FUTURE SOCIAL AND TECHNOLOGICAL CHANGE AND ITS IMPACT ON TRANSPORTATION PLANNING AND MANAGEMENT

EDWARD A. BEIMBORN, Director, Center for Urban Transportation Studies, University of Wisconsin–Milwaukee

JAMES SPONHOLZ, Research Assistant, Center for Urban Transportation Studies, University of Wisconsin–Milwaukee

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ABSTRACT

The pace and complexity of change has become so rapid over recent years that traditional approaches to transportation planning and management no longer appear to be valid. Transportation engineers and planners need to develop better insight into the range of future conditions in order to help them better cope with change over the next ten to twenty-five years. The objective of this paper is to explore future social and technological change as it relates to transportation decision making. Major changes have occurred and will continue to occur in communications, transportation technology, office automation, life styles, land use and economic conditions. The changes have been so profound that conventional methods for planning and management no longer appear to be possible. An alternative futures approach based upon recent experience in Milwaukee, Wisconsin, USA is described and appears to be a useful way to deal with uncertainty in formal planning efforts. A technology assessment and transfer process is also given as a way to improve transportation management and its ability to adopt innovation and change.

INTRODUCTION

1. The pace and complexity of change in transportation planning and management has become so rapid over recent years that traditional approaches to transportation programs and policies no longer appear to be valid. Transportation engineers, planners and decision makers need to develop better insight into the nature of change as well as the range of conditions they may encounter in the next ten to thirty years.

2. The objective of this paper is to describe some of the social and technological changes that are affecting transportation programs and policies in the U.S.A. and to discuss methods for transportation planning and management which are beginning to be used to cope with these changes. These methods are an alternative futures approach for transportation planning and a technology assessment and transfer process for transportation management. This paper is an outgrowth of several activities. These are: the development of a series of symposia for the Wisconsin Department of Transportation on future change and its impact on transport; preparation of a primary transit systems plan for the Milwaukee urbanised area and an ongoing research effort at the University of Wisconsin – Milwaukee on technology transfer in transportation agencies.
3. Future technological and social change and its effect on transportation programs and policy were explored through a series of symposia held jointly between the Wisconsin Department of Transportation and the University of Wisconsin – Milwaukee and Madison campuses in 1987-1988. The purpose of this symposium series was to develop a dialog within the department and with the university on the effects of long run changes on transportation activities upon their policies and programs. This was done through background research, use of outside experts and discussion by program participants. Five symposia were held. These were: A Changing Technology, A Changing Land Use, A Changing Economy, A Changing Freight System, and A Changing Energy Future.

4. These symposia have graphically demonstrated to the participants the rapid and significant change which will affect transportation programs and policy (Sponholz, 1987, 1988). Among the changes identified at the symposia were the following:

COMMUNICATIONS

(a) Integrated Services Digital Networks (ISDN), with voice and information lines linked through conventional wiring or lightguide fibers, will be the communications standard of the 21st century.

(b) Development of lightguide fiber capacity is expected to continue.

(c) Deregulation of telecommunications systems will continue incrementally.

TRANSPORTATION TECHNOLOGY

(d) The auto fleet is expected to stabilise at a 40% small, 40% medium and 20% large vehicle mix. Fleet fuel economy will reach only about 8.1 litres per 100 km (29 miles per U.S. gallon). The auto fleet in the United States will grow to about 167 million vehicles by 2010.

(e) Little evolution in the trucking fleet is expected. More highway trailers will be transported over rail, with the RoadRailer concept improving cost efficiencies of piggyback service.

(f) Vehicle location systems are expected to be used along with automated dispatching by railroads, although adoption by the trucking industry is expected to be slow. Liability concerns over the accuracy of information could limit system availability.

(g) Alternative fuels such as methanol and compressed natural gas will be used to a greater degree as petroleum drilling becomes more expensive.

(h) Aircraft will become lighter and more fuel efficient through increased use of composite materials and redesigned engines.

(i) Developments in communication technology will affect urban settlement patterns, and may
reduce travel related to personal banking, shopping, and entertainment.

(j) Urban rail travel will continue to be attractive where costs and aggravations lie below those associated with auto travel.

OFFICE AUTOMATION

(k) Clerical work will decline from a peak in the 1990s. Keyboarding will account for much of the decline, as automated systems will capture information at the point of origin.

(l) Automation will continue to improve office productivity.

(m) Home-based work, part-time employment and offshore industries will become more widespread as the information economy becomes more pervasive.

SOCIAL AND DEMOGRAPHIC CHANGE

(n) The rate of growth of the work force in the United States will decrease as the "baby boom" generation ages and smaller numbers of persons now under the age of 25 enter the work force.

(o) The increase of women in the work force will account for a large share of the total growth in commuting traffic.

LOCATIONAL CHANGE

(p) The pattern of suburb-to-suburb commuting is the fastest growing form of commuting in the United States. Such travel is nearly completely dependent upon the automobile.

(q) The number of households is increasing rapidly and along with it an increase in car ownership which approaches the number of licensed drivers.

(r) Suburbanisation of jobs and work sites is another major trend. Suburban office development in American cities is taking place on a scale rivaling that of urban central business districts.

(s) The potential for local control of development activity in the United States is low because of competition between various local jurisdictions and because of government's limited powers to regulate land use.

ECONOMIC CHANGE

(t) Manufacturing activities in the U.S. are no longer tied to a specific location because of the nature of their businesses. Manufacturing has become a small portion of the economy while service related activities have grown substantially.

(u) This change in economic activities means a shift away from industries that use a lot of transportation input towards those that use less transportation input.
(v) Economic change may lead to a growing underclass of individuals, urban poor, who may find it difficult to participate in the new economic structure. Urban issues such as education, crime, accessibility may become more significant if such trends continue.

5. The net conclusion of the symposium series is that our society in general and transportation in particular have and will be undergoing significant changes. These changes have come at a rapid rate and cut across a wide range of subjects from pure technology to highly complex shifts in life style and patterns of social interaction. These changes have or will be quite profound and escape the realm of easy predictability. It is futile to try to accurately forecast the future and to rely only on conventional methods of planning and management to deal with it. An organisation, therefore, needs to plan its future activities in such a way as to be highly adaptable and forward looking to the potential impacts of future changes. Two efforts, an alternative futures planning process and an internal technology transfer assessment and transfer group are suggested as a way for an organisation to successfully deal with future change.

**ALTERNATIVE FUTURES PLANNING**

6. The traditional approach to transportation system planning has been to focus on a single forecast of future levels of population and economic activity and of such factors as the cost of automobile operation, and to use these forecasts to test and evaluate alternative land use and transportation system plans. This approach has worked well in periods of relative stability when historic trends in the factors underlying and influencing population and economic change and technological change could be reasonably expected to extend over the plan design period. However, during periods of major changes in social, technical, environmental and economic conditions, the assumption that historic trends will continue becomes uncertain and different procedures become necessary.

7. Alternative futures planning is quite different from conventional planning in that the focus is on extreme limits of future conditions rather than upon the most likely conditions (SEWRPC, 1980). In conventional planning, it is common for a planning project to have high, medium and low forecasts of say population or economic conditions. However, there is a tendency to select a most likely future which is usually a midpoint as a basis for analysis. Too often traditional planning methods fail because they fail to explicitly deal with the uncertainty of the future and fail to relate future uncertainty directly to planning decisions. In alternative futures planning the future is developed to directly relate to the decisions to be made. Alternative futures are viewed in the context of decision making and are designed to represent a range of reasonable extreme future conditions that a transportation system may be expected to exist under. By testing the alternatives under these extremes, a plan can be selected which performs well under a wide range of future conditions and this can be further staged out over time as more certainty in the future develops. Thus the futures are designed to fall along a continuum with one extreme being a future where nearly all events which have occurred are highly conducive to the success of an alternative plan (the upper future) and the other extreme being one where events are all negative towards the plan (the lower future). This approach is quite different than traditional planning in that the futures are decision oriented. They are not selected on the basis of likely conditions but rather are configured to provide extremes which are directly related to the potential for success of an alternative. Furthermore the approach used permitted the use of a larger number of variables in the futures. Traditional planning is limited to only a few variables. Otherwise the number of
combinations becomes so large that they are impossible to work with. With an alternative futures approach, the levels of each variable can be set based on the decision at hand. With such an understanding, the process of defining the future becomes relatively straightforward. Futures then represent what could occur in the future rather than a best guess of what will occur. This approach was very efficient in that it limited the amount of analysis effort and permitted the early elimination of several alternatives.

8. Such an approach was used by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in its study of primary transit alternatives for the Milwaukee Metropolitan area. The process which was used is shown in Fig. 1. First, key external factors were identified and alternative scenarios of future change in these factors were developed. These external factors were: motor fuel cost and availability; technology and the conservation of energy; population lifestyles; and economic conditions. These factors were chosen since they affect transit needs directly, for example, by affecting the cost of urban travel, or indirectly, by affecting regional growth or decline. An extensive effort was made to develop an understanding of how these factors interacted with transportation decision-making and forecasting and to identify key variables which could be used to represent their influence on transportation supply and demand. Using these variables and the background information, estimates were made of a reasonable range of values over which they would occur in the future. Two scenarios were then developed by combining the variables in such a way as to represent consistent and reasonable upper and lower extremes of futures conditions as they relate to potential transit utilisation. The upper future was intended to provide particularly favorable conditions for public transit, with the external factors leading to moderate population and economic growth, centralised land use and significantly higher energy prices and potential for motor fuel supply restrictions acting as incentives for increased transit use. The lower future as intended to provide conditions less favorable to transit utilisation, with the external factors leading to a stable economy, a slight population decline, decentralised land use, and moderately higher energy prices which, when combined with the increased fuel efficiency, would provide a decrease in the real cost of automobile travel. These futures present different conditions for automobile travel and may not be appropriate for highway decision making. For a highway decision, futures would be defined to represent upper and lower limits of conditions that relate to the highway project success.

9. The second phase of the alternative futures process was the development of future population and employment forecasts for each of the two futures based upon assumptions consistent with the futures. These forecasts were prepared by using the key variables as inputs to the forecasting process in order to develop internally consistent estimates of future conditions. These estimates included not only total population and economic levels, but included further breakdowns such as age distribution of the population, household characteristics, structure of the economy, employment distribution, income levels, automobile availability and future land use demand. In the third phase of the process, centralised and decentralised land use plans were developed for each scenario in order to represent reasonable extremes of land use distribution and intensity. The result was a total of four alternative futures which could then be used for the testing of alternative transit plans.

10. A full testing of alternative transportation plans was then conducted under each of the alternative futures with the purpose of selecting the "best" plan for each future (SEWRPC, 1982a). This testing involved a comprehensive travel demand forecast based upon the
assumptions of the future being used. Performance of the transportation plans were evaluated using approximately 50 criteria following a trade-off analysis technique. The best plans were then compared and combined to develop a best overall plan. It was important to identify alternatives that worked well across the range of future conditions. If an alternative, say heavy rail transit, did not perform adequately in the upper future where all conditions were most conducive for its success, it could be dropped from further analysis. If it worked well in both the upper and lower future, it would be a strong candidate for early stage implementation.

KEY VARIABLES

11. An important step in the development of the alternative futures was to identify those variables which were major determinants of future travel demand and cost and which would directly relate to the success of an alternative. Extensive background analysis (SEWRPC, 1980) was conducted in four subject areas – energy, technology, life style, and economy – in order to identify key trends and driving factors and their influence on the transportation modeling process. For example, it was found that future energy assumptions affect trip production rates, ridesharing assumptions, and highway operating costs. These factors could in turn affect total market size and market share. In addition, energy characteristics also had effects on the supply side by influencing operating costs of transit systems. In a similar manner, population, life style, and economic conditions influenced the forecasting process in a number of ways.

12. The influence of energy and technology was included through the rate of change in oil prices in constant dollars over a twenty year period and through assumptions in future automobile fleet fuel efficiency. These two measures when combined yield an average automobile operating costs value in cents per mile as the major indicator of fuel price and energy conservation changes. Energy assumptions were also used to modify ridesharing relationships and trip production rates.

13. Lifestyle assumptions were reduced to an indication of the future role of women in society through female labor force participation rates, fertility rates and household size assumptions. These three factors are complementary in that a high female labor force participation rate would likely be accompanied by low fertility rates and household sizes. Accordingly, the two scenarios utilised opposite extremes of these factors to represent a range of possible future conditions.

14. Economic futures of the region were represented by the degree to which the region will remain competitive with other areas of the United States as evidenced by the net migration rate and by the change in real income as measured by the rate of change in real income. In the upper scenario the region was assumed to remain competitive and have little out-migration and an increasing real income. In the lower scenario, the region did poorly in competition with other regions and had no growth in real incomes.
Figure 1 - General process for alternative futures development.
RESULTS

15. The four alternative futures were used to compare a range of primary transit systems alternatives as part of a level I Alternatives Analysis for the Milwaukee area. Six alternative modes were investigated. These included: a base plan with relatively small changes from the current bus-based system; bus on freeway; commuter rail; light rail; busway and heavy rail alternatives. Each alternative was also supplemented with extensive coverage of the urbanised area with local transit service and feeder service to the primary transit system. Space does not allow for a detailed discussion of results. These are available elsewhere (SEWRPC, 1982a). The testing of the alternative transit systems went through a number of steps as they were compared under a given future. First, maximum extent plans which included extensive coverage of the urbanised area and beyond were tested. Those links or modes which did not have an acceptable performance in the upper future were then eliminated to develop truncated plans. The truncated plans were then compared to each other under the different futures in order to reach a conclusion for the study.

16. The study concluded that only bus on freeway or light rail transit were feasible modes for the Milwaukee area. Furthermore the alternative futures concept led to a two tier plan, with a bus based system in the short term and an option to move to adding light rail transit at a later time depending on how the future in fact evolved. The alternative futures process were very useful in developing a range of strategies for transit improvement in the area for various circumstances. Furthermore it provided a method to quickly deal with a wide variety of future situations and to select alternatives in the light of considerable uncertainty.

TECHNOLOGY ASSESSMENT AND TRANSFER

17. The alternative futures approach is a useful method for dealing with complex long range systems planning issues. It provides a structured, formalised process that explicitly recognises the boundaries of change and develops strategies to implement adaptive systems over time. However, as the WDOT conferences pointed out, there are also many other types of change and innovation that will also affect transportation agencies in the future that may not directly relate to long term planning issues. These are innovation in technology and procedures which may be relatively small or incremented but nonetheless can have significant long term impact.

18. Most organisations, particularly public agencies, are poorly equipped to deal with rapid change and innovation. There is a natural, built-in resistance to change and initial opposition to anything new. Most new ideas are greeted with comments about why it won't work here and criticism. New procedures, if adopted by management, often have to be forced upon unwilling users and it may take a long time for changes to be successfully implemented. People at lower levels of an organisation who want to make changes are often frustrated by endless barriers to change and opposition by management and others.

19. While such problems may always be with us, it appears that there are better methods to deal with change in a public organisation (Beimborn, 1985). One such method is to develop an explicit technology assessment and transfer focus to deal directly with innovation and change. Such techniques have been explored through a series of projects at the University of Wisconsin – Milwaukee with the Federal Highway Administration. These projects have involved techniques for technology transfer and have resulted in the definition of a process whereby transportation agencies can more effectively
implement change. This process would involve the following activities:

(a) User assessment.

(b) Technology assessment.

(c) Develop transfer strategy

(d) Evaluation.

USER ASSESSMENT

20. Before any significant progress can be made in the adoption of innovations, it is essential that the nature of the potential users of the innovation be clearly understood. An explicit user assessment should take place. This would include a discussion of user needs and problems, an understanding of user attitudes towards change, an assessment of user capabilities to understand and utilise the change, an assessment of user networks (how do they interact with their peers?) and an understanding of the organisation in which the user works. User assessment is a continuing process and is done through one-on-one discussions in an informal setting and through a high degree of communication between users, developers of innovation and technology transfer agents. Information and innovations must be targeted to an audience that is clearly understood in order to be effective.

TECHNOLOGY ASSESSMENT

21. A second activity is technology assessment. Technology assessment is a process whereby innovations are carefully examined to determine how easy they will be to implement with a given group of users. Technology assessment assumes that the innovation is feasible and promising and focuses on the barriers that it may have to adoption. Some of the questions asked are:

(a) What is its relative advantage of the innovation over current techniques? A significant advantage is required to make it worthwhile to adopt an innovation.

(b) How easy is it to try the innovation? Those innovations that require a long term commitment are much less likely to be adopted than those that can be tried for a short period on a temporary basis.

(c) How observable are the benefits of the innovation? It is important to have direct, obvious effects from a change in order to successfully implement it.

(d) How complex is the innovation? The easier it is to understand a change and why it is being done, the more likely it will be accepted.

(e) What does it cost to implement the innovation? Generally speaking, the less costly a change is, the more likely people will be willing to try it.

(f) What are the consequences of a failure? This is perhaps one of the most critical questions. People in public agencies tend to be very fearful of failure and avoid taking risks. An innovation that will cause
serious problems if it doesn't work is very unlikely to be adopted.

**DEVELOP TRANSFER STRATEGY**

22. Once there is a clear understanding of the user and of the innovation, it is possible to develop a strategy to implement the change within the organisation. Ideally this is done with a strong user involvement in order to identify problems at an early stage and to modify the innovation as necessary to lead to a successful implementation. The transfer strategy may include well developed training programs, specifically targeted dissemination material, opportunities for feedback, a sequence for implementation and demonstration projects. The techniques chosen should consider the needs for timely information, adaptability, complexity and cost.

**EVALUATION**

23. The final activity in technology assessment and transfer is an evaluation of the success of the innovation. Feedback must be obtained to determine the reaction of users to the innovation as well as to the means that were used to implement it. An evaluation also needs to be made of the effectiveness of the innovation itself in solving the problem for which it was proposed. Evaluation is important because it will help tell us what worked and what didn't and how to modify systems now and in the future so that they work better.

24. The process described above should be a continuing one with broad participation. It requires unique individuals who are able to lead others to adopt changes and who are unselfish towards others. This process has a good potential for bringing order to an agency undergoing rapid external and internal change.

**CONCLUSIONS**

25. This paper has looked at the rapid change that has been and will continue to affect transportation programs and policies using experiences in the State of Wisconsin in the U.S.A. as a point of reference. These changes have or will be quite profound and escape the realm of predictability. It appears futile to try to accurately forecast the future and to rely only on conventional methods of planning and management to deal with it. Transportation organisations need to adopt more flexible techniques to deal with rapid change.

26. In the area of planning an alternative future approach is described. This approach focuses upon decision making and defines alternative futures to represent the range of conditions that transportation alternatives may face. An upper futures is defines to represent a set of circumstances which are highly conducive to the success of a transport plan. A lower future which is pessimistic towards success is also defined. By testing alternatives under both futures, alternatives that function under a wide range of future conditions can be identified and strategies for their implementation can be developed. Such a technique can be very useful for dealing with a highly uncertain future.

27. In the area of management a technology assessment and transfer process is proposed. Such a process provides explicit methods to conduct assessments of the needs and capabilities of potential users of new technology; to assess new technologies or procedures for implementation problems and potentials; to develop strategies to transfer the innovations and bring about their use and to evaluate the
process of technology transfer as well as the innovation itself.

28. These two techniques in transportation planning and management provide techniques for dealing with a complex, dynamic future and have the potential for maintaining some order the transportation programs and policies into the next century.

REFERENCES


