

COMPUTER-ASSISTED PRODUCTION OF THE 1980 POPULATION DISTRIBUTION MAP

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ABSTRACT

The Census Bureau is completing production of a map showing the 1980 population distribution of the United States. This product of the Geography Division represents a transition in Census Bureau mapping operations; it is the first wall-sized map produced largely by computer-assisted cartographic methods. This paper describes the problems encountered and solved by computer-assisted production of the map.

INTRODUCTION

The Geography Division traditionally publishes a map showing the distribution of the population as reported in each decennial census; the map displays the urban and rural character of the distribution using multiple symbolization techniques. For example, the 1970 Population Distribution Map used three types of symbols: point symbols to represent rural population and urban place population outside of urbanized areas, graduated circles to represent urbanized area population, and an areal fill pattern to represent the extent of urbanized areas.

In the past, all wall-sized Census Bureau maps were produced using manual cartographic techniques; however, for the 1980 Population Distribution Map, an effort has been made to automate production as much as possible. This has allowed and sometimes has necessitated many changes in the design of the map.

Computer-assisted cartography allows the cartographer a great deal of flexibility in the design process. With automation, several different versions of a single map can be made quickly and compared before final production. Map parameters such as line width, symbol size and symbol placement can be adjusted by minor changes to computer programs and the results can be seen almost immediately. In addition, computers can provide accurate and repeatable linework with a quality only previously produced by the most skilled technicians.

Computer-assisted cartography is not without its shortcomings. Automation creates a set of problems not encountered in manual production. The use of computers can

place constraints on design considerations. The hardware available to the cartographer (in the case of the Census Bureau, Tektronix 4014 and 4115 graphic terminals for research and design work, and a Gerber 4477 photo head plotter for production of overlays) limits what can be plotted on the map. By using the computer as a mapping tool, the cartographer also is confronted with handling massive data files. In turn, the information on the files limits the area and subject matter to be mapped.

This paper outlines the various stages encountered in the automated production of the 1980 Population Distribution Map. In particular, the predesign considerations, the design of the test map, and final design stage are discussed.

PREPROCESSING DATA FILES

The structure and content of the data files took precedence among the design considerations. Considerable preprocessing was necessary long before a mapping product could appear or a program could be written. The Census Bureau file used to produce the map was the Master Area Reference File 2 (MARF 2)*. The file contains much more information than is necessary to produce the map. The MARF 2 contains population and locational data for all levels of census geography for each state or state equivalent. The file was stripped of extraneous information (for example, unneeded variables) before being used as input to the mapping programs.

INITIAL DESIGN PROBLEMS

The preliminary design problems centered on programming to plot the map elements. A map program was needed to convert latitude-longitude coordinates of the centroids to the map projection. In addition, algorithms were required for placement of symbols for three classes of population: rural, non-rural place outside urbanized areas, and urbanized area.

PROJECTION

A new projection program was written for the 1980 Population Distribution Map. The projection chosen was the Albers equal-area polyconic based upon the Clarke 1866 ellipsoid. The coterminous United States was shown at a scale of 1:5,000,000 while the insets were shown at various scales.

*This file is available for public use through the U.S. Bureau of the Census, Data User Services Division, Washington, DC. 20233.

RURAL POPULATION SYMBOLS

The rural population symbols were placed using data available in MARF 2. A program was written to sum the population of rural enumeration districts. When the population exceeded the value to be represented by one symbol on the map, a symbol was placed at the centroid of the last enumeration district added to the total. The population value per symbol was then subtracted from the total and the remainder carried over to be used in the next cumulative sum.

Placement of the symbol at the exact centroid, however, created an undesirable gridlike pattern especially apparent in the midwestern states, as seen on the 1970 map. A routine was, therefore, developed to randomly scatter the placement of rural symbols within approximately two symbol diameters from the centroid to reduce this problem.

PLACE POPULATION SYMBOLS

The positioning of rural and urban place population symbols was determined from a file containing the centroids and population class code of all "place" enumeration districts. Most places are made up of more than one enumeration district, so placement of the symbols became problematic. Simply placing the symbol at the average location of the centroids for a given place could, in some cases, cause a symbol to be placed inaccurately (for example, in a body of water or outside the areal extent of the place). To solve this problem, symbol placement was determined by an iterative process which moved the symbol location close to the densest concentration of enumeration districts for each place.

The symbols chosen to represent place population (filled circles, squares and triangles) were not included in the Gerber plotter software repertoire; therefore, programmed instructions were written to draw the symbols. Although these symbols appear solid on the map, they are actually plotted as successively larger symbol outlines, each of which uses the same center point.

URBANIZED AREA POPULATION

Previous population distribution maps have represented the extent of urbanized areas by a solid fill pattern bounded by each area's defined limits. Because these boundaries were not available in the MARF 2, a new method of depiction was necessary for the 1980 map. Using a file similar to that used for place population, a dot was placed at the centroid of each block group in urbanized areas. These dots coalesce to delineate the areal extent of the population.

A further change to the 1970 design involved the mapping method used to depict the size of urbanized area population. The graduated circle representation was dropped and a choroplethic technique using redefined class intervals was substituted.

THE DESIGN TEST

The northeastern United States was chosen as a test area. Since this area is the most densely populated area of the United States, problems in design would likely surface here.

Two versions of the map were tested. On one version, six classes of urbanized areas were shown (each in a different hue) and four classes of place symbols were plotted. The other version had three classes of urbanized areas (shown in a progression of hue from light purple to dark purple) and three classes of place population. In addition, two versions of the rural population symbols overlay were produced: one dot per 500 people and one dot per 1000 people. Color keys were produced for each version; these were then circulated within the Census Bureau for review.

As a result of the review, the six-class urbanized area, four-class place population version was rejected. The colors used in that version were thought to have a "fruit-salad" appearance. Furthermore, the class intervals chosen for this version did not represent a sufficiently smooth progression. Bureau tradition prevailed in retaining rural population symbolization of one dot per 500 people.

The three-class urbanized area, three-class place population version was modified, however, before acceptance as the final design. The size of the dot representing rural population was reduced. The dots used in the test had overwhelmed the other data on the map as a result of their large size and solid black color. In addition, the program to scatter the rural dots was adjusted to reduce the amount of scatter, thereby reducing the number of dots being erroneously placed within urbanized areas.

TRADITIONAL CARTOGRAPHIC INPUT

As a result of time constraints and the unavailability of certain data, the production of some elements of the 1980 Population Distribution Map will not be automated. Although the Census Bureau continues its efforts in computer-assisted cartography, as this paper goes to press, all type, coastlines, state and county boundaries are planned to be created using traditional methods. If time allows before publication of the map, all linework (coastlines, state and county boundaries, graticule) will be through computer-assisted means. The production of all publication negatives will be achieved through photo and photo-mechanical techniques.

SUMMARY

The 1980 Population Distribution Map is another step for the Census Bureau toward producing all thematic mapping products through computer-assisted means. With minor

adaptations, the software and data files created for this project will be used in future automated projects. Although the time spent in research and design was considerable, the lessons learned from this experiment in mapping methodology will benefit the Census Bureau's mapping operations in the future.