compare fatal-accident data from one year to another without also considering the economic conditions in the years compared.

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**Mr. Eshler was with Nationwide Insurance, Columbus, Ohio, when this research was performed.*

Analysis of Countywide Accident Data by Rate and Frequency

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A Highway Safety Program Standard (Identification and Surveillance of High Accident Locations) requires each state and local community to have an established procedure for the identification of high accident locations. The standard, however, specifies neither definite criteria nor procedures for the identification of such locations. Consequently, communities throughout the country use a variety of identification methods with varying degrees of success and accuracy. These range from the accident-frequency method to the accident-rate method and various combinations of them. The result of these procedures is the identification and selection of the most critical accident locations. A methodology for the analysis of large numbers of locations has been developed and implemented in Oakland County, Michigan, as part of a countywide comprehensive traffic engineering project. The methodology uses both accident-frequency and accident-rate data for each intersection and highway link to identify the most critical locations. The procedure stratifies the data from a number of intersections (or links) and assigns each location to a cell within a matrix that considers accident frequency on the horizontal axis and accident rate on the vertical axis. The locations contained in the cell corresponding to the highest frequency and the highest rate are identified as the most critical locations. Locations with a high frequency and a low rate or a high rate and a low frequency are considered less critical. A computer program was developed that determines the rate and frequency for all highway locations (intersections or links) being analyzed, assigns each location to the appropriate cell in the rate and frequency matrix, and then prepares reports indicating the locations contained in each cell and the pertinent data for each location. The rate and frequency analysis procedure was tested by using countywide accident data, as well as data from smaller political jurisdictions, and was an effective and valuable traffic-engineering tool.

Increased travel on our roads and highways is causing a corresponding increase in the number of accidents. However, when these numerical increases are compared with the higher travel loads, there has been a net decrease in accident rates (1). This decrease can be attributed, at least in part, to the positive effects of safety-improvement programs. Continued safety improvements require the comprehensive assessment of problem locations and subsequent corrective actions.

A Highway Safety Program Standard requires each state and local community to have an established procedure for identifying high-accident locations. Most communities identify such locations by considering either accident frequencies or accident rates and using assigned threshold values (2, 3). The use of a single indicator and an arbitrary threshold value, however, sometimes results in the selection of noncritical locations for improvements and may omit locations that are more critical.

STUDY OBJECTIVES

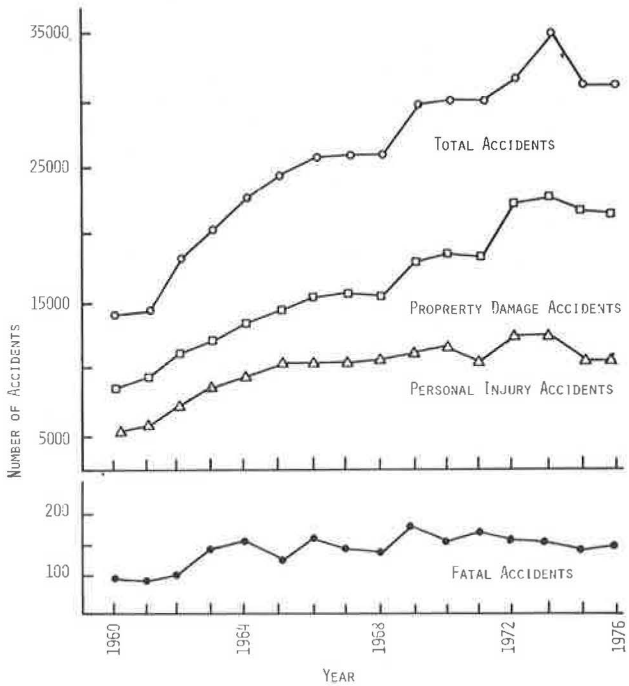
The object of this study was to develop a methodology that would stratify the highway locations in an area in a manner that would eliminate the possibility of selecting noncritical locations for remedial action. The basic steps in the countywide accident study were to

1. Develop a methodology that allows an analyst to establish the relative standing of all accident locations in a community;
2. Develop a computer program that can use the available accident data, determine the overall and by-type accident frequencies and rates, and generate a rate and frequency matrix indicating the relative standing of the intersection and highway-link locations in the county; and
3. Test the procedure with the Oakland County, Michigan, accident data to identify high-accident locations and to prove the validity of the system.

The frequency of accidents at an intersection or a link location is an important measure of safety conditions. A location, however, may have a low accident frequency and a very low traffic volume and thus a high accident rate, whereas another location may have a high accident frequency and a very high traffic volume and thus a low accident rate. It must then be determined which of the two locations is more critical.

Accident frequency is defined as the number of accidents at a location per year. Accident rate is defined (for intersection locations) as the number of accidents per million vehicles entering the intersection per year and (for links) as the number of accidents per million vehicle kilometers of travel per year.

Figure 1. Oakland County accident trends.



The study was conducted in Oakland County in southeastern Michigan. The county has an area of 2351.2 km^2 (907.8 miles^2) and had a 1975 population of 975 097. The trend of the overall accident frequency since 1960 has been to increase except in 1968, 1971, 1974, and 1975 (Table 1). The overall accident statistics, when plotted, indicate a leveling off in the numbers of fatal and personal-injury accidents (Figure 1).

ANALYSIS PROCEDURE

Defining high, moderate, and low accident locations is an essential prerequisite to any plan to reduce safety hazards on highways. The establishment of criteria for such categorization, however, varies in different communities. Therefore, this study attempted to develop an analysis methodology that could categorize accident locations by both their accident frequencies and rates. A community could then develop a priority scheme based on its available resources.

To identify high-hazard locations in the county on a basis of either accidents or accidents of specific types, a computer program was developed to determine the accident frequencies and rates for all locations and to assign each location to a position in the rate and frequency matrix.

This methodology is based on a simultaneous consideration of accident rates and frequencies by using a

Table 1. Countywide accident statistics.

	Accidents				Persons			Annual Percentage Change in Total Accidents
Year	Total	Property Damage	Injury	Fatal	Injured	Killed	Total	
1960	13 722	8 385	5 234	103	8 517	122	8 639	—
1961	13 947	8 194	5 656	97	9 327	108	9 435	1.6
1962	18 051	10 730	7 219	102	11 825	115	11 940	29.4
1963	20 251	11 854	8 252	145	13 654	163	13 817	12.2
1964	22 571	13 115	9 291	165	15 258	202	15 460	11.5
1965	24 472	14 260	10 076	136	16 359	164	16 523	8.4
1966	25 650	15 122	10 361	167	16 692	179	16 871	4.8
1967	25 814	15 648	10 021	146	16 289	165	16 454	0.6
1968	25 799	15 104	10 554	141	17 218	163	17 381	0
1969	29 414	17 958	11 275	181	18 165	201	18 366	14.0
1970	29 987	18 458	11 372	157	18 072	173	18 245	1.9
1971	29 433	18 720	10 541	172	16 284	189	16 473	1.8
1972	34 366	22 170	12 035	161	18 601	179	18 780	16.8
1973	35 020	22 681	12 180	159	18 426	186	18 612	1.9
1974	32 401	21 665	10 588	148	15 812	160	15 972	7.5
1975	32 415	21 583	10 679	153	16 117	161	16 278	0

Figure 2. Typical rate and frequency analysis matrix.

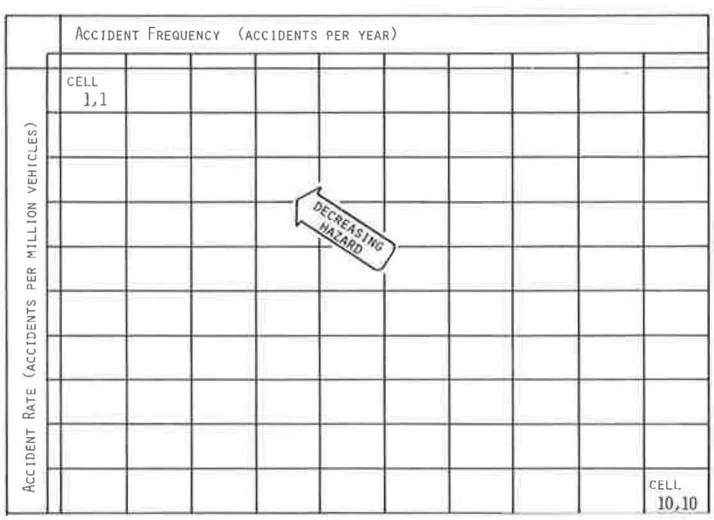
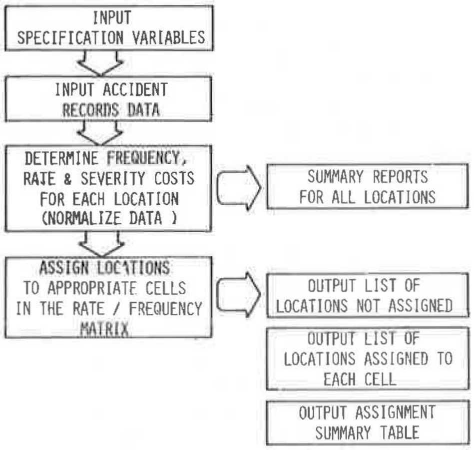


Figure 3. Macroscopic program flow chart.



matrix format (Figure 2) in which the horizontal axis of the matrix is divided into 10 increasing increments of annual accident frequency, and the vertical axis is divided into 10 increasing increments of accident rates. For roadway segments or links, the rate was based on accidents per million vehicle miles per year per mile of road; for intersections, the rate is based on accidents per million entering vehicles per year. (SI units are not given for the variables in this matrix because it was developed for use with U.S. customary units.)

The location of a cell in the matrix defines a certain level of hazard. The most hazardous intersections or links in the system are located in the lower right-hand cell of the matrix, i.e., cell (10, 10). Decreasing levels of hazard are represented by other cells in the matrix as one moves toward the upper left-hand corner, i.e., toward cell (1, 1).

The computer program uses accident-inventory data files to produce reports indicating the allocation of in-

Figure 4. Cell-assignment summary: 1973 intersection accident data file.

1973 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL INTERSECTION ACCIDENTS)
RATE/FREQUENCY MATRIX CELL ASSIGNMENT TOTALS

ACCIDENT RATE	ACCIDENT FREQUENCY (ACCIDENTS/YEAR) 0- 4	5- 8	9- 12	13- 16	17- 20	21- 24	25- 28	29- 32	33- 36	37-150
0.0 - 0.59	119	39	5	2	0	0	0	0	0	0
0.60- 1.19	62	66	52	18	6	6	3	2	0	1
1.20- 1.79	22	40	33	22	14	8	6	8	2	6
1.80- 2.39	17	19	21	16	14	9	6	1	3	13
2.40- 2.99	4	9	17	18	5	6	8	1	9	21
3.00- 3.59	3	4	4	10	6	7	5	4	5	15
3.60- 4.19	1	3	6	2	3	5	2	2	1	13
4.20- 4.79	0	1	2	2	4	1	3	4	2	9
4.80- 5.39	1	3	1	2	0	2	3	0	0	10
5.40- 24.00	9	7	8	5	3	0	2	2	0	22

TOTAL INTERSECTIONS ASSIGNED 968

Figure 5. Intersection locations assigned to cell (10, 10): 1973 intersection accident data file.

1973 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL INTERSECTION ACCIDENTS)

INTERSECTIONS ASSIGNED TO CELL 10 , 10 PAGE 105

INTER ID	ACCDNT	VOLUME	(DATE)	RATE	SEVERITY F	PI	PD	COST	CNTRL	INTERSECTION NAME	
38	45	20000	13/70	6.16	0	16	29	68320.00	1	E. WIDE TRACK	E. HURON
39	51	15000	13/70	9.32	0	9	42	50760.00	1	E. WIDE TRACK	UNIVERSITY
41	38	15000	13/70	6.94	0	20	18	76640.00	1	E. WIDE TRACK	SAGINAW
44	56	25000	13/70	6.14	0	13	43	64840.00	1	W. WIDE TRACK	W. HURON
122	49	24000	13/70	5.59	0	20	29	81920.00	1	STEPHENSON	THIRTEEN MILE
124	118	49258	5/71	6.56	0	60	58	231840.00	1	STEPHENSON	FOURTEEN MILE
126	46	12949	6/69	9.73	0	18	28	74640.00	1	ROCHESTER	WATTLES
132	69	25000	13/70	7.56	0	28	41	114880.00	1	ROCHESTER	AVON
173	43	9000	13/70	13.09	0	14	29	61520.00	1	EAST BLVD.	UNIVERSITY
306	84	38383	5/71	6.00	0	18	66	92880.00	1	CROOKS	BIG BEAVER
478	37	18046	11/70	5.62	0	16	21	64480.00	1	MIDDLEBELT	ELEVEN MILE
498	85	38174	1/74	6.10	0	27	58	119640.00	1	ORCHARD LAKE	MAPLE
507	50	24395	1/73	5.62	0	17	33	73640.00	1	ORCHARD LAKE	MIDDLEBELT
547	37	17743	4/71	5.71	0	15	22	61560.00	1	HALSTEAD	GRAND RIVER
658	71	34742	9/70	5.60	0	23	48	101240.00	1	M-59/HIGHLAND	CRESCENT LAKE
659	57	28913	9/70	5.40	2	22	33	254640.00	1	M-59/HIGHLAND	AIRPORT
674	50	20771	6/73	6.60	0	23	27	91160.00	1	M-59/HIGHLAND	MILFORD
727	50	24743	8/70	5.54	1	15	34	149320.00	1	GRAND RIVER	NOVI
765	51	18857	7/71	7.41	4	16	31	397280.00	1	TEN MILE	NOVI
815	40	20000	13/70	5.48	0	14	26	60080.00	1	AUBURN	EAST BLVD.
819	57	23000	13/70	6.79	0	25	32	100360.00	1	AUBURN	PADDOCK
942	59	19310	9/71	8.37	0	26	33	104240.00	1	LAPEER	DRAHNER

tersections or links to the various cells of the matrix on the basis of preselected frequency and rate increments.

A macroscopic flow diagram of the computer program is shown in Figure 3. The program first reads specification variables such as

1. The name of the accident data file (page header);
2. The type of accident to be analyzed, such as total or motor vehicle and parked vehicle; and
3. The increments of accident rate and frequency to be used.

The program then reads accident-record data from tapes for the time period being considered in the analysis. The accident-record data are summarized and normalized for each location, and a summary report of such items as the accident frequency, accident rate, and severity cost for each location is printed out. The program then assigns each location to the appropriate

Figure 6. Cell-assignment summary: 1974 intersection accident data file.

1974 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL INTERSECTION ACCIDENTS)
RATE/FREQUENCY MATRIX CELL ASSIGNMENT TOTALS

ACCIDENT RATE	ACCIDENT FREQUENCY (ACCIDENTS/YEAR) 0- 4	5- 8	9- 12	13- 16	17- 20	21- 24	25- 28	29- 32	33- 36	37-150
0.0 - 0.59	119	36	6	2	0	0	0	0	0	0
0.60- 1.19	67	72	54	13	7	8	1	2	3	1
1.20- 1.79	30	35	39	26	20	9	8	5	6	3
1.80- 2.39	7	24	18	17	21	15	13	1	6	12
2.40- 2.99	5	5	11	8	10	9	7	7	6	21
3.00- 3.59	3	3	4	5	7	1	2	5	2	13
3.60- 4.19	5	4	3	4	4	2	4	4	0	9
4.20- 4.79	2	1	2	4	3	1	1	3	2	7
4.80- 5.39	1	3	3	1	1	1	1	0	0	6
5.40- 24.00	5	3	7	3	4	2	2	1	1	5

TOTAL INTERSECTIONS ASSIGNED 961

Figure 7. Intersection locations assigned to cell (10, 10): 1974 intersection accident data file.

1974 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL INTERSECTION ACCIDENTS)

INTERSECTIONS ASSIGNED TO CELL 10 , 10 PAGE 105

INTER ID	ACCDNT	VOLUME (DATE)		RATE	SEVERITY F	PI	PD	COST	CNTRL	INTERSECTION NAME	
124	107	49465	3/74	5.93	0	28	79	133120.00	1	STEPHENSON	FOURTEEN MILE
306	95	45963	3/75	5.66	0	27	68	124440.00	1	CROOKS	BIG BEAVER
674	46	20771	6/73	6.07	0	16	30	68800.00	1	M-59/HIGHLAND	MILFORD
765	42	18857	7/71	6.10	2	15	25	227000.00	1	TEN MILE	NOVI
942	56	19310	9/71	7.95	0	26	30	102800.00	1	LAPEER	DRAHNER

Figure 8. Cell-assignment summary: 1973 link accident data file.

1973 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL LINK ACCIDENTS)

LINKS ASSIGNED TO CELL 10 , 10 PAGE 104

LINK ID	ACCIDENTS TOTAL	ACC/MI	VOLUME	(DATE)	RATE	SEVERITY F	PI	PD	COST	LNGTH	LINK NAME	
26.	134	134.00	19802	9/71	18.54	1	53	80	300600.00	1.0	JOHN R	10 MILE-11 MILE
60.	95	95.00	17000	13/72	15.31	0	33	62	141960.00	1.0	ROCHESTER	BIG BEAVER-WATTL
96.	99	99.00	11000	13/73	24.66	0	32	67	140960.00	1.0	LIVERNOIS/MAIN	14 MILE-MAPLE
119.	44	73.33	13094	10/72	15.34	0	12	32	56160.00	0.6	ROCHESTER	MAPLE-STEPHENSON
180.	71	101.43	17000	13/73	16.35	0	15	56	77880.00	0.7	ADAMS	WOODWARD-MAPLE
812.	123	123.00	20000	13/73	16.85	0	50	73	205040.00	1.0	9 MILE	JOHN R-DEQUINDRE
824.	34	48.57	6091	5/70	21.85	0	12	22	51360.00	0.7	10 MILE	HAGGERTY-GRAND R
862.	72	144.00	25000	13/72	15.78	0	31	41	125080.00	0.5	11 MILE	W MDSN HGHTS LMT
885.	65	65.00	9333	4/73	19.08	1	21	43	174040.00	1.0	12 MILE	FARMINGTON-ORCHA
892.	125	125.00	23483	4/73	14.58	0	29	96	144680.00	1.0	12 MILE	GREENFIELD-COOLI
968.	251	251.00	38462	8/73	17.88	1	98	152	488160.00	1.0	14 MILE	CAMPBELL-JOHN R
1117.	42	140.00	17412	9/73	22.03	0	13	29	58120.00	0.3	COOLEY LK	UNION LK-WILLIAM
1531.	144	160.00	26400	4/72	16.60	0	46	98	203440.00	0.9	M 59/HURON	TELEGRAPH-JOHNSO
1532.	112	160.00	21400	4/72	20.48	0	32	80	147200.00	0.7	M 59/HURON	JOHNSON-W WIDE T
1678.	13	65.00	9000	13/73	19.79	0	6	7	23760.00	0.2	LAFAYETTE	10 MILE-WOODWARD
1682.	28	46.67	5000	13/73	25.57	0	12	16	48480.00	0.6	FRANKLIN	S PNTC CTY LT-SO

cell in the rate and frequency matrix. The primary output is a report that lists all locations assigned to each cell and includes all the relevant information for each location. Locations that cannot be assigned because of missing data are indicated in a special report. Finally, the program summarizes the locations assigned to the rate and frequency matrix and the number of locations assigned to each cell.

The program was written in FORTRAN IV and has been implemented on an IBM 360-67 computer. It requires 130 kilobytes of central processing unit memory with data-storing capabilities on discs and magnetic tapes. An analysis of countywide accidents for 1973 and 1974 for all accidents in Oakland County required 1070 central processing unit s (this system included 1684 links and 1280 intersections).

Figure 9. Links assigned to cell (10, 10): 1973 link accident data file.

1973 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL LINK ACCIDENTS)
RATE/FREQUENCY MATRIX CELL ASSIGNMENT TOTALS

ACCIDENT RATE	ACCIDENT FREQUENCY (ACCIDENTS/YEAR/MILE) 0.- 4.	5.- 8.	9.- 12.	13.- 16.	17.- 20.	21.- 24.	25.- 28.	29.- 32.	33.- 36.	37.-260.
0.0 - 1.59	101	12	6	5	6	3	1	0	2	0
1.60- 3.19	73	35	31	16	8	5	3	1	5	10
3.20- 4.79	62	26	17	32	13	8	7	4	2	19
4.80- 6.39	48	25	15	12	11	15	5	11	5	38
6.40- 7.99	24	14	10	8	6	5	5	9	3	48
8.00- 9.59	20	3	8	3	3	4	3	1	1	29
9.60- 11.19	19	2	1	1	0	1	1	0	1	8
11.20- 12.79	14	1	0	0	0	1	0	1	1	10
12.80- 14.39	16	3	3	1	0	0	0	0	1	8
14.40-200.00	122	11	1	1	5	1	1	1	0	16

TOTAL LINKS ASSIGNED 1158

Figure 10. Cell-assignment summary: 1974 link accident data file.

1974 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL LINK ACCIDENTS)
RATE/FREQUENCY MATRIX CELL ASSIGNMENT TOTALS

ACCIDENT RATE	ACCIDENT FREQUENCY (ACCIDENTS/YEAR/MILE) 0.- 4.	5.- 8.	9.- 12.	13.- 16.	17.- 20.	21.- 24.	25.- 28.	29.- 32.	33.- 36.	37.-260.
0.0 - 1.59	129	19	10	5	5	4	1	3	1	3
1.60- 3.19	87	41	28	12	4	7	4	1	2	8
3.20- 4.79	65	37	20	26	17	10	11	6	5	22
4.80- 6.39	47	12	12	21	11	9	9	8	6	36
6.40- 7.99	28	8	6	3	6	7	4	4	5	36
8.00- 9.59	21	7	2	2	1	2	4	2	3	22
9.60- 11.19	15	2	3	4	2	0	2	0	0	16
11.20- 12.79	12	0	0	0	2	0	1	1	0	13
12.80- 14.39	14	1	2	0	2	0	0	0	1	4
14.40-200.00	134	13	4	3	1	2	3	0	0	7

TOTAL LINKS ASSIGNED 1201

Figure 11. Links assigned to cell (10, 10): 1974 link accident data file.

1974 OAKLAND COUNTY TRAFFIC ACCIDENT SUMMARY (ALL LINK ACCIDENTS)

LINKS ASSIGNED TO CELL 10 , 10 PAGE 103

LINK ID	ACCIDENTS TOTAL	ACCIDENTS ACC/MI	VOLUME (DATE)		RATE	SEVERITY F	SEVERITY PI	SEVERITY PD	COST	LNGTH	LINK NAME	
60.	117	117.00	17000	13/72	18.86	0	36	81	161280.00	1.0	ROCHESTER	BIG BEAVER-WATTL
96.	77	77.00	11000	13/73	19.18	0	29	48	121640.00	1.0	LIVERNOIS/MAIN	14 MILE-MAPLE
824.	28	40.00	6091	5/70	17.99	0	9	19	39720.00	0.7	10 MILE	HAGGERTY-GRAND R
968.	232	232.00	38462	8/73	16.53	1	63	168	376840.00	1.0	14 MILE	CAMPBELL-JOHN R
1117.	52	173.33	17412	9/73	27.27	0	10	42	54160.00	0.3	COOLEY LK	UNION LK-WILLIAM
1532.	100	142.86	21400	4/72	18.29	0	32	68	141440.00	0.7	M 59/HURON	JOHNSON-W WIDE T
1682.	30	50.00	5000	13/73	27.40	0	7	23	34840.00	0.6	FRANKLIN	S PNTC CTY LT-SO

DATA ANALYSIS

The model was tested by analyzing all of the accident data for Oakland County for 1973 and 1974. Sample outputs are given in Figures 4 through 11.

Figure 4 shows the number of intersections assigned to each cell for 1973. Twenty-two intersections were assigned to cell (10, 10) (the lower right-hand corner of the matrix), which signifies the worst intersections when both rate and frequency of accidents are considered. This table also gives the increments of accident rate and frequency used in the assignment of intersections to the matrix.

Figure 5 shows the specific intersections assigned to cell (10, 10) of the matrix. The information provided by the computer program includes the following:

1. Intersection identification number;
2. Accident frequency (accidents per year);
3. Intersection traffic volume;
4. Date of intersection traffic volume (month and year), where month = 13 represents an estimated volume;
5. Accident rate (accidents per million vehicles per year);
6. Accident severity data—(a) number of accidents involving one or more fatalities (F), (b) number of accidents involving one or more personal injuries (PI), (c) number of accidents involving property damage only (PD), and (d) severity costs, based on National Safety Council figures [F = \$82 000/fatal accident, PI = \$3400/injury accident, and PD = \$480/damage accident (all 1974 figures)];
7. Signal code—(a) 1 = traffic signal, (b) 2 = stop or yield, and (c) 3 = flasher signal; and
8. Intersection name.

The data provided in this output can also be used to rank intersections on the basis of accident-severity indexes.

The assignment results for the 1974 intersection accident data are shown in Figures 6 and 7. There were fewer intersections assigned to the matrix cell (10, 10). Because the same frequency and rate increments were used in 1973 and 1974, this indicates a general decrease in traffic accidents. This decrease can be attributed to reduced travel and the benefits resulting from safety-improvement projects.

Rate and frequency analysis was also performed on all roadway links in the Oakland County highway system. The figures showing the link-rating analysis are similar to those for the intersection analysis with the exception of the following differences in the link cell-assignment summaries:

1. Accidents are tabulated as total accidents per year per mile, which normalizes the effect of link length on the accident frequency, thus allowing comparisons between links, and
2. Link length rather than signal code is given.

Figures 8 and 9 show the link accident assignments and the list of links assigned to cell (10, 10) for the 1973 link accident data. Sixteen links were categorized in cell (10, 10). The corresponding assignments for the 1974 data are shown in Figures 10 and 11.

Similar rate and frequency analyses were also performed for various categories of accident types and roadway and environmental conditions. These analyses indicated the locations that are more critical with regard to specific problems that could be remedied by lighting, skid-resistant paving, and similar improvements.

STUDY OBSERVATIONS

The development of this rate and frequency analysis program showed that three important items influence its effectiveness. These are discussed below.

1. The accuracy of the volume data—the calculation of accident-rate statistics requires the input of traffic-volume data. The traffic-volume data available were often incomplete or obsolete. In many cases, the link or intersection traffic volumes were estimated or had been obtained from volume counts made several years earlier than the accident data. In other cases, no traffic-volume data had been recorded. The success of this form of analysis is highly dependent on the input of current measured traffic volumes.
2. Overlapping accident records—there was some overlap of accidents between the intersection and link rating analyses. The data file used allows an intersection to be examined within any defined radius from its center. The link data, however, are recorded from the centers of intersections; thus, a link may contain part of a major intersection. The use of merged accident files and a criterion [e.g., radius = 61 m (200 ft)] to separate intersection accidents from link accidents can solve this problem.
3. Selecting rate and frequency increments—the selection of the rate and frequency increments is important because they define the criterion assigning the intersections or links to the cells in the matrix. Changes in these increments can cause significant changes in the distribution of intersections and links to the matrix. Each agency using the rate and frequency matrix program may need to specify its own criteria for these increments. The selection of the rate and frequency increments should be such that the locations are scattered throughout the matrix. This allows identification of the differences among locations that vary in accident experience. Unequal increments of rates and frequencies may also be used to obtain a spread in location assignments to the rate and frequency matrix. These criteria for rate and frequency increments are treated as user-specified inputs to the computer model.

SUMMARY AND CONCLUSIONS

Rate-and-frequency analysis has been developed as a tool to assist traffic engineers in identifying critical accident locations in individual states and local communities. The computer program was developed as part of the Oakland County Comprehensive Traffic Engineering Project and can analyze accident inventory data and produce reports that define the allocation of accident locations in a community into the matrix. This analysis tool has been successfully tested with stratified accident data from Oakland County, Michigan.

This methodology has several important characteristics. The rate and frequency increments are based on user specifications, so as to meet the needs of individual communities. The associated computer program produces reports for various stratifications of accident data and user-specified criteria. The computer program does not make the decisions relative to priority ranking, but allows the community to make those decisions on the basis of its available resources. This method of analysis considers both accident frequencies and rates and is cost-effective. The computer use and data-input costs are insignificant when compared to manual methods of accident analysis such as the number and rate method.

It is essential to have accurate traffic-volume data to ensure the value and validity of this procedure. Current intersection and link volume counts are therefore a prerequisite to meaningful analysis.

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Effectiveness of Selective Enforcement in Reducing Accidents in Metropolitan Toronto

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The enforcement of traffic laws is based on the belief that it induces greater driver compliance with the rules of the road, which leads to a reduction in the number of accidents. Conclusive empirical evidence substantiating this belief has, however, not previously been presented. The availability of computerized accident records for the Metropolitan Toronto Police Selective Enforcement program provided a unique opportunity to test whether increased enforcement was followed by a reduction in the number of accidents. By using accident records for 1800 locations over a period of 4 years, estimates of accident rates were obtained that accounted for a time trend and seasonal variations. The expected number of accidents so obtained was compared to the number of recorded accidents. Locations that received increased enforcement showed consistently fewer than the expected number of accidents. In the experiment, all important factors except increase in enforcement are randomized. Thus, unless there is some undetected causal factor, the reduction in accidents is statistically significant and can be attributed to the increased enforcement. If then, selective enforcement leads to a reduction in accidents, enforcement of traffic laws in general has the potential to reduce accidents. Therefore, it is important to deploy available enforcement resources to maximize their effect.

Primarily, the task of the police is to enforce the law. This being so, the effect of enforcement should be measured by the degree of compliance with the law. In more basic terms, however, the role of the traffic law and its enforcement is to induce patterns of behavior that make for safe conditions on the road. Consequently, the success or failure of the enforcement of the traffic law must be evaluated, in the final count, in terms of its effect on the occurrence of accidents.

Whether traffic-law enforcement has an effect on accident occurrence is at present largely a matter of belief. The absence of factual knowledge about effectiveness of enforcement is regrettable in view of the resources spent for this purpose. However, lack of reliable information on the effect of safety countermeasures is not confined to the field of law enforcement. Alcohol legislation, publicity campaigns, demerit point systems, vehicle inspection programs, and such are all costly countermeasures with essentially unproven effectiveness.

Why then, after decades of experience, are we still groping in the dark? Probably the most important objective impediment to the determination of the effectiveness of countermeasures is the difficulty of conducting controlled experiments. The conduct of a controlled experiment requires, in the present context, the existence of two groups of drivers that are identical in all respects (age, sex, education, experience, driving conditions, distances traveled, vehicles, and such), yet exposed to a significant difference in the variable whose effect is being investigated. Of course, occasions to structure such experiments in traffic safety are rare to nonexistent.

In 1973, Transport Canada conducted a study of the effect of enforcement (1) that was close to being a well-controlled experiment. At six of seven locations, various levels of enforcement were applied, with the remaining location serving as a control. The effect of enforcement on the number of violations was studied. During the course of this project we first learned about the selective-enforcement practice in Metropolitan Toronto. In Toronto, locations that have the dubious distinction of accumulating the largest number of accidents during a certain period of time are selected for increased enforcement. The existence of this process offered a unique opportunity to examine the effect of increased enforcement on the number of accidents in an experiment in which causal factors (which have been recognized as such) are either constant or else randomized.

SELECTIVE-ENFORCEMENT PROCEDURE AND ACCIDENT DATA BASE

Metropolitan Toronto is divided into five police districts. Each district receives periodically a list of the 20 street sections (intersections or midblock sections) on which the largest number of accidents occurred during the pre-