

A CONTINUOUS MEASUREMENT ALTERNATIVE FOR THE U.S. CENSUS

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I. BASIC IDEA OF THE "CONTINUOUS MEASUREMENT OPTION"

The original definition of the Continuous Measurement Option in U.S. Department of Commerce (1992), was:

- collect only "basic headcount and minimal data" on the decennial census
- replace "data traditionally obtained on a sample basis in the decennial" by a collection program "spread out in some fashion over the decade."

Different "fashions of spreading out collection" have been suggested. (Eckler (1972); Kish (1981, 1990); Alvey and Scheuren (1982); Herriot, Bateman, and McCarthy (1989); Herriot and Schneider (1990).) The immediate goal of our present research is to select a specific prototype design, determine its feasibility and cost, and describe it to our various stakeholders and review committees. Using their responses, the Census Bureau will decide whether to proceed with further testing and development.

First, though, why consider Continuous Measurement? The reason is that it has several potential benefits which make it very appealing.

- First, it would produce more timely and relevant "census" data.
- Second, the decennial census is a huge operation done in a short time period by a mostly newly hired staff. This leads to some quality problems and makes it hard to apply methods for continuous improvement to the data collection. A continuous process may be better in this respect.
- Third, Continuous Measurement may make the decennial task easier by eliminating the content part of the task. This would allow more opportunity to concentrate on counting and coverage.
- Finally, it may provide an opportunity to integrate data from the census, Federal household surveys, and administrative records into a single estimation system.

Although we tend to focus attention just on the data collection, there are three important components to Continuous Measurement.

1. Continuous Address List Construction, emphasizing continuous improvement by a permanent field staff. If we pay attention to doing it well, this could give us a better list going into the decennial census;
2. The data collection itself, which in our prototype we call the Intercensal Long Form Survey (ILF);
3. An Integrated Estimates Program, in which the continuously updated address list eventually links together the ILF, other household surveys, and administrative records data. This would be a rich data set, and could let us get good small-area estimates with a smaller ILF sometime in the future.

II. DECISIONS WHICH HAVE DETERMINED OUR PROTOTYPE

To describe the prototype, I shall list sequentially the decision which determined it.

1. The intercensal component should concentrate on content and not try to replace the enumeration portion of the year-2000 census. We considered proposals to spread the enumeration throughout the decade, either through counting different places in different years or by using models to make estimates based on partial counts. These methods were technically very uncertain, and very likely could not be used for reapportionment without a Constitutional Amendment, so these ideas were dropped.
2. The intercensal sampling frame will be the Master Address File (MAF), with enhancements. The Census Bureau is already developing the MAF, which will regularly update the 1990 census Address Control File by using Postal Service lists, and potentially local government lists, linked to the TIGER geographical database. For Continuous Measurement, this updated file is too good an opportunity to pass up.

Continuous Measurement will require some enhancements to the MAF, mainly to develop a system to quickly include updated addresses uncovered by the field operations. The details of the field procedures must be designed with this in mind.

3. The prototype assumes pre-2000 implementation of the ILF, so that the 2000 census long form would be eliminated. If that doesn't work out, we can always drop back later and aim toward replacing the 2010 long form. Right now it looks like we may be able to do something reasonably good by 2000, but we need to make some decisions and get moving with some real testing and development soon. The original prototype assumes that listing would start in 1997, with full implementation by 1998, following tests in 1995 and 1996.

4. Continuous Measurement must produce data for most 1990 long form characteristics for small areas, with more or less the same reliability as the 1990 long-form design. Some of us had conjectured that many characteristics might not have truly important uses for small areas, and that some small-area objectives could be dropped in favor of better data for larger areas. A review of uses of census data for Federal programs, and non-Federal uses which people at the Census Bureau were familiar with, dispelled this notion. Pretty much every item on the questionnaire had important programmatic uses at the tract levels. Most of these uses were at least indirectly in response to legislative requirements, although the specific questionnaire item was ordinarily not mandated. To eliminate substantial portions of the long form estimates would involve making many changes to the law, finding many new sources of small-area data, or getting by without data where data now are used.

Obviously there are some changes in census content every decade, and there is some flexibility in the exact sample size, but if we want to "replace" the long form sample, we must have an intercensal system which can produce small area data with reliability like that of the 1990 long form.

5. The prototype should rely on direct sample-based estimates for small areas, rather than indirect synthetic estimates or

administrative records. Because of the decision to try to be ready by 2000, we ruled out designs relying primarily on indirect estimates. It would be impossible to develop, test, and win public acceptance for such new methods in time for our "go/no-go" decisions, which are needed around the end of 1995. However, I think we need to keep research on indirect methods as part of the program, since those methods could substantially reduce the cost and increase the benefits of Continuous Measurement after 2000.

6. Interviewing will be spread evenly across the year and across the Nation. Previous proposals to do different states in different years, or different parts of the same State in different years, got a poor reception from data users. It is clear that many important uses require data from all areas at once.

The prototype goes further, dropping the fixed reference date of April 1 and spreading collection throughout the year. The reference date would be the time of collection whenever that makes sense. For example, Unemployment might be as of "last week", averaged across the year. Income would probably be asked for the previous calendar year, but it would be asked throughout the following year, and the results averaged across the year. This has advantages and disadvantages, but it is clearly the natural approach for a continuous survey. Therefore we will start out by trying to sell data users on an annual average reference population whenever possible.

7. Small-area estimates will be rolling cumulations of five years of data. For example, in 2003 we would release the 1998-2002 average for each tract/Block-Numbering Area; in 2004 we would release the 1999-2003 average, etc. Estimates for Block Groups or user-defined areas could also be made, as long as we know which blocks are included in the area.

For small areas like tracts, we can't afford the sample size to match long-form reliability with our annual estimates, so cumulation of several years' data are essential. A five-year window was chosen as being short enough to be clearly more timely than once-a-decade estimates, but long enough maybe not to be too expensive.

Annual estimates will be fairly reliable for many characteristics for areas of 250,000 persons or more.

8. The prototype ILF will be a separate survey, not an expansion or modification of any current Federal household survey. Our research compared the cost for constant variance for a variety of hybrid designs in which part of the sample would come from current household survey designs, possibly with some modification, and part from a design which is efficient for cumulations without having to meet any special requirements of the household surveys. We solved for the optimal mix of the two designs for given variance requirements. It became clear that for plausible values of the relative costs and design effects, the best design for meeting long-form reliability requirements involved a large sample from the cheap cumulations design, and the current-survey-like design would have very little impact on the cumulations.

Some of the barriers to using a cheap cumulations-oriented design for the current surveys are:

- 1) mail surveys are too slow for CPS monthly estimates;
- 2) some of the surveys are already too long;
- 3) some of the surveys have complicated questionnaires, which would be hard to administer by mail;
- 4) some of the surveys require multiple visits at the same household for bounding or for collecting longitudinal characteristics, which is not an efficient design for cumulations;
- 5) the surveys' sample sizes are too small to have much impact for cumulations.

The small possible gains from using other surveys' sample households as part of the ILF did not seem to justify the disadvantages for the other surveys of having to add long-form questions to their interview and redesigning their sample to fit ILF's needs. So a stand-alone ILF is proposed. Integration of ILF and current surveys estimates is part of the future plans for the IEP, but not common sample designs or data collection modes.

If the goal were to make estimates for medium-sized areas such as counties or cities, modified

versions of the CPS or NHIS designs would be much more attractive.

This work, included in the draft report CM-5, should be regarded as suggestive rather than conclusive. Once it seemed clear where the results were headed, attention was switched to other issues, without completing the documentation of the result based on more precise estimates of relative cost and design effects.

III. BASIC ILF PROTOTYPE

There will be a monthly mailout of 500,000 questionnaires, spread evenly over all blocks, with one interview per address. The mailing will include various devices to improve response, including a prenotice letter, a respondent-friendly questionnaire, a reminder card, and a replacement questionnaire. There will be telephone followup for some item nonresponse. The prototype assumes the same content as the 1990 long form.

Mail nonreturns will be followed up by telephone. Telephone numbers will be obtained from commercial lists, the previous census, and possibly "last resort" reminder cards.

Our design research looked at subsampling mail nonreturns for telephone followup. Based on standard optimal allocation formulas, the optimal subsampling rate would have been about 3 in 4, which is not worth the extra complication. The prototype therefore assumes that all mail nonreturns for which we can get a telephone number would be followed up by telephone.

Cases which can't be reached by telephone, including vacant units, would be subsampled for personal visit interview. The typical rate would be 1 in 3, but in sparse rural areas rates of 1 in 5 would be used; the exact rates will be determined after a more precise review of field costs. In rural areas, noncompact clusters of three addresses in nearby tracts would be formed for the personal visits.

The prototype includes oversampling of governmental units with population less than 2500, as was done in the 1990 long form sample. One-fifth of the addresses in such areas will be in sample each year.

Even after allowing for differential weights, this design would match 1990 long-form reliability, comparing five-year cumulations to the corresponding long-form estimate, for "typical characteristics." The exception is the small governmental units, where the ILF variance slightly exceeds the 1990 variance.

IV. PLANS FOR PREDICTING THE COST OF THE PROTOTYPE

The Census Bureau's "Year 2000 Census Input/Output Model" will be used to try to predict the annual cost of the prototype, and to estimate the savings in the decennial census from eliminating the long form.

Four basic scenarios will be costed out, corresponding to the possible combinations of:

- 1) 100% or 64% of 1990 effective sample size; and
- 2) with or without oversampling of governmental units with less than 2500 persons.

The 64% sample size was chosen to correspond

to a 25% increase ($1/\sqrt{.64} = 1.25$) in coefficient of variation, which has an effect on the confidence interval roughly the same as going from a 90% to a 95% confidence level.

The cost model will be applied with high, medium, and low variations of operational parameters, such as:

- mail return rate
- telephone number availability
- edit failure rate
- personal visit response rate
- miles per case
- field cases per day
- miles per case
- proportion of addresses requiring listing

Once these operational costs have been estimated, we need to decide how to look at the "net cost for a decade". I propose looking at the first (partial) decade as the period 1998-2002, in which five years of ILF data collection replaces the 2000 long form. Then the system enters its steady state, with 2003-2012 data collection replacing the 2010 long form. During this and later decades (2013-2022, etc.) there will be additional savings and efficiencies which would not apply in 1998-2002. In particular, since MAF will have been running continuously since

2000, we may find ways to save work on the 2010 census address list construction. Also there will be savings from using MAF for the current household surveys, plus a possibility of reducing ILF sample size if the Integrated Estimates Program makes better estimates possible from a smaller sample size.

Besides the basic operational costs of the Continuous Measurement system, which have been included in our research, we need to decide how to count associated costs, such as the cost of the basic MAF, any additional headquarters costs for research or management, and costs of increased publication and data analysis for possible new uses of the data.

V. OPERATIONAL ISSUES

Our research has looked at the data collection and processing issues in a fair amount of detail for this stage of the research. Some critical uncertainties are:

- coverage of MAF
- need for special field operations to locate MAF addresses
- how to include non-city-style addresses
- mail return rates
- sampling and interviewing Group Quarters
- telephone number availability
- hard-to-reach areas
- within-household coverage
- benefits of MAF quality assurance
- coordination with census address list development
- how soon do we need to start development and testing

Developing the system will be a challenge. Although all these issues will have an important impact on cost and quality, the only operational problems I see as potentially fatal are if our ideas for including rural-style addresses (e.g., Post Office boxes or general delivery) don't work out, or if MAF has unexpectedly poor coverage.

VI. DATA QUALITY ISSUES

A more serious potential barrier to acceptance of Continuous Measurement is a range of data quality issues.

A. Definitional Issues of collecting census data throughout the year:

- seasonal vacants

- residence rules
- reference period
- ability to recall income, etc.

Specialists in measuring income are particularly worried about possible recall problems as interviewing moves away from April.

B. Acceptability of rolling five-year cumulations instead of once-a-decade measurement.

Moving averages are a new way of looking at things for many users. There are some clear technical problems, especially for estimation of medians and other percentiles. Some of the issues:

- cohort analysis
- matching studies
- effect on percentiles
- adjustments for inflation
- changes of boundaries
- accuracy of variance claims

For some characteristics, our statement that the ILF has the same variance as the long form is based on oversimplified assumptions. For example, we need 60 months of sample to match long-form reliability, but for a ski resort where all the action takes place in 3 months of the year, we have more like 15 months of effective sample. This illustrates the complexity of some of the quality comparisons: how do you compare the loss from this inflated variance for ILF with the loss of having only April data, albeit with better variance, for a ski resort?

C. General quality issues

Some examples:

- control counts for weighting
- quality of field staff
- coverage
- reliability of funding
- interview mode effects

Decennial long-form estimates can be ratio-adjusted to the complete count from the full census, even for small areas like tracts. Controls this good would not conceivably be available for the ILF.

Our regular household surveys have a loss of coverage relative to the census, in part due to missed persons within households. Only a field test would show whether the ILF procedures, which are a mixture of census and current survey procedures, would share this problem.

On the other hand, the ILF would have better quality field staff, more opportunity for content reinterview, etc.

The question is, all-in-all, would the small-area data from our Continuous Measurement prototype be better than a once-a-decade long form? The Census Bureau's own experts on different uses of small-area data gave us a fairly consistent response, which I think we are likely to get from other users:

the timeliness is VERY attractive, but they need to see more details before they are comfortable with the effect on their favorite statistic.

If we proceed further with Continuous Measurement, our next step is to list specific estimates from the 1990 long form, decide exactly what estimate the ILF would produce in its place, and then analyze specific strengths and weaknesses.

VII. OTHER POSSIBILITIES

In the course of our research, we've considered other possibilities that we are still keeping in mind.

A. Start in 1999 rather than 1998

This might permit greater coordination with the 2000 census address list operation. The initial sample size would be increased, so the program would start out with a 1999-2002 or 1999-2001 cumulation to replace the 2000 long form.

B. Gradual introduction

- Keep the 2000 long form;
- Develop continuous address list construction prior to 2000;
- Do research on the Integrated Estimates Program;
- Select current household surveys sample from MAF after 2000;
- Drop the 2000 long form.

The idea is that further development of the Integrated Estimates Program would let us get good small-area estimates with much less direct data collection, i.e., at a lower cost.

C. "Medium-form" in 2000, plus intercensal large-area estimates from a design making heavy use of other Federal surveys' sample cases.

This design did not seem useful for the objective of replacing tract-level estimates. If cost, or a re-evaluation of data needs, prevents

us from getting small-area estimates for the full range of long-form items, some other designs could be worth considering.

D. Start telephone interviewing before 1998, to produce estimates for large areas.

This has been proposed recently as a way to phase in Continuous Measurement. Using the already developed methods of list-assisted random digit dialing, supplemented by nontelephone households from CPS, a survey would start in 1995 or 1996 to produce annual data for areas of 500,000 or more. This would let people get a look at data from the system right away, so that the ILF content could evolve to meet actual data uses.

VIII. CONCLUSION

The next three months are critical for the future of the Continuous Measurement option. We hope to release our predicted cost ranges, and to start providing a better description of what Continuous Measurement means for specific estimates. Based on the reaction, the Census Bureau will decide whether to devote the resources to further planning, development, and testing of the system.

References: References are contained in a larger version of this paper, "A Continuous Measurement Alternative to the U.S. Census," Report CM-10.

This paper reports the general results of research undertaken by Census Bureau staff. The views expressed are attributable to the author and do not necessarily reflect those of the Census Bureau.