Vehicle Origin Survey

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The vehicle origin survey (VOS) is an effective and economical method of determining the origin (home address) of motorists by using vehicle license plate numbers recorded at selected locations. The license plate numbers are matched against the national registration files of R. L. Polk and Company and based on the vehicle owner's address, various geographical codes (including zip code, census tract, and block group) are applied to establish the origin of the vehicles surveyed. Applications cover a broad spectrum including transit planning (park-and-ride and nonwork bus route needs), transportation planning (commuter traffic and origin/destination trip tables for airports, employment centers, stadiums, etc.), and environmental engineering (gas conservation and air/noise quality). In short, VOS can be of assistance to any local government or private activity or business that relies on or is related to the automobile (including light trucks) as a means of transportation. The process of selecting survey locations, the collection time periods, and the size of the sample are defined by the user and depend on the scope, extent, and intent of the survey. Data collection is a straightforward process that can be provided either by the user or by an outside collection agency. Quality control is the key element with emphasis on recording the license numbers accurately and legibly (on forms) or dictating clearly on voice tape. Survey outputs are in the form of statistical tables and computer tapes (geocoded to census geography), which can be supplemented by graphic presentations and computer dot mapping overlaying local street maps.

The majority of personal transportation needs are provided by passenger cars and light trucks. By recording vehicle license plate numbers gathered at any location (intersection, destination, etc.), the residence (origin) of the vehicle owners can be established.

This is a straightforward approach that has been proven effective but because of methodological complexity and cost has been somewhat restricted in use. The vehicle origin survey (VOS) overcomes these difficulties and offers an efficient and economical way to obtain the benefits of this technique. License plate numbers are gathered, transferred onto magnetic tape, and matched against the R. L. Polk and Company nationwide motor vehicle registration files. Matched output is provided on computer tape and summary statistical reports. Computer-generated maps can be prepared that identify the geographic location of the registered owner. The following items concerning the owner and the vehicle are provided:

1. Geography of owner's residence--county, postal town, zip code, census tract, and block group; and
2. Vehicle information--model year, fuel type, number of cylinders, and cubic-inch displacement.

In addition to the standard geographic codes listed above, other geographical indicators could be provided (e.g., traffic zones, municipalities).

Agreements with various states preclude the use of name and address of the registered owner; therefore, this information can be provided to the public sector only if written approval is granted by the appropriate state motor vehicle authorities.

SURVEY APPLICATIONS

The VOS has been used to provide essential data for various planning programs. These include the following:

1. Park-and-ride lots--Surveys were conducted in the Detroit area by Southeastern Michigan Transportation Authority (SEMTA), which identified the areas where commuter bus and commuter train riders originated. The results also indicated mileage (as the crow flies) from residence to parking location, residence location overlap between adjacent stations, and information concerning the need to extend certain routes (Figures 1 and 2).
2. Airport use--A survey of motor vehicles parked at the Greater Cincinnati Airport established the residence distribution of airline passengers throughout the metropolitan area. Figures 3 and 4 specify the origin of these vehicles by distance (1-mile increments) from the airport and also the relative vehicle density by distance from the airport. The number of vehicles from the area covered by each 1-mile concentric ring is divided by the square miles in that geographical area to determine the vehicle density per square mile.
3. Commuter parking--Data gathered at a major Cincinnati downtown commuter parking facility (Riverfront Stadium) indicated that 50 percent of the commuter vehicles were from 11 zip-code areas, 75 percent from 30 zip-code areas, and all 613 vehicles in the survey covered almost 100 zip codes (Figures 5 and 6).
4. Commuter traffic--Commuter entrances to downtown Cincinnati were surveyed at peak hours to determine the origin of vehicles at the various entry points. Figure 7 summarizes the results by census tracts. Figure 8 charts vehicle residence location for the Central and Seventh entranceway and indicates that the majority of vehicle owners using this entrance lives within a radius of 5-10 miles.
5. Bus-route planning--SEMTA is using the nonwork trip data gathered at major regional shopping centers to assist in planning nonpeak bus routes to better utilize equipment and provide a public transportation alternative for shoppers. Figures 9 and 10 illustrate the type of data used in this survey.

VOS, particularly when coupled with follow-on surveys, can also be effectively applied to a variety of other transportation studies. Technical vehicle information (vehicle type, model year, cylinders, cubic-inch displacement, etc.) included in the output could prove valuable in estimating fuel consumption and air and noise quality.

Since VOS data are coded at various geographical levels, the output is being used effectively in conjunction with other data bases. SEMTA has incorporated VOS with demographic data, employer data, and home interviews in their total planning efforts.

SURVEY STRUCTURE

The survey method is dictated by the location(s) and the purpose of the survey. Survey location, days of the week, time of day, number of days, etc., as decided on for two of the applications described above were as follows:

1. Park and ride--Gather all license plate numbers of vehicles using parking lots of park-and-ride facility. Observe vehicles and record license numbers for vehicles parking and for vehicles dropping off individuals. Observe vehicles to exclude (or separately identify) non-park-and-ride use of lots.
2. Commuter traffic--Record license plate numbers of vehicles passing the location from 7:30 to 9:00 a. m. on a typical weekday.

Figure 1. Vehicle origin survey: Jeffries and Middlebelt park-and-ride lot.

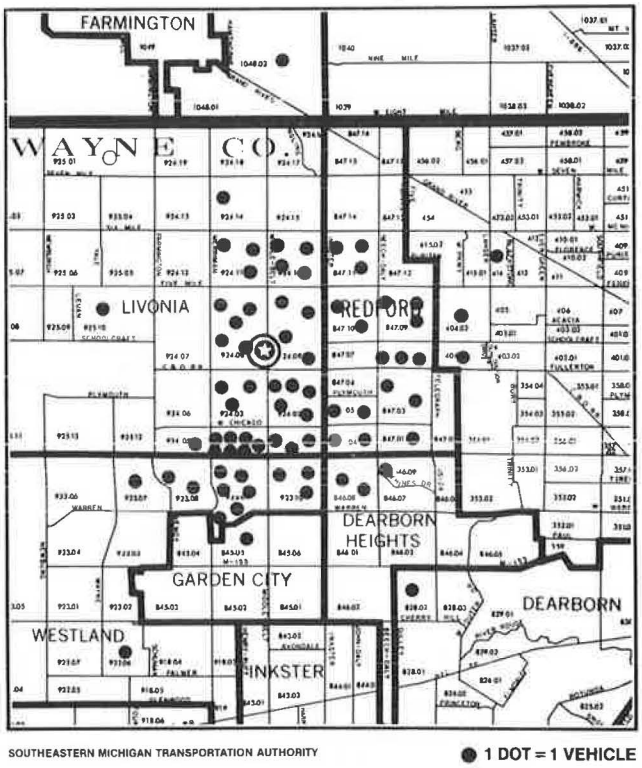

Figure 2. SEMTA park-and-ride survey.

LOCATION: FOREST CITY - JEFFRIES FREEWAY AND MIDDLEBELT

DATE	TIME	PLATE	ZIP	TRACT	COUNTY	********TOWN**
102479	920AM	LRR163	48073	1021.00	26125	ROYAL OAK
102479	920AM	JGJ838	48024	1048.02	26125	FARMINGTON
102479	920AM	PXD231	48060	6106.00	26125	PORT HURON
102479	920AM	NSW783	48205	64.00	26163	DETROIT
102479	920AM	DYS629	48210	122.00	26163	DETROIT
102479	920AM	DXJ761	48223	404.01	26163	DETROIT
102479	920AM	MHL535	48223	404.02	26163	DETROIT
102479	920AM	NSZ880	48223	414.00	26163	DETROIT
102479	920AM	MBJ565	48205	707.03	26163	DETROIT
102479	920AM	MFJ568	48128	828.02	26163	DEARBORN
102479	920AM	MBZ378	48135	845.05	26163	GARDEN CITY
102479	920AM	NTH833	48127	846.08	26163	DEARBORN HTS
102479	920AM	DYK136	48127	846.08	26163	DEARBORN HTS
102479	920AM	NTH351	48127	846.09	26163	DEARBORN HTS
102479	920AM	RCJ660	48239	847.01	26163	DETROIT
102479	920AM	MFM398	48239	847.03	26163	DETROIT
102479	920AM	MFR669	48239	847.03	26163	DETROIT
102479	920AM	NSY776	48239	847.04	26163	DETROIT
102479	920AM	NTB893	48239	847.04	26163	DETROIT
102479	920AM	DKB766	48239	847.05	26163	DETROIT
102479	920AM	PCF925	48239	847.05	26163	DETROIT
102479	920AM	MHL461	48239	847.08	26163	DETROIT
102479	920AM	TJK625	48239	847.08	26163	DETROIT
102479	920AM	PKX853	48239	847.08	26163	DETROIT
102479	920AM	JCM925	48239	847.09	26163	DETROIT
102479	920AM	NJG371	48239	847.09	26163	DETROIT
102479	920AM	MLX911	48239	847.09	26163	DETROIT
102479	920AM	DJP443	48239	847.10	26163	DETROIT
102479	920AM	HHZ642	48239			
102479	920AM	CJM179	48239			
102479	920AM	DKF647	48239			
102479	920AM	DJS673	48239			
102479	920AM	DNZ325	48185			
102479	920AM	MMG188	48185			
102479	920AM	NST823	48185			
102479	920AM	RBZ158	48185			
102479	920AM	RNV257	48185			
102479	920AM	CHV789	48185			
102479	920AM	PXG510	48185	523.09	26163	WESTLAND
102479	920AM	DKH935	48185	523.09	26163	WESTLAND
102479	920AM	PCK808	48185	523.09	26163	WESTLAND
102479	920AM	DGF444	48185	523.09	26163	WESTLAND
102479	920AM	TML198	48185	523.10	26163	WESTLAND
102479	920AM	NTD816	48185	523.10	26163	WESTLAND
102479	920AM	NSY721	48185	523.10	26163	WESTLAND
102479	920AM	RSS428	48150	524.01	26163	LIVONIA
102479	920AM	NST390	48150	524.01	26163	LIVONIA
102479	920AM	RDP166	48150	524.01	26163	LIVONIA
102479	920AM	NTC973	48150	524.02	26163	LIVONIA
102479	920AM	NSV761	48150	524.02	26163	LIVONIA

This is a partial listing of the data used to conduct a Vehicle Origin Survey for one of several SEMTA Park & Ride locations. The dot map on the opposite page illustrates, by census tract, the area this location serves. When evaluated in conjunction with surveys for other locations and with other data bases (demographic, employment, interview), the need for & effectiveness of a transit system can be determined

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DETROIT, MICHIGAN JAN 21, 1980

SAMPLE SIZE

A VOS can be conducted by gathering all vehicle license plate numbers or relying on a representative sample. Samples will be more effective when the total number of license plates to be recorded would otherwise be very large. The total number of license plates to be recorded depends on both the extent of the geographic areas to be covered and the level of geographic detail required.

1. Regional application--When vehicles are expected to originate from an entire standard metropolitan statistical area, or a major portion of one, a survey size equivalent to approximately 1 percent of total households (but not less than 2500 license plates) is required if reasonably adequate counts are to be expected at the census-tract level. If reliable measures by time of day and/or day of week are also desired, larger samples may be required. Increases in sample size will be necessary if data are gathered for several different survey locations.
2. Local application--Surveys with as few as 300 observations have proven effective when a low-volume location with a more localized draw is involved.

MATCH RATES

On average, approximately 75 percent of the license plate numbers are matched in the R. L. Polk and Company files. The primary factors for a 25 percent nonmatch rate are as follows:

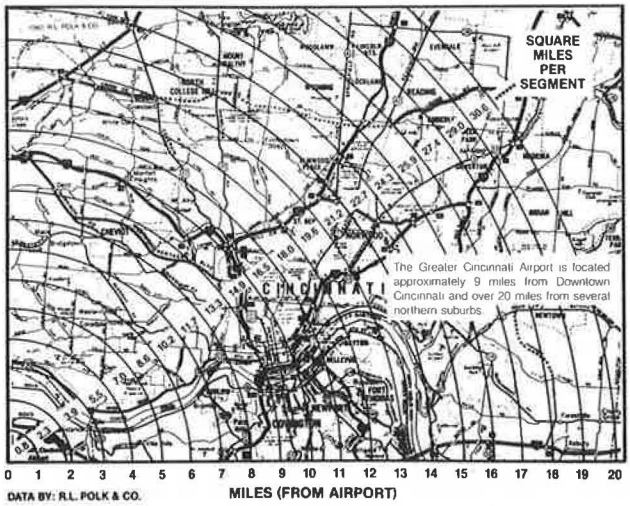
1. A portion of the vehicles originates outside the geographical area included in the study (for cost effectiveness the portion of the registration file to be searched is predefined),

Figure 3. Vehicle origin survey: September 1980, Cincinnati metropolitan area.

SAMPLE CONTAINS 567 OBSERVATIONS WITH 178 DIFFERENT CENSUS TRACTS

RANK	CENSUS TRACT	COUNTY	COUNT	% OF TOTAL	ACCUM. %
1	109.00	17	29	5.11	5.11
2	251.00	61	22	3.88	8.99
3	221.01	61	12	2.12	11.11
4	239.00	61	11	1.94	13.05
5	244.00	61	11	1.94	14.99
6	215.02	61	11	1.94	16.93
7	319.00				18.69
8	221.02				20.28
9	215.03				21.69
10	249.00				23.10
11	240.00				24.81
12	215.01				25.75
13	214.02				26.98
14	235.00				28.22
15	226.00				29.45
16	212.00				30.69
17	207.03				31.92
18	236.00				33.16
19	250.01				34.39
20	42.00	61	6	1.06	35.45

License plate numbers gathered in the parking lots (including satellite lots) at the Greater Cincinnati Airport were processed and 567 of the license plate observations were census tract coded. These 567 vehicles originated from 178 different census tracts and the tract with the greatest number was 109.00 (29 vehicles or 5.11% of the total). The cumulative percent (Accum. %) indicates that 25% of airport usage originated from 12 census tracts.



2. There are errors in the collection or preparation of data, and
3. New license plate numbers are not yet in the registration files (the vehicle registration files are updated from one to three times per year depending on the state involved).

An analysis of the unmatched records found in vari-

Figure 4. Vehicle origin survey: Greater Cincinnati Airport.

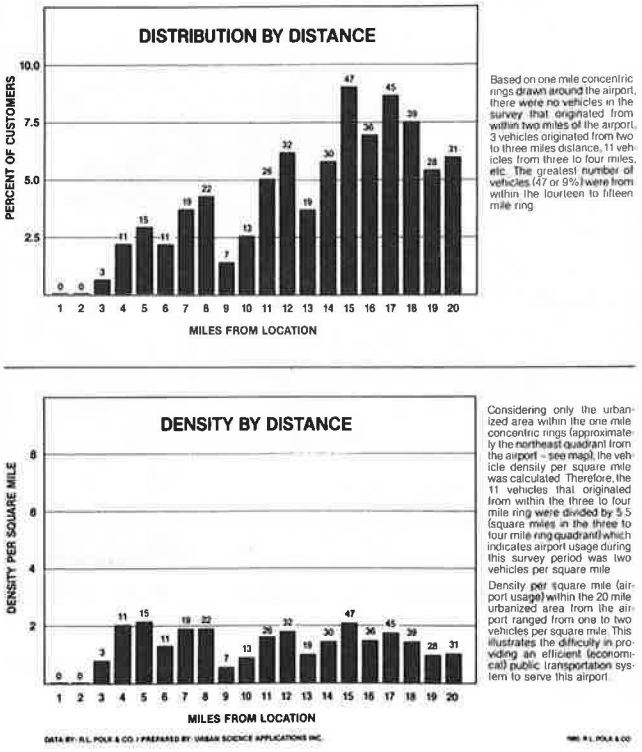


Figure 5. Vehicle origin survey: September 1980, Riverfront Stadium.

TOTAL SURVEY CONTAINS 613 OBSERVATIONS WITH 96 DIFFERENT ZIP CODES

RANK	ZIP CODE	COUNT	% OF TOTAL	ACCUM. %
1	45236	75	12.23	12.23
2	45211	50	8.16	20.39
3	45230	42	6.85	27.24
4	45239	30	4.89	32.14
5	45242	23	3.75	35.89
6	45231	19	3.10	38.99
7	45208	15	2.45	41.44
8	45244	15	2.45	43.88
9	45224	15	2.45	46.33
10	45215	14	2.28	48.61
11	41017	14	2.28	50.90
12	45220	13	2.12	53.02
13	45240	13	2.12	55.14
14	41075	11	1.79	56.93
15	45236	10	1.63	58.56
16	45014	10	1.63	60.20
17	45243	9	1.47	61.66
18	45245	9	1.47	63.13
19	45204	9	1.47	64.60
20	45237	8	1.31	65.91
21	45213	7	1.14	67.05
22	45223	7	1.14	68.19
23	45246	7	1.14	69.33
24	45140	7	1.14	70.47
25	45227	6	0.98	71.45
26	45212	6	0.98	72.43
27	45209	6	0.98	73.41
28	45002	5	0.82	74.22
29	45206	5	0.82	75.04
30	45205	5	0.82	75.86
31	45229	5	0.82	76.67
32	41011	5	0.82	77.49
33	45241	5	0.82	78.30
34	45225	5	0.82	79.12
35	45233	5	0.82	79.93
36	45216			
37	45219			
38	45226			
39	45069			
40	45102			
41	41042			
42	41015			
43	45013			
44	45030			
45	45150			
46	45217	3	0.49	86.79
47	45202	3	0.49	87.28
48	45001	3	0.49	87.76
49	45015	3	0.49	88.25
50	45036	3	0.49	88.74

Riverfront Stadium and adjacent areas are used as commuter parking lots during normal working hours. A survey of these lots during a work day (when special events were not taking place) resulted in 613 vehicles originating from 96 different zip codes.

Zip code 45238 had the greatest number of vehicles (75 or 12.23% of the total). The last column (cumulative %) indicates 50.90% of the vehicles originated from only 11 zip code areas, and 75.04% from 29 zip codes.

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Figure 6. Vehicle origin survey: commuter parking, Riverfront Stadium area.

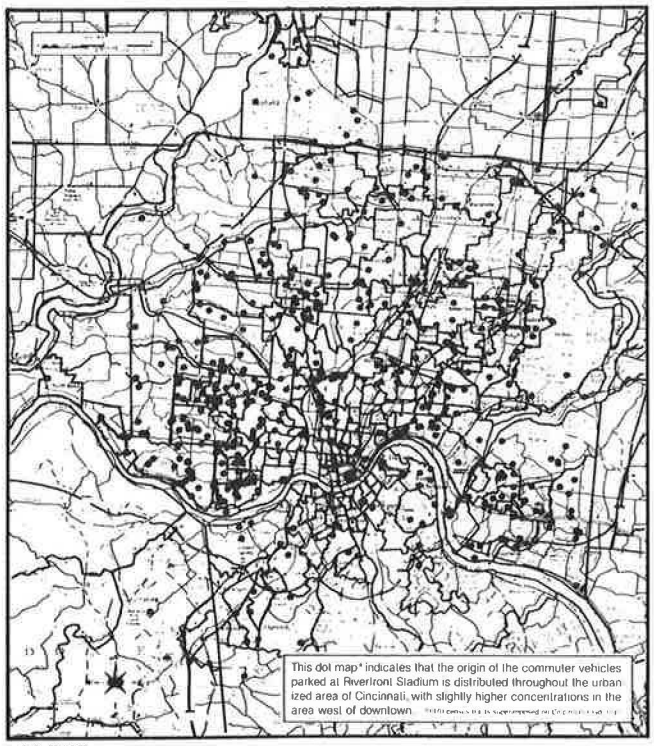

Figure 7. Vehicle origin survey: commuting traffic, Central and Seventh, Cincinnati metropolitan area.

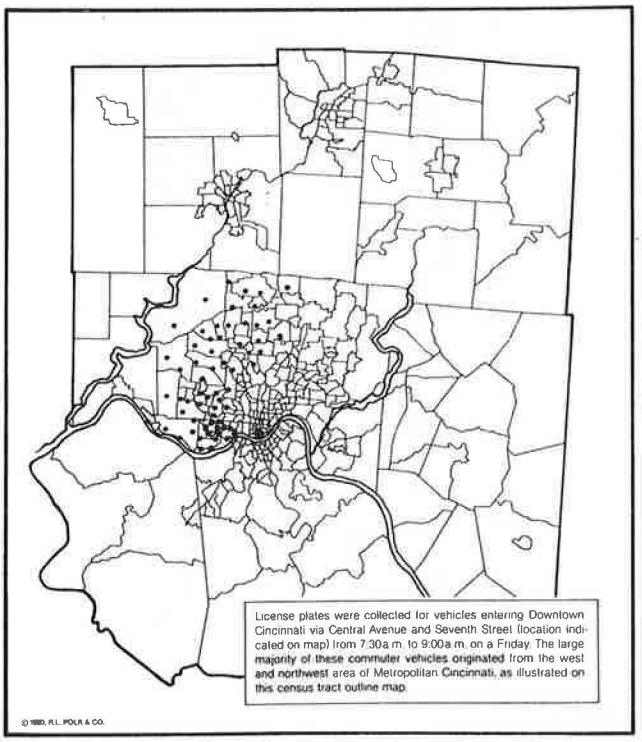

Figure 8. Vehicle origin survey: distribution by distance, Cincinnati metropolitan area.

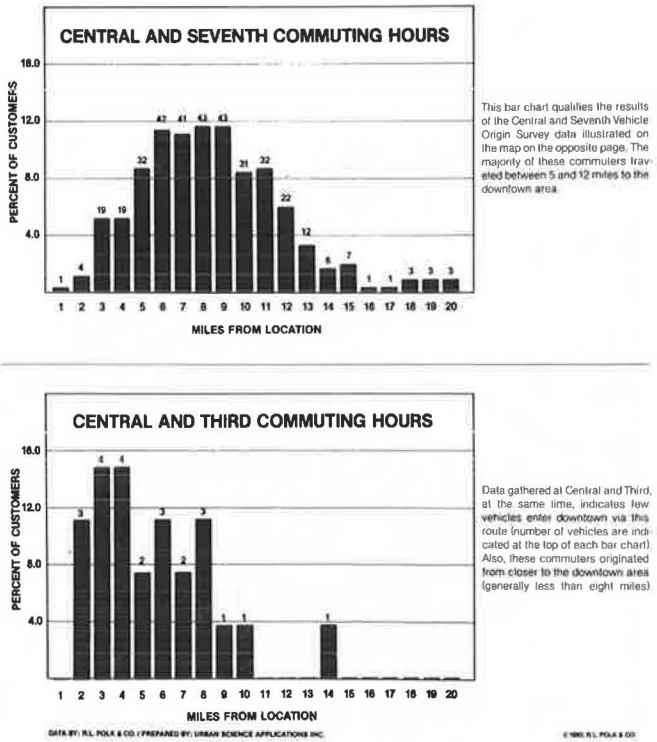

Figure 9. Vehicle origin survey: Regional Mall, Cincinnati metropolitan area.

TOTAL SURVEY CONTAINS 2041 OBSERVATIONS WITH 134 DIFFERENT ZIP CODES

RANK	ZIP CODE	COUNT	% OF TOTAL	ACCUM. %
1	45240	190	9.31	9.31
2	45231	153	7.50	16.81
3	45014	147	7.20	24.01
4	45246	143	7.01	31.01
5	45215	137	6.71	37.73
6	45069	124	6.08	43.80
7	45241	88	4.31	48.11
8	45239	76	3.72	51.84
9	45011	72	3.53	55.36
10	45242	62	3.04	58.40
11	45013	52	2.55	60.95
12	45218	50	2.45	63.40
13	45140	44	2.16	65.56
14	45040	43	2.11	67.66
15	45042	42	2.06	69.72
16	45236	36	1.76	71.48
17	45224	34	1.67	73.15
18	45211	32	1.57	74.72
19	45237	29	1.42	76.14
20	45238	27	1.32	77.46
21	45230	22	1.08	78.54
22	45015	20	0.98	79.52
23	45247	19	0.93	80.45
24	45150	18	0.88	81.33
25	45212	18	0.88	82.21
26	45216	18	0.88	83.10
27	45223	16	0.78	83.88
28	45220	15	0.73	84.62
29	45243	14	0.69	85.30
30	45213	13	0.64	85.94
31	45056	13	0.64	86.57
32	45227	13	0.64	87.21
33	45208	12	0.59	87.80
34	45229	11	0.54	88.34
35	45209	10	0.49	88.83
36	45030	9	0.44	89.27
37	45005	9	0.44	89.71
38	45232	9	0.44	90.15
39	45036	8	0.39	90.54
40	41011	6	0.29	90.84
41	45039	6	0.29	91.13
42	45122	6	0.29	91.43
43	45157	5	0.24	91.67
44	45050	5	0.24	91.92
45	41017	5	0.24	92.16
46	45205	4	0.20	92.36
47	45414	4	0.20	92.55
48	45370	4	0.20	92.75
49	45219	4	0.20	92.94
50	45133	4	0.20	93.14

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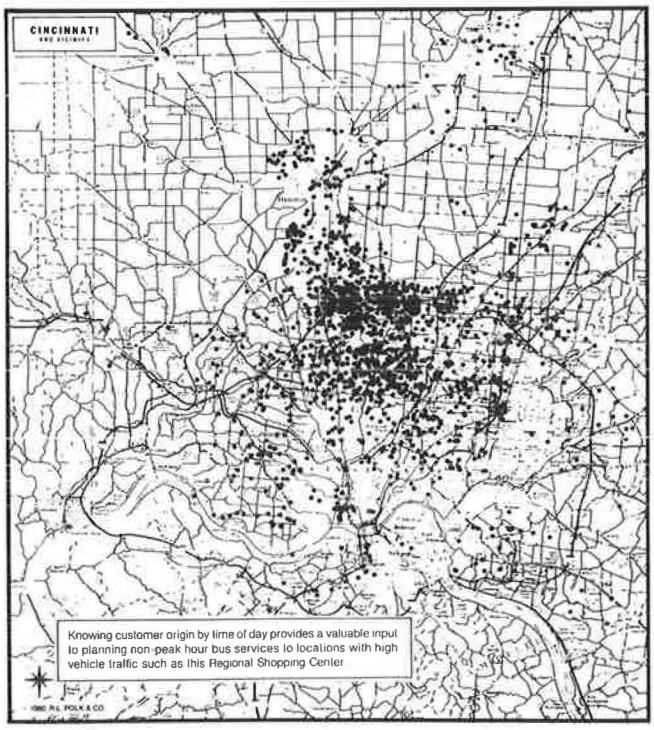
DATA BY: R.L. POLK & CO. OCT 17, 1980

Figure 10. Vehicle origin survey: Tricounty Regional Mall, Cincinnati metropolitan area.



ous surveys has been carried out; the results are as follows:

Factor	Percent
Outside survey area	10
Not in state file (input error)	8
In state file, not yet in R. L. Polk and Company file	7
	25

Further analysis of the 7 percent not yet in Polk files indicated that these were generally distributed in the same manner as the matched license plates.

The match rate is used as a quality control measure to evaluate surveys from market to market and from time period to time period. Also, by assigning codes to data collectors and keypunch operators, the accuracy of recording and preparing data can be measured by comparing individuals' match rates to the norm.

DATA-GATHERING TECHNIQUE

Gathering data is more logistical than technical. Users can easily collect their own data or employ outside data collection. The technique for gathering the numbers, like the sample size, is dictated by the survey location and purpose. A commonsense approach is required:

1. Stationary point--Moving traffic requires a vantage point that gives a clear view of all vehicles (from the rear only in one-license-plate states). The collector must be close enough (preferably within 50 ft) for visual observation of the license numbers on vehicles in all traffic lanes. This can be accomplished by standing on a sidewalk, on the shoulder of the road, or even on an overpass. If a low profile is desired, the collector

can sit in a parked vehicle adjacent to the observation point. This same technique can be followed to record license plates as cars enter downtown parking garages.

2. Walking--An area such as a commercial strip that is congested with vehicles scattered throughout requires the data collector to walk. It is too difficult and often dangerous to drive under these conditions and effectively collect the data.

3. Moving vehicle--Large parking lots (e.g., regional shopping centers and commuter parking lots) that hold great numbers of vehicles can efficiently be surveyed from a moving vehicle. Traffic is usually light and the lot can be driven slowly to ensure accurate collection of data.

SURVEY METHODOLOGY

Two methods of recording data have been used effectively to date. These are forms and voice tape. Each has advantages and disadvantages that, in part, depend on the location as well as the individual collector.

1. Forms
   a. Use when small number of vehicles per site expected or small sample collected
   b. Maximum of 300 license plate numbers per hour can be recorded
   c. Requires less training and skill than voice recording
   d. Forms easily controlled and audited
   e. Writing, however, must be legible so as not to confuse 8 and B, 2 and Z, etc.
2. Voice tape
   a. Use when large sample required and vehicles concentrated
   b. 500 plate numbers per hour easily recorded
   c. More effective when collecting from moving vehicle
   d. Diction and enunciation very important (use words instead of letters--"Able" or "Apple" for A, etc., and say "Stop" after each license plate number)
   e. More equipment, greater expense, and sometimes technical problems
   f. Data preparation personnel must be trained to keypunch accurately from voice tape
   g. Greater potential for error

Cameras and hand-held keyboard entry directly to tape are also available but have not been used in VOS and thus cannot be evaluated at this time.

CONCLUSION

Experience to date has demonstrated that the VOS can provide a cost-efficient, highly useful data input to the overall transportation planning process, which can be further enhanced by follow-on surveys of motor vehicle owners. In addition, the ability to computer-map motor vehicle origin by census tract (or other small area) provides the professional and nonprofessional alike with an immediately understandable picture of the commuter and nonwork trip "marketplace" by specific destination. And when coupled with total vehicle ownership by census tract, demographics, etc., this service provides other measures such as "market penetration" relationship between public and private transportation use at the small geographic area level.

The service includes output tapes, statistical reports, and computer mapping. It is important to restate that name and address of registered owners are not available to the commercial or private sector and only available to the public sector when written approval is granted by the appropriate state motor vehicle authorities.

Analysis of Employee Residential Locations for Transit Planning

RAI PARVATANENI AND TIMOTHY LAMBERT

The development of a data base that describes the residential locations of employees working in the Detroit central business district (CBD) and adjoining major activity centers is described. The data base helped to conduct immediate and short-term transit service planning functions of the Southeastern Michigan Transportation Authority in the Detroit metropolitan area. This data-base development was undertaken because of the limitations of the existing sources that describe the work-related travel. Data describing the employee residential locations of selected major employers were gathered from personnel departments. The employers provided either an address list of their employees or summaries by zip-code locations. The residential locational descriptions of 33 555 employees for the CBD and 34 583 employees for the adjoining activity center represented sample rates of 31 and 52 percent of the total employment. An expansion methodology was developed and deployed to project sample data to the total employment population for 1980. Further, 1985 residential location projections were made by using the base-year data and regional population and employment-growth factors. The base-year location data at census-tract level for each employer or groups of employers and summaries for the total employment became valuable information in instituting peak-period route services; existing services were modified and route-effectiveness measures were developed. The base-year and 1985 data were also used in short-term transit service planning.

The Southeastern Michigan Transportation Authority (SEMTA) plans, constructs, and operates public transportation facilities and services. Although the authority's area of jurisdiction covers the seven counties of southeastern Michigan, SEMTA primarily serves suburban to downtown Detroit commuter travelers and travel demands between suburban communities. Under a purchase-of-service agreement, SEMTA is also responsible for Detroit services operated by the City of Detroit Department of Transportation (DDOT).

Although SEMTA was created in 1967, the authority's operations actually began in 1971, with the first of several purchases of private carriers. Over the years, SEMTA ridership has steadily increased. Ridership since 1974 has increased at an annual rate of 13 percent from 7.1 million to more than 13.4 million annual passengers. Because of the trend toward ridership increases, SEMTA will have to