The Effect of Future Trends on Trip Patterns, Urban Commercial Structure, and Land Use

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ABSTRACT

The "Third Wave" or the information society is changing our society. The major effects are: (a) reductions in traditional labor activities such as manufacturing and data gathering; (b) growth in jobs that deal mainly with information; such jobs can be located almost anywhere, including the home; and (c) growth in available leisure time, and an increase in the potential for achieving living style objectives. One possible outcome of these major effects is a dramatic restructuring of urban areas including the decentralization of urban nodes over a whole region. This is in direct contrast to the industrial society in which the urban structure has a highly centralized, hierarchical form focusing on the regional or metropolitan city as aptly described by central place theory. This growth pattern reversal dramatically changes the requirements for transportation facilities from those contained in existing transport facility plans. The effect of the third wave may result in the placement of many existing plans at risk in that the projected transport demands may not materialize. In this paper an approach to evaluating the risks to transport investment in southern Ontario is described. A series of exploratory models is being developed to implement the concepts presented in the paper. By incorporating other dimensions of the locational behavior of individuals, these models are extensions of economic base theory and the Lowry model.

The "Third Wave," or the information society, is predicted to sweep across our society in the next few years (1). Many changes are expected to take place in its wake. The objective of this paper is to assess the impact of these changes on urban structure and transportation. In particular, an approach is proposed to estimate the changes in the southern Ontario region, which is centered on Toronto.

The term "wave" implies a washing effect of all-encompassing change, which will characterize the Third Wave. It is based on the widespread application of computers in all aspects of life and an order of magnitude advance in communication systems. So many changes are expected to occur in so many sectors so quickly that modeling them with certainty would be an impossible task, yet it is believed that the impacts of these changes are too important to ignore. By identifying the major trends, it may be possible to estimate the direction and the likely magnitude of changes in both population and employment and their impact on the requirements for new capital investment in transport.

The changes become clearer if the current urban structure is examined. With the industrial revolution and the development and maturation of the industrial society, there was a continual growth in cities within a region. This growth was focused in a hierarchical way on the central city in the region; for example, reference is made to the New York region, the Chicago region, and the Toronto region. Around the central city were a number of subregional cities and a number of local cities as described in the classical central place theory. The driving forces were the economies of scale from mass production and the advantages of locating firms near the market and near a large skilled labor pool. These forces continued unabated until about the 1950s when a few of the world's largest cities began to decline. People from rural areas were attracted to the growing hierarchical cities by better jobs and a higher standard of living.

The driving forces behind the industrial society are accurately represented by the Lowry model. The Lowry model uses basic employment as the driving force behind the location of land use. Around this basic employment the population and labor force is located within commuting distance, then the service employment and its associated population and labor force is added. Today, however, basic employment is declining because of increased mechanization, replacement of office functions by computers, and so forth. Therefore the use of the Lowry model to predict future land use will no longer be valid because the driving forces of the industrial society are changing.

The information society has been appropriately conceptualized by Toffler (1) and its progress has been monitored by Naisbitt (2). It is estimated that as much as 75 percent of the current labor force deals only with data and information. There is no longer the necessity to be at a particular physical location because data and information can now be communicated and processed anywhere. Moreover, the large mass production, industrial, and manufacturing plants that were the root cause of the location and growth of regions of cities were the first to be computerized and automated. They had many repetitive, low skilled, high-wage jobs that had the best return on computerization.

Figure 1 shows the impact of the decline in manufacturing on population and transport volumes in London, England. (Personal communication with D. Bayliss, London Regional Transport.) The data are for Greater London and illustrate the decline in manufacturing and employment and the growth in the service sector. The growth in employment in finance, business, and public service is also subject to reduction through computerization, and the first

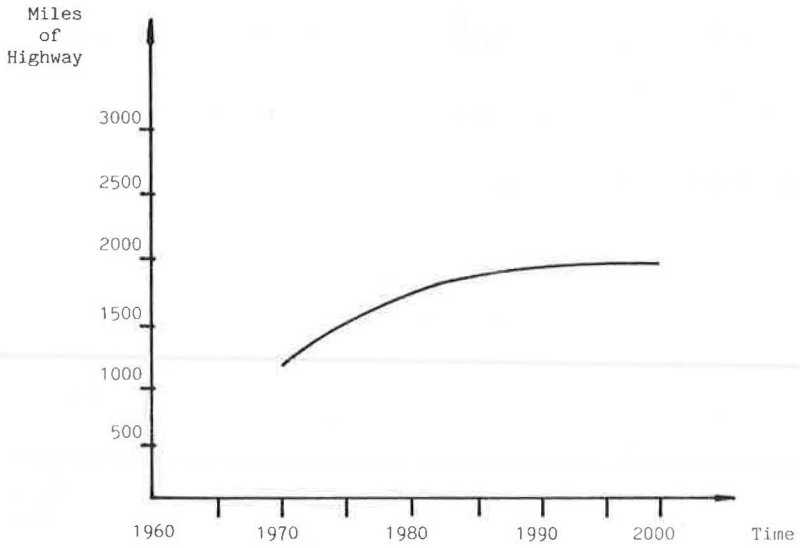

FIGURE 4 Time series plot for highway miles: policy no. 2.

Further, the methodology or modeling technique can be used to communicate and incorporate the views and opinions of groups not involved in the building of the model. By experimenting with changes in policies and model parameters and observing the effects of these changes on behavior, these groups can help or be helped to better understand the dynamic forces at work in the real world.

At first glance, the size (eight sectors) and "seeming complexity" of the model (feedbacks and differential difference equations) might be questioned for its usefulness for transportation planning. However, the allocation of large sums of money in transportation and related economic infrastructure that affect the lives of present and future generations must of necessity be carefully analyzed if negative impacts are to be minimized.

A planning model that affects growth should provide insights into where the economy is likely to go for a given urban investment policy. The output from the model for a given policy is not significant in terms of its absolute value but rather should be used as information indicating the direction in which the city is likely to evolve in the forseeable future for a given urban policy.

Further, because the output from the model is a trace of the performance of the economy through time, the model can be used to study post-project (decision) performances. If forecasted values are not realized, timely adjustments could be made to key resources (inputs) in the city to correct unwanted impacts.

Policy 3 for a simplified macroscopic approach to the Charlotte scenario provides the best (i.e., positive) impacts on highway miles and level of surface and should be further investigated, that is, more adeptly calibrated and simulated for a given horizon or planning period.

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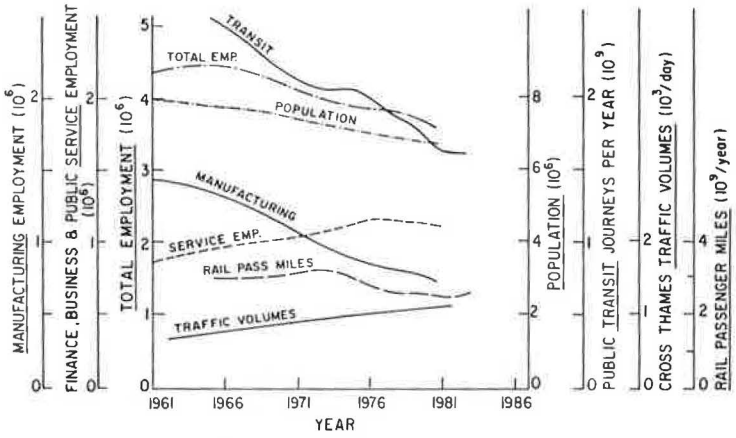


FIGURE 1 Trends in Greater London at the onset of the information society.

sign of this was seen in the late 1970s. The decline in employment and population in Greater London has an associated growth in population in the rest of the London region as the population has decentralized to other urban areas in the region.

As shown in Figure 1, there is a significant decline in the use of the total transit system while the traffic volumes continued to grow and now appear to be stabilizing. Rail passenger miles that mainly serve the central area have maintained their level primarily because of increasing journey length from an average of 4.45 mi in 1965 to 4.80 mi in 1983.

The impacts in terms of investment requirements in transport facilities show an interesting shift from expansion of capacity to a focus on quality of service and efficiency.

> [In] the 1960s it was anticipated that investment (in London's public transportation system) would be needed to increase capacity by the expansion of signalling sections on key sections of the railways, increase train lengths and building new underground lines to provide relief to the worst overcrowding. Most of these capacity expansion schemes have been abandoned with the exception of resignalling the busier main line termini approaches. Even this is designed to improve quality of service as much as capacity. The emphasis currently is to invest to improve productivity in order to sustain the network, to improve interchange to increase its appeal and to expand coverage to complement and assist new development. (Bayliss, personal communication, 1985.)

It is expected that as the information society gains momentum it will increasingly affect the regional distribution of population and employment and thus the resulting requirements for transport investment. It is the authors' view that these requirements may represent a complete about face in the characteristics of transport investment. For these reasons a study was undertaken of the Toronto-centered region in order to understand the potential impact of the Third Wave and to evaluate the associated risk for transport capital investments.

The approach taken has been to

1. Review the trends of the information society;
2. Conceptualize the variables and the process that will adequately describe the impacts on transportation;
3. Create exploratory models of (a) interurban location of population and employment, and (b) the location of service employment; and
4. Test a number of future scenarios to define the elements of a more definitive study to evaluate the risk.

The first three approaches are described here. The study area is shown in Figure 2. It consists of the whole of southern Ontario, bounded by the Great Lakes and focusing on Toronto, the regional city. Toronto is a classical industrial society city. It was located at a break in the transportation system for the preindustrial fur trade and has developed as a center of finance, government, industry, population, and service within a hierarchical region of supporting cities.

INFORMATION SOCIETY TRENDS

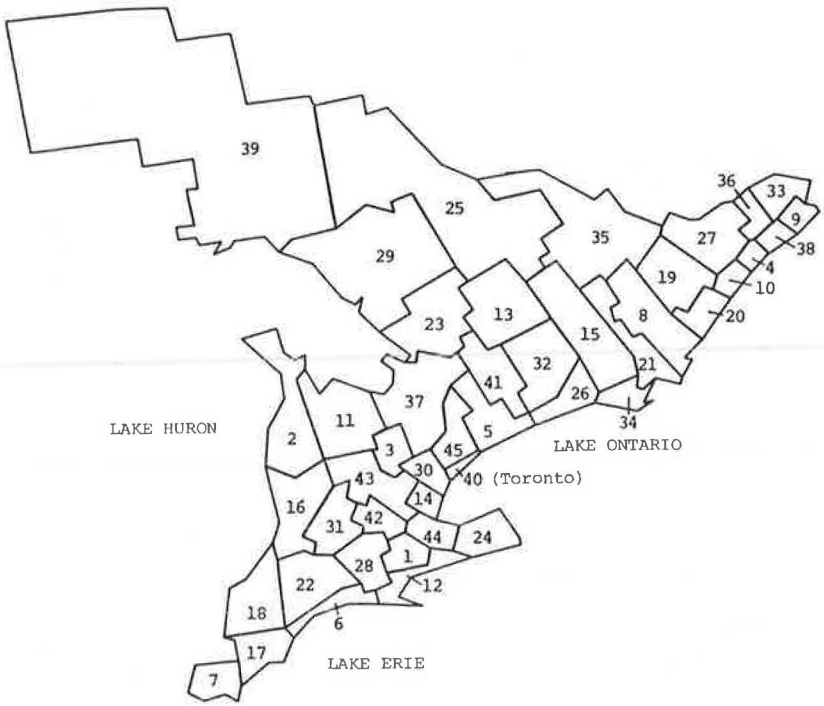
A number of observable trends, representative of the Third Wave, will increasingly have an important effect on society.

Computers

The information society is mainly driven by developments in computing. The trends toward faster, cheaper, higher capacity, more available computing power is so well known that it need not be discussed. This trend is expected to continue, and within the next decade the average dwelling and its occupants will have as many computers as those today have electric motors. This trend will be pervasive and will forever change the way things are done and, thus, will change our lives.

The Declining Workweek

The average workweek decreased from about 67 hr in 1860 to about 42 hr in 1952 (3). In the 30 years following the average workweek has remained approximately constant as shown in Figure 3, which is partly the reason for the current high unemployment situation. Technological changes have increased worker productivity but there has not been a corresponding decrease in the length of the workweek.



1 - Brant
2 - Bruce
3 - Dufferin
4 - Dundas
5 - Durham
6 - Elgin
7 - Essex
8 - Frontenac
9 - Glengarry
10 - Grenville
11 - Grey
12 - Haldimand-Norfolk
13 - Haliburton
14 - Halton
15 - Hastings
16 - Huron
17 - Kent
18 - Lambton
19 - Lanark
20 - Leeds
21 - Lennox
22 - Middlesex
23 - Muskoka
24 - Niagara
25 - Nipissing
26 - Northumberland
27 - Ottawa
28 - Oxford
29 - Parry Sound
30 - Peel
31 - Perth
32 - Peterborough
33 - Prescott
34 - Prince Edward
35 - Renfrew
36 - Russell
37 - Simcoe
38 - Stormont
39 - Sudbury
40 - Toronto
41 - Victoria
42 - Waterloo
43 - Wellington
44 - Wentworth
45 - York

FIGURE 2 The southern Ontario/Toronto study area.

In order to keep pace with the technological advances the average workweek will have to decline. Across the entire labor force, this may take various forms; for example, the average day or the average week may decrease or the worker may take longer vacations or retire earlier. These changes may be accompanied by increases in job-sharing, parttime work, or high levels of unemployment. In any event the available leisure time or "nonwork" time will steadily increase.

Flexibility in the Workplace

With the arrival of the information society, many jobs have become increasingly location-free. People

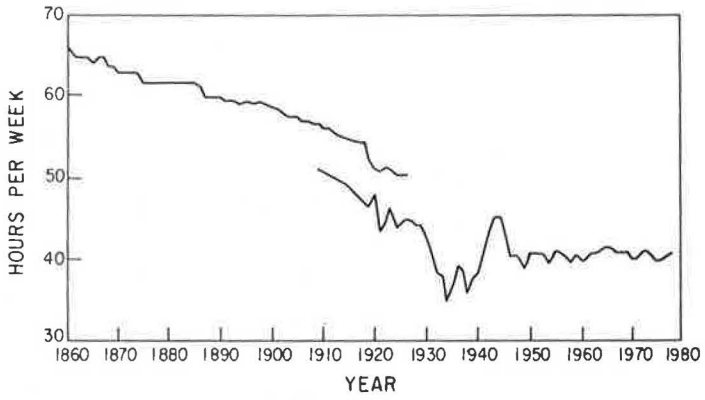


FIGURE 3 Average workweek in manufacturing industries in the United States.

can, or will be able to work wherever they choose and merely send or receive products along information channels. The cost of sending information is distance insensitive, meaning that it costs no more to send the same information across the country than it does to send it across the city. Many workers will be able to work wherever they choose, which will often be at home or at a local office, rather than at the firm's main location.

The office as it is currently known may never be the same. Some of the large, centrally located offices will become obsolete. They may be replaced by small, local offices that workers can easily get to from their residences. Therefore, there may be an increase in "rent-an-office," which a company will be able to rent and use for a few days or for several years. It is necessary to distinguish between workplace, where a person actually works, and work base, which is the location of the work control function. Traditionally, these have been at the same physical location but this is no longer necessary.

It is noted that not all workplaces will become location-free, but the number will continually increase over the next 20 years and will become a significant proportion of the employment sector. A large number of workplaces will exist in part at home and in part at the office. The personal meeting between two people cannot easily be replaced by communications between two spatially separated points. Therefore, many workers may still travel to a central office, but only for 1 or 2 days a week.

Manufacturing

One of the most important changes will be the continuing decrease in employment in the manufacturing sector. Employment in manufacturing currently accounts for about 28 percent of total employment in Ontario. It has been predicted that this figure will decrease to as low as 6 percent by the year 2000 because of the increase of automation in manufacturing. Robots are increasingly being used in manufacturing processes, especially in countries such as Japan.

Within the manufacturing sector itself, factories will become smaller and more efficient, and as a result, more easily relocatable from their traditional big city locations. More efficient use will be made of available factory space as robots will be able to work 24 hr a day, 365 days a year. Large companies will decline and smaller companies will increase as information, design capability, manufacturing technology, and marketing services become available on a wider basis and not just to companies with large personnel and financial resources. Mass production will decline as factories become smaller in size. Small production runs of a few hundred units will become commercially viable because of computer-aided manufacturing systems.

Office

The structure of the office will also continue to change. A completely computerized office is now a reality. As more office workers begin to work at home, and job sharing increases, the need for office space will decline. Computer-aided design, drafting, accounting, inventory control and ordering, filing, and word processing will all aid in the decline of the large centrally located office. In the extreme case in which an office only processes information, it may disappear completely. This, for example, has happened to many individual middle management positions whereby the availability of computerized data has completely replaced the need for middle managers while also improving the quality of the information available for decision making.

Information Employment

The decrease in the manufacturing sector must be met by an increase in another sector of employment. The development of the information society is triggering an increase in the sectors of employment related to information. The sale, distribution, and availability of information is increasing and becoming a major sector of the economy. The longer term future of this sector of the economy is very uncertain because by definition it will ultimately make itself obsolete. In the recent past this has been observed with the decline in computer analysts as computers were made more user friendly.

Corresponding to this increase in the information sector is a dramatic change in the workplace, both in its location and its size. During the industrial society, factories had to be made large in order to take advantage of economies of scale, and they also had to be located in large cities to be close to their labor pool. Now, however, any person employed in an information-related job can work anywhere where there is a computer terminal and a telephone. Factories now need fewer employees and the factory is no longer tied to the large city. The expected decentralization of employment on a regional scale may also lead to a significant change in the structure of employment.

Demographic Changes

The composition of the family is also changing. Birth rates have declined; the incidence of divorce and family splits is on the increase. People are leaving home earlier but deciding to marry later. These changes have led to an increase in the number of people living on their own or in smaller family units.

The composition of the work force is also changing. As the baby boom generation gets older the average working age will increase. An increasing number of women are entering the work force. However, the work force is no longer growing as fast as it previously did. In the 1970s the work force increased by an average of 2.7 percent, whereas in the 1980s it will probably only increase by about 1.5 percent (4). As the workers of the baby boom generation begin to retire, the work force may actually start to decline.

In Canada for the years 1981-2001, the most significant population increases are in the over 45 age groups whereas the 0 to 45 age groups will actually decline. The median age will increase from 26.3 in 1961 to 35.7 in the year 2001.

An important demographic change is the increasing education and level of knowledge of the population and the increase in employment positions. For example, in Ontario from 1971 to 1981 employment grew 110 percent in management positions, 65 percent in professional and middle management positions, and only 33 percent in semiskilled and unskilled positions (5).

Communications

The large-scale development of the computer has led to an increase in the availability of information that will increasingly influence our lives. The development of communication networks such as TELIDON

will dramatically increase the ease of access to information. For example, Northern Telecom predicts that in 1985 products will be available that allow a 300-page book to be transmitted in 5 sec over twisted wire telephone lines.

The option of shopping at home may soon become a reality as people will be able to examine and purchase goods through their television screens. Information on almost any topic will become easily available. For example, choosing from recreation and entertainment possibilities will be easier with information available at the touch of a button. Planning a holiday can occur without the travel agent from the comfort of one's home by accessing files on prices and flight times.

Improvements in communications are expected to lead to many other changes. Separation of workplace and work base will become cheaper. There will be an incentive to develop extensive on-line data bases as the feasibility of marketing them increases. Distance education may become the norm in the next century. The impacts of communication may eventually be more significant than the computer.

Diversity and Prosuming

At the start of the industrial revolution almost all occupations could be listed in a nursery rhyme, "the butcher, the baker and the candlestick maker..." Moreover, knowing a person's occupation revealed how they spent most of their time, where they lived, their income, their religion, their pastimes, and so forth. However, today there are at least 200 different types of engineers and perhaps 1,000 common occupations. Knowing a person's occupation today indicates a little about their life style but not much.

This increase in diversity is expected to continue as work requirements decrease and nonwork time increases. One way to describe the Third Wave is: "Production is independent of labor." That is, the production of many goods and services within the traditional production units will no longer have a significant input of labor. The information, technology, energy, capital, and land inputs will predominate. This is, of course, the reason for the expectation of both increasing affluence and increasing nonwork or leisure time. It also explains the current discussion on the implications of the decline of the work ethic, which was the cornerstone of industrial society.

It is a truism that computers cannot be eaten, and except for games and entertainment, they are pretty well useless as direct consumer products. Thus, it becomes clear that computers will not be an activity that uses the increased nonwork time. Moreover, it appears that people have an inherent need to do something productive with at least part of their nonwork time. This leads to the suggestion by Toffler (1) that prosuming will continue to grow. Prosuming is the integration within the household unit of both the production and consumption of goods and services. The increase in crafts, cottage building, gardening, and so forth, all attest to this trend. There is, for example, currently a rapid increase in specialized publications on all aspects of living and prosuming. These publications are characterized by small circulations over wide geographical areas. Prosuming may become an important element in determining the locations selected by people as they are able to separate the workplace from the work base.

It appears that there will be a continuing increase in the diversity of the occupations and living styles of the population as a result of the information society, and, in turn, this may become the hallmark trend of the Third Wave society.

Uncertainty

One of the unanswered questions of the information society is what jobs will replace those lost in manufacturing and offices. The growing sectors of information, health, recreation, education, entertainment, and so forth, are not adequate to provide jobs for everyone as attested to by the present and future unemployment prospects.

In the industrial revolution when more than one-half of the labor force lost their jobs, it was clear that the new jobs would be created first in the manufacturing and then in the service sector. In the Third Wave the character of the new jobs is unclear. The expectation for increased diversity along with the implications of regional decentralization of employment suggests that it may not be possible to make accurate manpower forecasts. If future employment characteristics are unable to be predicted, then the prediction of future locations of population and employment also become increasingly difficult and uncertain.

Finally, it must be noted that the whole future of society is also uncertain. The social structure of the industrial society is vastly different from that of the agricultural society. The transition to the industrial society spanned 10 generations. The transition to the information society is expected to span only one or two generations. The rate of change may be too rapid and this, in itself, introduces tremendous uncertainty in predicting the future.

EVALUATING TRANSPORT IMPACTS OF THE INFORMATION SOCIETY

The Lowry and other urban land use models were developed in the 1960s in order to try to predict future urban land uses. They were developed in a time of extensive economic growth. The manufacturing sector was rapidly increasing as well as most other sectors of employment. These models were successful in sketching the development of cities. Their main variables were the given location of basic employment and the estimates of population and service employment to complement the basic employment. They also used daily commuting accessibility over a congested transport system as the main determinant of spatial structure.

As indicated the "basic" employment of the Lowry model is now rapidly declining as is the need for daily commuting, and even a decline in transport congestion may not be far behind. Moreover, existing land use models focused on the urban rather than the regional level. For these reasons they are no longer useful.

In the transition to the information society there are a number of additional variables besides employment and travel time that must be included to forecast the structure of regions. The following variables have been identified: living style, environment, cultural heritage, and quality.

Living Style

It was necessary to eliminate the artificial separation of population and employment. Living style is a classification that includes both a person's residential activities and his nonwork activities. The living style variable ranges between an industrial society living style and an information society

living style. The main determinant is the degree of locational freedom of residence and workplace and the extent to which the locational choice recognizes both nonwork objectives and also personal satisfaction in the work activity. At one extreme there is an individual who travels during peak hours, 5 days a week, to work at a large industrial plant and has residential choices limited by the large size of the city. At the other extreme is an individual whose workplace has been moved to a smaller city in the region to take advantage of the local beach and skiing opportunities, who travels only 10 min to work and whose work base is in the region's central city.

In the absence of any appropriate and available data to classify the study area population by living style, the standard census occupation and industrial classifications were examined and a subjective classification made at five levels of living style. The classifications of both the occupation data and the industrial data were coordinated so that there was the same number of people in each class. Comparison of the data over the period 1961 to 1981 indicated that there was good agreement between the two distributions. Figure 4 shows the historical and forecast living styles for all of Canada based on the Standard Industrial Classification. The growth of the information society and the decline of the industrial society can be clearly seen.

Environment

This variable is a measure of the attractiveness of an urban area in terms of natural landscape; housing quality, cost, and availability; education, health, and cultural activities; population density; and other quality of community life variables. This variable represents the attractiveness of a community for living. It is being measured by assembling all of the available data and then using a factor analysis to reduce the variables to a manageable number. In the preliminary analysis the important factors include education and income of the resident population, population density, climate, local tax base, and retail sales.

Cultural Heritage

This variable is a special quality-of-life variable that identifies the historical and cultural ties of a particular urban area or region. For example, in Canada, for many years the population of the Maritime provinces had to leave in order to find employment. In recent years, with the possibility of local employment, many people have returned home to work or to start new businesses. This variable is currently measured by the population of the area in 1950. Although conceptually it is believed to be important, there is not yet any evidence to suggest that it requires separate treatment.

Quality

This variable relates entirely to the transport system. It is believed that the Third Wave will place an increasing emphasis on the quality of life, and thus within the transport sector, the operative variable should be the quality of transport, which will include reliability, comfort, and convenience, as well as the traditional travel time variables. It is expected that as the frequency of journeys decreases and the lengths increase (especially to the work base), the quality of transport will become very important.

In the authors' opinion these types of variables that are not represented in existing land use models are critical to forecasting the changes that will occur in urban regions. In the remainder of this paper two models that are being used in the study area to explore the possible future impacts of the information society on urban regions are described. The first model forecasts the expected migrations of population from one area to another in the region. Preliminary results have explained 60 percent of the population changes that occurred between 1971 and 1981 in the 45 zones of the study region. The second model is concerned with the location of the consumer service sector.

Figure 5 shows the expected changes in locational forces that will occur during the transition from a second wave to a third wave society. The industrial society is characterized by a strong tie between the home and both the place of work and services. There are also fairly strong ties between the work base and the labor pool, market, geography, and so forth. This resulted in a concentration of basic employment in the region's central city core area with the rest of the central city and surrounding region focused on and supporting this concentration.

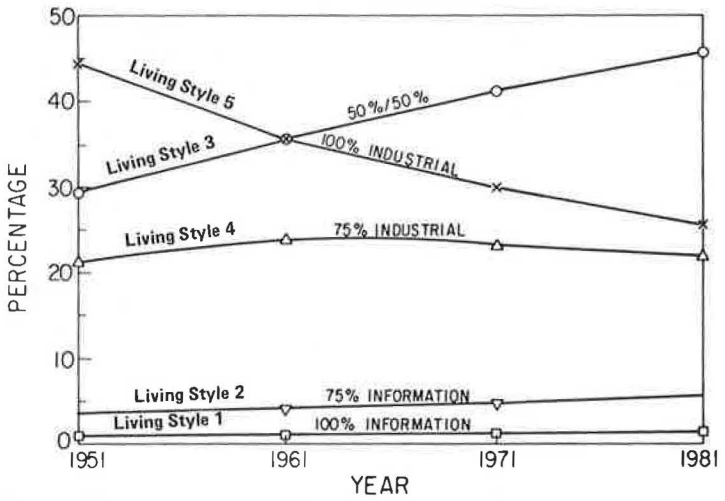


FIGURE 4 Living style trends in Canada for five classes based on a subjective allocation of available data by the standard industrial code.

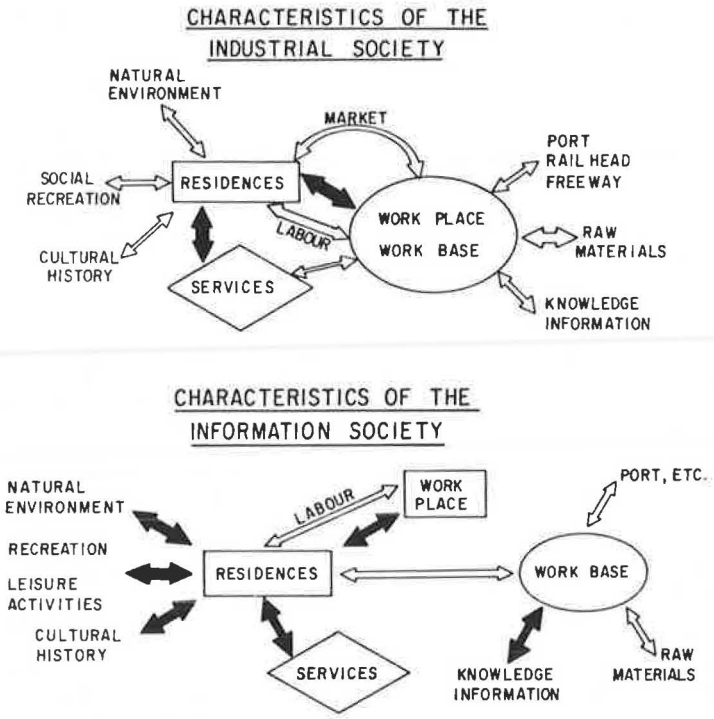


FIGURE 5 Changes in the location forces from the second wave to the Third Wave in a regional setting.

The purely Third Wave or information society as shown in Figure 5(b) will be characterized by much weaker links between the work base, market, labor pool, geography, and the home and/or workplace. The home will have much stronger ties with the environment, services, cultural heritage, and so forth. As people and employers become more location-free, other reasons such as the environment and quality of life will become more important in determining the living style and thus the choice of location. The information society will tend to break up the existing regional structure, as small packets of basic and service employment break off from the central city and locate elsewhere in order to satisfy living style objectives. There will no longer be the large concentrations of employment in the central business district (CBD) and other areas of the central regional city.

The weaker links between the residence and the work base are created in two ways. As the workweek continues to decline and an increasing number of people can, for at least some of the time, work away from the work base, the importance of the travel linkages between home and work will decline. People will make fewer journeys to work, and in some cases work will become location-free. Therefore, people will not be constrained to live close to their place of employment. Even if people have to make one or two journeys to work per week, they will be willing to make a longer trip if it means that they can live in a preferred location. For example, instead of working 5 days a week and traveling to the cottage on weekends, people may live at their cottage and journey to work only when necessary. This may result in large cities becoming increasingly decentralized. However, many people will prefer a highly urban environment that will lead to a counterbalancing centralizing force (6).

Firms are becoming location-free as they become smaller and more information oriented. Although employees of these firms may still have to travel to work every day, the firm and its employees will move together to a preferred location and this also will lead to a decentralization of population.

Modeling Intraregional Population Shifts

The proposed model allocates population and employment together as the living style variable. The basic model hypothesis is that as society moves from the industrial to the information society, people will have increased freedom of location. The locational choice will be based on such factors as the environment or amenity of the zone, accessibility to employment, and the distance from the zone of origin. These factors will have varying importance depending on the living style classification being considered.

The model is similar to a singly constrained gravity model. Five-year time increments are used in the model with the allocation process performed at the end of each time period. At the end of each 5-year time period, the population of each zone is increased by the predicted average population increase for the entire study area. The increases and decreases in each of the living style categories are determined for each zone, based on those predicted for the total study area from trend projections such as those shown in Figure 4. Living styles 4 and 5 are closest to the industrial society and are in decline. The associated population is then allocated to the predicted increases in the information society living styles 1, 2, and 3. The basic allocation equation is:

$$M_{i,j} = O_i * A_i * D_j * I_{ij} * ff_{ij}$$

where

M_{ij} = the movers from zone i to zone j;
O_i = decreases in zone i in living styles 4 or 5;

D_j = increases in zone j in living styles 1, 2, or 3;
A_j = balancing factor for the origin zone, $= 1/(D_j I_{ij} ff_{ij})$;
I_{ij} = interactions between zone i and zone j, $= a * (ENV_i/ENV_j) + b * (ENV_i/ENV_j) + c * \ldots$ where a, b, c are calibrated weights; and
ff_{ij} = friction factor between zone i and zone j, $= 1/Dist_{ij}^n$ with n = calibration constant.

The interaction term includes the environment, cultural heritage variables, as well as a measure of accessibility to other population in the region. The interaction term is in a comparative ratio form to reflect the comparison of conditions in one zone with those in another. The model will be calibrated using maximum likelihood for both the coefficients of the interaction term and the distance exponent.

After the 5-year allocation process each zone is checked to determine if it has grown more than the zone capacity allows. If any zone has a population greater than this maximum, that particular zonal population is set to the maximum and the excess population is allocated to the adjacent zones. The excess is allocated in the same proportions as the predicted increase for the adjacent zones in the last 5-year time increment. A check is made to restrict any increase or decrease in population to a maximum 5-year rate of change determined from observed maximum historical changes. This is to represent the inertia of the city.

The model outputs will be analyzed to determine if they are reasonable estimates of what might happen in the future. A sensitivity analysis can also be performed to determine how much the model is affected by its inputs. This will result in a range of possible outputs and provide information for more realistic specification of the allocation model. It should be noted that data are very scarce, especially for some of the environmental and living style variables.

Location of the Consumer Service Sector

It is expected that the Third Wave trends will reshape the urban structure of Ontario including the service sector. In fact, the service sector will become increasingly important as manufacturing declines. Moreover, as the population of the region decentralizes, there are expected to be significant impacts on the location of the consumer service sector.

Consumer-service firms abound in the modern city--almost on every corner there is a restaurant, gasoline station, or corner store. Most of these firms will not be visibly shaken by the Third Wave. Some, however, will have a sizable portion of their "reason d'être" (their market) removed. Some of this market deterioration will be due to a shift in the "drop-in" or link-trip trade, which has been previously ignored in traditional consumer-service location models, such as the Lowry model.

Link trips involve the subordination of certain secondary trip purposes to other primary purposes in an attempt by trip makers to conserve time, effort, and, hence, energy. By making a less important stop on the way to a more important destination, the trip maker fulfills his need for a certain good or service without having to make a special trip at another time. Both the existence of trip linking by consumers and link-trip orientation by consumer-service firms has been documented in recent research, but little effort has been applied to the connection between consumer and firm behavior over urban space. On the consumer, or demand side of the relationship, Hanson (7) found in Uppsala, Sweden, that many urban trip linkages involve either home or work as primary activities. In the Third Wave, the home-work-home pattern will be dramatically altered, and with it the link-trip patterns that have shaped the existing urban consumer-service land use pattern. Research on the supply side clearly shows that firms are oriented to different combinations of the surrounding residential and passing traffic markets, reflecting underlying operating strategies (8-11). Through quantifying these operating strategies by type of consumer-service firm, we hope to be able to predict the firm's orientation to the "linear hinterland."

Figure 6 shows the basic approach to the consumer service location model. The demand for services is separated from the supply of services. Link trips for consumer services are secondary to primary trips, such as work trips, and distinct from other primary trips for consumer services that go directly from home to the service and return. The model considers demands from linked or secondary trips separate from primary demands for consumer services. Also, the relative demands are expected to vary over time as living styles change. For example, the Ontario data on secondary trips indicated that executive/manager employees made 41 percent secondary trips whereas clerical/sales employees made only 25 percent secondary trips. There was a direct relationship between socioeconomic status and the percentage of secondary trips. Thus the expectation is that the percentage of linked trips will increase in the future.

As shown in Figure 6 the supply side will be

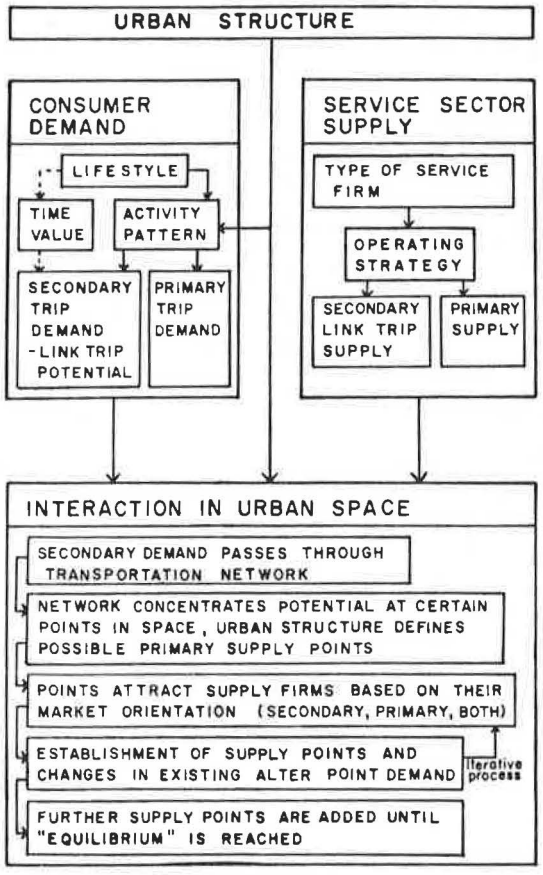


FIGURE 6 Flowchart of proposed consumer service location model.

considered to respond to both secondary and primary consumer trips. The supply of link trips is the provision of locations at which consumers may stop while traveling from one primary activity to another. It is the decision by an operator of a firm in the consumer-service sector to capture this link trip potential flowing through the urban transportation network. The network is represented in the model simply by the major nodes in the transport network, as these points already have maximum accessibility to link trips.

The secondary trips are assigned to the nodes according to the minimum path of the primary trips on which they depend. The potential market available to each node is the summation of these secondary trips for the primary trips passing through the node, plus the potential primary service trips distributed to that node in the preceding step.

The supply of consumer service centers will be determined in an iterative fashion by 5-year time periods. At the beginning of a time period, all nodes in the network receive a service center. The node with the lowest potential is tested stochastically for removal. The stochastic element simulates business risk and the required threshold potential. After a center has been removed, the potential is reallocated to other nodes. Equilibrium would be reached when there are no further reductions in supply points.

It is expected that the results of the consumer service location model will be able to reproduce the observed trends toward ever larger commercial complexes at more decentralized network nodes. It is also expected that when applied at a regional level, the model will be able to predict the observed trends for intercity locations for some fairly large and specialized commercial activity centers.

SUMMARY

The objective of this paper was to present some ideas on the impacts of the Third Wave or information society on transport. Research to date revealed that (a) there are no data, (b) there are no theories, and (c) there is no experience. The intent was to develop a fairly comprehensive model that would keep track of individuals, estimate the transitions between living styles, and so forth. It became clear that the transition to the Third Wave would be over before this research was finished.

The impacts of the Third Wave are believed to be revolutionary. The regional centralizing forces of the past 200 years are expected to reverse, and regions will experience a series of very strong decentralizing forces as the importance of manufacturing and daily commuting decline. The Toronto-centered region is currently being studied in an attempt, even in a preliminary way, to assess the risk associated with proposed investments in transport facilities.

The approach taken is one of conceptualizing the operative variables, mainly (a) living style, (b) environment, (c) cultural heritage, and (d) quality of transport, and obtaining crude measures of these variables from available data for the study area. The model is proposed to allocate population by living style, between urban areas, at a regional level of analysis. The model is driven by trend forecasts of the population in each living style class. The objective of this initial modeling activity is to use it to explore the ways in which the Third Wave will affect our cities and through this process define more specific future research objectives.

The main conclusion is that the impacts of the Third Wave demand a complete reexamination of transportation requirements as embodied in existing plans.

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