magnitude as the problems of using the alternative public sources of data. Finally, commercial data sources promise to be increasingly competitive with other sources. As such, they justify the intensive, innovative efforts currently being made by the providers, the users, and the funding agencies to further improve them. Thus, transportation planners in small and medium-sized communities should investigate commercial data sources in deciding on the means of creating and maintaining their files.

Iowa Urban Transportation Area: Traffic-Counting Program

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An overview of the traffic-counting program for urban areas in Iowa is presented. The Iowa Department of Transportation has an extensive program that covers 15 urban areas in the state that have populations of 25 000 or more. The types of traffic data collected, the problems and difficulties encountered in collection and processing, and the varied uses that are made of the data are reviewed. Preliminary results of the Sioux City counting program are included.

The Iowa Department of Transportation (IDOT) conducts traffic-counting programs in the 15 Iowa urban areas that have a population of 25 000 or more. The content of the counting program varies with the needs of the particular urban area and those of IDOT. The urban-area counting program is part of a statewide traffic-counting program that includes traffic surveillance at specified time and location intervals on approximately 179 200 km (112 000 miles) of Iowa streets and highways.

The 15 urban areas have a total of approximately 8874 km (5546 miles) of streets and highways, of which 1013 km (633 miles) are under state jurisdiction. Because IDOT is responsible for the highways under state jurisdiction, more emphasis has been placed on maintaining a current record of traffic data on these highways. These data and additional supportive inventory data on items such as roadway conditions and serviceability index are used to determine the need for and magnitude of improvements for highways.

The development of the federal-aid realignment study in 1976 has placed more emphasis on maintaining traffic data on the federal-aid road system in urban areas. The IDOT traffic-counting program now includes the monitoring of traffic data on the federal-aid urban system. In the 15 urban areas, there are 2451 km (1532 miles) of federal-aid urban highways.

IDOT also supports a cooperative counting program between urban areas and the state. Under the cooperative program, the urban area and IDOT coordinate the locations to be counted and the methodology and type of count to be taken. The costs involved in collecting the data are shared by the urban area and IDOT, and IDOT assumes the responsibility of processing the data. The urban area and the state also cooperate on the cost of installation and maintenance of permanent traffic recorders.

Because many of the urban areas in Iowa involve more than one jurisdiction, problems often arise as to the sharing of responsibility among the different jurisdictions. Typical of this is the Des Moines urbanized area, which includes eight different cities. However, continued efforts by IDOT on the exchange of traffic data between the state and the jurisdictions have kept these problems to a minimum.

TYPES OF TRAFFIC COUNTS

Six types of traffic counts are made:

1. Permanent-traffic-recorder counts,
2. Cordon and screen-line counts,
3. Turning-movement counts,
4. Portable-recorder counts,
5. Vehicle-classification counts, and
6. 24-h control-station counts.

Permanent Traffic Recorders

IDOT maintains 85 permanent traffic recorders at 64 locations on the highway system and 21 at 13 locations in urban areas. These permanent recorders provide continuous traffic data on highways that have different traffic characteristics, functional classifications, areas served, and types of system. Hourly, daily, weekly, monthly, and annual traffic volumes are obtained for each recorder and stored on magnetic tape.

The data obtained are compiled from each recorder and a 3-year average is computed. Factors are developed from these 3-year averages that expand the short-term counts to an average annual daily traffic volume.

For example, for a 7-11 a.m. and 2-6 p.m. manual count taken on a July weekday, these factors ranged from 1.665 for a location on I-235 in Des Moines to 1.960 for a local city street in a residential area of Ames.

Data from these recorders are also used in computing the 30th-highest-hour volume at urban-area recorders. These data are expressed as percentages of the average annual daily traffic and used in highway design.

Cordon and Screen-Line Counts

These counts are conducted on a 2-year cycle in urban areas. The cordon-count locations are established at all highways entering the urban-area boundary, and the screen-line-count locations are established along the boundary of a natural barrier such as a river or a railroad within the city. The counts are generally mechanical recorder counts taken at the specified location for a period of 24-48 h.

In urban areas such as Iowa City or Ames where a state university is a major traffic generator, the counts are conducted during the school year.

A comparison with a previous count period is made to evaluate traffic-volume changes. This alerts transportation planners if unusual changes have occurred in the traffic pattern and can be used to update external-external and external-internal traffic movements in transportation studies.

Turning-Movement Counts

These are short-term (generally 8-h) manual counts. To obtain peak-hour volumes, the count period is generally 7-11 a.m. and 2-6 p.m. on a weekday. For specific areas where peaking occurs outside of these hours or possibly on a weekend, adjustments are made to the count schedule. Vehicular movements are accumulated in 1-h increments or, during peak hours, in 15-min increments; mechanical accumulators that identify each directional movement are used by the individual conducting the count. Portable recorders that have 1-h or 15-min accumulative volumes are often set in conjunction with a manual turning-movement count. The counts are adjusted to an average annual daily traffic volume by using the appropriate factors from the permanent-traffic-recorder counts.

Turning-movement counts that include vehicle classification are usually short-term (generally 8-h) manual counts. To obtain the mix of vehicles during peak hours, the count period is generally 7-11 a.m. and 2-6 p.m. on a weekday. Where possible, counts are conducted at intersections where turning-movement data are also obtained. Under this counting program, vehicles are manually divided into three categories: (a) passenger automobiles, pickup trucks, and panel trucks; (b) single-unit trucks; and (c) truck-tractor and semitrailer combinations. The manual count data are adjusted to an average annual daily traffic volume by using the factors developed from the permanent-traffic-recorder counts.

Portable-Recorder Counts

These counts are the major portion of the traffic-counting program in many of the urban areas of Iowa. In the cooperative counting program for urban areas, recorder counts are those most widely used by the cities. Portable recorder counts are used to identify traffic-volume changes between manual counting locations and can also be used to cordon off specific areas of a city (such as a central business district or a shopping center) to evaluate traffic volumes into a given area. They are also used extensively in the local city-street counting program for urban areas.

Often called blanket counts or coverage counts, these counts are generally obtained for 24-48 h during weekdays, unless a longer period is needed for the evaluation of special traffic conditions. Count locations are sometimes randomly selected to collect traffic data on various street systems that cover the different types of land uses and sometimes selected to identify specific traffic data needs.

Depending on the detail of the traffic data needed, the type of mechanical counter used will vary. IDOT uses a combination of recorders varying from a small accumulative recorder to dual recorders that obtain directional data on multilane divided highways.

Vehicle-Classification Counts

These counts are taken to obtain complete vehicle classification by 13 vehicle types that range from passenger automobiles to double-bottom semitrailers. The counting period is generally for 24 h to obtain hourly variation by vehicle type. Counts are also made each season to determine seasonal variation in vehicle type. Because of the high expense of this type of count, this program is on a 4-year cycle. The major use of these data is the development of the distribution of traffic on major highway segments by vehicle type and of vehicular kilometers of travel by vehicle type.

TYPICAL USES OF TRAFFIC COUNTS

The data obtained are used for numerous planning, design, and safety studies of highway improvements. Basic traffic data for developing travel forecasts on proposed highway improvements are provided. Turning-movement data provide information that can be used to identify needs such as provision of signals at intersections and left-turn storage lanes and changes in existing traffic-signal timing and to compute accident-frequency rates. Vehicle-classification data are used to prepare forecasts of commercial vehicle use on proposed improvements in highways, and vehicular kilometers of travel by vehicle type can be used for sufficiency ratings and needs studies.

Statewide Primary-Highway Counting Program

This program is conducted on a 2-year cycle; the eastern half of Iowa is counted in odd-numbered years and the western half is counted in even-numbered years. Both rural and urban primary highways [16 680 km (10 425 miles)] are included in the program. The data collected are a balanced mixture of turning-movement counts, vehicle-classification counts, and recorder counts. The approximate number of counts conducted in 1977 and 1978 are summarized below:

Type of Count	Number
Turning movement	2380
Recorder	4510
Vehicle classification	100
Total	6990

Data are collected during the summer months only and factored to average annual daily traffic volumes by using data from the permanent traffic recorders. A state primary-road traffic log and book is published, along with a statewide traffic flow map. The traffic data are also recorded on the highway base-record files and used as input for determining sufficiency ratings and for highway-needs studies.

Cooperative Traffic-Counting Programs

Although IDOT conducts cooperative traffic-counting programs in several urban areas, the degree of cooperation varies with the urban area. In Sioux City and Davenport, formal agreements have been developed in which the duties and responsibilities of each jurisdiction are defined. The programs are subject to periodic review to change count locations, type of data collected, jurisdictional responsibilities, and such.

The Sioux City cooperative counting program has been very successful. The numbers of counts that have been made in this program are summarized below:

Type of Count	Sioux City	IDOT	Total
Turning movement	32	48	80
Recorder	72	91	163
Total	104	139	243

Under this program, IDOT is responsible for summariz-

ing, factoring, and publishing in appropriate format all of the count data collected.

In Davenport, the city has elected to publish traffic-flow maps of the count data. IDOT provides the service of summarizing and factoring the count data.

In other urban areas, cities have purchased and installed permanent traffic recorders. IDOT processes the recorder tapes and provides the city with the data, as well as including the data in the permanent-recorder program. Other cooperative programs have included use by the cities of the IDOT portable recorders to conduct special counting programs.

Local-City-Street Program

In these programs, recorder and manual traffic counts taken in urban areas are classified by type of area, functional classification of highway, and population of urban area as shown below:

Type of Area	Functional Classification of Highway
Central business district	Municipal arterial
Fringe	Arterial extension
Outlying business district	Arterial-collector extension
Residential	Trunk extension
Rural	Travel-collector extension
	Municipal collector
	Municipal service

Portable traffic counts are taken on a random basis at approximately six-block intervals covering all highway classes and types of areas in an urban area. The traffic volumes recorded are assigned to a specific length of the respective functional classification of highway. A matrix that includes traffic, functional classification of highway, type of area, and population of urban area is developed. From this matrix, an average traffic volume is obtained for each functional classification, area, and population. This average traffic volume is applied to all locations where no counts are available to obtain the vehicle kilometers of travel for all highways in the urban area. The typical or average traffic volume is also included as a value for traffic on the city-street base record. This information is used in statewide highway-needs studies that include urban areas as well as rural areas. These programs have been conducted in 10 urban areas.

Sioux City Counting Program

The purpose of the Sioux City counting program was to test a program of procedures for sampling traffic counts and estimating vehicle kilometers of travel in urban areas that has been developed by the Federal Highway Administration (FHWA).

By using criteria and formulas from this program and existing traffic data, a sample size was drawn for a 95 percent confidence level. The sample selection was stratified by volume grouping and functional classification of highways to select the following numbers of counts:

Functional Classification	No. of Counts
Local service	182
Arterial	63
Freeway and expressway	32
Total	277

In addition, 28 screen-line locations and 21 special 5-day counts (7 each on local, arterial, and freeway and expressway systems) were selected, and three permanent-recorder locations were included.

The screen-line and 5-day counts and the permanent-recorder data will be used to evaluate spatial and seasonal variations in the count sampling.

The 326 count locations were randomly scheduled for counting during calendar year 1978. A total of 232 days (excluding all holidays and weekends) were used for scheduling the counts. All counts were to be made by using portable traffic recorders that print hourly traffic data. During the first four months of 1978, a total of 108 counts were scheduled.

Of the 108 counts, only 73 locations produced valid count data; at the remaining 35 locations, 28 had invalid data or no data because of weather problems such as snow removal and cold weather and at 7 there were problems due to vandalism of the recorders or recorder malfunction. Some of the counts were rescheduled for a later date, but others were lost for the program. As of December 1, 1978, 28 locations remained to be counted.

Because approximately one-third of the locations had no data, a summer count program was proposed. For this program, 305 count locations were randomly selected; these locations were not necessarily the same as those for the year-round program. Only 50 days were available for scheduling the summer program; however, all but 6 of the 305 scheduled counts were valid. (The summer counts collected will be adjusted to an average annual daily traffic by using the permanent-traffic-recorder data and then used to compute the vehicle kilometers of travel by using the FHWA procedure. These results should be available in April 1979.)

QUESTIONS ON FHWA PROGRAM

Although the FHWA procedure calls for hourly data for calculating vehicle kilometers of travel, the program could be conducted more economically by using accumulative recorders and this might be sufficient for some purposes.

Statistical sampling for both location and scheduling does not always provide for a convenient work program. This could be modified to even out the number of counts per day and allow for a more uniform flow of the work.

Relative to the paper by Stuart, it was pointed out that the cost of commercial data for Portland, Oregon, was $12 000. It was also noted that some commercial data sources overstate employment records by publishing the highest number of persons employed by a firm, rather than the average.

State employment payroll records are often very good sources of data. However, it was reported that, if the state records had been used in Portland, it would have cost $30 000 in staff time to process the file, eliminate extraneous information, and add supplemental information for noncovered employment.

In Ohio, individual areas have acquired data through commercial firms at an average cost of $4800 each. The Ohio Department of Transportation has purchased the entire state file for $19 000 in an attempt to establish a more cost-effective program.

The workshop participants generally agreed that employment data are a very important item, although there is some variation in accuracy. There was no consensus as to the accuracy needed or required.

A workshop participant reported about an area in which the use of home-interview surveys will be eliminated because employment data can be acquired directly from the employers. The addresses of all major employers (who account for 85 percent of areawide employment) are available, and the remaining 15 percent are distributed to the traffic zones based on best judgment. The model set used develops trip tables for analysis purposes.

This effort was initiated in an attempt to explain an increase in traffic volumes along one major corridor. Information showed that the traffic was probably originating in a 600-unit subdivision outside the urbanized area. This information plus trip-generation rates from the Trip Generation Manual of the Institute of Transportation Engineers enabled the study staff to verify their models against areawide ground counts. The

work was considered successful and will be used in subsequent revisions.

After a review of various problems in gathering employment data, the workshop participants recommended that the U.S. Department of Labor advise the states that employment records can be shared with metropolitan planning organization staffs without confidentiality problems. More and more states are restricting the use of the employment file, which is considered an important data source for a key indicator of changes in an area.

Population is the most important planning variable that all should collect. It was noted that the Office of Management and Budget requires that all federal agencies use revenue-sharing estimates and that state agencies should do the same. Each state or local area can find any number of methods for estimating and forecasting population.

Relative to Studer's paper, it was noted that, although population estimates and forecasts are important, a transportation analyst relates to traffic-count data. The traffic-counting program in the United States is extensive and participated in by all levels of government. In many areas, it is the basic source of data for urban-area surveillance.

The uses of traffic-count data are extensive. If the data are properly organized, one count at one location can be used for many purposes: calculation of vehicle kilometers of travel, traffic-flow diagrams, trends, congestion indicators, fuel use, calibration of models, accident rates, local area travel as part of a larger total, Environmental Protection Agency needs, and especially citizen and business needs.

The workshop participants generally agreed that traffic counts are worth their cost. There are, however, improvements in the efficiency of the process that can be made; it can be more highly mechanized and the duration of the counts can be shortened. State counts can be subcontracted to local units of government to decrease travel expenses. Similar administrative revisions in procedures could reduce the costs. (The costs of traffic counting in 10 states range from $400 000 to $1 300 000/year. In Minnesota, it is estimated to cost $15-20/short mechanical count.)

Some of the final observations include the following:

1. Traffic counting is both essential and traditional.
2. The input from urban planners into the location of traffic counting stations should be increased.
3. There should be more short counts.
4. There is generally too much rural counting and not enough urban counting.
5. Metropolitan planning organizations should consider collecting sufficient traffic counts during 1980 when the census will be undertaken.
6. Existing traffic-counting programs at the local level should be coordinated among the various governmental agencies.
7. Traffic counts are a very effective basis for a surveillance program.
8. Sampling theory is very important in selecting traffic-count locations.

Geographic Data Resources for Small and Medium-Sized Urban Transportation Planning Programs

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Census data in terms of total numbers are sometimes of limited value to transportation planners. Some of the special tools developed by the Census Bureau can be more useful in obtaining small-area data. For example the geographic base file-dual independent map encoding (GBF/DIME) system provides what is essentially a computerized map of an area and is invaluable to any local planning effort in cross-referencing street addresses and in geographic coding of an identifiable addressed area. Another helpful program was developed to correct, update, and extend the information contained in the GBF/DIME system. The Census Bureau has also done extensive work in identifying legal geographic entities and in determining their relationships to one another, based on laws, statutes, court rulings, and such. In addition to legal area boundaries, which change frequently, the bureau defines fixed statistical geographic units (such as census blocks, census-designated places, and county divisions) that can be useful in urban transportation planning.

The value of census data is directly related to the ability of the Census Bureau to classify them geographically. The total population of the United States is an interesting number—about 218 million persons at this time—but, by itself, this number has limited use. For the local data user, it is important to be able to identify the population, for example, within the state of Florida, within the corporate limits of Sarasota, within census tract 10, perhaps even within block 301.

The same is true in the transportation planning process, whether it is for a small or a large urbanized area. Total figures are interesting, but they do little to provide the information needed by those working in the week-to-week planning process. This paper reviews certain geographic tools, as well as selective legal and statistical areas developed or used by the Census Bureau, that have also been adopted and used by many transportation planning operations to obtain small-area data.

THE GBF/DIME SYSTEM

What Is the GBF/DIME System

A computer file that contains systematically organized geographic information is referred to as a geographic base file (GBF).

In an approach to the organization of a GBF that uses graph theory as the conceptual framework, each street on a map can be considered as a series of lines and each intersection of lines as a node point. An entire map sheet, therefore, can be viewed as a series of interrelated lines, node points, and enclosed areas (see Figure 1). This approach is referred to as dual independent map encoding (DIME). The term DIME describes the fact that the basic file that represents the map geography can be defined by two independent sets of identifiers for each line segment: (a) the node points at the end of each line segment (e.g., nodes 24 and 25 in Figure 2) and (b) the enclosed areas on either side of the line segment (e.g., blocks 101 and 102 in this figure).

Thus, the Census Bureau GBF, which uses the DIME approach is referred to as the GBF/DIME file. The total GBF/DIME system is composed of a computerized geographic reference file, a metropolitan map series, a series of clerical and computer maintenance programs, and a series of user-oriented programs.

The GBF/DIME file, itself, is a computerized version of a map. It contains all of the features shown on the Census Bureau's metropolitan map series plus block-by-block address ranges, ZIP codes, and X-Y coordinate values (latitude-longitude and state plane) where map features intersect.

Each computer record in the GBF/DIME file identi-