Implications of Continuous Measurement for the Uses of Census Data in Transportation Planning

Bureau of Transportation Statistics

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PREFACE

The Bureau of the Census received a great deal of congressional criticism concerning the cost and accuracy of the 1990 census. In response to that criticism, the Bureau extensively evaluated alternative methods for conducting the decennial census. Early in the planning process, the Census Bureau selected a new data-collection system for thorough testing and possible implementation as an alternative to the traditional census in 2000. Under this new system, called "Continuous Measurement," the detailed social, economic, and housing information, including journey-to-work data, traditionally collected decennially with the long-form questionnaire on a sample basis, would instead be obtained by an ongoing, "continuous" monthly survey. The census would obtain only population and housing unit counts and a few basic characteristics.

A change from the traditional long-form census questionnaire to Continuous Measurement could significantly impact how state and metropolitan transportation planners use decennial census data. Pursuant to its statutory responsibility for representing the Department of Transportation and the transportation community in matters of federal statistical policy, the Bureau of Transportation Statistics conducted a study to assess the implications of Continuous Measurement data for the uses of census data in transportation planning.

This study of Continuous Measurement began in mid-1994 and concluded in early 1995. The report presents the findings from that study, and reflects the Census Bureau's proposal for Continuous Measurement at that time. Soon after the study's completion, Census officials received the report so as to inform the Bureau's decisionmaking for the 2000 census. Since then, the Bureau has made minor changes to its plans, but the basic proposal for an ongoing monthly survey remains the same.

On February 28, 1996, the Census Bureau formally announced that it planned once again to use a long-form questionnaire in the 2000 census, but as a bridge to a new Continuous Measurement system in the next decade. The Bureau is conducting an operational test of Continuous Measurement in selected metropolitan and rural areas in 1996 in anticipation of initiating the Continuous Measurement survey, now called the American Community Survey, in 1999. The Bureau of Transportation Statistics' study of Continuous Measurement and this report are, therefore, an important first step in informing the transportation community of the new census data system that it must adapt to after the 2000 census.

The American Community Survey will be a large monthly household survey independent of the census. For the years 1999 to 2001, the survey will consist of the same questions asked in the 2000 long form, and will go to 400,000 households per month. After 2001, the content can vary and the sample size will likely drop to 250,000 households per month.

The overlap between the decennial long-form data and data from the American Community Survey will allow transportation planners to compare the two data sets to determine the implications of Continuous Measurement for the uses of decennial census data in transportation planning.

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EXECUTIVE SUMMARY

BACKGROUND

State and metropolitan transportation planning organizations rely on the data from the decennial census for a broad array of applications. Data from the long-form census questionnaire, which includes questions covering place of work, mode of transportation to work, carpooling, travel time and time of departure to work, vehicles available, and mobility limitations are used for planning and modeling travel behavior. The Intermodal Surface Transportation Efficiency Act of 1991, the Clean Air Act Amendments of 1990, and the Americans with Disabilities Act all increase the transportation planning requirements and related data requirements of states and metropolitan planning organizations (MPOs).

Congress has expressed concern about the accuracy and the cost of the 1990 census effort. In response to this concern, the Census Bureau is considering alternatives to the traditional long-form questionnaire for the 2000 census. One of these alternatives, called Continuous Measurement, would replace the long-form questionnaire with an ongoing sample survey conducted each month, and the decennial census would only collect the count of the number of persons and housing units and a few key population and housing characteristics.

Continuous Measurement has been heavily promoted by the Census Bureau as a replacement for the long form. Because of the potential for loss of the critical transportation data collected by the long-form questionnaire, and the prospect for collection of such data in a new Continuous Measurement process, the Bureau of Transportation Statistics contracted with the COMSIS Corporation to study the implications of Continuous Measurement for the uses of census data in transportation planning.

DESIGN AND METHOD OF THE STUDY

COMSIS assembled a panel of seven experts on the uses of data in the field of transportation planning to assess the implications of Continuous Measurement. Prior to the first meeting of the group, extensive background materials were sent to all participants describing uses of census data in transportation planning and the methodology of and proposals for Continuous Measurement. Panel members were asked to identify issues for discussion at the first workshop.

At the first workshop, held in September 1994, representatives of the Census Bureau provided the panel with an overview of Continuous Measurement and presented the Bureau's current thinking on its testing and implementation. The panel also heard a debate on the merits of Continuous Measurement between Dr. Leslie Kish, Professor Emeritus, University of Michigan, and Dr. Stephen Fienberg, Carnegie Mellon University. The panel then identified key Continuous Measurement issues to be developed into position papers for presentation and discussion at the panel's second session.

During the nine weeks between the first and second workshops, each member of the panel prepared a paper analyzing a specific topical area or issue pertaining to the implications of Continuous Measurement for the use of census data in transportation planning. The panel reconvened in November 1994, and presented their papers, discussed and debated issues regarding Continuous Measurement and data needs for transportation planning, determined the findings of the study, and made recommendations.

GENERAL FINDINGS

The transportation planning expert panel assembled for this study found that Continuous Measurement holds promise for providing useful data for transportation planning, but that Continuous Measurement is an untested process, the results of which need to be compared and evaluated against those obtained from a conventional census. The panel questions the advisability of the Census Bureau making a decision in 1996 to eliminate the long-form questionnaire for the 2000 census without sufficient testing, and questions the Bureau's ability to implement new systems to put Continuous Measurement into operation by 1999. The panel believes the Census Bureau should undertake a test for the 2000 census where long-form data are collected nationwide and compared with a parallel collection of Continuous Measurement data for a representative sample of geographic areas. The panel expressed concern about the potential loss of benchmark data at the beginning of a new millennium. The panel also expressed skepticism about congressional funding of Continuous Measurement past the first three years at the sampling rates currently proposed.

DETAILED FINDINGS

Study findings are organized into four major topics of discussion: 1) Data Availability, 2) Data Suitability for Planning Needs, 3) Process/Implementation Issues, and 4) Summary Recommendations.

DATA AVAILABILITY

■ *Timeliness and Currency*

The panel believes that more timely and current data under Continuous Measurement are a major benefit of the proposal. Under Continuous Measurement, the Census Bureau anticipates that data products will be made available within one year of the collection year, and annual updates of data will be available continuously.

■ *Continuity and Cost*

Continued availability of the data collected in the long-form decennial census questionnaire is imperative. Long-form census data provide larger samples at lower costs per person than surveys conducted locally for specific uses. The panel perceives threats to the continued availability of data under Continuous Measurement, such as the potential for congressional reductions in funding, which may reduce Continuous Measurement sample sizes or cancel the Continuous Measurement process altogether sometime in the future.

The panel recommends further evaluation of other options to Continuous Measurement, such as an intercensal long-form collection at mid-decade with appropriate reductions in sample size to keep costs in line with once-a-decade collection. The panel emphasizes the need for a smooth transition between the current method of collection and Continuous Measurement if it is implemented.

■ *Accessibility and Confidentiality*

The trend in transportation planning has been to narrow the focus of analysis in geographic detail, from ZIP Codes to census tracts and even smaller units. Census data from 1990 from Summary Tape Files 1 and 3 and the Census Transportation Planning Package (CTPP) are very important for this level of analysis. Travel and land-use studies make extensive use of cross-sectional data (e.g., travel mode by income and by size of household) available only in the CTPP. The Census Bureau's Public Use Microdata Sample data are also very helpful in this type of analysis, but are geographically limited.

The panel believes that it is important to ensure that data will be readily accessible to users as quickly as possible after collection. As sample sizes decrease under Continuous Measurement, the panel is concerned that the Census Bureau's Microdata Review Panel may increasingly restrict access to microdata to protect confidentiality. The panel respects concerns about confidentiality, but would like a full examination of alternatives to maintain and increase user access to data, such as deputizing researchers and MPO staff or shielding personal data through creative means of disclosure avoidance. The panel recommends that public use microdata from Continuous Measurement be released for geographic areas of 100,000 or more population.

DATA SUITABILITY FOR PLANNING NEEDS

Data that are collected and made accessible must still pass the test of suitability for the desired task. The panel identified concerns with various facets of data accuracy, both in the Continuous Measurement proposal and in current long-form data collection efforts. The panel was also impressed by promised Continuous Measurement flexibility features.

■ *Accuracy*

With Continuous Measurement, the Census Bureau anticipates greater accuracy in coding and interviewing due to permanent staffing, instead of the temporary staffing associated with taking the census every 10 years. The Census Bureau acknowledges that significant sampling error would be present in annual Continuous Measurement data, which will be alleviated by creating multiyear moving averages. However, representatives of the Census Bureau assured the panelists that annual point estimate data from Continuous Measurement would be released with caveats, because of their high sampling error. Some panel members expressed concern that the high sampling error in annual Continuous Measurement, compared with long-form data, would reduce the suitability of data for various applications, while other panelists asserted that the reduced levels of confidence and increased error are acceptable for the types of applications performed with the data.

The panel also expressed concern for the accuracy of Continuous Measurement's projected response rates and of the representative demographic sampling of those responding. The potential exists for reduced response rates if the data are not collected in a decennial census with its national publicity program and media coverage, which would then negatively impact quality or increase the cost of data collection.

■ *Flexibility in Content and Sampling*

The panel was impressed with Continuous Measurement's potential for flexibility in content and sampling, including experimenting with wording of questions such as journey to work, adding questions for particular needs such as response to a new rail opening or a flood, and increasing sampling rates in a state or region for special purposes. The panel cautions users about the conflict between continuity and flexibility.

■ *Content and Geocoding*

The panel was very concerned about the accuracy of place-of-work geocoding in general (whether or not Continuous Measurement is implemented). The proposed Master Address File continuously corrects and updates residence addresses, but not businesses. The panel strongly recommends that the Census Bureau update business addresses for use in place-of-work coding on a level comparable to that made for household addresses.

The panel expressed concern about the wording of certain questions, such as the journey to work. Asking about the "usual day" rather than a specific day underrepresents lesser used transportation options. The panel recommends experimentation with additional questions such as nonwork trips and trip chaining.

PROCESS/IMPLEMENTATION

The panel expressed misgivings about Continuous Measurement as a "moving target." The Continuous Measurement process is evolving, and a final Continuous Measurement proposal may be far different from the proposal evaluated by this panel, and possibly far less appealing.

■ *Costs and Implications of Maintaining and Updating Data*

The panel recognized the increase in data maintenance that will occur under Continuous Measurement. The panel questioned who would incur the costs if the Census Bureau relies on continuous updating of geographic information by states and MPOs. This may be an unacceptable burden if funding is not provided, particularly for small MPOs.

Concern also existed about changing geographic boundaries on a constant or annual basis. Annual data must be coded to a consistent geography from year to year to be valuable, or, if updated, flagged in a reference file associated with the zone. Annexations and other boundary changes could make analysis much more difficult. Implementing the plan without working out such details with the transportation community, states, and MPOs is not advisable.

■ *Intergovernmental Cooperation*

A smooth transition from decennial long form to Continuous Measurement demands the participation of interested parties. The Department of Transportation, groups such as the American Association of State Highway and Transportation Officials, committees of the Transportation Research Board, and others need continued involvement in testing data, content, and methods, and in identifying products. The panel suggested that the U.S. Department of Transportation (DOT) and the Census Bureau establish a mechanism for interested parties to receive continued updates on plans and procedures, such as electronic bulletin boards and newsletters.

SUMMARY RECOMMENDATIONS

Several recommendations were made by the transportation planning expert panel for consideration by the Census Bureau, federal decisionmakers, and the transportation community.

CENSUS BUREAU

1. Set up a process to allow transportation experts access to the results of its Continuous Measurement simulation project.
2. In cooperation with the transportation planning community, implement a design and content effort for journey-to-work and related questions. In addition to research on the wording of the journey-to-work question itself, the expert panel also recommends testing questions on access and egress modes from the "major" commuting mode (e.g., driving or walking to a bus stop or rail station). Distinguishing among the combinations of modes used to get to and from work, which may often differ for many people, is an important concern to transportation planners.
3. Improve transportation data user access to census data, such as deputizing researchers and MPO staff.
4. Emphasize the continual update of business addresses, including geocoding and test methods.

Other issues that the Census Bureau needs to consider include proper representation of rare populations, development of procedures for more cooperative inter-

action with MPOs, and potential improvements to transportation models. The panel expressed concern about lower or biased response rates. The panel recommends that the Census Bureau conduct research during the testing to determine whether response rates are consistent across a broad spectrum of the population, and what steps could be taken to reduce bias from nonresponse.

FEDERAL AND CONGRESSIONAL DECISIONMAKERS

1. Invest in research and experimentation, including parallel long-form collection in the decennial year along with Continuous Measurement, to ensure availability of needed data at appropriate levels of accuracy.
2. Consider total costs to the user community (i.e., state and local governments, and MPOs) of changing collection methods, not only costs of the Census Bureau. The transportation planning expert panel believes it would be valuable to study what the different approaches would cost various levels of government. One example is the need for various agencies to continually maintain geographic referencing systems and other data, in order to keep the Census Bureau Master Address File current for Continuous Measurement implementation. Federal decisionmakers need as complete an estimate as possible of the full cost differences for the collection methods, and not just the costs to the Census Bureau and to other federal government agencies, in order to choose the best option.

DEPARTMENT OF TRANSPORTATION

DOT needs to intensify the research and training it provides for various users of census data in the transportation community. The transportation planning expert panel recommends, in particular, establishing specialized training oriented to the needs of small and medium-size MPOs. The panel expressed concern that the staffs at such MPOs might try using data from a Continuous Measurement approach in the same way that data developed for one point in time had been used from the previous decennial censuses.

CONCLUSIONS

Continuous Measurement has the potential for increasing the utility and timeliness of census data for transportation planners if:

- it is tested in parallel to the regular decennial long form in the year 2000 to provide users with comparative data;
- users determine that Continuous Measurement data are an acceptable alternative to the conventional census; and
- it is carried out as planned and promised with full continuous surveys, with the promised data products provided in a timely manner, and with flexibility for special requests honored and completed at a reasonable cost.

CHAPTER 1 PURPOSE OF THE STUDY

State and metropolitan transportation planning organizations rely on the data from the decennial census for a broad array of applications. Data from the long-form questionnaire, which includes questions on place of work, mode of transportation to work, carpooling and vehicle occupancy, travel time to work, time of departure from home to work, the number of vehicles available to each household, and the number of persons with a health condition that limits their mobility outside the home are used for planning and modeling travel behavior.

Transportation data have been collected with the long form in each census since 1960. After the 1970, 1980, and 1990 censuses, the U.S. Department of Transportation (DOT) funded the development of a special tabulation by the Census Bureau of data tailored to the transportation planning data needs of over 300 metropolitan planning organizations (MPOs) and the 50 state departments of transportation.

State and metropolitan transportation agencies are increasingly reliant on census data to meet the requirements of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990 (CAAA). The procedures involved in the comprehensive transportation planning process required by the ISTEA are very data intensive. Small-area data from the decennial census provide much of the required information for trend analysis, travel modeling, and other analyses related to highway, transit, and multimodal planning and development. The CAAA, for example, requires state and local public agencies to prepare comprehensive vehicular travel and pollutant profiles. These profiles require analysis of detailed household characteristics, mode of travel, trip lengths, and commuter patterns for which data are frequently obtained from the decennial census.

Despite the increasing dependence of states and MPOs on decennial census data, the Census Bureau is considering eliminating the long-form questionnaire for the 2000 census and replacing it with a Continuous Measurement data-collection system. Congress has expressed concern about the increasing undercount and cost of conducting the decennial census, and some critics attribute a large share of these increases to the long-form data collection. Continuous Measurement is one response to that criticism.

Under Continuous Measurement, the 2000 census would collect on a 100-percent basis only basic items including population and housing unit counts and a few key population and housing characteristics. The more detailed characteristics collected in past censuses from a sample of households using the long-form questionnaire would not be collected. Instead, the long form would be replaced by a smaller sample survey that would be conducted monthly on a "continuous" basis.

Discussion of the Census Bureau's plans for the 2000 census took place at a session of the 1994 annual meeting of the Transportation Research Board. Attendees expressed concern over the potential for loss of the time series of transportation data traditionally collected with the long-form questionnaire, and the collection of such data in an untested Continuous Measurement process. The attendees called for an evaluation of such a change as it would affect transportation planning.

In response to the concerns of the transportation profession, DOT's Bureau of Transportation Statistics (BTS) contracted to have an independent assessment made of the implications that a "Continuous Measurement System," compared with the long-form questionnaire, would have on the extensive uses of the data from the decennial census for transportation planning. This report documents the study conducted and provides conclusions and recommendations regarding the possibility of implementing a Continuous Measurement system.

BTS has the mandated responsibility for representing DOT and the transportation community in matters related to federal statistical policy and is the DOT representative to the Federal Agency Policy Committee on the Year 2000 Census. BTS provides the Office of Management and Budget with DOT's requirements for data from the decennial census for use in state and local transportation planning activities required by federal legislation.

CHAPTER 2 IMPORTANCE OF CENSUS DATA FOR TRANSPORTATION PLANNING

HISTORICAL PERSPECTIVE

The Bureau of the Census has included transportation questions in the long-form questionnaire for each decennial census since 1960. The 1960 census included three questions pertaining to transportation: worker's place of work (city, county, and state), worker's mode of travel to work, and the number of automobiles available at home. Journey-to-work questions were first added to the census primarily to collect data on commuting interchanges between large cities and their suburbs. These data were then used to delineate metropolitan statistical areas. Also, during the 1960s, most urban areas simultaneously conducted extensive origin-destination (OD) surveys, and transportation planning efforts relied on census data to check the results of the surveys.

Most urban areas continued to use their basic OD survey data in the 1970s, and utilized 1970 census data to update this information. However, the 1970 census marked a major advancement in the availability of data for urban transportation planning. For the first time, place-of-work and means-of-travel-to-work data were coded to the census block, using Address Coding Guides and the Dual Independent Map Encoding files developed by the Census Bureau. The block-level data could then be aggregated to form user-defined tabulation areas.

After the 1970 census, the U.S. Department of Transportation (DOT) funded the creation by the Census Bureau of the Urban Transportation Planning Package (UTPP). The UTPP was a special tabulation of 1970 census data tailored to meet the data needs of metropolitan transportation planning. The data contained in the package were tabulated by traffic analysis zone (TAZ), developed by the local metropolitan planning organizations (MPOs). Each planning agency wishing data in the UTPP format contracted with the Census Bureau directly for processing the data.

From 1975 to 1977, the Census Bureau included questions pertaining to the journey to work as part of the Annual Housing Survey (AHS). The transportation supplement to the AHS was sponsored by DOT. Surveys were conducted in 60 metropolitan areas over the three-year period, and a national survey was conducted in 1975. During this time period, the Journey-to-Work Statistics Branch was created within the Census Bureau to oversee the collection, processing, tabulation, and analysis of journey-to-work data.

The transportation supplement to the AHS increased the demand for transportation planning data among MPOs, and the escalating cost of conducting OD surveys contributed to the MPOs' increased dependence on decennial journey-to-work data. The 1980 census included several transportation data items not collected in 1970. In addition to questions regarding place of work and mode of travel to work, the following were included on the long-form questionnaire for 1980:

- type of carpooling arrangement,
- number of persons riding in the carpool,
- travel time from home to work,
- number of automobiles available to each household,
- number of trucks or vans available to each household, and
- number of persons with a disability that limited or prevented access to public transportation.

The 1980 place-of-work data were once again coded to census tract and block. As a result of the improvements in the coding reference materials developed under the direction of the Census Bureau's Journey-to-Work Statistics staff, the majority of workers were coded down to small-area geography, a significant improvement over the 1970 census.

Again, after the 1980 census, the Census Bureau produced and DOT sponsored the UTTP special tabulations, which states and MPOs had the option of purchasing. Nonmetropolitan transportation agencies could purchase a modified version of the package.

The 1990 census produced several new advancements in the funding, geocoding, and processing of transportation statistics. The 1990 Census Transportation Planning Package (CTPP), formerly called the UTPP, was sponsored by the 50 state departments of transportation through a pooled-funding arrangement with the American Association of State Highway and Transportation Officials (AASHTO). The funding supported the processing of data in the CTPP format for all states and MPOs for the first time. In contrast to the

1970 and 1980 UTPPs, the 1990 CTPP comprised two separate packages: one for states, the State Element; and the other for MPO planning regions, the Urban Element. The Urban Element is coded at the TAZ level, while the State Element provides demographic and commuter data for political units such as cities and counties throughout the state.

Further technical advancements by the Census Bureau and DOT were achieved in the place-of-work coding for the 1990 census. The first was the development of the Census/MPO Cooperative Assistance Program, which provided MPOs the opportunity to assist Census in geocoding place-of-work data for their region. The second advancement was the development and implementation by the Census Bureau of an automated place-of-work coding system.

USES OF DECENNIAL CENSUS DATA

State and regional transportation planning agencies have grown increasingly dependent on census data over the past 30 years. Federal legislation enacted since the last decennial census, including the Intermodal Surface Transportation Efficiency Act (ISTEA), the Clean Air Act Amendments of 1990 (CAAA), and the Americans with Disabilities Act (ADA), require more detailed analyses of transportation systems and environmental impacts than previously conducted. As a result, these analyses require better quality data for smaller geographical areas. Over the years, the decennial census has become one of the most dependable and consistent sources of journey-to-work, household, income, and employment data available to the transportation planning profession. This also applies to the myriad of governmental agencies at all levels with responsibilities to plan and develop transportation systems. Demographic and journey-to-work data are used in a variety of transportation, land-use, and air quality analyses. A brief discussion of the various uses of census data in transportation planning follows.

SURVEY EXPANSION

Many of the metropolitan planning organizations in large urbanized areas periodically collect a sample survey of demographic and travel data of people and households. Because the data-collection effort is so costly, most small urban area MPOs do not collect travel survey data and rely solely on the demographic and journey-to-work data provided by the decennial census. However, in most large urban areas, locally collected travel survey data are augmented by the census demographic data for sampling, weighting, and expansion, to provide more information on geographic and demographic variability. Typically, the survey samples are very small, in many cases representing one-half to one percent of the population. Many MPOs use census data to:

1. determine sample sizes and the categories used for sampling through a stratified sample design,
2. check for biases in the survey results, and
3. expand and weight the travel survey data to represent the regional population.

TREND ANALYSIS

Transportation planners utilize census data to monitor trends in travel behavior. The decennial census provides consistent comparable data for states and metropolitan areas throughout the country. The decennial census is an excellent source of cross-sectional and time-series demographic data within and among metropolitan areas. Planners and policymakers can consistently observe changes over decades in mode of travel, carpool size, trip length, household size, vehicle ownership, and so forth—all of which affect the development of metropolitan, state, and national transportation policies. Regionally, trend analyses are used to develop strategies that reduce traffic congestion and improve air quality (e.g., transportation control measures and travel demand management programs).

TRANSPORTATION MODELING

Travel demand models try to replicate people's travel behavior by time of day, trip purpose, and mode choice. Models are adjusted or calibrated to match current base-year travel and are then used to simulate and forecast travel in future years. The travel demand forecast process is designed to estimate the demand and use of major highway and transit improvements, an important factor in deciding whether or not to make such investments. Model sets require household and trip data for traffic analysis zones. The variables most commonly used in current transportation models include, income, household size, place of work, and vehicle ownership, all of which are major factors in determining a household's overall trip-making decision.

Once models are developed they must be validated against "observed" data, such as data from the decenni-

al census. That is, the model results (trip volumes and traffic flows) are compared with observed data and the model is adjusted until it replicates what is occurring during a specific point in time—the base year. Aggregate work-trip data by traffic analysis zone of residence, zone of employment site, and by the interchange between the two areas are used to validate modeled work-trip distribution and mode choice models.

LAND-USE MODELS

Land-use models spatially allocate future total regional household and employment data and determine the impacts of these allocations on transportation and land–use policies. Land-use models are applied at census tract, aggregations of census tract, or traffic analysis zone levels of geography and require household data by place of residence and employment data by place of work. As in transportation modeling, land-use models are developed using cross-sectional data sets obtained primarily from census data. The models are validated to a specific point in time (the census year), and then forecast the spatial allocation of households and employment in future years.

TRANSIT ANALYSIS, CIVIL RIGHTS, AND ADA REQUIREMENTS

Transit planners utilize census data to identify existing and potential markets of transit riders. Markets are identified by tracking changes in the region's population and employment base. Census data are also used to compare the proximity of transit service to populations with special needs and to establish the ridership potential of extending transit and adding transit service into new areas.

Federal requirements call on transit operators and planners to conduct analyses on the equitable provision of service to minority populations and to provide comparable accessible transit service to elderly and handicapped persons. The Federal Transit Administration requirements of Title VI of the Civil Rights Act of 1964 require that transit operators equitably provide transit service to minority populations within the transit operator's service area. The analysis requires transit operators to compare service provided to minority and nonminority tracts. This analysis relies heavily on short- and long-form decennial demographic data at the census tract level.

The ADA requires state and local transit operators to provide comparable transit service to elderly and handicapped persons within one-quarter mile of a bus route in the transit system's service area. Census long-form data identifying persons with mobility impairments are used to develop and improve transit services for these groups.

FEDERAL TRANSPORTATION AND ENVIRONMENTAL REGULATIONS

The 1991 ISTEA, together with the 1990 CAAA, call on transportation planners to manage congestion, analyze the environmental impacts of transportation projects and programs, and assist those areas that are not in attainment of National Ambient Air Quality Standards to achieve attainment. To achieve these goals, transportation planners rely heavily on census results for demographic (primarily short-form) and journey-to-work (long-form) data to carry out several functions:

- quantify the air quality benefits of projects,
- select projects that maximize the effectiveness of discretionary funds, and
- select projects that will enable states and MPOs to conform to the goals established in their State Implementation Plans (SIPs) for air quality.

All of the transportation planning activities described above (e.g., travel demand forecasting, trend analysis, and land-use model allocation) are necessary activities within each of these functions. For example, land-use and transportation models are used together to forecast traffic volumes, speeds, and trips. These data are used to estimate emissions associated with different transportation projects and programs. The emissions results are then used in the conformity analysis to revise the SIPs for air quality, and to subsequently carry out conformity analysis of transportation plans and programs with those SIPs.

THE FUTURE OF TRANSPORTATION PLANNING MODELING

In the 1993 report *Transportation Infrastructure: Better Tools Needed for Making Decisions on Using ISTEA Funds Flexibly*, the General Accounting Office (GAO) determined that to fully respond to the requirements of the CAAA and the intent of the ISTEA, the transportation profession needed to improve transportation travel forecast models. GAO recommended that travel models be improved to provide better information

for analyzing the impacts of transportation projects on air quality. This report gave rise to the Travel Model Improvement Program (TMIP) by DOT. "TMIP is designed to implement enhancements to the current travel demand models and to develop new modeling procedures that accurately and reliably forecast travel for a broad range of modes, policy actions, and operational conditions."[1]

Preliminary findings of TMIP indicate a shift from aggregate levels of analysis to more detailed analysis. Modeling is moving toward being done in a more disaggregate fashion. In addition, modeling has to become more sensitive to analyses of projects and policies beyond those related to traditional large capacity increases such as changing travel demand to match supply of services available. More detailed analysis requires the continued support of the short-form decennial census, preservation or enhancement of long-form data whether collected decennially or continually, and further improvements in the geocoding of place-of-work and place-of-residence data at small levels of geography.

CENSUS PRODUCTS

The Bureau of the Census produces four data products from the decennial census that are used in transportation planning. The following section provides a brief description of each of these products.

CENSUS TRANSPORTATION PLANNING PACKAGE

The CTPP, formerly the UTPP, has been produced for the past three decennial censuses and has evolved to be one of the largest Census Bureau special tabulations. The 1990 CTPP required an estimated budget of $2.6 million. AASHTO organized the funding to obtain data for all metropolitan areas and states, representing the first national accumulation of this information. Full funding for the project came from urban and state planning monies provided to metropolitan areas and states by DOT. The CTPP includes special tabulations of journey-to-work data for states and MPOs. The data are issued on magnetic tape by the Census Bureau and on CD-ROM by the Bureau of Transportation Statistics.

SUMMARY TAPE FILES (STFs)

STFs contain demographic, social, economic, and housing data weighted to represent the total population. The data are coded to residence geography and are issued on magnetic tape and CD-ROM. The STFs provide data for states and their subareas, for example, county, census tract, and block group.

TIGER FILES

Topologically Integrated Geographic Encoding and Referencing System (TIGER) files include a coordinate-based digital map of the entire United States and an automated geographic database. TIGER files are used for mapping, geocoding addresses to census geography, aggregating census data to transportation analysis zones and districts, analyzing network attributes, and for routing/accessibility studies and travel demand modeling/simulation. TIGER files are available from the Census Bureau on CD-ROM. The Bureau of Transportation Statistics provided funds to develop the CD-ROMs.

PUBLIC USE MICRODATA SAMPLE (PUMS) FILES

PUMS files contain a sample of individual responses (housing units and persons) to the census long form. PUMS files are not tabulated like the CTPP and STF files. To protect the confidentiality of individual responses, PUMS files are only released for large geographic areas with a population exceeding 100,000 persons. The files also contain weights for persons and households that expand the sample data to the total population. The Census Bureau makes PUMS files available on magnetic tape and CD-ROM.

[1] *Travel Model Improvement Program Newsletter,* August 1994.

CHAPTER 3 CENSUS PLANS FOR CONTINUOUS MEASUREMENT

As Continuous Measurement is currently in the developmental stages, no definitive "Continuous Measurement Proposal" is available in a single source document. The Census Bureau staff provided the transportation planning expert panel with several working papers written on Continuous Measurement.[1] (See chapter 4 for a description of the expert panel and its role in this study.)

In addition to the background papers, the transportation planning expert panel was given the opportunity to question the Continuous Measurement staff. In some cases, Census Bureau representatives amended or clarified the positions established in the background papers, particularly in terms of levels of geography and frequency of delivery of certain products. Therefore, the Continuous Measurement proposal as evaluated by the panel is based on these Census Bureau papers, with modifications as stated by Continuous Measurement staff during the panel meetings.

CONTINUOUS MEASUREMENT SYSTEM

Under a Continuous Measurement system, the decennial census conducted in 2000 would collect on a 100-percent basis only the population and housing unit counts and minimal demographic information such as age, race and Hispanic origin, sex, and household relationship. The transportation characteristics traditionally obtained from a sample of households using the long-form questionnaire, as well as the whole range of social, economic, and housing data collected on the long form, would not be collected. Instead, the long form would be replaced with a monthly Intercensal Long-Form Survey

Data from these continuous monthly surveys would be cumulated to produce averages over various periods of time. Annual estimates for large cities, metropolitan areas, and states could be derived by cumulating 12 months of interviews, but a five-year cumulative average would be required to produce estimates for small areas, such as traffic analysis zones, that are based on a sample of comparable size to that obtained in the traditional decennial census.

SAMPLING RATES

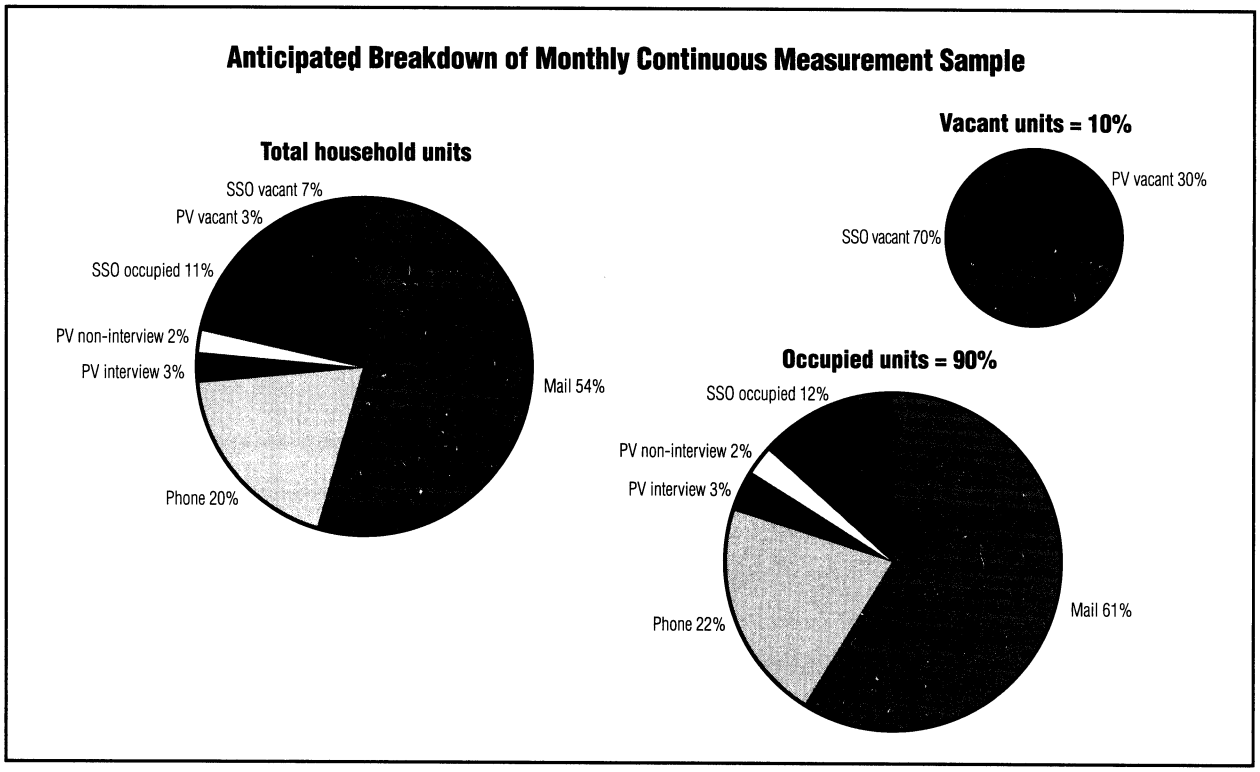
The sampling frame for the Intercensal Long-Form Survey would be a Master Address File of all housing units in the United States, which the Census Bureau will construct and update on a continuous basis. The Census Bureau plans to mail Intercensal Long-Form Survey questionnaires to about 400,000 households each month during the first three years (1999 through 2001) of the Continuous Measurement program, dropping to a steady state of about 250,000 households each month thereafter. The steady state sampling fraction is about 0.25 percent per month, for a total sample of about 15 percent over a five-year period. The Census Bureau expects that about 10 percent of units in the mailouts will be vacant. Of the occupied units, 60 percent are expected to respond through the mail, an additional 22.4 percent through phone contact.

The Census Bureau plans personal visits for a 30-percent sample of the remaining households. In other words, 30 percent of those who are not successfully surveyed by mail or phone (30 percent of the remaining 17.6 percent) will be designated for a personal visit, while 70 percent will be subsampled out (with no further attempt at contact). Of those designated for a personal visit, it is anticipated that 57 percent will be successfully interviewed. Overall, 85.5 percent of surveys mailed to occupied households are expected to be successfully completed (see figure).

TESTING PROGRAM

The first stage of the Census Bureau's multiphased testing program consists of testing and data collection under the Cumulative Estimates Simulation Project. In this project, 1990 data from the Oakland region are ran-

1 All papers are listed in the Bibliography, appendix C. Two of the key papers by Charles Alexander of the Census Bureau are included in appendix E: "Small Area Estimation with Continuous Measurement: What We Have and What We Want," document CM-14 in the Continuous Measurement Series, March 1994; and "A Prototype Continuous Measurement System for the U.S. Census of Population and Housing," document CM-17 in the Continuous Measurement Research Series, May 1994, hereinafter referred to as CM-17.



domly "split" to represent three separate "dummy" years and collection points of data. The "new" data sets are being tested to identify variances, changes in weights, averaging of data, and potential data products. Several additional tests and data collection activities will take place over the next four years, including alternative versions of the questionnaire, and collection and processing issues (see table 3-1).

SCHEDULE FOR IMPLEMENTATION

The Census Bureau anticipates testing the Continuous Measurement system through 1998, and beginning actual Continuous Measurement data collection in 1999. The decision on whether to go ahead with Continuous Measurement or stay with the decennial long form (or some combination thereof) must be made in calendar year 1996.

REPORTING OF DATA

The Census Bureau plans to release both summary tape files and microdata files from Continuous Measurement, similar to products that are issued for the decennial census.

SUMMARY TABULATIONS FOR LARGE GEOGRAPHIC AREAS

Census will release statistically reliable annual estimates for large geographic areas of 250,000 population or more. Census Bureau staff advised the transportation planning expert panel that annual summary data might be made available for areas of 100,000 population or more if the Bureau's Micro Data Review Panel approves release of these data. The Census Bureau states that annual summary data will be available within one year of the ending date of collection, and in some cases sooner.

SUMMARY TABULATIONS FOR SMALL AREAS

For small areas, such as census tracts, census documents indicate that geographically detailed general purpose files will be released, so that users can aggregate the geography as they wish. Continuous Measurement will produce small-area estimates with the following characteristics: "the CM estimate will be an average over a five-year period (three years for 1999-2001); the five-year average will be updated annually; and the CM estimates will typically have a 25% higher standard error" than current data.[2] Census Bureau staff told the transportation planning expert panel that the

[2] CM-17, p. 5.

TABLE 3-1: ACCELERATED MASTER ADDRESS FILE-BASED CONTINUOUS MEASUREMENT DATA-COLLECTION ACTIVITIES

Fiscal year	Data collection activity	Objectives
1994	Cumulative Estimates Simulation Project.	- Demonstrate properties of cumulative estimates - Measure effect of population weighting controls on estimates - Illustrate data delivery system
1995	RDD test with 2,000/month total in 3-4 sites, starting November 1994. Convert to split-sample questionnaire test in July 1995. Small mail pretest.	- Test alternative versions of questionnaire - Measure effect on time of year and moving reference period on income data, etc. - Demonstrate ability to deliver timely data - Tentative decision regarding 2000 long form
1996	MAF-based test with at least 4,000/month total in 4 sites, starting October 1995.	- Develop/test field procedures - Measure coverage of MAF/SACFO - Decision regarding 2000 long form
1997	MAF-based "development survey" for congressional-district-level estimates, full speed in January 1998. Rural sample clustered in PSUs.	- Refine actual procedures - Produce annual estimates for areas of 500,000 or more - Final content determination
1998	Expanded MAF-based sample size; change procedures and questionnaire to fix problems found in FY 1997. Better rural spread.	- Further evaluation of quality - More annual estimates for areas of 500,000 or more - Phase-in full system
1999	Full MAF-based system. Complete rural spread.	- Collect small-area data to replace 2000 long form

KEY: MAF = Master Address File; PSU = primary sampling unit; RDD = random digit dialing; SACFO = sampling and address correction feedback operation (see CM-17, p. 2 for explanation).

SOURCE: Charles H. Alexander, U.S. Bureau of the Census, "A Prototype Continuous Measurement System for the U.S. Census of Population and Housing," document CM-17 in the Continuous Measurement Series, 1994.

Bureau would consider releasing annual small-area data, but that the estimates would not be "official" because they would be based on a statistically unreliable sample.

PUBLIC USE MICRODATA SAMPLES

The Census Bureau goal is to provide public use microdata for areas with a population of 100,000 or more, but confidentiality restrictions may require a higher population threshold. Public use microdata from the decennial census is a 1 percent or 5 percent sample of the overall census sample. However, the thinking by Census Bureau staff was for all the sample records from the annual Continuous Measurement sample to be released in a microdata file.

CHAPTER 4 DESIGN AND CONDUCT OF THIS STUDY

The study design was as follows: to assemble a panel of experts on many facets of transportation planning, to expose them to information on the census proposal and to expert opinions on Continuous Measurement's statistical implications at a first workshop, to give them the opportunity to think and write about the implications, and finally to form conclusions and recommendations, which were expressed at a second workshop.

PARTICIPANTS

USER PANEL OF TRANSPORTATION PLANNING EXPERTS

The panel selection began with lists of Transportation Research Board members on panels related to census issues, and was soon broadened through a networking process to include different transportation planning fields and user groups. Brief biographies were prepared for 16 potential panel members, pared from a list of over 30. Five of the 16 were chosen to be on the panel, with two additional members chosen from the network of knowledgeable persons in the industry, and another chosen as the facilitator of the second session. The selection of the seven panel members was designed to include recognized experts in the field of transportation planning, with additional criteria to add breadth to the study as follows:

- affiliation with metropolitan planning organizations, institutions of higher learning, consultants, transit agencies, and other users of transportation data;
- experience in the uses of data for land-use, travel forecasting, modeling, air quality analysis, traffic studies, and other applications;
- representatives from various regions of the country to provide additional perspective.

The final list of panel members with recent and current affiliations, and geographic work sites follows in table 4-1. Brief biographies of the user panel are included as appendix B.

STATISTICAL TRANSPORTATION PLANNING EXPERTS

To help the panel members fairly assess the statistical impacts of Continuous Measurement on transportation planning, preeminent members of the statistical community were asked to present their positions and debate the issue for the benefit of the panel members. The statisticians had to be knowledgeable about Continuous Measurement and the decennial census, and had to represent clear pro and con positions. A moderator was also desired. The project recruited some of the most noted names in the field.

- Dr. Leslie Kish, Professor Emeritus, Institute for Social Research at the University of Michigan, is a much-cited authority in the field of rolling samples and Continuous Measurement. Three of his papers were included in the informational packets sent to the user panel.
- Dr. Stephen Fienberg, Maurice Falk professor of statistics and social science at Carnegie Mellon University, is a member of the National Research Council Panel on Census Requirements in the Year 2000 and Beyond. As former chair of the Committee on National Statistics, he was instrumental in the creation of its panel on Decennial Census Methodology in the 1980s.
- Dr. Barry Edmonston (moderator) is the study director for the Panel on Census Requirements in the Year 2000 and Beyond conducted by the Committee on National Statistics for the National Research Council. He has also been involved in demographic research and teaching at Stanford University and Cornell University.

CENSUS BUREAU PARTICIPATION

Two key members of the Census Bureau associated with Continuous Measurement, Charles Alexander and Larry McGinn, were involved throughout the project. Charles Alexander provided papers he and others wrote, which became a major part of the background reading. Charles Alexander is Assistant Division Chief, Longitudinal and Expenditure Surveys Design, Demographic Statistical Methods Division. Larry

TABLE 4-1: MEMBERSHIP OF THE TRANSPORTATION PLANNING EXPERT PANEL

Name	Recent and current affiliations				Current location
	MPO	Other public	Academic	Consultant	
James Bunch		X		X	Silver Spring, MD
Bruce Douglas				X	Herndon, VA
Greig Harvey			X	X	Berkeley, CA
Keith Lawton	X			X	Portland, OR
Steve Putman			X	X	Philadelphia, PA
Karl Quackenbush	X			X	Boston, MA
Peter Stopher			X	X	Baton Rouge, LA
Alan Pisarski (Facilitator)		X		X	Falls Church, VA

McGinn is Chief of the Continuous Measurement Staff. Alexander and McGinn spent much time at the two workshops held for the transportation planning expert panel.

WORKSHOPS

Several weeks prior to the first session, all participants received background reading materials, including five papers from the Census Bureau describing various aspects and proposals for Continuous Measurement, three papers from Dr. Kish, and nine papers on different aspects of uses of census and other data in transportation planning. (A copy of the initial bibliography is included as appendix C.) Panel members were also requested to identify preliminary issues to be discussed at the first workshop.

FIRST WORKSHOP

The objectives of the first workshop were to ensure a common body of knowledge and identify issues requiring additional research. At the workshop, held in September 1994, Charles Goodman, Office of Policy Development of the Federal Highway Administration, reviewed the uses of census data in transportation planning. The Census Bureau staff then presented the most current thinking on the Continuous Measurement proposal, and answered questions from the members of the transportation planning expert panel. The moderator of the statistical panel provided background on the debate, and the two statisticians presented their viewpoints, briefly debated the issues, and answered questions from the transportation panel. The transportation planning expert panel then identified issues for further research and questioning, and determined topics and assignments for papers.

PAPER PREPARATION

During the nine weeks between the first and second workshops, the transportation planning expert panel members prepared papers on their chosen topics. Independent research included surveys of colleagues, additional reading, calls to Census Bureau staff for clarification, and further investigation of the implications of changes.

SECOND WORKSHOP

The objectives of the second workshop were to review the prepared papers, gain additional information as necessary from Census Bureau staff, and develop conclusions and recommendations on the topic, includ-

ing recommendations for further research. At the two-day workshop, held in November 1994, the panel queried Census Bureau staff to clarify issues that had arisen during the paper preparation. Panelists presented their papers and resumed the discussion of issues from the first workshop. Finally, panelists agreed on issues, concerns, and recommendations to be made to the Census Bureau, Congress, and the U.S. Department of Transportation.

FINAL REPORT

This report is the final step in this project. The panel participants reviewed the paper to ensure that their comments and views are accurately represented. The paper expresses serious concerns, makes recommendations for greater involvement in testing, identifies requests for specific products, and defines needs for additional research.

CHAPTER 5 STUDY FINDINGS

An excellent partnership exists between the Census Bureau and the transportation community, with the Census Bureau developing new tools and products to make census data more usable and accessible. This has greatly increased the use of and reliance on census data. Many small metropolitan planning organizations (MPOs) rely almost exclusively on census data for their transportation modeling needs, while larger MPOs use the census results extensively as weighting controls for other surveys and to calibrate their models. Because requirements of the Intermodal Surface Transportation Efficiency Act (ISTEA), the Americans with Disabilities Act (ADA), and the Clean Air Act Amendments of 1990 (CAAA) have increased the data collection and modeling needs of states and MPOs, there is significant concern about any potential disruption to the flow of good census data, which after decades of development is now efficient and effective. The sources of potential disruption that generate the greatest concern are: 1) uncertainty about the "final" makeup of the Continuous Measurement proposal, 2) the potential that Congress will reduce or eliminate funding for continuous sampling, 3) the potential that data will be withheld at levels necessary for analysis due to confidentiality concerns, and 4) loss of single point-in-time, decennial census estimates with good reliability.

Continuous Measurement, if implemented as currently proposed, may provide significant improvement over current data and census products. The availability of data on an annual basis (taking into consideration the higher standard error due to sample size) will help transportation planners build more timely forecasting models. Using three- or five-year moving averages for small-area data for point-in-time models remains problematic, though. Before the transportation planning panel for this study would welcome the use of Continuous Measurement, considerable attention must be given to issues of timeliness, currency of data, program flexibility, cost, and impacts on small-area data. Any radical change must be viewed objectively, studied systematically, and implemented in such a fashion as to minimize risks to stakeholders.

The transportation community is a major stakeholder in the use of census data, both long form and short form. These data are significant in the planning and support of the multibillion dollar annual program of transportation infrastructure and improvements. The Census Bureau, the U.S. Department of Transportation (DOT), MPOs from regions large and small, and transportation planners from public agencies, academia, and the consulting environment must maximize information, communication, and cooperation in evaluating and possibly implementing this change.

DATA AVAILABILITY

TIMELINESS AND CURRENCY

Historically, the Census Transportation Planning Packages are released from three to four or more years following the conclusion of the decennial census. Thus, planners typically use data that are at least three years old, and possibly up to 14 years old, prior to the release of the next census data set. Planners, especially in larger metropolitan planning areas, have established numerous methods for updating small-area population and employment estimates, using data from such sources as building permits, utility hookups, vehicle registrations, and various state employment and labor files. However, significant changes in job markets, two wage-earner families, and other factors affecting traffic and travel patterns are best captured by detailed surveys.

If a Continuous Measurement system is implemented, the Census Bureau could produce census transportation packages within six months after the close of the year, each year after the third year of data collection. The data for traffic analysis zones will be available as statistically reliable moving averages and can be made available as single-year point estimates that will not be statistically valid. The data will be valuable for tracking trends and for maintaining an up-to-date picture of the region. Sociodemographic estimates for metropolitan areas and states, as large geographic units, for example, are expected to be more accurate under Continuous Measurement, due to continual updates.

The panel expressed concern that currency can in essence be a double-edged sword. First, most planners do not recalibrate models every year, so the utility of obtaining new data every year is questionable. Keeping up-to-date could demand major new resources. The Process/Implementation section below examines this issue more closely. Second, for legal and other considerations, it may be advisable to have a single "official" base year. For example, a CAAA plan established on base year 2005 values might be challenged by an organization using 2006 values. The legal concerns, which were discussed at the first workshop, were not revisited at the second workshop, and presumably outweigh the benefits of timeliness.

CONTINUITY AND COST CONCERNS

■ *Continuity*

Transportation planning relies on long-form census data to fulfill both congressional mandates (e.g., the CAAA, the ISTEA, and the ADA) and to carry out state-of-the-art practices of modeling. Transportation planners currently receive decennial census data once every 10 years. These data are needed for controls, to compare with other means of tracking (e.g., vehicle registrations), to expand other surveys with reliable data, and for other planning purposes. The papers by Karl Quackenbush and Peter Stopher in appendix D provide very thorough descriptions of the uses of census data and the implications of Continuous Measurement.

The transportation planning expert panel concluded that the transportation community and other users need a smooth transition between the two forms of measurement. Year 2000 data must be comparable in form and quality to the data made available in 1990. The transportation planning expert panel believes that an interruption of data, for whatever cause, would be very detrimental to transportation agency responsibilities.

■ *Cost Effectiveness/Funding: Efficiency of Size*

The cost of the decennial census and the long-form data is far less per unit than comparable surveys performed individually for specific uses. The Census Bureau estimates that the incremental cost of the decennial long form will be about $500 million for the 2000 census, or about $5 per sample household. The incremental cost of Continuous Measurement is estimated at $30 per observation (although the context and calculations were not provided to the panel), compared with the average cost of a typical individual household survey (from $90 to $150, according to Peter Stopher), or the cost of an individual household for the Nationwide Personal Transportation Survey at about $120. The panel states that the long form is a bargain in the context of the need for continuity of data.

The transportation planning expert panel was very concerned about the lack of assurance of continued funding for Continuous Measurement, which is needed to provide full sampling levels (at a minimum steady state of 250,000 per month) and to ensure census product processing and distribution once the samples are collected. There was concern about the general context of the decision to explore Continuous Measurement. Is it possible, for example, that this process of reduced sampling sizes is the beginning of a continued "ramping down" of sample sizes?

The transportation community needs additional cost data, and more openness on cost data. Most cost estimates identify the cost for just three years. What is needed is an identification of the full-cycle costs. It is necessary to identify the cost of data collection compared with data processing and the creation of products, to ensure that funds are available to present the data in a usable format after they are collected.

As a separate but related issue, Census Bureau cost projections typically contain only Census Bureau costs. There needs to be identification and recognition of the full costs to users, as well as to the Census Bureau. The Process/Implementation section below includes a discussion of this issue.

The Census Bureau expects to generate internal cost savings, in part through sharing of data with other surveys. The panel questioned the likelihood of such savings. Experience shows that overruns are likely in many new programs. It is not clear whether Continuous Measurement is intended to be cost neutral or to generate cost savings. The cost data presented to the panel appeared to indicate that Continuous Measurement would neither be cost neutral nor result in cost savings, but in fact appears to be more costly. However, the panel did not have access to the detailed information about related programs that might tie into Continuous Measurement efforts. The panel also questioned the likelihood of the Census Bureau achieving permanent staff increases in the face of the policy of downsizing government. There is concern that cost overruns and staff increases could jeopardize congressional support, force reductions in sampling, and thus jeopardize the entire data-collection effort. As stated above, continuity of data is essential. It should be noted that many countries in Europe engage in continuous sampling in part to avoid budget spikes. Maintaining a steady funding level is an additional benefit of Continuous Measurement.

Continuous Measurement promises more frequent, and in many ways, better data. The Census Bureau may wish to investigate and determine the cost for replacement of current data versus the cost for better data. Continuous Measurement benefits include new sources of planning data such as trend analysis, more flexibility, greater timeliness, and better quality. These benefits are difficult to quantify in dollar terms, but their value may be worth some incremental cost difference from the status quo.

■ *Potential Disruption/Diminution of Sampling*

There is a significant risk in embarking completely on Continuous Measurement, as it will rely on annual appropriations from Congress which can be cut back or eliminated. Funding may be assured through 2001, but the program beyond becomes a policy issue open to question by a Congress intent on cutting costs. At that time, the program could be halted, or the sample size reduced to a meaningless level. Even the first three years may be in doubt, if cost overruns occur. The Census Bureau states that there is also no guarantee that the traditional long form will be funded. The question remains: what happens if the Continuous Measurement effort is discontinued or cut to the point of uselessness a few years into the process? At least with the decennial long form, good data are available at least once every 10 years. Disruption of this availability would severely impact transportation planning and would result in more costly and possibly inconsistent data-collection efforts by individual states and MPOs.

Many different constituencies use census long-form data. Some uses are mandated directly by Congress, some mandated indirectly through regulations and related references, while other uses are made of the data by the private sector. The transportation community may need to coordinate with other constituencies and identify common ground and common requirements to ensure survival of the long form, whether in the decennial or Continuous Measurement format.

EVALUATING ALTERNATIVES

The panel recommends further examination of alternatives to the long form. Is this Census Bureau's Continuous Measurement proposal the only possible alternative? The National Conference on Decennial Data for Transportation Planning, held in March 1994, offered multiple recommendations that have not been fully examined. The following are indicative of the range of recommendations from that conference:

- Sample every five years using one-half or one-quarter the full long-form sampling rate.
- Establish a longitudinal panel to measure change.
- By the year 2010, administrative records will be available to improve sampling. The Census Bureau needs to test Continuous Measurement from the year 1999 on, to be ready for full implementation in 2010.
- Determine how much Census would have to reduce the sample size of the long form in order to test Continuous Measurement: could it be done with a one-twelfth sample?
- Investigate the savings if Continuous Measurement is not conducted all across the nation, and instead tested only in certain geographic areas.
- Determine what level of parallel testing of Continuous Measurement with the decennial census is feasible.

■ *Parallel Testing vs. Untested Replacement*

A significant research effort is underway at the Census Bureau, but so far it is not sufficient to let transportation planners clearly decide the pros and cons of Continuous Measurement by the 1996 deadline. The transportation community is not yet involved in the testing and research; such involvement in the future is critical, because of the community's extensive use of cross-sectional data. The user panel believes that good science demands testing and experimentation prior to implementation.

An example of such good science is the change in collecting Bureau of Labor Statistics unemployment statistics. In that case, parallel counts were conducted for several years to ensure the comparability of data. The decennial long form is no less important; the transportation community and others need a good count in the year 2000. The panel, therefore, strongly recommends a parallel process for the year 2000: conducting the decennial count, including the long form, with a Continuous Measurement system implemented in parallel for selected areas.

ACCESSIBILITY AND CONFIDENTIALITY CONCERNS

The trend in transportation planning has been to narrow the focus of analysis in geographic detail, from ZIP Codes to traffic analysis zones to census tracts to XY coordinates. The Continuous Measurement staff of the Census Bureau may have every intention of releasing extensive public use microdata for planning purposes, but the Census Bureau's Micro Data Review Panel (MDRP) controls the release of specific geographic levels of census data. The MDRP reviews census data applications to ensure confidentiality of respondents. The MDRP also has significant veto power over proposed uses of data. As microdata samples are spread out over time, the MDRP may become even more con-

cerned about the possibility of identifying an individual. If the MDRP refuses to release small-area data to the public, then all research and data analysis must be done through the Bureau, possibly impacting planning work significantly.

The transportation community supports confidentiality and protection of individuals from disclosure in surveys in which they are required to participate. However, it appears that in some cases the MDRP may read meanings into Title XIII that go beyond the intent of Congress. In another context, for example, employers with more than 100 employees in regions of severe air quality nonattainment must release a geocoded file of their employees' addresses. Thus, if others release these data as a matter of course, MDRP standards may be excessive. Transportation planners lose valuable census data, used strictly for research purposes, because of excessive protection of confidentiality that suppresses such information as addresses. For accuracy in small-area studies, planners need access to data tabulated at fine-level detail.

There are means to protect identity and still generate the data needed by transportation planners, such as data switching and randomization.[1] As an alternative to releasing the information, Census can produce special tabulations. Another alternative strongly recommended by the panel maintains all legal and established constraints on confidentiality and data release: the Census Bureau can significantly increase its deputization of academics, consultants, MPOs, and so forth, to allow them to assemble and use the data.

The user panel strongly recommends the 100,000-population limit, rather than the 250,000-population limit, for the release of public use microdata from Continuous Measurement. The 100,000-threshold is critical to ensure the transportation community support of the Continuous Measurement proposal. A corollary desired improvement in public use microdata will increase acceptance of the proposal: namely that workplace be coded to public use micro areas, instead of to county as is done currently.

SUITABILITY OF DATA FOR PLANNING NEEDS

ACCURACY

The panelists as a whole agree that reliable data are the highest priority. Greater timeliness and flexibility are seen as bonuses, not tradeoffs for quality. The Census Bureau believes it will achieve better quality data with a Continuous Measurement system. The accuracy of the decennial count might be improved by the concentration of resources on the "headcount." The quality of the long-form results under Continuous Measurement may improve through a permanent dedicated staff, continuous training, continuous updates, and maintenance of the Master Address File, and the ability to return to problem areas and sample again or at higher levels to achieve the desired sampling levels. Quality also may improve through increased training for interviewers on followups to nonrespondents, and through improved data entry and geocoding.

■ *Standard Error*

General concerns about data quality and accuracy also involve sampling error. The Census Bureau states that the standard error of estimates will increase by about 25 percent for large geographic areas (from a 95-percent confidence level to a 90-percent confidence level), due to the change in sample size.[2] The standard error for small areas, which has always been large, will be larger. This element of data quality and accuracy will therefore be worse under Continuous Measurement. However, some panelists assert that the levels of confidence and standard error are acceptable for the types of applications performed with the data, and are less than the variances normally associated with survey data used in transportation planning.

Sampling Rates. The Continuous Measurement program for data collection would be based on a sampling rate of one in 34 housing units per year, rather than the one in six utilized in 1990. Using one in 34 housing units per year as the sampling rate would result in statistically valid data for large areas; however, the integri-

[1] For further discussion, see paper by Lawton, p. 6, in appendix D. Also see George T. Duncan et al. (eds.), *Private Lives and Public Policies: Confidentiality and Accessibility of Government Statistics* (Washington, DC: National Academy Press, 1993), for a full discussion of confidentiality and data optimization.

[2] Charles H. Alexander, "A Prototype Continuous Measurement System for the U.S. Census of Population and Housing," document CM-17 in the Continuous Measurement Series, May 1994 (included in appendix D), p. 3.

ty of the data would rely on the Bureau's weighting and expansion factors. This could be problematic if certain populations, such as households with zero vehicles, are underrepresented in the original sample.

Small-Area Data and Moving Averages. Further consideration should be given to the availability of small-area data and the meaning of moving averages at this level. (For further discussion of moving averages, see the section on Single Point-in-Time Estimate Data below.) If the samples are very small, there may be no statistical meaning to values in a cross-tabulation from a single year. (Papers by Lawton, Quackenbush, and Stopher, in appendix D, address these issues.)

■ *The Decennial Advantage*

The long-form survey is conducted during the decennial census. The decennial census is a well-publicized and highly visible public event. The combination of legal mandates, concentrated data-[2]collection efforts, and extensive census publicity campaigns yield a relatively high response rate for the long-form data collection. Essentially, the long-form questionnaire piggybacks on the success of the decennial census. In addition, the long-form surveying effort achieves high coverage at a marginal cost. By conducting the two surveys separately, the short form and the Continuous Measurement approach, the result may be lower response rates for Continuous Measurement. Efforts to improve the response rate could drive up the cost of the Continuous Measurement program beyond levels that Congress is willing to fund. As a result, less data could be collected and lower data quality achieved through Continuous Measurement.

■ *Income Data*

Travel modeling depends on having good household income data because, as discussed previously, income influences the number of trips made by household members and sometimes the modes chosen for those trips. The long form yields good income information, in part, because it is sent out in April when people have recently or are currently filing their tax returns. Continuous Measurement questionnaires would be sent out each month and many people may find it difficult to recall their prior year income. As a result, the quality of income data could diminish. Some panelists are convinced this is not likely to be a problem as most planning applications use quintiles of income data, which should not be affected by minor errors in recall.

FLEXIBILITY IN CONTENT AND SAMPLING

The Census Bureau has promised the advantage of significant flexibility in sampling in Continuous Measurement, in addition to more timely and more current data, including: 1) flexibility for heavier sampling on request, 2) flexibility and ability to experiment with content, and 3) flexibility to add questions for specific needs in a particular region.

■ *Heavier Sampling: General Population*

MPOs, state departments of transportation, and public agencies are promised the ability to contract with the Census Bureau to perform additional sampling. This could include heavier sampling in certain years to coincide with local sampling, before and after a major highway or transit facility opening, following a natural disaster or significant plant closing or opening, or other local interests. Similarly, agencies could contract for additional special-purpose questions of local interest, either in standard or heavier sampling frames. There may also be opportunities for overlapping samples to test changes in behavior over time.

Some panelists suggested the possibility of using larger samples in the year 2000, concurrent with the decennial census, perhaps a sample of one in 18 or one in 20, in addition to Continuous Measurement in 1999 and 2001. This could be used for analysis and comparison with previous data. It would have a higher sampling error than the 1990 long form, but could simulate the more complete sample and serve as a benchmark.

■ *Heavier Sampling: Rare Populations*

During the discussions at the first workshop, Census Bureau staff indicated that states or MPOs could contract with the Census Bureau for additional samples, that is, samples that capture rare populations such as transit users or disabled workers.

In later discussions, the Census Bureau indicated that these potential contractual efforts for rare populations would not occur during the Continuous Measurement process. Rather, the Continuous Measurement system could pull out populations with rare characteristics and followup interviews would be conducted later. In this way, other smaller surveys could obtain an oversample of the rare units, subject to Title XIII (confidentiality) constraints. The Census Bureau routinely conducts such follow-on studies for other surveys and does not see the need for further testing.

■ *Content Flexibility*

Because Continuous Measurement sampling takes place throughout the year, the natural variance over time and place also permits changes in wording to reflect the specific needs of the users, as in the journey-to-work (JTW) question. The decennial census asks "usual" day to avoid local or regional anomalies such as a transit strike or severe weather, on a single sampling day. However, this tends to hide the less common uses, such as telecommuting once every two weeks or carpooling once a week. The Census Bureau is willing to experiment and test changes in wording, such as changing the JTW question to "most recent work day" or "yesterday" instead of "usual." Further discussion on content, relevant to both Continuous Measurement and decennial long-form discussions, is in the section on Content and Geocoding Concerns below.

■ *Adding Questions*

Various participants expressed considerable interest in adding questions to the standard long form, such as access and egress modes from the "major" commuting mode. These questions could be tailored by region, so that only cities with a heavy rail or commuter rail system would be asked about that particular mode. There was also concern that the wording of the question, asking for (mode of) "longest distance," may actually be answered as "longest time" traveling. Costs of such changes to the user (and whether or not the Census Bureau plans to charge for question changes) have not yet been determined.

■ *Flexibility Concerns*

General concerns about the promised increases in flexibility include the unknown cost for changes, the ability of the Census Bureau to deliver on requests for increased sampling (in terms of human and other resources), the likelihood of access to sampling for rare populations due to confidentiality concerns, and the conflict between the desire for flexibility versus the need for the continuity of data over time. The conflict between continuity and flexibility has various facets, as shown in the following examples:

Example 1: The potential new category of ethnicity as "mixed." This new category is not an aggregate of others; there is no way of getting an average, but this is a growing element of the population.

Example 2: If the JTW question is changed, many models that build adjustments to the JTW data to match "reality" from other sources would require new relationships. (For example, JTW data do not, by definition, include nonwork trips. Based on current wording and information from other surveys, modelers develop relationships between work and nonwork trips. If the wording changes, these standard relationships that have been developed may also need to be changed.)

Example 3: If data are combined over three or five years (in moving averages), the questions for the years that will be combined need to be the same.

1999	*Question A*
2000	*Question A*
2001	*Question B*
2002	*Question B*
2003	*Question B*

Under this scenario, one would have to wait for year 2005 data to have a five-year accumulation of Question B, and Question A would not be available for a small geographic unit (except with unacceptably high standard error). If Question A is used consistently in every year, there could be a summary for each period (1999 to 2001, 1999 to 2003, 2000 to 2004, and so forth).

SINGLE POINT-IN-TIME ESTIMATE DATA

Census data are a major element in four different sectors of model development:

1. *allocation* of employment and population to geographic areas,
2. *factoring* base set of data—using census data and socioeconomic factors as multipliers for other surveys,
3. *calibration* and *validation* of models, and
4. *estimation* using transportation models.

Transportation planners usually interpret data over geographic space, rather than over time. Most planning is designed for a "snapshot" approach, compared with the continuous, "smoothed out" time series of moving averages promised in Continuous Measurement. Planners believe that a once-a-decade "slice" is necessary, and is currently used as a major input to travel forecasting models, including establishing a base year, developing model parameters, and checking model results. In addition, modelers frequently use surrogates

such as vehicle registrations, utility connections, and employment to represent growth patterns and estimate changes in travel patterns during intercensal years. Once a decade they can verify or fine tune their use of these surrogates based on the detailed decennial survey and long-form sample.

One method of achieving this decennial slice under Continuous Measurement is to increase sampling during the decennial year. Barring this, some of the panelists questioned how to use Continuous Measurement for calibration, and what changes will be necessary in the paradigm to go from fixed point to time-based studies. Other panelists did not see this as a problem.

■ *Moving Averages*

One concern about using Continuous Measurement was the meaning and measurement of moving averages. Continuous Measurement would seemingly change the nature of fixed point-in-time data estimates for small areas. Problems would arise in application because the census data, assuming data varied over the three- or five-year period, would be inconsistent with point-in-time model input such as travel times, costs, and facilities. For example, census data would represent averages over three years. It would, however, be impossible to average facilities over three years. If Corridor X had four lanes in year one, six lanes in year two, and four regular lanes with two carpool lanes in year three, how would a moving average of capacity be calculated and what would such an average mean? Averaged census data would no longer be consistent with the underlying data used in the transportation and land-use modeling process. Panelists also expressed concern about the meaning of moving averages for multivariate statistics. For example, what is an average of a trip interchange pattern? What is an average of behavioral changes, which are neither cross-sectional nor time series? What is the meaning of averages over time in income, house values, and so forth, and how will they be used?

Karl Quackenbush's paper (see appendix D) examines these issues at length; he firmly believes that any such problems are quite manageable. A key argument, neutral toward Continuous Measurement or decennial long form, is that the "gross level" of the majority of models will not be sensitive to the fine differences normally occurring. Single-year data from Continuous Measurement may provide some of what is needed. However, smaller areas may experience problems if they use annual data with higher standard error as if they were reliable. Further research is warranted relative to the sample size involved.

■ *Annual Data*

Annual data are essential for transportation planners. Transportation and land-use models are used to predict a point in time, hence, data are needed that relate to a point in time. Problems associated with moving averages are noted in relation to origin-destination movements. Data from a single year are likely to be too sparse to create a meaningful OD matrix using small-area geography. An OD matrix would prove impossible to create or would be so full of empty cells that it would be of little value. In addition, over a period of years there are likely to be significant changes in work-trip patterns from new housing and employment locations. According to many of the panelists, moving averages of these changes will be inapplicable for transportation modeling uses.[3]

During the panel discussions, the Census Bureau indicated that annual point estimates for small areas could be made available from Continuous Measurement; however, the data would come with a "warning label." That is, the data would be provided, but would not be an "official" Census-certified estimate, because the annual estimates would not be based on enough cases for analysis and would have dubious statistical confidence. Even with dubious statistical confidence, the annual data are important to the transportation planning community, because they provide the point-in-time data items needed by transportation planners. Many panelists could not support the Continuous Measurement proposal without a guarantee from the Census Bureau that annual point estimate data would be received for each of the years included in the moving average.

■ *Seasonal Variation*

Another minor concern with Continuous Measurement is seasonal variation. Continuous Measurement surveying would occur throughout the year, while past modeling efforts generally used the spring or fall as the most "normal" period of travel. Annual averages may, thus, present some problems for application within the traditional modeling context. Issues relating to seasonal variation include:

[3] Note that Quackenbush disagrees. See his paper in appendix D.

- Households containing students who are away from home during the school year will likely report larger household sizes in the summer than during the rest of the year.
- Regions attracting many tourists will report larger populations during the tourist season than other times of the year.
- Retirement communities in Arizona or Florida, for example, having partial-year residents would also report higher populations during parts of the year.

Continuous Measurement may actually provide more accurate representations of "annual" or "average" population and related data for the typical region. Its utility, however, may be limited unless the date of the Continuous Measurement survey is included in microdata files, and unless additional data products that specifically address seasonal variation are provided. The Census Bureau staff indicated that seasonal data products may be available, but that further research was necessary.

CONTENT AND GEOCODING CONCERNS

The panel identified several longstanding concerns as very high priority to address—for the Census Bureau and the transportation community at large—whether Continuous Measurement is adopted or the decennial long form is maintained. The concerns are broadly described as content and geocoding.

CONTENT OF QUESTIONS

The journey-to-work data gathered by the Census Bureau on items such as travel mode, travel time, and location of employment are used in a variety of applications by transportation planners as described previously. The transportation questions asked on the long form differ in some respects from those questions asked by transportation planners in local travel surveys. The main differences between census survey data and local survey data are attributed to the definitions of trips, and "yesterday" versus "usual day." Infrequently used alternatives will be underreported in census data, while frequently used modes will be overrepresented. For Continuous Measurement to prove beneficial, the issue of questionnaire content needs to be addressed. Annual averages of "usual" behavior are likely to be more problematic and harder to interpret than current data.[4]

The statistical characteristics of location and land-use models are usually estimated and begin their forecasts from a cross-sectional data set. It is common practice to have a decennial census year as the main data time point with local estimate data for intercensal years. Locally collected data items that build on the decennial census journey-to-work data typically pertain to mode, vehicle occupancy, intermediate stops, time of departure, and time of arrival, and are used to "build" the journey to and the journey from work.

■ *Work-Trip and Nonwork-Trip Issues*

Work trips constitute approximately 25 percent of trips. However, the long form does not gather data on nonwork trips. In addition, part-time employment is missed. The realm of trip chaining, whereby, for example, a person picks up groceries and/or a child at day care on the way home, or otherwise combines a work trip with other necessary personal business, is also fertile ground for additional investigation, relating to the Continuous Measurement promise of content flexibility.

RECOMMENDED IMPROVEMENTS

The user panelists agreed that geocoding for place of work must improve. Work-trip destinations of some workers are misrepresented, since address files often reflect the business address (i.e., headquarters office site) rather than work site. Household data are coded by place of residence, while employment data are coded by place of work. Both trip ends must be accurate in order to effectively model the journey-to-work pairs critical to travel demand and land-use models. Generally, unreliable employment data is one of the major data problems for MPOs attempting to implement location and land-use models. The current Census Bureau plans for the Master Address File extend to household residences, not business addresses. Workplace Topologically Integrated Geographic Encoding and Referencing System (TIGER) files and their maintenance should be included in the ongoing Census Bureau budget. Having the Census Bureau maintain updated files of business addresses is a high priority for transportation planners.

[4] See Lawton, Quackenbush, and Stopher papers in appendix D.

PROCESS/IMPLEMENTATION

The transportation community welcomed the opportunity to join the debate in the formative stages of the process. The discussions sensitized Census staff to specific transportation needs and concerns, and the Continuous Measurement staff promised service, flexibility, and data products at fine levels of detail. However, the proposal is still in development and the transportation planning expert panelists were faced with in essence a "moving target." Support for the Continuous Measurement proposal is contingent on many variables. A radical change in design, sampling levels, data release levels, costs, or any of several other critical factors could undermine data quality or availability. The panel had this single opportunity to respond to changing proposals; at another point in time, with a different proposal, the recommendation might be different. In summary, no statements herein should be construed as a blanket endorsement of Continuous Measurement.

IMPLICATIONS AND COSTS OF MAINTAINING AND UPDATING DATA

The panel was sensitive to the limited staff and funding available for planning, especially in small MPOs. Therefore, new responsibilities for states and MPOs, implicit in the Continuous Measurement proposal, were a concern to the panel. The new responsibilities include the costs of maintaining and updating data on a more frequent basis, geocoding, and revising plans. Specifically, the panel questioned what proportion of the cost does the Census Bureau assume will be handled by local agencies. A related concern is that the Census Bureau's Geography Division does not have in place a mechanism to integrate locally maintained geographical information system (GIS) files into TIGER. It is not clear that such a system will be in place by 1998 for use in 1999.

■ *Geographic Locators*

To support the Continuous Measurement program, the database of geographic locators, addresses, place names, and so forth, would require continuous maintenance. Most MPOs currently developing or maintaining a GIS will be able to integrate their GIS with the database of geographic locators. A continuous maintenance process may be easier for an MPO to staff.

MPOs typically volunteer to assist the Census Bureau with coding, including place-of-work coding. This offer, however, by MPOs was turned down by the Census Bureau in 1990 due to "time constraints." There was a question of how and whether the Census Bureau would use such MPO assistance. Either the Census Bureau or the MPO would seemingly have to produce monthly or quarterly files with workplace address, residence address (tract-level only perhaps), and travel time and mode. Some method of improving address geocoding, particularly for place of work, needs to be developed by the Census Bureau and MPO staffs with local GIS capability. Serious inaccuracies and omissions exist in place-of-work coding in the Census Transportation Planning Package data files. Properly maintaining such files on an ongoing nationwide basis would seem to be a huge challenge for Continuous Measurement.

Concern was also expressed about how information is updated. Providing manual files as was done in the past is not feasible. The Bureau could send an MPO the bare addresses, with census identification numbers known only to the Bureau. MPO staff could then do the geocoding in cooperation with the Bureau. During the process, complete confidentiality would be maintained through an identification number provided by the Census Bureau for each location (or location pair, if home and work).[5]

■ *Geographic Boundaries*

The Continuous Measurement program indicates that geographic boundaries will change annually. Census relies on local jurisdictions, mostly states, to provide political boundary changes. However, it is unclear how or when tract boundaries would change under Continuous Measurement. There is concern that data tracking will become unmanageable; analysis from year to year may be muddied by an annexation or other boundary change. Such changes could also jeopardize the Census Bureau's ability to deliver products on time. The Census Bureau needs to establish protocols to accept electronic files and facilitate the transfer and updating of information. The Census Bureau, in cooperation with the transportation community and others, needs to establish benchmarks for updating geographies, and a process for the continual tracking of changing geographies (e.g., tracts and zones).

The transportation planning expert panelists agreed that the annual data must be coded to a consistent geog-

[5] For further discussion, see Lawton's paper in appendix D.

raphy from year to year for the data to be valuable, or, if updated, that a type of "red flag" reference file be associated with each zone to identify changes in geography. In addition, the geography level must be maintained at the block or census tract to be valuable.

INTERGOVERNMENTAL COOPERATION

A smooth transition from the decennial long form to the Continuous Measurement intercensal long form demands the participation of interested parties. The U.S. Department of Transportation (DOT) and groups such as the American Association of State Highway and Transportation Officials and committees of the Transportation Research Board need continued involvement in testing data, content, and methods, and in identifying products.

DOT and the Census Bureau need to establish a mechanism for interested parties to receive continued updates on plans and procedures. One possibility would be a newsletter. Another is to reopen the "Census 2000" (Census Bureau) computer bulletin board topic to the public.

DOT will need to establish an ongoing process and related funding to support and coordinate local efforts, including training state DOTs, MPOs, and others in the proper use of Continuous Measurement data. The change to Continuous Measurement may have significant impacts on users, for example, TIGER file maintenance. DOT may be expected to support state departments of transportation and MPOs in their continual updating of geographic bases and other planning activities. Further, DOT may be expected to support state DOTs and MPOs in funding special or super sampling efforts for specific needs. DOT needs to assess the costs of these activities and consider, for example, additions to planning funds for MPOs or increases in the planning and research set-aside from construction funds.

Finally the transportation community should establish contact with other stakeholders in census data (e.g., users of poverty data and household data) to establish common ground, and identify a framework for cooperation. The transportation community and other stakeholders will likely find it far less costly to cooperate and preserve key elements of the long form (whether decennial, Continuous Measurement, or both) for a transition period, than to reproduce the data elements, data quality, and sample size of the long form in individually sponsored surveys.

ENDNOTE

Subsequent to the second panel meeting, and during the writing of the final report, the National Research Council (NRC) issued its report, *Modernizing the U.S. Census*, the final report of the Committee on National Statistics Panel on Census Requirements in the Year 2000 and Beyond. The report is the culmination of a three-year study on the census.

The study reported here, *The Implications of Continuous Measurement for the Uses of Census Data in Transportation Planning*, was conducted independently of the National Research Council. However, the study did call on two people who were members of the NRC panel, Barry Edmonston and Stephen Fienberg, to assist the transportation planning users panel in better understanding the statistical implications of Continuous Measurement. The conclusions of the two groups are likewise independent. There is some overlap as well as differences in the general recommendations, which are noted below.

Modernizing the U.S. Census, Conclusion 6.4, states in part: "We conclude that it will not be possible to complete the needed research in time to make the critical decisions regarding the format of the 2000 census. We therefore do not recommend substituting Continuous Measurement for the long form in the 2000 census." Conclusion 6.3 states: "The panel recommends that the 2000 census include a large sample survey that obtains the data historically gathered through a long form." The transportation planning expert panel sees many advantages in Continuous Measurement, but is also concerned about dropping the long form prematurely. However, the transportation planning expert panel recommends a parallel approach, whereby Continuous Measurement is tested during the 2000 census, to compare results.

APPENDIX B: BRIEF BIOGRAPHIES OF PANEL MEMBERS (IN ALPHABETICAL ORDER)

JAMES BUNCH

Mr. Bunch is currently with Bunch & Associates, where he provides consulting services in transportation analysis and evaluation, travel forecasting, and demographic analysis. Throughout his career Mr. Bunch has developed his expertise in transportation policy evaluation and alternatives analysis, travel forecasting methods, and data development for travel forecasting. He has worked in varied planning environments including a regional metropolitan planning organization, a transit operating and planning agency, and private consulting.

Mr. Bunch attended Northwestern University, where (as an intern) he co-authored "Strategies and Options for Development of the Chicago Regional Passenger Transport Network to the Year 2000." At the University of Houston, he studied policy analysis. He has a bachelor's of civil engineering from the University of Michigan.

G. BRUCE DOUGLAS

Bruce Douglas, a nationally recognized transportation planner and traffic engineer, is a senior transportation planner at Parsons Brinkerhoff. Dr. Douglas has extensive experience in the application of new travel demand models using microcomputer and mainframe environments. These models include the Urban Transportation Planning System (UTPS) program battery; MINUTP (microcomputer model); TRANPLAN; QRS 2; EMME/2 and its forerunners, the Network Optimization System (NOPTS) and the Transit Network Optimization Program (TNOP). He is also accomplished in the use of TransCAD, a program that combines transportation analysis with geographic information systems (GIS) analysis. His research and practice have resulted in new uses for interactive computer graphics in transportation analysis and the development of new computer simulation models of modal choices for urban analysis. Dr. Douglas earned a Ph.D. in Civil and Urban Engineering from the University of Pennsylvania, an M.S.C.E. from the University of Pennsylvania, and a B.S.E. (Civil) from Princeton University.

GREIG HARVEY

Mr. Harvey's work includes a series of transportation planning and management studies for the Bay Area Metropolitan Transportation Commission, and preparation of reports on transportation—air quality planning and transportation pricing for the Federal Highway Administration, assessment of TCM cost-effectiveness for the Bay Area Air Quality Management District, and urban land-use and transportation demand model development and application for the Bay Area and Los Angeles. Mr. Harvey has published numerous papers on ground access to airports, demand forecasting, and organizational and institutional aspects of civil engineering.

T. KEITH LAWTON

Mr. Lawton is a specialist in transportation and land-use modeling for MPOs. He is the Technical Manager for Metro, Portland, Oregon. Mr. Lawton led the enhancement of Portland's regional transportation models to include urban design and heterogeneity of land-use effects on auto ownership and travel behavior in partnership with an environmental group's study (1000 Friends of Oregon). Mr. Lawton was closely involved with the choice of the GIS software (Arc-Info) and the development of the Regional Land Information System. T. Keith Lawton holds an M.S. in engineering from Duke University.

ALAN PISARSKI

(FACILITATOR, SECOND SESSION)

Mr. Pisarski is a private consultant who has been an active participant in the national transportation policy scene for more than 20 years. His work related to transportation and particularly commuting has been reviewed, discussed, and quoted in major national news magazines and newspapers. He has also appeared on major national radio and television network programs, such as *Nightline* and *20/20*, discussing national transportation issues. He currently serves as content advisor to a major new public television series on transportation.

STEPHEN H. PUTMAN

Mr. Putman has 30 years experience in combining theory development with practical application of mathematical models for urban and regional forecasting and policy analysis. He is Professor of City and Regional Planning, and Director of the Urban Simulation Laboratory at the Department of City and Regional Planning of the University of Pennsylvania. He teaches courses in quantitative analysis for urban and regional planning, in computer use in planning, and in integrated transportation and land-use modeling. He is Principal of S.H. Putman & Associates, a consulting firm with an international reputation for integrated land-use and transportation planning, forecasting, and policy evaluation. His EMPAL and DRAM computer models have been used by numerous metropolitan regions in the United States, and are currently licensed for use in a dozen such areas. As part of his ongoing involvement in research, teaching, and consulting, he has given numerous presentations, written four books, and published more than 50 papers on these topics.

KARL QUACKENBUSH

Mr. Quackenbush is Deputy Technical Director of Operations at the Central Transportation Planning Staff in Boston. He co-directs and coordinates the organization's technical work in the areas of regional multimodal travel modeling, small-area traffic forecasting, traffic engineering, air quality analysis, and transit service planning. Mr. Quackenbush earned a Master's in City and Regional Planning from Harvard University and a B.A. in Geography from the State University College of New York.

PETER R. STOPHER

Dr. Stopher is Professor of Civil and Environmental Engineering at Louisiana State University. He was director of the Louisiana Transportation Research Center from 1990 to 1993. He has served as consultant and/or project director for numerous studies, including impacts of capacity increases on air quality, household surveys for travel demand estimation, on-board transit passenger surveys, goods movement, short-, medium- and long-range transportation plans, forecasts and networks, and design, redesign, calibration and refinement of travel forecasting models. He is author or co-author of eight books and dissertations, including *Urban Transportation Planning and Modeling*, reprinted five times. His formal publications, refereed papers and presentations number over 100, including *Travel Forecasting Methodology: Transfer of Research into Practice* (1985); *Deficiencies in Travel Forecasting Procedures Relative to the 1990 Clean Air Act Amendment Requirements* (1992); and *Blow-Up: Expanding a Complex Random Sample Travel Survey* (1993). Dr. Stopher received the Bachelor of Science in Civil and Municipal Engineering from University College, London (University of London), and a Ph.D. in Traffic Studies, Faculty of Engineering, University College, London.