increase in the ability of man to associate with his neighbors, both within the city and between adjoining cities. Both Doxiadis and Spilhaus speak of an optimum city size of the order of 2 miles square so that one could walk at the ground level under traffic-free conditions to the edge of the city in 10 to 15 minutes. If the intercity transportation system is placed underground in tubes and has speed capabilities of the order of 400 miles per hour and if cities are spaced at 100-mile distances, one could go from the center of one city to the center of the next in an acceptable commuting time of 15 minutes. Thus, one could walk from one edge of the city to the center or travel from one city to another in 15 minutes or less.

Both Fuller and Spilhaus (13) have stated that there should be no reason why transportation in the horizontal direction could not be just as free as travel is in the vertical direction, i.e., elevators. They believe that the cost of operating a transportation system should be included in the overall costs for service in the city.

MXC Transportation Ideas

In a paper prepared for the MXC project, Fuller (14) conceives of the transportation service arranged in such a way as to employ credit cards with computerized ticketing and automated billing. The traveler would insert into a transmitting machine his credit card that would include information such as destination point, times of arrival and departure, and accommodations. A ticket would emerge from the machine containing information on routing and accommodations, and all charges would be automatically billed to his personal account.

Various configurations (15) have been suggested for the Experimental City. In the simplest arrangement, the city might take the form of a circle, perhaps 1 to 2 miles in diameter. Fuller visualizes that the entire complex could be covered by a hemispherical dome. In this arrangement, a circumferential transportation system located underground could be used to move people and goods to various positions along the edge of the enclosure. The above-ground portion of the system could consist of passenger conveyors moving people and goods in the radial directions.

In the Experimental City, there would be a unique opportunity to develop a totally integrated movement system under a single management. Such a system would permit balanced services, equalized user costs, and a performance geared to the particular needs of the City. This would be a radical departure from present situations where the dominant mode is private and where 85 percent of the transportation money is spent on the vehicle and only 15 percent on the plant.

Such a total movement system could greatly enhance the standard of living in the Experimental City. It could open up new choices in living patterns and increase accessibilities between competing opportunities; it would play a key role in the design of functional modules for the city and, to a large degree, determine the way in which these modules are linked. Some factors of particular concern in the design of the system would be mode interchanges and points of interface; integration of horizontal and vertical movement in a system; security; and locational relationships for airports, shopping centers, sports center, major industries, and places of residence. Although there is conflicting opinion about the desirability of complete separation of pedestrian and vehicular traffic, there is support for separation of certain kinds of traffic where necessary for safety and efficiency.

EVALUATION OF CANDIDATE SYSTEMS

Intracity Movement

A wide variety of transportation technologies, old and new, exotic and mundane, are available for consideration in the Experimental City. Choices among these competing technologies cannot be made on the basis of transportation criteria alone; nor can they be made on the basis of narrowly defined profitability. Equally important is a concept of what the city wants to be and wants to make possible and an understanding of how transportation can achieve those ends. Obviously social benefits and social costs can no longer be ignored any more than their monetary counterparts.

Preliminary to the design of the City's transportation system, studies will be required to examine the range of alternative systems appropriate for intracity movement in the proposed city. Studies will be needed to define desirable standards in terms of qualities such as population density, critical mass at microscale, relationship between activities and land uses, and distribution of activities. The problem is, of course, to reach a balance between transportation as a service system and transportation as a controlling element of city form. An obvious factor influencing this balance would be the level of transportation substitution. Development of sophisticated communication techniques, such as phonevision, could be expected to decrease transportation demand. The scale of the City could also affect demand, as exemplified by the pedestrian city.

Evaluation of candidate transportation systems for the Experimental City should be made concurrently with other systems for which decisions must be made. Extreme forms of the City might be studied along with movement systems consistent with those forms. Needless to say, desired performance characteristics should be established in advance of economic evaluation. Although some value should be attached to being able to test untried systems, those chosen for the City should first reflect the needs of a new, smaller city, not of a megalopolis. Further, impact of the system on the potential population and economic activities should be an important factor in its evaluation.

In a study carried out at North Star Research and Development Institute for the Metropolitan Transit Commission of Minneapolis and St. Paul (16), it was determined that the ideal urban transportation system will have to be faster than competitive modes of transportation, provide nonstop transportation service from point of origin to point of destination, provide service on demand—no waiting, be economically viable, cost less to operate than current competitive systems, be capable of handling both people and goods, and not be a source of pollution to the surrounding environment. Some of these requirements apply more to the development of a rapid transit system for a conventional city than to a transportation system for the Experimental City. Further, if automobiles and buses were banned in the Experimental City, the new transportation system would not have to compete for customers. Any information gained and any systems devised in the Experimental City, however, will be beneficial in application to the development of transportation systems for existing cities.

An ideal transportation system for the MXC should be capable of transporting both people and goods. A large number of new concepts for urban transportation systems has been advanced and studied, and several demonstration systems of these new concepts are now in operation. They all have been designed for the movement of people, however, and little research and development has been expended in developing a system that is also capable of moving goods. The economic structure and development of a region is strongly tied in with the transport of goods. Inadequate transportation facilities have created an enormous problem for retailers and manufacturers, whose annual costs for delayed handling and routing of goods are staggering. Similarly, charges for handling are problems to medical and educational institutions. Extensive savings could be realized in movements of goods if efficiencies could be effected at the broad scale of the community or city.

Many systems for intracity movement would be possible, and the completed package might contain elements from several systems. Unless the Experimental City takes an extreme form, however, it is likely that the frequently mentioned new systems, including most rail systems, would be overengineered for the City's needs. A real constraint, of course, will be the amount of development time available and interface requirements with intercity movement. It is, of course, possible that the Experimental City will bypass systems currently being discussed and opt for something totally new. In this case, desired system performance characteristics would be defined, and a new system or systems would be generated to correspond.

Intercity Movement

Interface requirements with transportation systems outside the Experimental City will influence the range of choice and final nature of the City's systems. Although the transportation system for intracity use will likely be a system that is independent of systems needed for intercity use, in certain cases the same mode (perhaps with propulsion modification) may serve both. Regardless of what internal means are provided for transportation within the MXC, systems enabling residents to move freely to other parts of the region and nation would be necessary. Equally important would be provisions for nonresident travelers to the new City.

It is certain that the MXC will be served by air transportation for movement of both people and goods on trips of 100 miles or more. This service could presumably be provided by 1 or 2 commercial carriers, by air taxi, and by private plane. For a city of about 250,000 people, 1 airport would probably be adequate. If the MXC is completely enclosed, some of the problems that are now encountered with noise from aircraft entering or leaving the airport would not be as serious because of the attenuation of the noise by the enclosure cover. This might mean that the air terminal could be located closer to the Experimental City complex, thus simplifying the transportation requirements between the air terminal and the city proper. It would be highly desirable to have a multimodal interface facility for all forms of transportation, whether it be by water, rail, pipe, road, or air. At this facility, all necessary transfers and sorting could take place efficiently with minimum transfers before goods reach their final destinations.

Demand for intercity passenger service, at least by today's standards, indicates that railroads would be inadequate for moving people. This situation would, however, be affected by such factors as the distance of the MXC from its near city neighbors, the nature of the links, and the quality of service possible. On the other hand, rail freight service would appear to be essential, in view of the level of activity in a city of 250,000. The nature of service would depend on the types of industries to locate in the City. Intercity highway connections would be necessary for delivery of goods and people to and from a new city. A normal city of a quarter of a million population without suburban development might attract between 5,000 and 10,000 outside vehicles per day, and roughly 10 percent of this total would be truck traffic.

A new city could profitably innovate in the area of transfer terminals for people and goods. In existing cities, there is evidence that the quality of terminal or transfer facilities is a factor influencing modal choice in people trips. Clustering terminals at key nodes for different types of transportation appears desirable, but the number of necessary changes in mode would probably be kept to a minimum. Because modal changes often occur where intercity and intracity transportation meet, these facilities should also be clustered where possible.

A terminal for the transfer of goods might be established to receive and deliver all shipments originating outside the city and brought in through the intercity transportation modes of air, rail, and truck. At such a terminal, goods (including mail) could be sorted, then delivered, in containers where feasible. Final distribution could be by combined pneumatic tube, mechanized hauler, or drayage truck. It might also be desirable to have some shipments originating within the city processed through the same terminal for destination beyond the city. Implicit in the foregoing is the assumption that in-city industrial sites would not be provided with rail services. Industries requiring such rail service would be located at the edge of or outside the city.

In considering the goods terminal innovation, one should also recognize its logical implications for the spatial arrangement of activities. The terminal could be expected to become a major focal point at which activities such as warehousing would cluster. Some industries having relatively large transportation costs might also find a near terminal location desirable. As an employment note, appropriate services would have to be provided and so on.

SUMMARY

In determining the role of transportation in shaping the form of the Experimental City, we must consider several factors.

Primary or Secondary Role

A primary role might be indicated if innovations in the transportation system appear especially promising and other values are not violated in the process. The secondary role would be appropriate if no candidate transportation system were prominent and if priority were given to experiments in the ordering of urban activities at the level of community microscale.

Transportation Alternatives

Standards for a transportation system appropriate for intracity movement in a city of 250,000 have to be defined in terms of social goals pertaining to population density, critical mass at microscale, relationships among activities and land uses, and distribution of activities. The problem is to reach a balance between transportation as a service system and transportation as a controlling element.

Transportation Substitution

The scale of the city could affect the required levels of transportation as, in the extreme, a pedestrian city would. New developments in communications might obviate some need for transportation. In each case, the trade-off range and cause-and-effect relationships would be examined to determine the most appropriate and desirable substitution level.

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