Uses of Census Data in Kansas

Stanley E. Young and Rick W. Miller, *Kansas Department of Transportation*

The recent uses of decennial census data within the Bureau of Transportation Planning of the Kansas Department of Transportation are overviewed, and one project pertaining to travel times in the Wichita metropolitan area is presented in detail as a case study. The presentation of the projects, which includes the identification of the census products and software tools used, serves as the foundation to discuss problems and possible solutions encountered in processing census data. The paper is divided into three parts. First is a quick overview of projects for which census data have served as the main source. Second is the presentation of the Wichita travel-time case study, which is an excellent example of both the use of the census data in transportation planning and the difficulties involved in processing census data. Last is a general discussion of tools needed to access and present census data, which census products are found pertinent to transportation planning, and what products the planning staff at Kansas Department of Transportation would like to see in the future, including content and format of the 2000 census as well as accessibility to past census data on CD-ROM. The paper concludes with a list of recommendations.

The uses of decennial census data in the Bureau of Transportation Planning within the Kansas Department of Transportation (DOT) include both travel modeling and numerous small research and data-gathering activities. Since other case studies have concentrated on the use of decennial census data as input parameters for travel models, this paper focuses on how census data are used in other aspects of transportation planning.

As frequent users of census data, the staff of the Bureau of Planning responded eagerly to the request to submit a paper pertaining to use of such data for transportation planning in Kansas. While seeking to identify an appropriate case study, staff quickly concluded that the census data served frequently as either the sole source or the most accessible source of information for numerous projects and small reports. To demonstrate, a list of recent projects was compiled in which census data have served as the primary source of information for analysis purposes. This list, given in the next section, demonstrates the wide range of uses for the census data apart from modeling. Much of the effort in using census data was given to data conversion and presentation, limiting any efforts with census data to those that warranted the time necessary to overcome the formatting problems frequently encountered.

The case study chosen for presentation in detail was a travel-time report prepared for the Wichita-area planning office. The study was performed just before the writing of this paper and reflects the current mode of operation in terms of tools, data sources, and methodology of the Bureau of Transportation Planning. Great detail is given to the tools and methodology in the hope that other planning organizations that are similarly fiscally

limited when it comes to software and hardware tools will gain some insight from this experience or be able to share solutions for these problems. A general discussion is given in the last section pertaining to types of census products the planning staff would like to have in the future, a discussion of geographic information system (GIS) tools in view of the difficulties with using census data, and comments concerning the 2000 census.

General Uses of Census Data

After a review of the proceedings from the 1994 Conference on Decennial Census Data for Transportation Planning (*1*), it became obvious that examples showing specific uses of the census data would be useful to show the breadth and depth of applications that can benefit from census data in general and would serve as a basis for describing some of the problems and difficulties experienced by the Kansas Bureau of Transportation Planning. For these reasons, a list of projects from the preceding year was constructed for which census data have served as the primary source of analysis. Listed for each entry are what data were used, the purpose they served, and alternative data sources available, if any. (The projects listed include small projects apart from the office's central mission of transportation planning that the staff is called upon to perform because of their experience and expertise in formatting and displaying geographically related data.)

1. **Shawnee County voting district map:** The Shawnee County planning office was given the task of exploring voting district boundaries for possible redistricting. After hand calculating a few scenarios, the staff inquired if the Bureau of Transportation Planning had any tools to help speed the process. Using the Urban Element, Part A, of the 1990 Census Transportation Planning Package (CTPP) for the Topeka area, an electronic map was produced showing population by census block. By overlaying existing voting district boundaries on the map, the Shawnee County staff were able to quickly see the effects of shifting established district boundaries. Data for this project were available from other sources, but the CTPP data combined with the 1994 Topologically Integrated Geographic Encoding and Referencing (TIGER) File formed the easiest source from which to obtain a useful map.

2. **Needs of the mobility disadvantaged within Lawrence, Kansas, metropolitan area:** The Urban Element of the CTPP was used extensively in the background research for the 20+ year plans developed for the metropolitan areas within Kansas in compliance with the regulations of the Intermodal Surface Transportation Efficiency Act (ISTEA). In particular, the census data were used to study the needs of the mobility disadvantaged. In the case of Lawrence, both the Summary Tape Files and the CTPP Urban Element were accessed to evaluate the transportation needs of the non-automobile-oriented community. Such data are difficult to obtain short of sponsoring an independent survey.

3. **Native American reservation population:** This project originated as a simple data-gathering effort but later contributed to a debate concerning the collection of fuel taxes on reservations. Statewide CTPP data were used in conjunction with the TransVU CTPP Edition, Version 1.1, to produce simple maps showing the ethnic distribution of reservation inhabitants.

4. **Statewide trip exchange matrix:** Again using the CTPP Statewide Element, Part 3, a work trip exchange matrix was created to study the movement of employment-related traffic between counties and other places throughout Kansas. No sources were available other than census data.

5. **Donor-borrower relationship between Lawrence and Kansas City:** Lawrence is typically thought of as a bedroom community for the Kansas City metropolitan area. Analysis of the journey-to-work data in either the Statewide or Urban Element of the CTPP dispelled this myth, showing that Lawrence attracted as many work-related trips to the region as it contributed outside the region. No other source of data besides the CTPP was available.

6. **Municipal airports in Kansas in relation to population centers:** This is a pending study to evaluate the relation between the location of municipal airports and the distribution of population. Statewide population statistics will be plotted alongside airport locations.

7. **Downtown Wichita travel-time study:** The Wichita planning office performed a travel-time study from downtown Wichita to major intersections on the periphery of the downtown area. The planning office staff requested that the state planning office provide 1970, 1980, and 1990 mean and median travel times for Wichita and Sedgwick County to augment the study. The requested information was provided using the Wichita CTPP and Urban Transportation Planning Package (UTPP) data plus traffic analysis zone (TAZ) specific travel times. This project was selected as the case study to present in more detail because it not only reflects the uniqueness of the census data, but it also demonstrates the difficulties and obstacles that need to be remedied.

In addition to the projects just cited, census data have been used on numerous occasions in site-specific studies for major developments, road improvements, or both, as a quick check on surrounding development or to confirm existing data from other sources.

Summing up some of the important aspects as reflected in the examples above, first, granted that the census data are not the sole source for much of the data used in terms

of economics and population, but they are the most comprehensive and the easiest to access. If census data were not available, a good portion of the information upon which an analysis is based simply would not be collected. The second important aspect is the journey-to-work information. It simply is not available or would be fiscally unpractical to collect for most areas were it not for the census data and related products.

Wichita Travel-Time Case Study

The case study described here reflects not only how the data are used, but also many of the difficulties that are encountered. Included in this case study are details concerning which census product was used (or not used), what computer tools were necessary, and the difficulties encountered. A general discussion of the census products and computer tools is reserved for the next section.

The Wichita planning office requested information to supplement a travel-time study they had performed (Table 1). The travel times and speeds given in Table 1 are for trips originating in downtown Wichita at the intersection of Douglas and Broadway to major intersections on the fringe of town. [The map of Wichita in Figure 1 shows some of the locations referred to in Table 1. (The end points shown on the map reflect 1995 travel-time studies. Insufficient information was available to pinpoint exact end points for the routes with data from 1980 only.) The intersection of Broadway and Douglas is labeled "Downtown."]

TABLE 1 Wichita Travel-Time Survey

Routes	Distance	1995	1980	1995	1980
	(Miles)	Travel Time (min-sec)		Travel Speed (mph)	
1 I35	7.90	13.23	15.25	35.42	30.75
2 North Meridian	8.70	18.38	21.12	28.01	24.64
3 West 21st North	9.40	21.20	-	26.44	-
4 West Central	8.20	-	19.55	-	24.70
5 West Kellogg	8.50	15.51	-	32.18	-
6 Airport 1	7.20	14.59	-	28.83	-
7 Airport 2	7.20	11.53	-	36.35	-
8 K-42	8.10	15.16	18.05	31.83	26.88
9 South Seneca	7.20	15.21	-	28.14	-
10 South Broadway	6.80	13.54	16.56	29.35	24.09
11 K-15	6.40	13.48	17.50	27.83	21.53
12 South Oliver	7.50	-	-	-	-
13 East Pawnee	8.80	18.18	-	28.85	-
14 East Kellogg	8.70	-	19.34	-	26.68
15 East Central	6.4	21.11	24.2	18.13	15.78
16 North Rock 1	9.7	-	25.15	-	23.05
17 North Rock 2	9.9	15.52	-	37.44	-
18 North Oliver	7.5	18.41	-	24.09	-

Summary of results of timed trips originating in downtown Wichita at the intersection of Broadway and Douglas to various intersections on the periphery of the city.

The planning office specifically requested the mean and median regionwide travel times for Wichita City and Sedgwick County from the 1990, 1980, and 1970 census data. Data from the 1990 CTPP, Part A, Tables 38 and 39; Part B, Tables 20 and 21; and Part C, Tables 6 and 7, were used to construct tables relating 1990 travel times to means of transportation to work. The data were extracted from electronic data-base files stored on a personal computer at the office. These data bases were originally constructed by parsing and formatting census text files downloaded from census data tapes on the agency's mainframe computer (a time-intensive task involving three separate software programs). After the data base was queried for the appropriate information, it was uploaded to a spreadsheet and formatted into tables.

Data from the 1980 UTPP, Part 1, Table 17, and Part 3, Table 6, were used to construct similar tables for 1980 travel times. The 1980 UTPP data were available on hardcopy printouts stored in the office. Data from the appropriate sections were transcribed from hardcopy into a spreadsheet and formatted into tables. Additional data equivalent to the 1990 Part C were available but were not gathered in part because of difficulty in accessing the data manually. The 1970 journey-to-work data were no longer available in the office and therefore were not gathered.

In addition to the data requested by the planning office, a map based on Wichita TAZs was constructed that would provide additional insight into the Wichita travel-time study. Using the 1990 CTPP Urban Element for Wichita, maps were constructed using TransCAD Version 3.0 Pre-Release for Windows. These maps are labeled with the average of the mean and median travel times from each TAZ to the four TAZs near the center of the downtown area at the intersection of Broadway and Douglas. The data were taken from Part C, Tables 6 and 7. One such map is the one shown in Figure 1, formatted to a smaller size. It is shown here only as an example of the type of output generated at a larger scale. Again the data were obtained from electronic data-base queries and ported electronically into TransCAD for display. The information contained in Part C, Tables 6 and 7, of the 1990 CTPP is not directly comparable with the travel times collected by the planning staff. The Wichita travel-time study was from intersection to intersection, whereas the CTPP data were door to door, including terminal times for both ends. Nevertheless they do provide a means of comparison that would otherwise not be available.

The 1980 UTPP data contained the information necessary to construct similar maps, but since the data were stored in hardcopy rather than electronically, the time

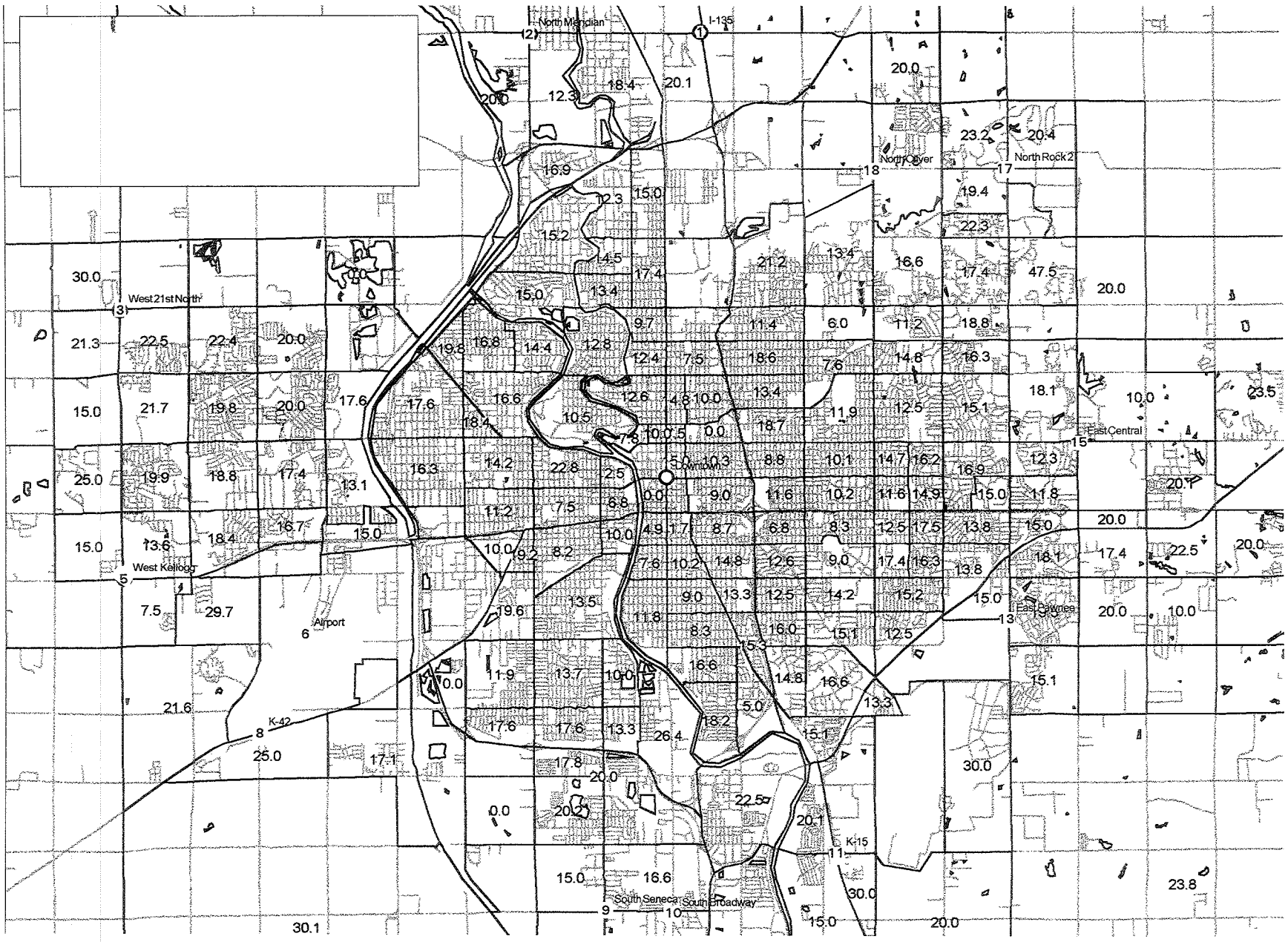

FIGURE 1 CTPP travel times: average of median travel times in minutes from each TAZ to TAZs near intersection of Broadway and Douglas for single-occupant vehicles for all times (1990 Wichita CTPP, Part 3, average C06C002 to TAZs 62, 64, 74, and 77).

required to transcribe all the necessary data made their use infeasible.

The data used to perform this study could only be obtained through a comprehensive survey of the Wichita metropolitan area. If the CTPP and UTPP portions of the census were not available, it is doubtful that sufficient planning funds would be committed to such a data-gathering effort. In this case the planning office would be limited to their simple (but arguably effective) approach for assessing regionwide travel times to downtown Wichita. If the scope of their study broadened to include suburb-to-suburb travel times, the resources for collecting data would quickly be exhausted. The CTPP portion of the 1990 census (as well as the similar portion of the 1980 census) contains the data to carry out a comprehensive travel-time study from any area within Wichita to any other area in Wichita.

Tools of the Trade

Much of the analysis performed in transportation planning is inherently graphical (or two-dimensional) in nature. Much of the information, including most of the census data, is only meaningful when viewed in relation to surrounding geographical attributes. This graphical nature is especially true for any type of transportation modeling but also carries over to many of the small studies mentioned earlier. As a result, the end products of most studies are maps labeled with the appropriate attributes.

Available software tools that possess robust graphing and mapping features combined with robust data-base capabilities are needed. The Kansas DOT currently uses TransCAD Version 3.0 Pre-Release for Windows combined with DBase III+ to carry out much of this work. (TransVU Version 1.1 is also used when appropriate.) Data are transferred from the original source and format (ASCII data files in the case of census data) into a DBase III+ file format. Base maps within TransCAD are constructed from the TIGER File obtained from the U.S. Geological Survey and distributed on CD-ROM. Attributes contained in the data fields of the TIGER File, such as TAZ zone numbers, allow for quick linking to DBase III+ files within TransCAD. TransCAD also contains several GIS tools for analysis, such as merging areas and their associated data-based geographic attributes.

One noteworthy problem encountered in the current practice of using DBase III+ files within a TransCAD environment is a result of building base maps from the TIGER File. At large scales the high resolution of the TIGER File detail slows the operation of TransCAD, produces large files for storage, and stresses the ability to obtain output. For example, a single county boundary in Kansas may be composed of hundreds of line segments. For planning purposes the same county could be represented by fewer than a couple of dozen line segments with no detriment to the end product. This is not a TransCAD problem nor is it a TIGER File problem. It is a fundamental aspect of geographical data that needs to be addressed. An autoscale feature, common in many mapping programs, is used to control whether or not a certain map layer is activated depending on the current map scale. As the map scale increases, the highly detailed layers are switched off and the less detailed map layer depicting the same features is turned on. In the case of the base maps constructed from the TIGER File, no "less detailed" map layers exist for larger scales. These layers can be created manually by tracing over the TIGER File base maps, which is very labor intensive. Earlier versions of TransCAD supported a function called "squeeze," which more or less performed this function electronically. Unfortunately, it was never fully developed and was excluded from the latest beta release for Windows.

The Kansas DOT planning staff evaluated a few GIS software packages (more were not evaluated because of time and budget constraints), and from this experience found that most GIS software either originated in the data-base world and lacks robust graphing and mapping tools or originated in the CAD and drafting world and lacks robust data-base tools. TransCAD appears to be a good tradeoff between the two extremes. MicroStation's MGA/MGE is an example of a GIS package originating from the CAD world. MicroStation is the standard road and bridge design tool within the department. Using the MicroStation GIS tool would allow seamless sharing of output devices as well as access to existing maps and drawings. The graphics were found to be exceptional, as expected from the software's roots in the CAD world. However, even though the data-base links were available, it required much manual effort to link a base map with an associated data base. The ability to use the TIGER File to construct base maps was absent. An attempt was made to exploit the DFX file format to port maps, using the "tag" attribute to transfer either attributes or indices from one application to another. This met with limited success because of various interpretations of the DFX file format.

The entire planning bureau is currently in the process of changing several large flat file data bases into relational formats to ultimately interface with a GIS system. It is hoped that GIS systems will evolve with robust interfaces to both the mapping and data-base world to facilitate easy integration. No doubt many of the lessons learned will be transferable to the census data effort, and vice versa. Also during the past 5 years the agency has been shifting from mainframe-based applications to PC and client-server types of applications. Before about 1994, the size of the census data files was such that they could not be efficiently processed on a PC, requiring any

type of analysis to be done with the help of a mainframe programmer. The PC is now the main analytical tool for census data, allowing access by more individuals while at the same time stressing existing tools that run on a PC.

Kansas DOT currently accesses and uses the 1990 CTPP urban and statewide data sets, Summary Tape Files, and PL94171 census products electronically. Hard copies of the 1980 UTPP and other census products are available in the office. Part C of the 1990 CTPP urban and statewide data sets that relate trip ends is the most critical to the Kansas transportation planning mission and the most difficult to replace. Population and economic data are most easily and economically available through the use of census data, but could probably be estimated from other sources, albeit with less accuracy and at greater expense.

A major aspect of the planning work at Kansas DOT involves trend analysis as reflected in the travel-time case study in Wichita. In the same vein, the content of the 2000 census journey-to-work data should at a minimum be consistent with 1980 parameters in order to facilitate trend analysis. Having past census data released on CD-ROM would greatly enhance the ability to perform trend analysis. It could be argued that 1980 census data are even more valuable today than when first released in 1980, partly because of trend analysis but also because the capability to analyze and process data has grown to the point at which research that once required a team of programmers and analysts can now be done by one person with a desktop PC. The end result is that even past data can be more thoroughly analyzed today than when released years ago.

In addition to review of previous years' data, a more appropriate data format is needed to transmit census data. With more processing power available at the user's end, the Census Bureau no longer needs to cross-tabulate data in exhaustive detail. The use of a relational data-base format combined with some form of freely distributed data compression software would greatly ease the burden of conveying the census results. Also, much of the current census data has a built-in redundancy that is not needed. For example, a population will be listed as total, male, and female. Any two of the above categories uniquely determine the third. The general comment to the Census Bureau is to concentrate on providing as much base-level data as possible, leaving some of the tabulation responsibilities to the end user.

CONCLUSIONS

Census data have proved valuable not only as the base for socioeconomic data for transportation modeling, but also for numerous smaller studies as demonstrated by the list given earlier. The data are invaluable as quick reference for socioeconomic and travel-related factors for smaller communities in which no other source exists. They also serve as one of the primary sources of data to perform trend analysis over significantly long periods of time. The case study involving travel times for the Wichita–Sedgwick County area showcases the typical way that census data are used and processed on a PC.

Recommendations for future census products and GIS tools as a result of experience with census data to date are as follows:

- Older census data increase in value with time because of their value in trend analysis as well as the continually increasing ability to process and analyze large volumes of data. For this reason previous years' census data (in particular for 1960, 1970, and 1980) should be redistributed on CD-ROM.
- With the increase in computing power at the end user's fingertips, the need for specialized cross-tabulation output in ASCII format disappears. For this reason, the Census Bureau should concentrate on providing as much base-level information as possible, output in a machine-readable, compressed format. A relational data-base format distributed on CD-ROM in a publicly available file compression format appears to be the most logical choice at this time.
- Because trend analysis is such an important feature in planning work, consistency between the 2000 census and previous censuses is essential to evaluate changes over time. This is not to discourage new and different types of information from being collected nor to discourage omitting outdated questions, but simply to ensure that the format allows for backward compatibility in key areas.
- The largest obstacle to using census data at present is the available software tools to display and manipulate geographical information. Prerelease TransCAD 3.0 for Windows is a first-generation tool that is truly a GIS in that it has robust mapping and graphical capabilities as well as powerful data-base tools. Transportation planners do not wish to spend time authoring new maps or indexing old ones. Additional tools to overcome these deficiencies in current products are needed.
- The most critical part of the 1990 census data has been Part C of the CTPP urban and statewide data. Parts A and B, residence and work-end data, respectively, of the CTPP are available or can be estimated from other data sources but at significantly greater expense. Part C data, which relate to trip ends, are not available from any other source apart from comprehensive, and expensive, local travel surveys.

REFERENCE

1. *Conference Proceedings 4: Decennial Census Data for Transportation Planning.* TRB, National Research Council, Washington, D.C., 1995.