ALLOCATION OF PATROL MANPOWER RESOURCES

IN THE SAINT LOUIS POLICE DEPARTMENT

VOL. II

ALLOCATION OF PATROL MANPOWER RESOURCES
IN THE SAINT LOUIS POLICE DEPARTMENT

An Experiment

CONDUCTED UNDER OFFICE OF
LAW ENFORCEMENT GRANT #39

July 1966

VOL. II

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PREFACE

Volume II is a technical description and evaluation of the St. Louis Resource Allocation Project. Chapter 1 of this Volume was prepared by Mr. Richard Crowther of Systems Science Corporation, Silver Spring, Maryland. The intent of Chapter 1 is to provide a description of the quantitative evaluation of the Project. In order to understand the evaluation fully, the Chapter has been prefaced with a description of patrol scheduling problems.

As stated in Volume I, an important aspect of the evaluation concerned the impact on officer morale of the new methods for allocating patrol manpower and establishing patrol beat patterns. For this evaluation, Dr. Philip H. DuBois, of Washington University, St. Louis, Missouri, was employed. The results of his evalution were summarized in Volume I, and Chapter 2 of this Volume gives a technical and detailed account of the study conducted by Dr. DuBois.

It was believed that a description of the data processing systems, which were designed to produce the various reports used during the Project, would be beneficial to other law enforcement agencies. For this reason, Chapter 3 of this Volume provides a general description of the systems, accompanied by systems flowcharts. This chapter emphasizes the processing of data rather than individual computer programs. Finally, an Appendix has been included which describes the mathematical model for forecasting call-for-service information.

Chapter 1

QUANTITATIVE EVALUATION OF THE PROJECT

I. Description of Scheduling Problems

Long Term Trends: Demands for Police Services

St. Louis, like most American cities, has experienced a substantial growth in demands for police services in recent years. While there is no single adequate measure of these demands, individual components can be analyzed to determine trends. Table 1 shows five of the major components: Index Crimes, Part I Crimes, Radio Calls, Total Reported Traffic Accidents, and Personal Injury and Fatal Traffic Accidents.

The Index and Part I Crimes are defined under the Uniform Crime Reporting System. The Index Crimes, which actually are a subset of the Part I Crimes, are those crimes which are most likely to be reported to the police. Both series can be considered as indicators of the demand on police departments for crime prevention activities.

The Radio Calls series contains a yearly count of the number of radio transmissions over the Department's radio system. Specifically, the series contains the total number of requests out of service, directed incidents, and directed assists. Because the number of requests out of service and directed assists are influenced by the mix of one- and two-man patrol units, the series represents more than demands for police service. Despite these shortcomings, the Radio Calls still are a good measure of the total demand for all police patrol services.

The Total Reported Traffic Accidents series is simply a count of the number of reported traffic accidents occurring each year within St. Louis. The Personal Injury and Fatal Accidents series is a subset representing the more serious accidents.

Table 1

ANNUAL MEASURES OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS FOR THE YEARS 1948-1966, INCLUSIVE

Year	Index Crimes	Part I Crimes	Radio[a] Calls	Total Reported Traffic Accidents	Personal Injury and Fatal Traffic Accidents
1948	10,388	15,932	215,622	7,187	3,874
1949	10,654	16,340	272,975	7,607	4,177
1950	10,281	15,766	318,730	9,254	4,919
1951	11,701	18,075	258,766	11,127	5,151
1952	12,754	20,044	272,315	11,480	5,360
1953	14,062	22,273	282,163	10,751	4,957
1954	17,013	27,667	283,182	10,445	4,994
1955	18,327	30,511	279,167	11,032	5,109
1956	19,628	35,016	288,927	11,052	5,262
1957	21,802	37,897	338,223	12,275	5,323
1958	23,574	41,001	386,223	12,183	5,257
1959	23,175	37,121	451,165	12,674	5,741
1960	23,349	38,810	468,566	12,792	5,637
1961	20,557	35,557	489,231	13,031	5,600
1962	22,618	42,787	544,929	14,254	6,045
1963	24,792	48,746	599,556	15,248	6,366
1964	26,692	54,824	629,526[b]	18,834	7,069
1965	25,750	53,530	626,354	20,800	7,675
1966	25,798	50,940	651,575	21,347	7,542

[a] Total number of requests out of service, directed incidents, and directed assists.

[b] Estimated.

Sources: Index Crimes — 1966 Annual Report, Police Department, City of St. Louis.
Part I Crimes and Radio Calls — Administrative Analysis Division, Board of Police Commissioners.
Accidents — Analysis Division, Bureau of Field Operations.

The data in Table 1 extend from 1948 through 1966. In order to summarize the trends of these services over this period, linear regression functions were calculated, with the values of the series as the dependent variable and the last two digits of the year as the independent variable. The results, set forth in Table 2, can be regarded as indications of the changes which have taken place during the 19-year period in the demands for police services.

The data for the Index and Part I Crimes represent a good fit. Apparently, the number of reported Index Crimes in St. Louis has increased at an average rate of 984 per year, and the number of Part I Crimes has increased about 2,278 per year. The Radio Calls series shows a substantial increase per year of almost 25,000 radio transmissions. An increase of 630 per year is shown for all reported traffic accidents, while personal injury and fatal traffic accidents are increasing at a rate of 162 per year. Even though both series are increasing, it should be noted that the very serious accidents are increasing at a lower rate.

The data are summarized in Figures 1-5, which show the demands and the regression lines.

Table 3 shows the data projected to 1975 and 1980 by means of the regression functions. Thus, if the factors which caused the series to grow in the last 19 years continue to operate at the same average level of intensity, the Police Department can expect that, in the eight years between 1968 and 1975 inclusive, the number of Part I Crimes will increase by more than 18,000; that radio calls will increase by almost 200,000; and that reported traffic accidents will increase by more than 5,000.

The factors which underlie the growth in demands for police services are varied and complex. There is no reason at this time to believe that they will cease to operate. Thus, for the next few years at least, St. Louis police executives will have to anticipate growth rates of the order of magnitude given.

The St. Louis experience in the area of demands for police services is similar to that of other major cities. Figure 6 gives comparative statistics for St. Louis and all cities in the United States over 500,000 with declining populations. In total, at least, St. Louis has performed slightly better than the average comparable city.

There has been no deterioration in St. Louis in the level of police response to calls from the public. Despite the very substantial growth in calls for service over the past 19 years, there has been a negligible number of calls to which either no response was made or to which response was delayed. Service by the Department can be considered to have kept pace with the increase in calls for service.

Table 2

REGRESSION SUMMARIES OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS FOR THE YEARS 1948-1966, INCLUSIVE

Series	Equation[b]	Standard Error Of Coefficient	R^2	Current Growth Rate[a]
Index Crimes	Y=984T - 36,986	75	.91	3.3%
Part I Crimes	Y=2,278T - 96,130	145	.94	3.9%
Radio Calls	Y=24,828T - 1,012,291	2,104	.89	3.7%
Reported Traffic Accidents	Y=630T - 23,103	70	.83	3.2%
Personal Injury and Fatal Traffic Accidents	Y=162T - 3,655	18	.83	2.2%

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[a] Calculated as the ratio of the predicted growth during the year to the predicted value of the corresponding series for 1968.
[b] T represents the last two digits of the year: T=48, 49, . . ., 66.
Source: Data from Table 1.

Table 3

PROJECTED DEMANDS FOR POLICE SERVICES IN ST. LOUIS FOR 1975 AND 1980[a]

Year	Index Crimes	Part I Crimes	Radio Calls	Total Reported Traffic Accidents	Personal Injury and Fatal Traffic Accidents
1975	36,800	74,700	849,800	24,100	8,500
1980	41,700	86,100	973,900	27,300	9,300

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[a] All calculations have been rounded to hundreds.
Source: Projected, using equations in Table 2.

FIGURE 1
INDEX CRIMES BY YEAR: 1948-1966

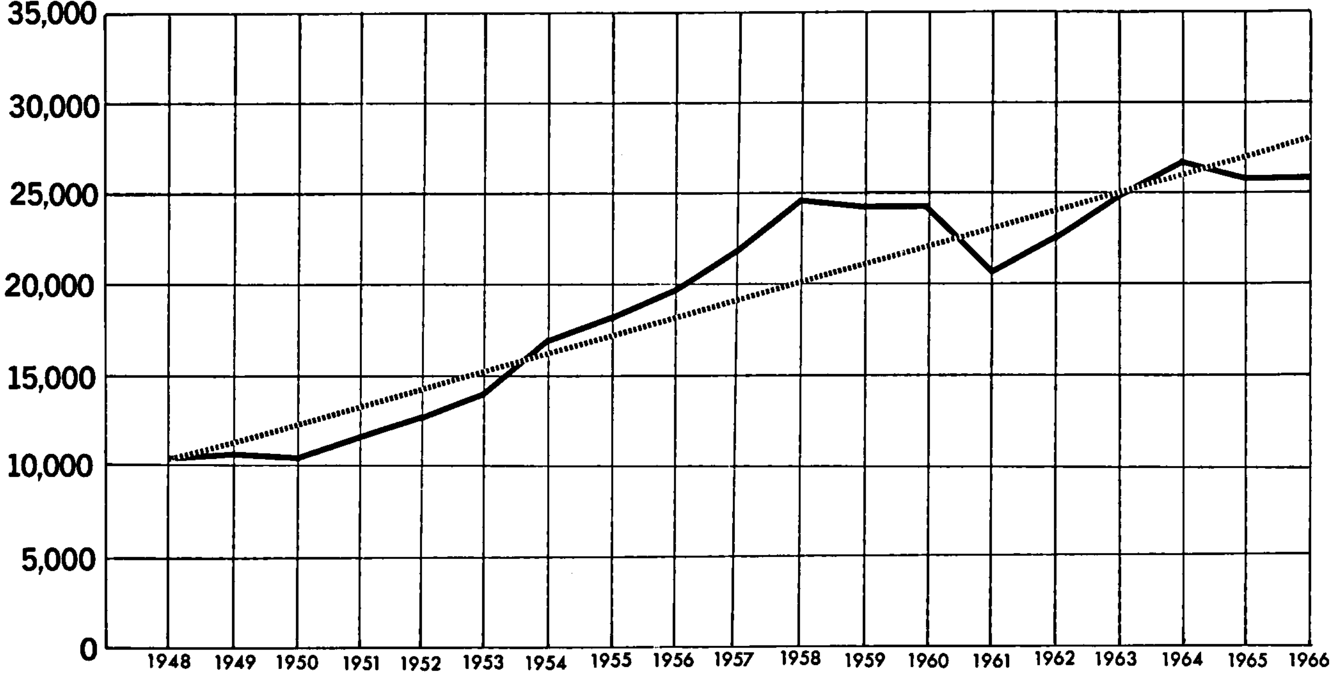


FIGURE 2
PART I OFFENSES BY YEAR: 1948-1966

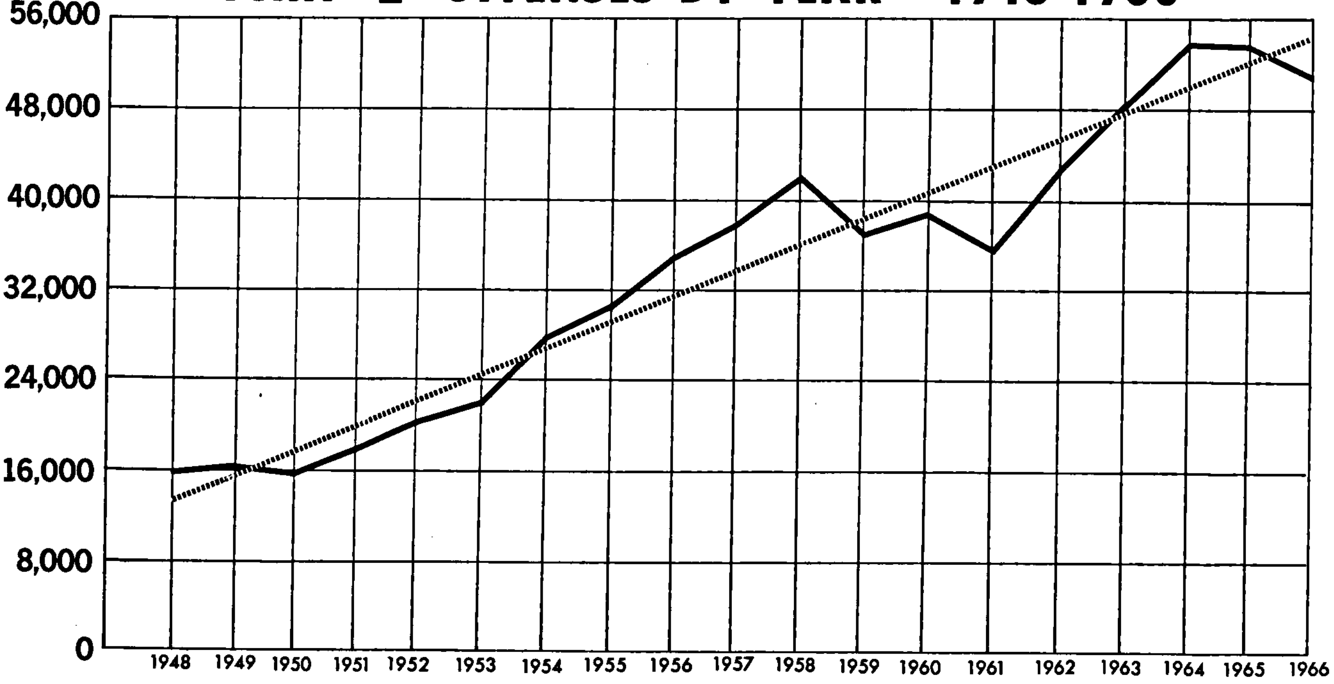


FIGURE 3
RADIO CALLS BY YEAR: 1948-1966

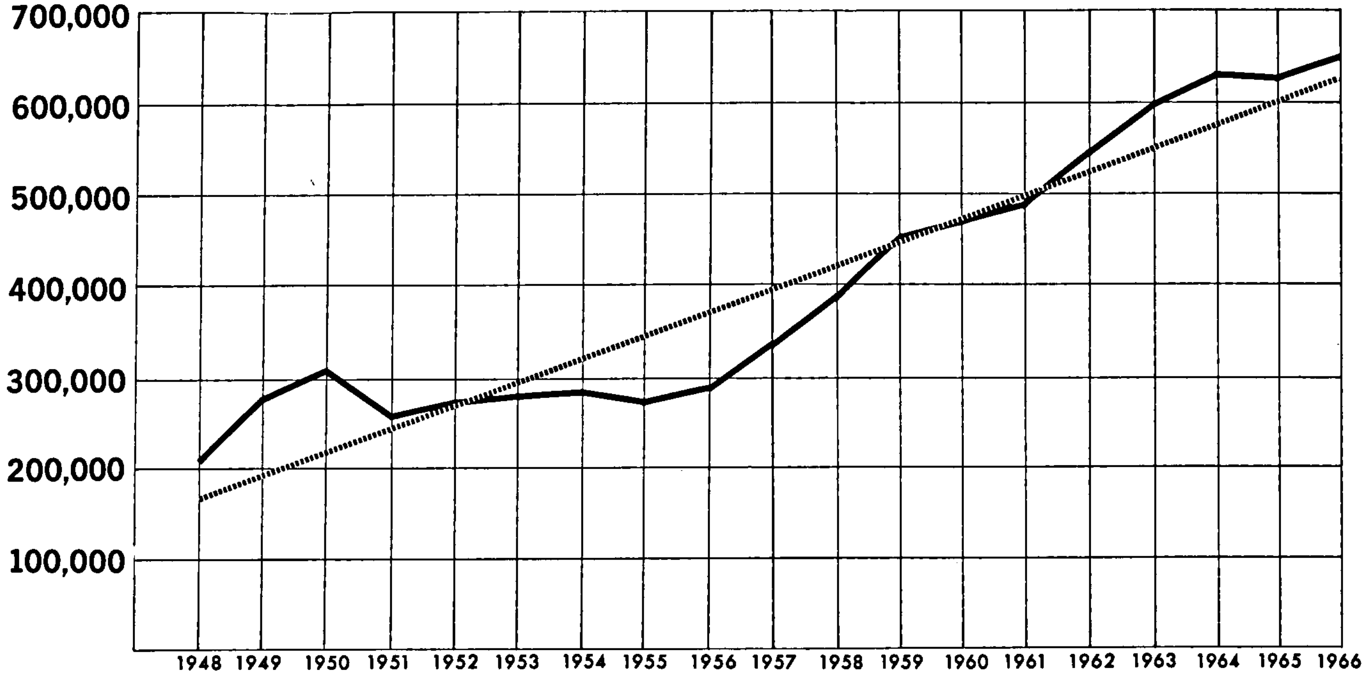


FIGURE 4
REPORTED TRAFFIC ACCIDENTS: 1948-1966

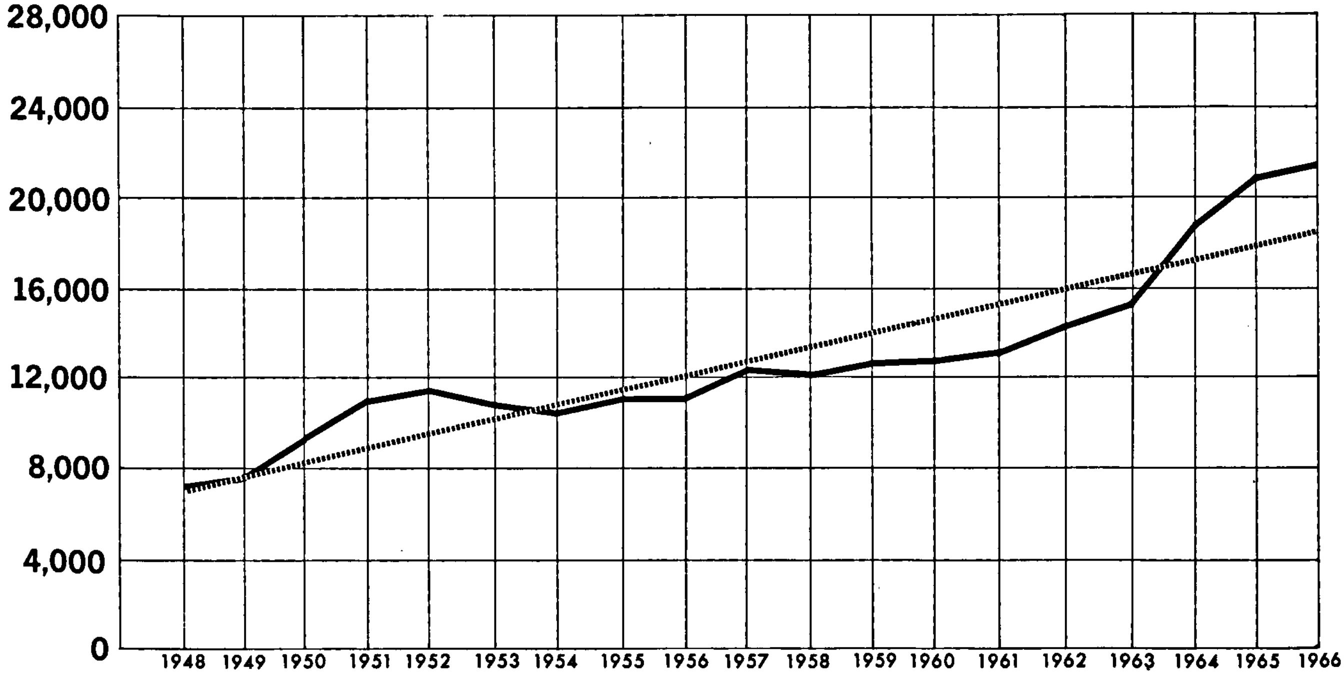


FIGURE 5
PERSONAL INJURY AND FATAL TRAFFIC ACCIDENTS: 1948-1966

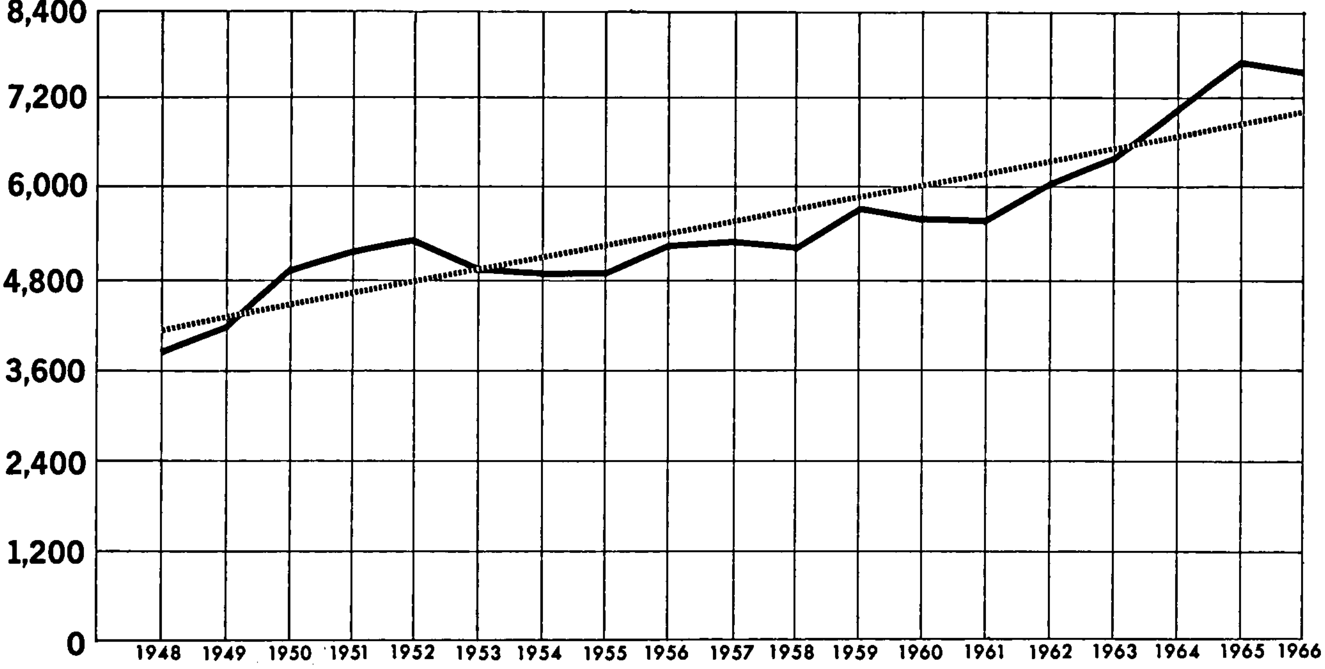


FIGURE 6
INDEX CRIME RATE
ST. LOUIS COMPARED WITH OTHER CITIES OVER 500,000 WITH DECLINING POPULATION

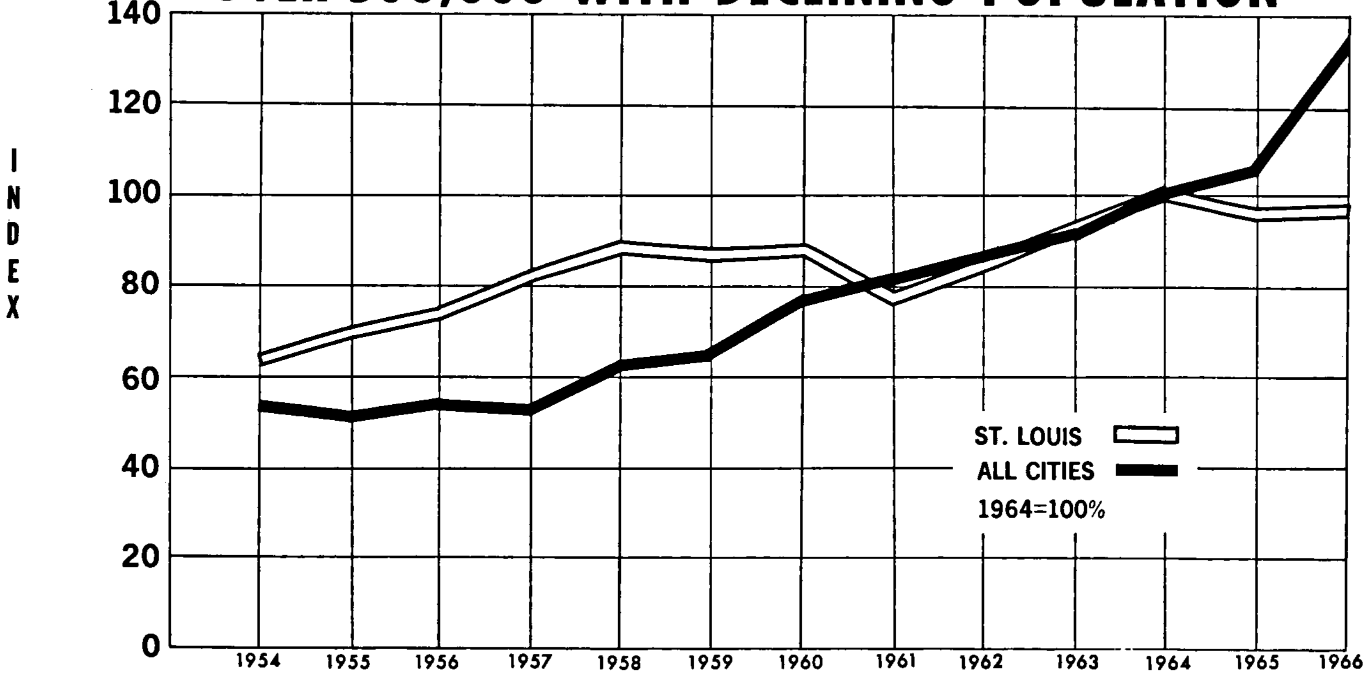


FIGURE 7
CLEARANCES AS A PERCENT OF INDEX CRIME: 1948-1966

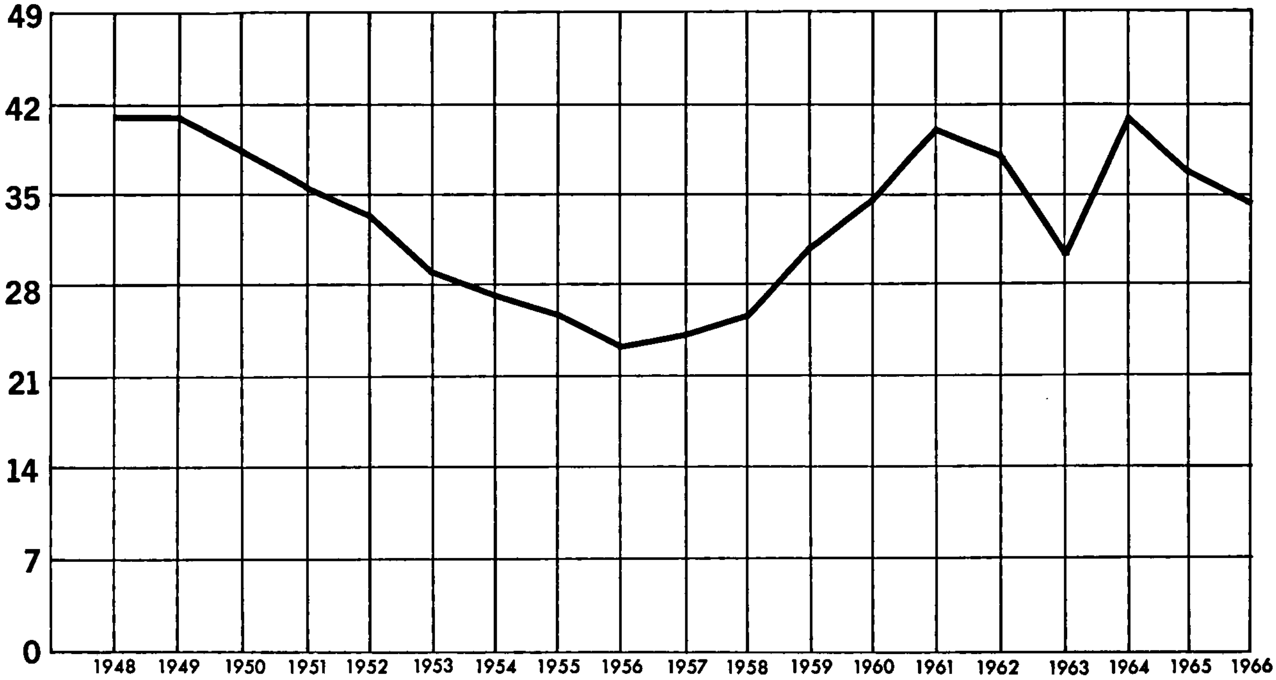
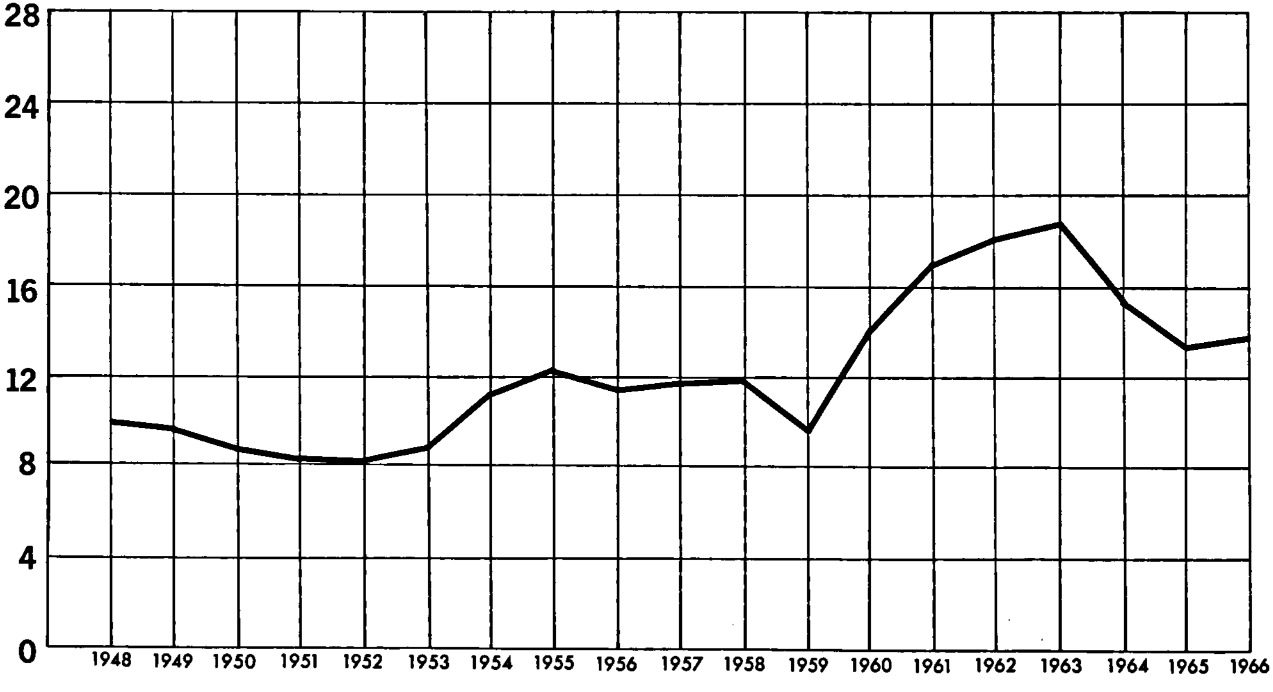


FIGURE 8
HAZARDOUS CITATIONS PER PERSONAL INJURY AND FATAL ACCIDENTS BY YEAR: 1948-1966



The foregoing indicators of demands for police services and of responses to those demands do not, of course, tell the whole story. The Police Department provides manpower for many duties for which no summary record over an extended period has been kept. For instance, the Department assigns officers to traffic control at specific locations during rush hours. The demands for this kind of service depend on the level and types of traffic congestion. There is no accurate measure of the amount and quality of congestion in St. Louis which would indicate that the objective need for this kind of service has been either shrinking or growing over the past 19 years, and no data exist which indicate that the level of service provided in this area has either increased or decreased.

Similar problems exist in many other areas, with respect either to the measurement of objective demands for services or to the measurement of the response to demands for services. The most important of these is the level of preventive effort provided. While the objective need for preventive service is fairly well indicated by the crime reporting system, there is no direct way to determine whether the quantity or quality of service provided in response to this need has increased or decreased proportionally.

Long Term Trends: Level of Services Provided

Just as there is no single satisfactory measure of the demands for police services, there is no such measure of the quantity and quality of the services provided. There are, however, partial indications of the level of services provided in individual areas. For instance, the level of service provided in response to the crime problem can be indicated by the number of arrests and by clearances by arrests. The response to the traffic problem can be measured to some extent in terms of the number of traffic citations issued. Table 4 shows the number of arrests, clearances, and hazardous traffic citations issued from 1948 through 1966.

Figures 7 and 8 show, for the past 19 years, clearances as a percent of the reported Index Crime, and hazardous traffic citations issued per fatal and personal injury accident. Although both ratios have varied greatly during the period, there has been no downward trend in either. Trend lines were fitted to both series by regression. While the coefficient was positive in both these cases, thereby indicating an upward trend, the fit was so poor that the regression cannot be regarded as an improvement over the 19-year average. Apparently, the St. Louis Police Department has been able to maintain essentially the same level of services, despite the strong upward trend in the demands for police service.

Table 4

MEASURES OF POLICE SERVICES PROVIDED BY THE ST. LOUIS POLICE DEPARTMENT FOR THE YEARS 1948-1966, INCLUSIVE

Year	Part I Arrests	% of Index Crimes Cleared By Arrests	Hazardous Traffic Citations
1948	1,997	40.9%	38,730
1949	2,145	40.9%	40,390
1950	1,439	38.1%	42,815
1951	2,117	35.4%	42,450
1952	3,588	33.5%	43,637
1953	3,997	28.8%	43,692
1954	3,444	27.3%	55,720
1955	3,706	25.4%	62,977
1956	4,216	23.2%	60,365
1957	2,726	24.1%	62,176
1958	3,782	25.5%	62,312
1959	4,990	30.9%	54,953
1960	6,714	34.8%	79,599
1961	6,995	40.3%	95,395
1962	9,457[a]	38.9%	109,322
1963	12,182	30.1%	118,833
1964	17,700	41.0%	109,181
1965	17,579	36.9%	102,417
1966	13,988	34.1%	103,800

[a] Figures since 1962 include arrests on suspicion of having committed a Part I Crime.

Sources: Arrests: Department Statistician, St. Louis Police Department.
Clearances: Administrative Analysis Division, Board of Police Commissioners.
Citations: Analysis Division, Bureau of Field Operations.

Long Term Trends: Resource Consumption

The measures of demands for police services and the measures of the levels of services provided indicate roughly the extent of the problem which police executives have been required to face in the past. To a surprising extent, the St. Louis Police Department has met the increase in demands for police services by methods other than a pro rata increase in the Police Department's total resources.

As shown in Table 5, the Department's annual expenditures have increased from $7.3 million in 1948 to $22.5 million in 1966, exclusive of City contributions to the police retirement system, which currently amounts to approximately $2.5 million per year. However, much of the growth in expenditures in current dollars is caused by price increases, rather than an increase in quantities of resources consumed. In order to eliminate the effects of price changes on the expenditures, use was made of the Implicit Price Deflators for Gross National Product, government purchases of goods and services, state and local, as published in "The National Income and Product Accounts of the United States, 1929 - 1965," a publication of the U.S. Department of Commerce. For this index, the deflated expenditure data are based on 1958 dollars.

Table 5

ACTUAL AND DEFLATED EXPENDITURES BY THE ST. LOUIS POLICE DEPARTMENT FOR THE YEARS 1948-1966, INCLUSIVE

Year	Actual Expenditures[a] ($000)	Deflated Expenditures[b] 1958=100 ($000)
1948	$ 7,311	$11,011
1949	8,134	11,806
1950	8,431	11,908
1951	8,939	11,624
1952	9,468	11,747
1953	9,396	11,348
1954	9,486	11,121
1955	10,775	12,314
1956	11,124	12,000
1957	13,234	13,601
1958	14,127	14,127
1959	14,213	13,853
1960	15,105	14,263
1961	15,033	13,741
1962	16,505	14,580
1963	16,536	14,218
1964	17,560	14,719
1965	20,757	16,848
1966	22,536	17,483[c]

[a] Exclusive of contributions by the City of St. Louis to the Police Retirement System.

[b] The National Income and Product Accounts of the United States, 1929-1965, Statistical Tables (United States Department of Commerce: Office of Business Economics), Table 8.1, "Implicit Price Deflators for Gross National Product" (government purchases of goods and services, state and local).

[c] Derived from Survey of Current Business, Volume 47, Number 2 (United States Department of Commerce: Office of Business Economics), Table 1, "Gross National Product in Current and Constant Dollars," (government purchases of goods and services, state and local), p. 8.

Source for Actual Expenditures: Annual Reports, Police Department, City of St. Louis.

A second possible adjustment was not made in Police Department expenditure figures. Capital expenditures are ordinarily made from regular annual appropriations. For most years, this is not an important item, since capital expenditures represent a small fraction of the total. In 1965 and 1966, however, the Department was in the process of paying for a computer system (both hardware and programs) which will be of use for several years after the payments are completed. These expenditures could be amortized over the combined useful life of the hardware and systems. The result of showing these costs as part of a year's current expenditures is to overstate resource use in 1965 and 1966.

Between 1948 and 1966, Department expenditures, in constant (1958) dollars, increased from about $11.0 million to almost $17.5 million, an increase of approximately 59% in 19 years. More than 40% of the total increase occurred during 1965 and 1966.

The most important Department resource is manpower. About 86% of 1966 expenditures went for salaries. Table 6 gives the number of commissioned personnel on the Department's rolls as of December 31 each year, from 1948 through 1966. During this period, the number of commissioned personnel increased about 10%—from 1,851 in 1948 to 2,035 in 1966. This figure substantially overstates the growth of this particular resource, since the hours of work per week were substantially reduced during the period.

No records are available which reflect some of the changes over the years in hours worked. For example, in 1948, officers did not receive compensatory time off for overtime worked. A substantial amount of overtime was involved in both normal police duties and court appearances. Currently, officers receive compensatory time. No estimate of the amount of overtime for the earlier periods exists, so no adjustment can be made for it.

In 1948, officers were scheduled to work 315 days per year. In 1952, this schedule was reduced to 303 days per year, and in 1958 a further reduction was made to 279 days per year. Since 1963, officers have been scheduled to work 247 days per year—the equivalent of a 40-hour work week. Thus, the manhours available to the Department per officer have decreased substantially over the years. About 1.28 officers were required in 1966 to produce the same total available manhours per year as one officer in 1948.

An index of the scheduled working days per year was constructed, using 1958 as the base year. The number of officers was then calculated in relation to the 1958 index of 100. The Equivalent Personnel column of Table 6 shows, for each year from 1948 through 1966, the Department's effective commissioned strength in relation to the base year. It can be seen that the Department's commissioned manpower resource has, in fact, declined between 1948 and 1966. The decline amounts to more than 13% for the period.

In order to obtain estimates of the growth of resources used over the 19-year period, linear regression functions were fitted to the deflated annual Department expenditures and equivalent personnel series, with time as the independent variable. The results are shown in Table 7.

Over the past 19 years, Department expenditures have increased about $300,000 per year in 1958 dollars. This is a rate of growth of about 1.8% per year. The number of equivalent personnel has decreased at an average rate of 25 per year. This is a decline of 1.5% per year.

Long Term Trends: Implied Productivity

As pointed out above (Table 2), demands for police services are increasing at a rate of from approximately two to four percent per year. The measured level of service provided apparently has not changed appreciably, nor has the flow of resources consumed by the Police Department.

In effect, the Department has been able to meet the growth in the police problem by the more intensive utilization of available resources. Thus, if the number of Index Crimes is taken as a measure of the demand for police services in St. Louis, these demands have grown 2.5 times in 19 years, or at an average compound growth rate of about 5.0% per year. To the extent that the Department has succeeded in meeting these demands, with no decrease in the level of service and no increase in resource use, the productivity per physical unit also must have grown at a mean rate of 5.0% per year.

This is an outstanding accomplishment. If the Department had responded by increasing the resource use in proportion to the growth in Index Crime over the past 19 years, its resource use would have grown 2.5 times. Because of the increase in prices over the same period, this would imply expenditures of 1966 dollars on the order of $35,483,000, rather than actual expenditures of $22,536,000. Almost 5,875 commissioned personnel would have been required to furnish a proportional number of man days compared to the 2,035 actually employed by the Department at year-end 1966.

Table 6

COMMISSIONED PERSONNEL AND EQUIVALENT PERSONNEL OF THE ST. LOUIS POLICE DEPARTMENT FOR THE YEARS 1948-1966, INCLUSIVE

Year	Number of Commissioned Personnel	Index of Days Worked Per Year Per Man (1958=100)	Equivalent Personnel[a]
1948	1,851	113	2,092
1949	1,883	113	2,128
1950	1,870	113	2,113
1951	1,872	113	2,115
1952	1,912	109	2,084
1953	1,856	109	2,023
1954	1,870	109	2,038
1955	1,880	109	2,049
1956	1,932	109	2,106
1957	1,920	109	2,093
1958	2,001	100	2,001
1959	1,966	100	1,966
1960	1,915	100	1,915
1961	1,889	100	1,889
1962	1,809	100	1,809
1963	1,831	89	1,630
1964	1,852	89	1,648
1965	1,987	89	1,768
1966	2,035	89	1,811

[a] For the definition of Equivalent Personnel, see text.
Source for Number of Commissioned Personnel: Annual Reports, Police Department, City of St. Louis.

While police operations are too complex to be completely described by such simple measures, these measures do convey many important features of the quality of the problem and the magnitude of the Department's response. Equally important, these data suggest the kinds of problems the Department will face in the immediate future. Undoubtedly, for the next few years demands for police services will increase at about the same rate as in the past and the cost per manhour will continue to grow. Both of these phenomena are beyond the control of the Department; these growths will occur, irrespective of its policy. The Department, therefore, must either find additional methods of increasing productivity or accept a decline in the level of services provided.

Seasonal Patterns: Demands For Police Services

There are short-term variations in the demands for patrol services in addition to those described as long-term trends. The most important of these are the hour-to-hour variations over a week and the week-to-week variations over a year. In all probability, a significant quasi-cyclical component could have been identified from data available through the Resource Allocation Project. This was not done, primarily because the Project's prediction system uses a technique which does not require the separation of the cyclical and trend components. Cycles present adminis-

Table 7

REGRESSION SUMMARIES OF DEFLATED EXPENDITURES AND EQUIVALENT PERSONNEL DATA IN THE ST. LOUIS POLICE DEPARTMENT, FOR THE YEARS 1948-1966, INCLUSIVE

Variable	Function[a]	Standard Error of Coefficient	R^2	Current Rate of Growth
Expenditures using deflated dollars (in thousands)	$Y = 302T - 3,940$	33.0	.83	1.8%
Equivalent Personnel	$Y = -25T + 3,375$	3.4	.76	-1.5%

[a] T represents the last two digits of the year: T=48, . . ., 66.
Source: Data from Tables 5 and 6.

trative problems very similar to those associated with seasonal patterns. The effect of cycles on the demands for police services is to make problems more acute during periods when trends and cycles reinforce each other.

Because of the somewhat limited scope of the Project, little adjustment to data about seasonal patterns of demands for police services was possible. For this reason, minimal data on the seasonal patterns were produced during the Project, although the programs have this capability. Table 8 shows for 1966 the monthly pattern of demands for police services, as reflected in Index Crimes, number of calls for service (directed incidents) and reported traffic accidents.[1]

Table 8

MONTHLY MEASURES OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS, 1966

			Reported Traffic Accidents	
Month	Index Crimes	Directed Incidents	Total	Personal Injury & Fatal
January	1,979	24,561	1,568	535
February	1,835	23,749	1,544	506
March	1,928	27,683	1,493	552
April	2,062	28,679	1,920	647
May	2,060	31,690	1,826	690
June	2,051	35,882	1,696	640
July	2,457	37,572	1,870	694
August	2,405	36,424	1,746	640
September	2,177	31,447	1,855	668
October	2,311	30,800	1,932	661
November	2,168	28,592	1,909	659
December	2,365	28,691	1,988	650
Total	25,798	365,770	21,347	7,542

Source: Index Crimes—1966 Annual Report, Police Department, City of St. Louis.
Directed Incidents—Computer Center, Office of the Chief of Police.
Traffic Accidents—Analysis Division, Bureau of Field Operations.

Table 9

INDEXES OF THE MONTHLY MEASURES OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS, 1966

(Average Month = 100.0)

			Reported Traffic Accidents	
Month	Index Crimes	Directed Incidents	Total	Personal Injury & Fatal
January	92.1	80.6	88.1	85.1
February	85.4	77.9	86.8	80.5
March	89.7	90.8	83.9	87.8
April	95.9	94.1	107.9	102.9
May	95.8	104.0	102.6	109.8
June	95.4	117.7	95.3	101.8
July	114.3	123.3	105.1	110.4
August	111.9	119.5	98.1	101.8
September	101.3	103.2	104.3	106.3
October	107.5	101.0	108.6	105.2
November	100.8	93.8	107.3	104.9
December	110.0	94.1	111.8	103.4

Source: Data from Table 8.

Table 9 shows each of these demands for police services reduced to an index. These demands tend to peak in the summer months. The indexes for July are greatest for three of the four series: Index Crimes, directed incidents, and personal injury and fatal traffic accidents. August and December also show high degrees of activity in two of the four series. The first three months of the year are below average for all four series. From this analysis, it appears that the Department cannot service these needs by merely switching its resources from one problem area to another over the year.

The range in variation indicated by these data is substantial. Thus, in July the number of directed incidents is 58% greater than the number in February, the number of Index Crimes is 34% greater, and the number of reported traffic accidents is 21% greater. Some, but by no means most, of this variation in rates can be accounted for by the fact that July has three more days than February.

To the extent that the variations in event rates are real and predictable, the Department is faced with a scheduling problem.

Hourly Patterns — Demands For Police Services

Demands for police services, in addition to following trend and seasonal patterns, follow marked hour-of-week patterns. These patterns constitute one of the major external factors which the allocation of patrol manpower must consider.

One important use of patrol manpower is to respond to calls for service. Response is here defined as a count of 1) directed incidents, 2) directed assists, and 3) requests out of service. The latter occurs when a supervisory or patrol unit requests that it be taken out of service to assist at the scene of an incident. It does **not** include self-initiated preventive activities. These three constitute the responses given by the Department to externally-generated demands. Table 10 shows the number of responses to radio calls in the Ninth District by hour of week for March 6-26, 1967. The most important feature of the table is the magnitude and patterns of the variation in the call-for-service workload over time. As shown in Table 11, Friday and Saturday have the greatest incidence of calls for service, with the Saturday index (119.7) far above average. Sunday and Monday are essentially average, and Tuesday, Wednesday and Thursday are well below average, with indexes of about 93.0.

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[1] Comparisons of data based on monthly tabulations generally are unsatisfactory for police planning, since the number of days and weekends varies from month to month. The use of series based on weekly data reduces these problems. However, monthly data are presented here, since the objective is to show general fluctuations of demands for police services over a year.

Table 10

NUMBER OF RESPONSES TO RADIO CALLS IN THE NINTH DISTRICT BY HOUR OF WEEK, MARCH 6-26, 1967[a]

Hours	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total
00-01	54	36	26	27	28	27	42	240
01-02	56	34	21	25	25	25	41	227
02-03	49	29	19	21	21	22	38	199
03-04	33	21	13	15	15	15	26	138
04-05	21	14	10	10	10	11	17	93
05-06	16	12	8	9	9	10	14	78
06-07	15	13	12	13	13	12	15	93
07-08	16	23	22	23	22	23	20	149
08-09	20	29	27	28	28	25	25	182
09-10	26	30	28	29	28	29	30	200
10-11	28	31	29	30	30	31	36	215
11-12	32	33	34	33	32	31	40	235
12-13	33	37	37	35	35	35	43	255
13-14	35	36	36	35	33	38	44	257
14-15	34	37	37	34	36	39	46	263
15-16	35	42	41	43	40	45	49	295
16-17	37	46	46	46	44	48	51	318
17-18	37	49	48	46	45	50	54	329
18-19	37	44	44	42	43	45	52	307
19-20	36	43	44	42	41	45	52	303
20-21	38	43	45	43	44	48	55	316
21-22	37	43	43	42	43	51	54	313
22-23	35	41	41	40	41	56	56	310
23-24	29	33	32	33	33	54	55	269
Total	789	799	743	744	739	815	955	5,584

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[a] Response consists of the total number of requests out of service, directed assists, and directed incidents.
Source: Analysis Division, Bureau of Field Operations.

Table 12 shows the index of the incidence of response to radio calls, by hour of day. From 1:00 a.m. to 11:00 a.m., the index is below average, reaching a minimum level of 33.5 for the hour starting at 5:00 a.m. For the remainder of the day, the index is above average, with separate peaks of 141.4 at 5:00 p.m. and 135.8 at 8:00 p.m. It will be noted that the proportional variation by hour of the day is larger than that by day of week. The day with the heaviest response load (Saturday) has about 1.3 times as much as the day with the least, while the load at 5:00 p.m. is about 4.2 times that at 5:00 a.m.

While Table 12 shows the distribution of the response load over the hours of an average day of the week, it is not a good representation for some individual days of the week. For example, Table 10 shows that the periods from midnight to 3:00 a.m. on Saturday and Sunday mornings are both above average, while the corresponding periods for all the remaining days, except Monday, are below average. The maximum proportional variation in the index is of the order of 7:1 between the highest and lowest hours (10:00 p.m. to 11:00 p.m. on both Friday and Saturday, and 5:00 a.m. to 6:00 a.m. on Tuesday, respectively).

In summary, the response load fluctuates significantly over the hours of the week, and the scheduling of patrol manpower should conform to this variation insofar as practicable. Another characteristic is the mix of calls to which re-

Table 11

INDEX OF RESPONSES TO RADIO CALLS IN THE NINTH DISTRICT, BY DAY OF WEEK, MARCH 6-26, 1967

(Average Day = 100.0)

Day	Index
Sunday	98.9
Monday	100.2
Tuesday	93.1
Wednesday	93.3
Thursday	92.6
Friday	102.2
Saturday	119.7

Source: Data from Table 10.

Table 12

INDEX OF RESPONSES TO RADIO CALLS IN THE NINTH DISTRICT, BY HOUR OF DAY, MARCH 6-26, 1967

(Average Hour = 100.0)

Hour	Index	Hour	Index
00-01	103.2	12-13	109.6
01-02	97.6	13-14	110.5
02-03	85.5	14-15	113.0
03-04	59.3	15-16	126.8
04-05	40.0	16-17	136.7
05-06	33.5	17-18	141.4
06-07	40.0	18-19	131.9
07-08	64.0	19-20	130.2
08-09	78.2	20-21	135.8
09-10	86.0	21-22	134.5
10-11	92.4	22-23	133.2
11-12	101.0	23-24	115.6

Source: Data from Table 10.

sponse is made. The relative frequency of various kinds of calls changes over the hours of the week. This should be considered in any manpower assignment plan which does not provide for immediate police response to at least the important calls.

Another important use of the patrol force is providing crime prevention activities. The time at which a crime is committed is important in planning preventive patrol activities, while the time the crime is reported to the Department is important for scheduling manpower to answer calls for service. For many crimes, however, the two times will differ markedly. In crimes against the person, the time of commission is generally known by the victim. On the other hand, many crimes against property involve stealth. As a result, some time usually elapses between the commission of the crime and its discovery and subsequent reporting to the police by the victim.

Table 13 contains an index of the incidence of crimes against the person over the 168 hours of a week. The data were collected for all crimes of murder, rape, robbery, aggravated assault, pocket-picking, and purse snatching which occurred in St. Louis in the first six months of 1967. A total of 2,625 crimes were included. Table 13 shows that effective scheduling of patrol manpower to control crimes against the person will require consideration of more than the hour-of-day or day-of-week marginal distributions. For example, as was the case with the response to calls for service, the period from midnight to 3:00 a.m. on Saturday and Sunday mornings has more than the average number of crimes against the person, while the same period for the other days of the week has a near- or below-average level of such crime.

Table 13

INDEX OF CRIMES AGAINST THE PERSON IN ST. LOUIS, BY HOUR OF WEEK, JANUARY 1 - JUNE 30, 1967

(Average Hour = 100)

Hours	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
00-01	186	51	51	109	83	32	198
01-02	256	32	122	77	109	83	282
02-03	134	13	64	32	26	38	122
03-04	77	51	00	19	19	38	70
04-05	70	13	19	13	13	38	64
05-06	32	19	00	19	06	06	83
06-07	45	19	13	06	26	45	51
07-08	32	13	00	13	13	45	19
08-09	45	45	19	13	19	32	58
09-10	51	58	13	13	32	26	58
10-11	77	58	19	26	32	96	122
11-12	64	19	26	32	83	96	83
12-13	26	77	45	45	58	96	128
13-14	13	38	70	51	51	122	147
14-15	51	70	83	115	77	122	218
15-16	51	128	154	134	128	205	179
16-17	26	128	134	109	166	154	224
17-18	102	186	141	160	115	186	211
18-19	128	166	166	147	96	192	166
19-20	147	186	198	109	122	326	365
20-21	102	211	160	198	154	352	288
21-22	122	128	186	154	173	243	288
22-23	109	134	134	147	160	371	192
23-24	64	147	134	115	115	346	211

Source: Analysis Division, Bureau of Field Operations.

Table 14

INDEX OF CRIMES AGAINST THE PERSON IN ST. LOUIS, BY DAY OF WEEK, JANUARY 1 - JUNE 30, 1967

(Average Day = 100.0)

Day	Index
Sunday	83.7
Monday	82.9
Tuesday	81.3
Wednesday	77.3
Thursday	78.1
Friday	137.1
Saturday	159.5

Source: Data from Table 13.

Table 14 contains an index of the incidence of crimes against the person by day of week.

Crimes against the person have a very heavy incidence on Friday and Saturday, as shown in the indexes of 137.1 and 159.5, respectively. For the remaining days, indexes cluster around 80. The incidence of crimes against the person on Saturday is roughly twice as great as for the quieter days.

Table 15 contains an index of the incidence of crimes against the person by hour of day. From 2:00 a.m. to 2:00 p.m., the incidence of crimes against the person is below average. The index reaches a low of 19.2 for the hour starting at 7:00 a.m. From 2:00 p.m. to 2:00 a.m., the incidence of crimes against the person is above average, with the index reaching a peak of 209.4 for the hour starting at 8:00 p.m.

The proportional variation of these crimes by hour of day is greater than that by day of week. The index for the day with the most crimes against the person is about twice as great as that for the day with the least crimes. The ratio of the lowest hour index to the highest hour index is approximately 1:10.

Table 15

INDEX OF CRIMES AGAINST THE PERSON IN ST. LOUIS BY HOUR OF DAY, JANUARY 1 - JUNE 30, 1967

(Average Hour = 100.0)

Hour	Index	Hour	Index
00-01	101.5	12-13	67.7
01-02	137.1	13-14	70.4
02-03	61.3	14-15	105.1
03-04	39.3	15-16	139.9
04-05	32.9	16-17	134.4
05-06	23.8	17-18	157.3
06-07	29.3	18-19	151.8
07-08	19.2	19-20	207.5
08-09	32.9	20-21	209.4
09-10	35.7	21-22	184.7
10-11	61.3	22-23	178.3
11-12	57.6	23-24	161.8

Source: Data from Table 13.

A study of the times of commission of crimes against property presents some difficulties. As previously explained, a time lapse generally exists between the commission of such a crime and its subsequent reporting to the police. One approach to securing distributions of the time of commission of crimes against property is to analyze reports of on-view arrests for such crimes. This approach has the advantage of obtaining accurate data since the time of the arrest generally can be used as the time of commission. Data for on-view arrests of crimes against property were gathered for the first seven months of 1967 for the combined categories of auto theft, burglary, and larceny from auto.

These data, shown in Table 16, are based on a sample of 783 crimes against property for which the time of commission could actually be determined. The data have some deficiencies, however. These crimes constitute in no sense a random sample from the population of all crimes against property. As a result, a bias of unknown magnitude and distribution was introduced into the index by the way in which the data were collected. In addition, the sample size is so small that sampling fluctuations are likely to be material.

Table 16

NUMBER OF SELECTED CRIMES AGAINST PROPERTY IN ST. LOUIS BY HOUR OF WEEK, JANUARY 1 - JUNE 30, 1967[a]

Hours	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total
00-01	6	9	8	4	1	5	7	40
01-02	10	3	7	6	8	8	5	47
02-03	5	7	7	10	5	4	4	42
03-04	1	2	6	5	5	0	6	25
04-05	6	2	2	3	3	5	2	23
05-06	2	0	1	2	1	1	1	8
06-07	2	0	0	1	0	0	1	4
07-08	0	0	2	2	1	1	0	6
08-09	1	1	0	1	0	2	0	5
09-10	3	0	2	3	2	2	2	14
10-11	2	3	3	4	5	4	5	26
11-12	0	5	12	8	5	7	6	43
12-13	0	6	5	7	3	7	1	29
13-14	1	7	9	3	6	10	5	41
14-15	1	5	8	8	5	0	13	40
15-16	5	9	12	11	9	7	8	61
16-17	4	9	9	4	8	10	6	50
17-18	1	2	7	5	10	3	6	34
18-19	4	6	6	6	5	5	6	38
19-20	5	5	4	9	9	5	7	44
20-21	2	7	8	9	6	12	5	49
21-22	3	6	6	4	1	9	5	34
22-23	8	3	8	3	5	8	7	42
23-24	8	4	4	6	5	9	2	38
Total	80	101	136	124	108	124	110	783

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[a] Based on the combined categories of auto theft, burglary, and larceny from auto.

Source: Analysis Division, Bureau of Field Operations.

Table 17 contains an index of the incidence of selected crimes against property, by day of week. The days with the highest value are Tuesday, (121.6) and Friday and Wednesday (both 110.9), respectively. The remaining days have below average indexes; the days with the fewest crimes against property are Sunday (71.5) and Monday (90.3).

Table 17

INDEX OF SELECTED CRIMES AGAINST PROPERTY IN ST. LOUIS, BY DAY OF WEEK, JANUARY 1 - JUNE 30, 1967

(Average Day = 100.0)

Day	Index
Sunday	71.5
Monday	90.3
Tuesday	121.6
Wednesday	110.9
Thursday	96.6
Friday	110.9
Saturday	98.3

Source: Data from Table 16.

Table 18 contains an index of the incidence of selected crimes against property, by hour of the day.

Table 18

INDEX OF SELECTED CRIMES AGAINST PROPERTY IN ST. LOUIS, BY HOUR OF DAY, JANUARY 1 - JUNE 30, 1967

(Average Hour = 100.0)

Hour	Index	Hour	Index
00-01	122.6	12-13	88.9
01-02	144.1	13-14	125.7
02-03	128.7	14-15	122.6
03-04	76.6	15-16	187.0
04-05	70.5	16-17	153.3
05-06	24.5	17-18	104.2
06-07	12.3	18-19	116.5
07-08	18.4	19-20	134.9
08-09	15.3	20-21	150.2
09-10	42.9	21-22	104.2
10-11	79.6	22-23	128.7
11-12	131.8	23-24	116.5

Source: Data from Table 16.

The index of the incidence of the selected crimes against property is below average between 3:00 a.m. and 1:00 p.m., with the exception of the hour between 11:00 a.m. and noon. For these hours, the index falls to a minimum of 12.3 at 6:00 a.m. and remains very low for the next two hours, with values of 18.4 and 15.3 respectively. Except for the noon hour, the index is above average from 11:00 a.m. to 3:00 a.m., reaching a peak of 187.0 for the hour starting at 3:00 p.m. A large variation in values of the index can be noted: the index value for the busiest hour is over 15 times the index for the quietest hour.

Unfortunately, these data have only moderate reliability. The number of observations is limited, so chance fluctuations in the rate of detection may be important. In addition, the probability of interrupting a given crime may be higher during some hours of a week than others. To some extent, the variation in the index over time can be accounted for by changes in the probability of interruption as well as changes in the incidence of crimes.

The Commander of the Analysis Division of the Bureau of Field Operations made a study in 1966 of the estimated time of occurrence of certain crimes committed by juveniles — residence and business burglaries and auto thefts. He used several data sources, including interrogation of juveniles apprehended for these crimes. The data were collected for all of 1965 and January through May of 1966, and are distributed by hour of day, rather than by hour of week. Table 19 shows the indexes of time of occurrence over the 24 hours.

Table 19

INDEXES OF SELECTED CRIMES AGAINST PROPERTY COMMITTED BY JUVENILES IN ST. LOUIS BY HOUR OF DAY FOR 1965 AND PART OF 1966

(Average Hour = 100.0)

Time	1965	1966[a]
00-01	107.9	61.1
01-02	77.1	73.3
02-03	54.8	42.7
03-04	44.5	67.2
04-05	42.8	30.5
05-06	18.8	12.2
06-07	15.4	24.4
07-08	24.0	12.2
08-09	27.4	24.4
09-10	44.5	36.6
10-11	77.1	91.6
11-12	125.1	67.2
12-13	92.5	91.6
13-14	132.0	146.6
14-15	166.2	158.8
15-16	114.8	189.3
16-17	111.3	85.5
17-18	90.8	91.6
18-19	107.9	109.9
19-20	133.6	195.4
20-21	246.7	268.7
21-22	203.9	171.0
22-23	200.4	183.6
23-24	140.5	164.9

[a] January through May data only.

Source: Analysis Division, Bureau of Field Operations.

There are differences in the indexes constructed from these data and the indexes in Table 18. The low crime periods from 3:00 a.m. to 11:00 a.m. coincide in both, and most of the high crime periods coincide. The major difference lies in the midnight to 3:00 a.m. period, where the indexes constructed from the juvenile data are low but those shown in Table 18 are high. The difference may well be accounted for by the restriction of the data to juveniles.

Another approach to determining the times of crimes against property is through a study of the time difference between when the stolen property was "last-seen" and when the crime was subsequently reported to the police. Such a study of auto thefts has been conducted by the Analysis Division of the Bureau of Field Operations. Time distributions were made, using the difference between the time an auto was parked and the time it was reported as missing. The results of this study were compared to the previously-mentioned data gathered by tabulating on-view arrests for auto thefts. The correspondence between the two studies was only moderately good. It appears that the present data on the distribution of occurrence of crimes against property probably should be regarded more as an example of the nature of the problem to be met, rather than as precise estimates of the need for preventive activity during specific hours of the week.

The concentration of crime in time is one aspect of the problem of prevention. A second aspect is the concentration of crime in space. Table 20 shows both the number and percent and the cumulative number and percent of Part I Crimes by Pauly Area for the Ninth District for the period January 1 - July 1, 1967. Omitted were four Pauly Areas which, although partially within the Ninth District, lie primarily outside it. The 36 Pauly Areas are ranked in the Table, beginning with the lowest number of Part I Crimes.

This table shows the extent to which Part I Crimes tend to occur in clusters. For instance, Pauly Area 5-33 had 9.2% of the crimes on which data were gathered. Almost 40% of the crimes occurred in six Pauly Areas, which amount to less than 17 percent of the total number of Areas. Those with the least crime have a very small percent of the total. Thus, the lowest 18 Areas, constituting half the Areas, contain only about 21% of the crimes, and the lowest six Pauly Areas have less than 4% of the crime.

This variation in density of crime by area is substantial. For all 36 Areas, the average for the six-month period was 119.8 crimes. However, the six highest Areas had an average of 284.7, almost 2.4 times greater than the average Area and over 10 times greater than the average of the lowest six Areas.

In addition to its major concerns of answering calls for service and preventive crime through effective patrol, the patrol force also has responsibility for traffic safety and, through selective enforcement of traffic regulations, the prevention of accidents. The classification of events called traffic accidents contains many subsets of individual interest. The most general classification can provide some indication of the problem, but substantially more information is required for the design of effective accident prevention activities. Several accident indexes are available to the St. Louis Police Department.

Table 20

PART I CRIMES BY PAULY AREA IN THE NINTH DISTRICT[a] JANUARY 1 - JUNE 30, 1967

Section and Block	Number	Percent	Cum. Number	Cum. Percent
4-42	21	.49	21	.49
4-46	22	.51	43	1.00
5-20	28	.65	71	1.65
4-43	30	.70	101	2.35
5-19	32	.74	133	3.09
5-21	36	.83	169	3.92
4-44	38	.88	207	4.80
4-46	38	.88	245	5.68
5-23	38	.88	283	6.56
5-25	42	.97	325	7.53
4-79	47	1.09	372	8.62
4-61	52	1.21	424	9.83
5-26	59	1.37	483	11.20
4-48	65	1.51	548	12.71
4-62	84	1.95	632	14.66
5-27	92	2.13	724	16.79
9-01	99	2.29	823	19.08
8-08	102	2.36	925	21.44
8-07	111	2.57	1,036	24.01
5-29	114	2.64	1,150	26.65
4-78	116	2.69	1,266	29.34
4-63	117	2.71	1,383	32.05
4-76	119	2.76	1,502	34.81
5-28	137	3.18	1,639	37.99
4-45	144	3.34	1,783	41.33
9-02	148	3.43	1,931	44.76
5-45	149	3.45	2,080	48.21
6-30	172	3.99	2,252	52.20
4-77	176	4.08	2,428	56.28
5-36	178	4.13	2,606	60.41
5-35	205	4.75	2,811	65.16
5-32	232	5.38	3,043	70.54
5-24	242	5.61	3,285	76.15
5-31	263	6.10	3,548	82.25
5-34	369	8.55	3,917	90.80
5-33	397	9.20	4,314	100.00
Total	4,314	100.00		

[a] Excluding four fractional Pauly Areas lying primarily outside the Ninth District.

Source: Analysis Division, Bureau of Field Operations.

The largest class of traffic accidents is measured from radio dispatch data. In general, officers are dispatched to the scene of an accident when it is reported to the police. These accidents can be identified by the event codes on the radio Dispatch Ticket. The investigating officers prepare Vehicle Accident Reports for approximately one-half of the accidents to which they are dispatched, under any of the following circumstances:

1. when injury or death occurs;

2. when city, state, or federal property is involved;
3. when a charge is preferred by one driver against another, or a citation is issued by the police for a traffic violation;
4. when a public conveyance, such as a bus or taxicab, is involved;
5. when damage to any one vehicle is in excess of $100; or
6. when any vehicle cannot be moved from the scene under its own power.

An accident card is punched from each such Report. These cards provide a second source of accident information which relate to the most serious accidents. As might be expected, these accidents involve either injuries or fatalities, and can be identified.

Table 21 shows the incidence of a city-wide sample of traffic accident calls in St. Louis for the period March 5 - May 27, 1967, as secured from radio dispatch data, by hour of the week.

The index of the incidence of traffic accidents by day of week, shown in Table 22, ranges from a low of 77.3 on Thursday to a high of 158.2 on Saturday. The accident problem appears to be greatest on weekends, since the three highest index values are those for Friday (120.6), Saturday (158.2), and Sunday (105.2).

Table 21

INDEX OF TRAFFIC ACCIDENT CALLS IN ST. LOUIS, MARCH 5 - MAY 27, 1967

(Average Hour = 100)

Hours	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
00-01	310	22	48	51	48	82	260
01-02	165	19	19	16	32	44	146
02-03	70	03	03	13	06	13	67
03-04	54	10	03	19	16	10	51
04-05	25	19	03	19	13	16	32
05-06	44	35	35	44	35	29	67
06-07	35	133	70	101	136	117	79
07-08	60	133	76	86	92	105	54
08-09	70	51	67	70	38	63	82
09-10	70	79	70	51	41	86	120
10-11	79	92	89	63	70	108	171
11-12	241	51	44	35	89	114	209
12-13	127	86	98	120	73	86	171
13-14	114	111	117	89	79	143	171
14-15	143	174	149	177	174	238	241
15-16	155	181	257	209	187	288	212
16-17	101	165	209	225	171	241	225
17-18	171	98	101	86	73	165	225
18-19	124	105	98	73	76	146	276
19-20	60	73	76	89	82	168	219
20-21	70	76	54	70	98	158	190
21-22	79	48	82	82	95	155	152
22-23	79	54	67	44	76	193	244
23-24	79	89	86	73	57	130	136

Source: Analysis Division, Bureau of Field Operations.

Table 22

INDEX OF TRAFFIC ACCIDENT CALLS IN ST. LOUIS BY DAY OF WEEK, MARCH 5 - MAY 27, 1967

(Average Day = 100.0)

Day	Index
Sunday	105.2
Monday	79.3
Tuesday	80.0
Wednesday	79.3
Thursday	77.3
Friday	120.6
Saturday	158.2

Source: Data from Table 21.

Table 23 contains an index of the incidence of traffic accident calls by hour of day. The index is below average for the hours between 1:00 a.m. and 11:00 a.m. and also for the two hours between 9:00 p.m. and 10:00 p.m. and 11:00 p.m. and midnight. The hours between 2:00 a.m. and 5:00 a.m. have the lowest index numbers, with a minimum of 18.1 reached between 4:00 a.m. and 5:00 a.m. The peak values of the index occur between 2:00 p.m. and 5:00 p.m., with the maximum value of 212.7 being reached between 3:00 p.m. and 4:00 p.m. Based on the sample, the incidence of reported traffic accidents is substantially greater at some periods than at others; the index value for the highest hour is more than 11 times greater than that for the lowest hour.

These short term patterns of demands appear to persist qualitatively, at least in those areas where data can be checked. Table 24 contains indexes of the incidence in St. Louis of reported traffic accidents, by hour of day, for the years 1965 and 1966. The patterns are quite similar for both years. Not only do the high and low periods of activity correspond, but the values for both years are close in magnitude, hour by hour, with maximums and minimums falling in corresponding hours. These indexes are also qualitatively similar to the index given in Table 23. Any differences can in part be accounted for by the fact that the accident sets from which the indexes are derived are different in definition, and that the indexes in Table 24 are based on two years' data, while the index in Table 23 is based only on accidents occurring in the months of March through May.

Summary: Patterns of Demands For Police Services

The externally-generated demands for police services in St. Louis have several important characteristics. First, they are growing at an average rate of approximately three percent per year. Historically, the growth rate has fluctuated; for some periods it has been substantially above average, for others below average. It can be safely predicted that police departments, generally, can expect to face increasing demands for services of all kinds over the next few years.

Police departments also face substantial seasonal fluctuations in demands for services by month of year. Generally, demand peaks in the summer months, with the maximum, as measured by both the crime and the directed incident indexes, being reached during July and August. Demands for police services also fluctuate by hour of day and by day of week. Different days of the week have perceptibly different distributions of demand rates.

In Table 25, the days of the week are ranked on the basis of response to calls for service, crimes

Table 23

INDEX OF TRAFFIC ACCIDENT CALLS IN ST. LOUIS, BY HOUR OF DAY MARCH 5 - MAY 27, 1967

(Average Hour = 100.0)

Hour	Index	Hour	Index
00-01	117.2	12-13	108.6
01-02	62.9	13-14	117.6
02-03	24.9	14-15	185.1
03-04	23.1	15-16	212.7
04-05	18.1	16-17	191.0
05-06	41.2	17-18	131.2
06-07	95.9	18-19	128.1
07-08	86.4	19-20	109.5
08-09	62.9	20-21	102.3
09-10	73.8	21-22	99.1
10-11	95.9	22-23	108.1
11-12	111.8	23-24	92.8

Source: Data from Table 21.

Table 24

INDEXES OF REPORTED TRAFFIC ACCIDENTS IN ST. LOUIS, BY HOUR OF DAY FOR 1965 AND 1966

(Average Hour = 100.0)

	Index			Index	
Hour	1965	1966	Hour	1965	1966
00-01	87.7	92.6	12-13	108.8	108.2
01-02	92.0	92.5	13-14	104.2	116.3
02-03	74.1	67.9	14-15	117.1	122.4
03-04	37.9	37.9	15-16	169.4	181.0
04-05	25.6	23.8	16-17	217.9	216.6
05-06	21.6	20.3	17-18	188.6	183.2
06-07	45.8	45.2	18-19	129.9	135.0
07-08	101.0	99.2	19-20	118.7	110.8
08-09	92.9	101.4	20-21	103.3	98.2
09-10	74.0	66.8	21-22	100.3	104.0
10-11	79.6	76.8	22-23	108.6	106.2
11-12	98.7	88.1	23-24	102.7	104.9

Source: Analysis Division, Bureau of Field Operations.

Table 25

DAY-OF-WEEK RANKS, BY LEVELS OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS

Police Service	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Response to							
Calls for service	4	3	6	5	7	2	1
Crimes against person	3	4	5	7	6	2	1
Traffic accident calls	3	5	4	6	7	2	1

Source: Data from Tables 11, 14 and 22.

against the person, and traffic accident calls. The table shows that the demands for police services in St. Louis are greatest on Friday and Saturday, and lowest on Wednesday and Thursday.

In Table 26, each hour of the day is ranked on the basis of the same indexes of demands for police services. The rankings are generally quite consistent over the three indexes, which indicates that all demands for police services tend to be either high or low. The lowest demands for police services are the hours from 2:00 a.m. to 10:00 a.m. This eight-hour period contains the eight quietest hours for response to calls for service, and seven of the eight quietest hours for crimes against person and traffic accident calls.

Table 26

HOUR-OF-DAY RANKS, BY LEVELS OF DEMANDS FOR POLICE SERVICES IN ST. LOUIS

Hour	Response to Calls for Service	Crimes Against Person	Traffic Accident Calls
00-01	13	12	7
01-02	15	9	19
02-03	18	16	22
03-04	21	18	23
04-05	22	21	24
05-06	24	23	21
06-07	23	22	14
07-08	20	24	17
08-09	19	20	20
09-10	17	19	18
10-11	16	15	15
11-12	14	17	8
12-13	12	14	10
13-14	11	13	6
14-15	10	11	3
15-16	8	8	1
16-17	2	10	2
17-18	1	6	4
18-19	6	7	5
19-20	7	2	9
20-21	3	1	12
21-22	4	3	13
22-23	5	4	11
23-24	9	5	16

Source: Tables 12, 15 and 23.

The highest rankings are not always consistent. The hour beginning at 3:00 p.m. has the heaviest demand for traffic accidents, but ranks eighth on response to calls for service and crimes against the person. In general, the hours of high demands ran from 3:00 p.m. to midnight.

In summary, the indexes by hour of the week indicate that when scheduling manpower, each day generally should be considered separately. The distribution of demands for police service in St. Louis differs from day to day. There is a substantial range of fluctuation. The level of hourly demands during a week may vary as much as 20 to 1. This implies that scheduling should reflect, as much as possible, the patterns of these demands. What is true for St. Louis probably will have validity for some police departments in other cities.

This hour-to-hour variation in the demands for police service of all kinds constitutes the basic external problem which the process of allocating police resources must meet. Other aspects of this problem are quite important. For instance, the long-term growth in demands for police service in St. Louis has been noted, as has the marked seasonal pattern in the demands for police service. The problems of deployment in area and time, of the need to provide more than a single policeman for some kinds of duty, of competing demands for patrol manpower, and of the constraints on scheduling, influence the possible solutions to the scheduling problem and will be considered later.

Patrol Organization

The patrol function in the St. Louis Police Department is carried out under the Bureau of Field Operations, which contains three commands. North Area and South Area commands cover the Department's nine districts. The Special Operations Command has several divisions, one of which, the Tactical Deployment Division, is engaged directly in patrol operations. This Division includes task forces and canine teams.

Table 27 shows the police manpower devoted directly to patrol and other Department functions

Table 27

DISTRIBUTION OF MANPOWER BY PATROL AND OTHER FUNCTIONS FOR THE ST. LOUIS POLICE DEPARTMENT ON DECEMBER 31, 1966

Type of Manpower	Patrol Functions			All Other Department Functions	Total
	Bureau of Field Operations[a]	Special Operations Command[b]	Total		
Commissioned	1,483	170	1,653	382	2,035
Civilian	39	5	44	622	666
Total	1,522	175	1,697	1,004	2,701

[a] Except for Special Operations Command.
[b] Except for Juvenile and Prisoner Processing Divisions.
Source: 1966 Annual Report, Police Department, City of St. Louis.

at the end of 1966. About 81% of the commissioned strength and about 63% of the total manpower of the Department were directly involved in patrol activities. This is such a large proportion of the Department's total manpower resources that efficient police operations overall depend in large measure upon efficient patrol operations.

The bulk of the resources devoted to patrol are administered through the nine police districts. Figure 9 shows the organization of the Ninth District, which was selected as the test district for the Resource Allocation Project. The organization is a typical one.

At the start of the Project, the district patrol forces were divided into four watches. Three watches, of approximately even strength, began at 7:00 a.m., 3:00 p.m., and 11:00 p.m., respectively. In order to provide additional manpower during periods of peak demand, a smaller "Fourth Watch" went on duty, usually at 6:00 p.m., for eight hours.

In St. Louis as in other cities, the patrol force is the single most important unit in the Police Department, not only in terms of size but also in function. O. W. Wilson has characterized patrol as "the backbone of police service," and as "the largest and most important unit."[2] Briefly, the patrol force has responsibility for crime prevention, for the protection of life and property, for the detection and arrest of offenders, and for providing a host of miscellaneous police services.

Many problems are associated with the administration of a patrol force. The force itself has to be created, maintained and, hopefully, constantly upgraded in quality and efficiency of operations. Officers must be hired, trained, and organized into units. The units must then be scheduled and deployed. The results of patrol depend on all these activities, all of which must be carried out well if the patrol function is to be performed properly.

Scheduling and deploying an existing patrol force has been widely recognized as a key problem in effective police administration. Several techniques are used to implement deployment and scheduling decisions. The watches (or shifts) may rotate, or be fixed. "Overlay" (extra) watches can be scheduled for peak periods of the day; special tactical units can be employed; and rotating watches can be phased to provide variations in on-duty strength which correspond to predictable variations in workload. The basic method of deployment is through the development of a patrol beat structure generally covered by mobile, radio-equipped units. This beat structure sometimes is augmented by other units assigned to larger areas as back-up, and by specialized patrol units of various kinds.

Several excellent descriptions of techniques associated with the scheduling and deployment of patrol forces have been published.[3] These publications emphasize that a series of interrelated decisions have a substantial effect on the efficiency of patrol. A major part of the problem is to insure that the manpower resources required to carry out the patrol function are available at the times and places where they are most required. Beyond this, there is the problem of tactics—the selection of specific patrol activities to be carried out, depending once again upon the time and place. It is clear that the problem of allocating resources and the selection of tactics interact. Thus, if more effective tactics can be developed for productive use against a specific kind of problem, then additional manpower resources should be made available at those locations and times during which the problem is the greatest.

In the allocation of manpower resources, consideration must be given to the distribution of events requiring patrol services in time and space. These patterns of distribution cannot be controlled by the Department to any large extent. They are, in effect, "given data" to which the Department must respond.

The St. Louis Police Department faces a rapidly changing environment. To keep pace with the increased demands such a change places on the Department, a better means of dealing with manpower assignment and scheduling problems has been sought. What is needed is not merely a set of good decisions, which may soon be obsolete, but rather a method for making good decisions which is of such reliability that it can be used again and again when new situations demand new answers.

The Resource Allocation System tested in St. Louis constitutes a method designed to meet these manpower assignment and scheduling problems, primarily in terms of a computer-assisted decision process. The computer's role in this system is to supply data which have been summarized, analyzed, and presented in a form which makes their implications reasonably clear. This output, combined with the judgment of experienced police officers, is then used to control the allocation of the available patrol force.

Other Demands for Patrol Manpower

Just as the demands for patrol service fluctuate over time, so the capacity of a police district to meet these demands fluctuates. Only part of the total district strength is scheduled to report

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[2] O. W. Wilson, **Police Administration**, 2nd Edition, (New York: McGraw Hill Book Company, 1963).

[3] Frank E. Walton, "Selective Distribution of Police Patrol Force," in **Police Patrol Readings**, ed. by Samuel G. Chapman (Springfield, Illinois: Charles C. Thomas, 1964), p. 176.

Roy C. McLaren, "Allocation and Distribution of Police Manpower," in **Law Enforcement Science and Technology**, ed. by S. A. Yefsky (Washington, D. C.: Thompson Book Co., 1967), p. 599.

O. W. Wilson, "Crime Prevention—Whose Responsibility," in **Law Enforcement Science and Technology**, ed. by S. A. Yefsky (Washington, D. C.: Thompson Book Co., 1967), p. 67.

Wilson, **Police Administration**.

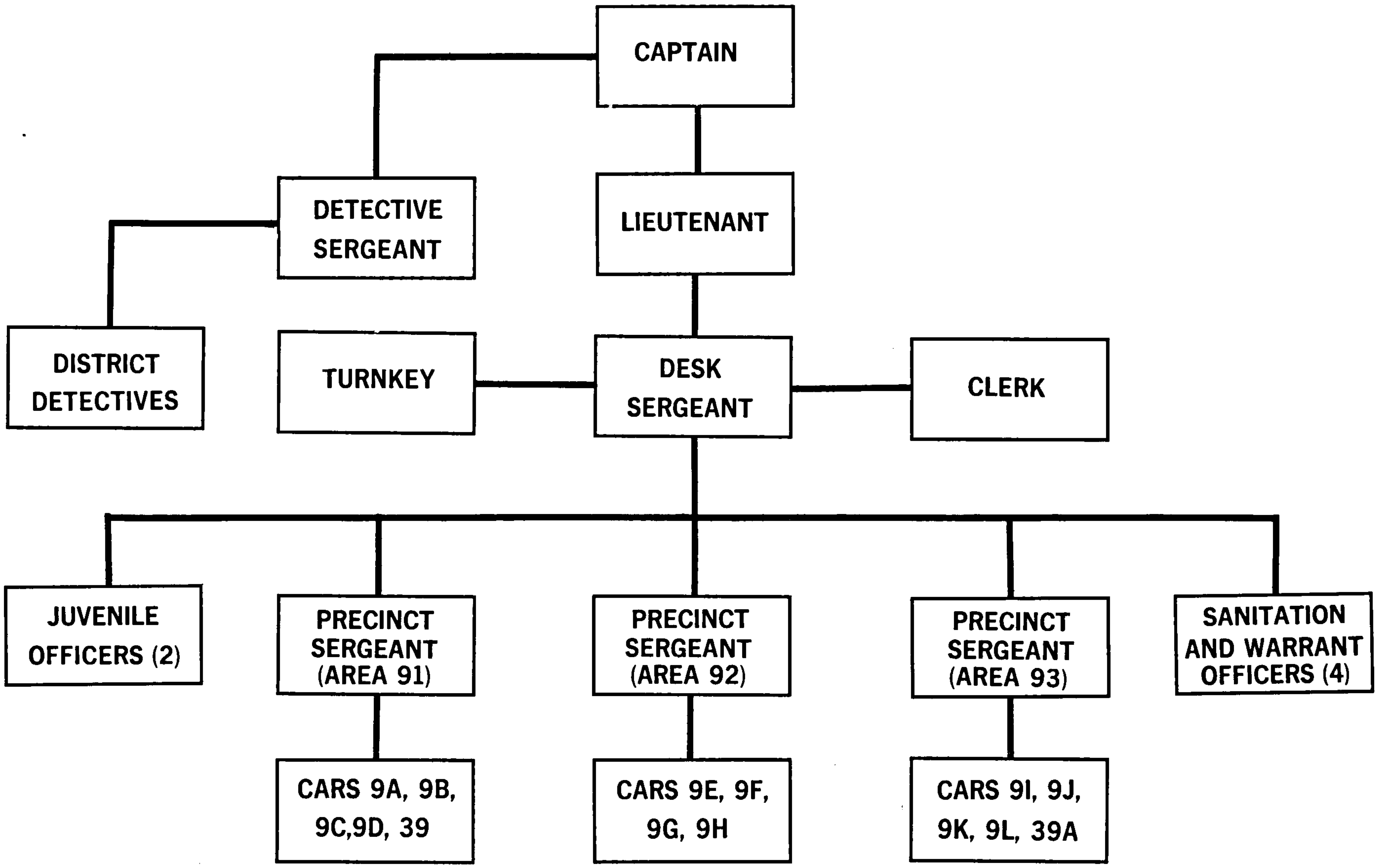

Figure 9. Organization of the Ninth Police District

for duty on any watch, and the part which actually reports is generally less than that scheduled. The major reasons for absence by officers from patrol duty include days off for recreation and vacation, illness, and assignment to details.

Table 28 shows, for 43 consecutive weeks in the Seventh District, the man days actually devoted to patrol, and the man days not available for patrol because of recreation, vacation, leave, and details. Patrol personnel absent from patrol duty amounted to 42% of those assigned to such duty. The bulk of such absence was accounted for by recreation time — regular days off — as might be expected. The total number of man days actually spent on patrol ranged from a low of 516 for the week starting November 28, 1966 to a high of 634 for the week starting March 13, 1967. Thus, effective scheduling of patrol manpower necessarily involves the anticipation of fluctuations in the amount of manpower which will actually be on patrol during a specific week.

In addition to manpower fluctuations from week to week, there are also fluctuations within a week. At the start of the Project, St. Louis police districts operated four watches, beginning at 7:00 a.m., 3:00 p.m., 6:00 p.m. and 11:00 p.m. Each watch lasts eight hours. For convenience, let these times have the following identifications:

Watch Beginning	Identification
7:00 a.m.	I
3:00 p.m.	II
6:00 p.m.	IV
11:00 p.m.	III

Watch times overlap due to the Fourth Watch, which begins at 6:00 p.m. To study the daily patrol strength, the hours of the day can be grouped and associated with the above identifications as follows:

Time Period	Strength
7:00 a.m. - 3:00 p.m.	I
3:00 p.m. - 6:00 p.m.	II
6:00 p.m. - 11:00 p.m.	II + IV
11:00 p.m. - 2:00 a.m.	IV + III
2:00 a.m. - 7:00 a.m.	III

In other words, the manpower on the watch beginning at 6:00 p.m. must be associated with two other watches. Table 29 shows the disposition of patrol manpower in the Seventh District by the foregoing time periods and by day of week for the rotation period March 6 - 26, 1967. An analysis of this table reveals a variation in the actual working strength by hour of week. Working strength ranged from a low of 65 men on Mondays between 2:00 a.m. and 7:00 a.m. to a high of 129 men on Fridays between 6:00 p.m. and 11:00 p.m.

Similar fluctuations are also revealed in Tables 30 and 31, which show summaries of the strength data. The two tables are indexes derived from marginal distributions by day of week and time period of data in Table 29.

Some of the withdrawals from service, up to a point at least, are under the control of the Police Department and can be scheduled to modify man-

Table 28

MAN DAYS SPENT ON PATROL AND MAN DAYS ABSENT FROM PATROL IN THE SEVENTH DISTRICT, BY WEEK SEPTEMBER 12, 1966 - JULY 9, 1967

Week Beginning	Man Days Spent On Patrol	Man Days Absent From Patrol[a]
September 12, 1966	574	448
September 19, 1966	568	443
September 26, 1966	566	439
October 3, 1966	594	415
October 10, 1966	582	406
October 17, 1966	562	439
October 24, 1966	563	416
October 31, 1966	592	386
November 7, 1966	595	394
November 14, 1966	549	429
November 21, 1966	546	418
November 28, 1966	516	436
December 5, 1966	609	417
December 12, 1966	602	426
December 19, 1966	602	424
December 26, 1966	586	424
January 2, 1967	581	448
January 9, 1967	581	435
January 16, 1967	610	408
January 23, 1967	589	418
January 30, 1967	595	418
February 6, 1967	576	424
February 13, 1967	584	401
February 20, 1967	578	413
February 27, 1967	630	413
March 6, 1967	602	440
March 13, 1967	634	419
March 20, 1967	623	427
March 27, 1967	632	406
April 3, 1967	612	413
April 10, 1967	603	434
April 17, 1967	608	428
April 24, 1967	585	433
May 1, 1967	607	405
May 8, 1967	574	408
May 15, 1967	594	425
May 22, 1967	601	440
May 29, 1967	601	443
June 5, 1967	608	424
June 12, 1967	576	442
June 19, 1967	561	446
June 26, 1967	532	494
July 3, 1967	542	393
Total	25,225	18,258

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[a] Patrolmen were unavailable for patrol duty because of recreation (regular days off), vacation, leave, and assignment to details.
Source: St. Louis Police Department Duty Rosters.

Table 29

DISPOSITION OF THE SEVENTH DISTRICT PATROL STRENGTH BY PERIOD OF DAY AND DAY OF WEEK, MARCH 6-26, 1967

	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
7:00 a.m. - 3:00 p.m.							
Assigned for Patrol Duty	128	121	128	122	119	122	127
Less Absences for:							
Recreation	41	38	27	38	12	36	41
Vacation	12	8	12	12	12	12	12
Sick	2	1	1	1	0	0	1
Leave	2	4	0	0	13	0	2
Details	3	0	17	0	0	0	0
Working Patrol Strength	68	70	71	71	82	74	71
3:00 p.m. - 6:00 p.m.							
Assigned for Patrol Duty	121	123	121	124	125	123	121
Less Absences for:							
Recreation	37	40	26	38	18	37	37
Vacation	9	6	9	9	9	9	10
Sick	1	2	1	1	1	1	2
Leave	4	3	1	0	23	0	1
Details	0	0	15	0	0	0	0
Working Patrol Strength	70	72	69	76	74	76	71
6:00 p.m. - 11:00 p.m.							
Assigned for Patrol Duty	204	205	204	205	206	205	206
Less Absences for:							
Recreation	67	67	45	60	24	61	64
Vacation	12	10	12	12	12	12	13
Sick	5	4	4	5	4	3	3
Leave	4	3	1	0	38	0	2
Details	0	0	17	0	0	0	0
Working Patrol Strength	116	121	125	128	128	129	124
11:00 p.m. - 2:00 a.m.							
Assigned for Patrol Duty	204	201	201	200	202	203	209
Less Absences for:							
Recreation	68	62	41	57	19	60	65
Vacation	12	8	12	12	12	12	12
Sick	12	11	12	12	11	9	8
Leave	1	3	9	0	33	0	1
Details	0	0	2	0	0	0	0
Working Patrol Strength	111	117	125	119	127	122	123
2:00 a.m. - 7:00 a.m.							
Assigned for Patrol Duty	124	121	119	118	119	121	121
Less Absences for:							
Recreation	38	38	35	22	35	13	36
Vacation	9	9	6	9	9	9	9
Sick	7	8	7	9	8	8	7
Leave	0	1	3	9	0	18	0
Details	0	0	0	0	0	0	0
Working Patrol Strength	70	65	68	69	67	73	69

Source: St. Louis Police Department Duty Rosters.

Table 30

INDEX OF PATROL MANHOURS IN THE SEVENTH DISTRICT, BY DAY OF WEEK, MARCH 6-26, 1967

(Average Day = 100.0)

Day	Index
Sunday	94.9
Monday	96.8
Tuesday	99.5
Wednesday	100.6
Thursday	105.1
Friday	103.4
Saturday	99.5

Source: St. Louis Police Department Duty Rosters.

Table 31

INDEX OF PATROL MANHOURS IN THE SEVENTH DISTRICT, BY HOUR OF DAY, MARCH 6-26, 1967

(Average Hour = 100.0)

Period	Index
07 - 15	81.8
15 - 18	82.0
18 - 23	140.6
23 - 02	136.2
02 - 07	77.6

Source: St. Louis Police Department Duty Rosters.

power availability. Other withdrawals, for such purposes as details and sick leave, are in effect externally generated demands for police services and are often outside the control of the Department. Table 32 presents a summary of the patrol manhours which the Seventh District lost during one rotation period because of details and in-service training.

Table 32

PATROL MANHOURS LOST IN THE SEVENTH DISTRICT, BECAUSE OF DETAILS AND IN-SERVICE TRAINING
MARCH 6-26, 1967

Assignment	Manhours Lost
City Hospitals Detail	304
Election Detail	296
Police Relief Association Detail	224
In-Service Training	136
Forest Park Detail	16
Total	976

Source: St. Louis Police Department Duty Rosters.

The competing demands for patrol manpower are large enough to constitute a serious part of the scheduling problem. The incidence of these demands affects a district's capacity to respond to demands for patrol services. Thus, the solutions to the scheduling problem must consider simultaneously the demands for call-for-service and prevention efforts, and the withdrawals from service which affect total manpower availability.

Scheduling Objectives And The Resource Allocation System

A major purpose of the Resource Allocation Project was to provide an evaluation of the results of using the Project methods. Before this could be done, it was necessary to define the objectives of patrol force deployment.

Scheduling — the provision of manpower over time — must allow for both calls for service and preventive patrol. Allowance must also be made for withdrawals of patrol manpower from service, for such purposes as special details, vacation, recreation, sickness, training, and a number of other activities. These withdrawals obviously reduce the commissioned strength available for patrol.

During the Project, the scheduling of manpower over time was done in such a way that all demands for police services could be met either at once or within a very short interval of time. This can be regarded as a minimal requirement for patrol schedules. Schedules which meet this requirement will be referred to as "feasible schedules." Schedules which do not meet this standard are to be avoided if a department has the resources required to maintain a feasible schedule. Throughout the entire Project, the St. Louis Police Department treated all calls for service from the Ninth District citizens as immediate demands for police service, and generally deployed a sufficiently large patrol force to meet these demands.

Some experimentation with "stacking" — delaying less important calls — was carried out during the test period of the Project. While this experience has since proved useful, it was not extensive enough during the Project to permit evaluation.

If, within a police department, more patrol manpower is available than that required to meet minimum response standards for calls for service, there will then be many possible feasible schedules. Since all demands for service are met by any feasible schedule, the criterion for preferring one feasible schedule to another does not concern calls for service. Rather, a desirable basis for selection from among a set of feasible schedules is crime prevention. By changing from one feasible schedule to another, a department can redistribute available patrol force time to provide a more effective crime prevention effort.

Thus, in order to choose best between two or more possible schedules, it is necessary first to know whether the schedules are feasible; and second, which such schedule will result in the most advantageous distribution of preventive effort in time. As part of the Resource Allocation Project, sets of computer programs were developed to provide data on which these judgments could be based.

One of the first steps in the Resource Allocation Project involved the development of a computer-based information system which could be used to determine the manpower needs for the call-for-service function. Since this system was a planning tool, some method of predicting was required. The call-for-service workload and the results of specific schedule selections had to be described far enough in advance so that the Police Department would have time to respond to the predictions.

A natural source of data is available in the area of calls for service. The Radio Dispatch Tickets used in the dispatching process provide a record of each call for service. The most important relevant information shown on the ticket is the time of dispatch of a patrol car in response to a call for service, the nature of the call, its location, the patrol unit assigned the call, the time the assignment was completed, and the disposition of the incident.

Simply tabulating the data by area is not sufficient, except in the very short run. Examination of the patterns generated by these calls shows that the patterns themselves change over time. Very short term planning could be carried out on the basis of only tabulated current data, but planning problems involving intermediate or longer time horizons require explicit allowances for these changes. As a result, a basic method of prediction, called exponential smoothing, was chosen. The exponential smoothing technique, described elsewhere in this report, provides a method for allowing for the patterns and changes in the patterns of the call-for-service workload over time.

The police problem is also a problem in space. As a result, information is needed by area and, in some cases, by small areas. This need was met in the St. Louis Police Department with the development of the New Location Code and the Pauly Area System. Under the New Location Code, each street in St. Louis is assigned a code number which becomes the basis of record maintenance for much of the data stored in the Resource Allocation System.

The Resource Allocation System for calls for service was designed with a capacity to record up to 15 classifications of radio calls. Two basic items of data are kept within each category: the smoothed event rate and the smoothed service time rate.

The following geographic oriented records are kept as part of the System: city block, Pauly Area, beat, district, and city. The classification is essentially hierarchical, with blocks contained in Pauly Areas. However, there are some Pauly Areas which straddle beat and district boundaries. In principle, it would be possible to make predictions of calls for service for an area as small as a single block. In practice, this is not done. Even for the blocks generating the greatest number of demands for service, the expected event rate and the expected total service time are extremely small. Use of Pauly Areas has the advantage of permitting the combination of several city blocks into a workable unit.

Once the event rate and service time data for an area have been accumulated, it is possible to construct predictions of the event rates, mean service times, and workloads for future periods by reseasonalizing the data. These predictions, which are essentially weekly averages expressed as a rate per day, can be converted to predicted number of events per hour and predicted minutes of work per hour by using the hour-of-week data stored in the computer. Thus, the computer system can produce predictions of workloads and event rates for specified classes or subclasses of events for any area which can be described in terms of blocks, Pauly Areas, beats, or districts.

Depending on how well the system does in fact predict, part of the scheduling problem has now been solved. At any time, estimates are available of the future workload, which constitutes a large part of the problem the schedule is to meet. However, additional problems in this area remain. The calls for service occur irregularly in time. Not only will the number of calls and workload fluctuate around the predicted values, but the workload and events will not be spread evenly through time. By chance, some periods of time will contain few or no calls for service, while others will contain several. For this reason, a schedule which provides barely enough manpower to meet the predicted workload is not a feasible one — response to some calls for service will be delayed because of random fluctuations in demands. In addition, what amounts to overhead time associated with patrol (time over and above the time out required for responses) must be provided for. Thus, the minimum number of patrol units required in a given area during a given period cannot be derived directly from the calls-for-service workload. For this reason, the Resource Allocation prediction system was extended to include some queueing analysis.

The queueing analysis uses the predicted number of calls for service and associated workloads. On the basis of these predictions, the computer system determines the results of assigning various number of units, and the number and per cent of calls for which a unit is immediately available, the average delay, and other variables related to queues. These data are given in part of this report, and a statement on the method of analysis is given in the Appendix.

In summary, the information system for call-for-service patrol by the St. Louis Police Department is based on analysis of the radio Dispatch Ticket data. These data are coded and processed on the computer. The results are stored in records corresponding to city blocks and larger areas in a form which facilitates predictions. Predictions of future event rates and workloads can be produced for any area in St. Louis and for any period of time one hour or longer, up to one year in the future. In turn, these predictions can be analyzed to find the operational results of assigning various number of patrol units to an area for a given future period.

While the programs to support manpower scheduling in the call-for-service area were being developed, a method for analyzing crime data for scheduling and assigning units for preventive activities was further developed. This method initially was designed for producing recommended assignments for the Department's task force personnel.

The problem of scheduling manpower resources for crime prevention is, in principle, similar to that of scheduling for calls for service. Estimates of the incidence of crime are needed by area and time in order to have efficient use of manpower for crime prevention. Areas of persistently high crime rates can be identified, and general crime distributions can be formed to show seasonal and hourly patterns. To this extent, the exponential smoothing model used for the call-for-service forecasts might also have been used for crime prediction. However, crime rates also include many short-term and transient fluctuations which must be quickly identified and utilized for practical crime prevention scheduling. These fluctuations are significant enough to suggest that an exponential smoothing model may be of limited value for crime analysis.

Once an area and a time period for preventive activities have been determined, the productivity of applied manpower resources will depend on the patrol tactics adopted.[4] It is clear that the productivity of preventive activities depends also on the nature of the times and places chosen for these activities, for if there is little or no crime to prevent, then the best tactics will produce little results.

In order to have some basis for evaluation, at least an approximation of the preventive mechanism is required. Quite generally, prevention can be considered to work either directly — through the apprehension of criminals in the act—or indirectly, through the psychological effect of conspicuous patrol. In either case, the opportunities for prevention in a given period will be proportional to the density of either events or people upon which the prevention tactics adopted are effective. Thus, as a first approximation, the patrol units assigned to crime prevention activities should concentrate in areas where the density of preventable events per patrolable mile per hour is expected to be high.

At this writing, there is no quantified formal theory of preventive patrol. This is a major handicap in the evaluation of that part of the Resource Allocation Project which was concerned with preventive activities. The lack of such a theory can be traced primarily to the problems of measurement, rather than to conceptual problems in developing a prevention model. Quantification of such a model will require both a high quality and a substantial quantity of measurement.

The primary purpose of preventive patrol is to reduce crime. In part, preventive tactics are associated with the simple presence of police officers at times and in areas where opportunistic crime or, more generally, misconduct is likely to happen. The activities which work in this way are referred to here as conspicuous patrol. The visible patrol officer acts as a direct deterrent.

Preventive tactics are also designed to work directly through the preventive patrol officer's constant viewing of his environment. He perceives misconduct, crime, or correctable hazard and, through direct activity such as on scene arrest, citation, warning, or other appropriate activity, fulfills his function.

Unfortunately, conspicuous patrol activity is subject to diminishing returns. Consider a specific Pauly Area for a given hour. Assume that the patrol tactics in effect result in a single tour of the Pauly Area in an hour, and under these circumstances a given number of crimes N_1 will be committed during the hour. If the enforcement rate is doubled so that there are now two tours per hour, and conspicuous patrol is effective, then the number of crimes should drop to N_2, where N_2 is less than N_1. The addition of expenditure of resources has produced a crime decrement of $(N_1 - N_2)$. If a third tour of the area is added, the total resources used will have tripled. If the additional effort is productive, then the number of crimes will be reduced from N_2 to N_3, where N_3 is less than N_2.

The argument of diminishing returns states that $N_2 - N_3 < N_1 - N_2$; that is, the decrement obtained by increasing resource expenditure from 2 to 3 is less than the decrement by increasing resource expenditure from 1 to 2. Less and less will be obtained for additional equal-sized increments of resources used in the same way in the same area. Thus, part of the resource allocation problem with conspicuous patrol is to determine at what point additional resource use ceases to be profitable.

Direct preventive activities should be less subject to diminishing returns than conspicuous patrol activities, in the range of patrol resources likely to be available. The problem of allocation of resources for direct preventive tactics is to concentrate these resources in times and areas which have a high incidence of preventable crime. Thus, the optimal distribution of preventive effort depends on several considerations — the distribution of crimes in time and space, the productivity of additional preventive effort, and the types of crime. It is not certain what an ideal distribution of effort would be, given the data currently available. One boundary is available: the prevention effort probably should move more than proportionally with the need for prevention. A more than proportional share of the available resources should be expended in areas and periods of very high crime density.

Other Scheduling Problems

Some specific examples may clarify the problems involved in the scheduling of police manpower usage in order to provide the maximum preventive services. Table 33 shows total Index Crimes and the number of self-initiated radio calls[5] in St. Louis during 1967, by month.

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[4] Although extremely important, the subject of tactics was not within the scope of the Resource Allocation Project.

[5] A self-initiated call occurs when a patrol unit requests that it be taken out of service to perform any of a variety of duties.

Table 33

SELF-INITIATED RADIO CALLS PER INDEX CRIME IN ST. LOUIS, BY MONTH, 1967

Month	Index Crimes	Self-Initiated Radio Calls	Self-Initiated Calls Per Index Crime
January	1,979	64,524	33
February	1,835	54,107	29
March	1,928	58,971	31
April	2,062	54,458	26
May	2,060	54,234	26
June	2,051	53,415	26
July	2,457	41,521	17
August	2,405	45,381	19
September	2,177	45,508	21
October	2,311	48,682	21
November	2,168	55,109	25
December	2,365	54,494	23
	25,798	630,404	24

Source: Computer Center, Office of the Chief of Police.

The number of Index Crimes is a good overall indicator of the need for prevention. The number of self-initiated radio calls reflects to some extent certain kinds of preventive activity by the patrol force, and can be considered as a partial index of preventive activity. To some extent, however, both measures are incomplete.

The data show that the level of preventive activity, as measured by the number of self-initiated radio calls, essentially moved inversely to the need for preventive services, as indicated by the number of Index Crimes. The number of self-initiated calls per Index Crime fluctuated from a low of 17 in July to a high of 33 in January, a substantial variation. July and August had both the greatest number of Index Crimes (2,457 and 2,405, respectively) and the fewest number of self-initiated radio calls per crime (17 and 19 respectively). The months with the highest ratio of self-initiated calls per crime were January, with 33, and March with 31. January had the third lowest number of Index Crimes (1,979) and March the second lowest (1,928).

To the extent possible, it would appear to be in the Department's interest to transfer some preventive activity from those months where the number of self-initiated calls per Index Crime is above the yearly averages to those months where it is below the average. If the ratio of self-initiated calls to Index Crimes is essentially constant, then some prevention activity should be moved from January, February, March, April, May, June, and November and added to such existing activity in December, September, October, August, and July. The extent to which this should be done would have to be determined by a more detailed examination of operations and objectives.

To a large extent, the inverse fluctuation in the measures of prevention activity and preventive need is generated by the patterns of other competing demands for police manpower over the year. Table 8 shows the number of directed incidents in St. Louis per month for 1967. These reached a peak during July and August. Thus, even if the number of officers available for patrol duty is constant over the year, the time available for prevention activities will be less in these two peak months. As discussed previously, there are patterns of demands for police services in other areas which also modify the time available for prevention activity.

The seasonal patterns of demands for services present a difficult scheduling problem primarily because there are limited scheduling variables which can be used to make manpower availability correspond to estimated requirements. One such variable was identified during the Project, however. St. Louis maintains a continuous cycle of in-service training. By eliminating this training during June, July, August and December for police officers assigned to patrol, and increasing the number of officers assigned to training during other months, additional manpower for the peak months could be made available without reducing the amount of training.

Other techniques, most of which involve costs of some kind, exist. These will vary from department to department, and each should be evaluated. The evaluation of the seasonal scheduling of manpower depends on the detailed scheduling and assignments used from week to week. In general, the expectation is that additional manpower applied to prevention activities will be more productive in July than in January, but whether these expectations materialize will depend on how this additional manpower is used.

Many of the decisions which affect the productivity of preventive patrol manpower involve consideration of the workload and need for prevention within short intervals of time. One problem, as an example, is the selection of the hours at which the watch or shift changes. The purpose of these scheduling decisions is to distribute the available manpower by hour of the week most advantageously. Different departments use different techniques to obtain variations in the number of officers on duty. Thus, the watch rotation can be scheduled so that some units are retained on the watch which has the heaviest workload; or an overlay (or "fourth watch") can be introduced into the rotation; or the reporting time of a portion of a watch can be advanced or retarded to obtain additional manpower during periods of high demand for patrol services.

Since the scheduling problem involves the simultaneous consideration of many variables, there is no particular set of watch change hours which can be selected as best. What is relevant is the capacity of a department to solve, by other means, the scheduling problems associated with a specific set of watch change hours.

The short-term scheduling process involves the externally generated demands for police services of all kinds, the existing organizational structure and administrative procedure, and the specific requirements for preventive service by area and time.

II. Quantitative Evaluation

Introduction

Of the many aspects of the Resource Allocation Project which can be examined, the most important are those directly associated with the Information System. If the predictive and analytical programs developed during the Project function satisfactorily, other police departments will be able to use them. If these programs prove unsatisfactory, then any improvements in manpower scheduling which occurred during the Project must be attributed to other sources.

It is not possible to separate completely the evaluation of the Information System and the methods by which the data were used. For example, possible gains from improvements in scheduling depend on the adequacy of the previous scheduling methods. The better the former methods, the less there is to be gained. The scheduling choices that a department has are a result of the current organization and administrative practices. The nature of the external problems to which the department must adjust, the average ratio between workload and manpower, and a great number of similar variables make the problem unique for each department. In contrast, the methods of solution — through the systematic collection and analysis of the relevant data — are available to any department.

Brief Outline of the Project from Quantitative Analysis Viewpoint

Operationally, the St. Louis Police Department's Allocation Project was both a pilot study (or field test) and an experiment. Two similar police districts, the Seventh and the Ninth, were selected for the study. The actual test was conducted in Phase II of the Project, from January 2, 1967 to July 9, 1967, a total of nine three-week watch rotation periods. During this Phase, the Ninth District switched to new methods of operation, using data made available by the Resource Allocation Research Unit, while the Seventh District continued its regular method of operation.

It was hoped that the Seventh District would provide a standard against which the effectiveness of the changed operations in the Ninth District could be judged. To assist in this part of the evaluation, data were collected from both districts for both Phase I (July 1, 1966 to January 1, 1967) and Phase II. In some areas, data collected in the Ninth District alone served for evaluation.

The most important change introduced in the Ninth District at the start of Phase II was the functional division of its patrol force into preventive and call-for-service units. The latter units were two-man cars assigned to patrol beats and required to remain in service except in emergency situations. The preventive units also primarily were two-man cars, with differing areas of assignment from day to day as conditions dictated.

The number of call-for-service cars was determined for the Ninth District through the examination of the predicted workloads for four-hour intervals for each day of the week for each three-week watch rotation period. Thus, for each such rotation period, data for 42 time intervals (6x7) were considered. After determining the number of call-for-service units required, Pauly Areas were grouped together into a set of beats. In order to maintain area responsibility, the supervisory areas (precincts) within the District were not changed after the first rotation period of Phase II.

In principle, it would have been possible to have a different set of beats for each of the six four-hour periods in a day for each of the seven days of the week — or 42 different sets of beats during a given rotation period. After the first rotation period of Phase II, however, beat patterns changed only at the regular watch change hours — at most, three times a day. This restricted the possible number of beat patterns per rotation period to 21. In practice, this large a number never materialized. At most, there were only five different sets of beats during a single rotation period.

Distribution of Calls for Service

The development of good scheduling and assignment policies is limited by the quality of forecasts or predictions available. Scheduling and assignment are essentially planning functions which can be executed satisfactorily only if appreciation of future problems exists. The manpower requirements for calls for service are developed from the event and workload predictions supplied by the Resource Allocation prediction programs. Thus, the question of whether this output is sufficiently reliable is extremely important.

The Resource Allocation prediction programs assume that the generation of calls for service is essentially Poisson. Examination of the distribution of calls for service at the St. Louis Police Department and other police departments supported this assumption.

The basic formula for the Poisson probability distribution is:

$$P(x \mid m) = \frac{e^{-m} m^{x}}{x!}$$

where $P(x \mid m)$ is the probability of x events in a fixed interval, given that the average rate is m per interval. The mean m is determined for a given area and period from the exponential smoothing process (see the Appendix for a discussion of exponential smoothing). The probability of no events is represented by $P(0 \mid m)$, the probability of exactly 1 event by $P(1 \mid m)$, etc.

One important characteristic of this distribution is that the variance is equal to the mean. This implies that substantial fluctuations about even an exactly predicted mean are not unusual. The standard deviation grows as the square root of the mean number of events. Thus, the larger the mean which is predicted, the greater is the percent accuracy of a prediction, and the less is the absolute accuracy.

These sampling fluctuations are allowed for in the queueing analysis of the Resource Allocation prediction programs. The analysis does not assume that precisely the predicted number of events and workload will materialize, but rather that the observed values will behave as if they were generated by a Poisson process with the predicted mean.

This dependence of the mean and variance is important both in the use and evaluation of the predictions. Predictions made for short periods of time and for small areas, where the mean number of events is low, will have relatively high percentage error and low absolute errors. Predictions for longer periods or larger areas, where the expected number of events is higher, will have lower percentage errors but larger absolute errors. For a large enough mean m, and sample size n, the Poisson distribution can be approximated by a normal distribution. For regression analysis of a variable following the Poisson distribution, the square root transformation is often appropriate. This is a "variance stabilizing" transformation of the observations. The approximate normality can be used to derive a formula for approximate percentiles of the Poisson distribution. Hald gives, where x is a number which will exceed a random observation from a Poisson population with mean m, with a probability p[6]:

$$x_p \doteq m - 0.5 + u_p \sqrt{m} + 0.25\, u_p^2$$

The u is a number which will exceed a random observation from a standardized normal distribution with probability p. Values of u can be obtained from tables. Thus, u =1.96 and u = +1.96. The probability that a random observation from a standardized normal distribution lies between –1.96 and +1.96 is 0.95.

The corresponding values of x are:

$$x_{.975} \doteq m + 1.96 \sqrt{m} + .46$$

and

$$x_{.025} \doteq m - 1.96 \sqrt{m} + .46$$

These will bound 95% of the realizations from a Poisson distribution with a parameter m.

Table 34 shows these two limits for selected values of m between 10 and 100. The range defined by $x_{.025}$ - $x_{.975}$ will contain 95% of the random samples generated by a population with the given mean. This indicates that about one sample in 20 will fall outside the range. This table illustrates that substantial deviations from the predicted mean number of events are not improbable, even if there is no error in the prediction of the mean. Thus, if the expected or predicted number of events is 100, by chance alone once in 20 times either 80 or less, or 120 or more, events will occur.

This table also illustrates the limits of prediction. Even if the expected event rate is predicted exactly, substantial sampling fluctuation can be anticipated if this is a quasi-Poisson process. In addition, the error in the prediction of the mean event rate itself will contribute to the total error in estimation.

Allocation of manpower for calls for service was based on a set of programs which processed the

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[6] A. Hald, A Statistical Theory with Engineering Applications, (New York: John Wiley and Sons, 1952), pp. 717-719.

Table 34

APPROXIMATE 2.5 AND 97.5 PERCENTILES FOR SELECTED VALUES FOR THE MEAN OF A POISSON DISTRIBUTION

Population Mean	Percentiles	
	$x_{2.5}$	$x_{97.5}$
10	3.7	16.1
15	7.3	22.5
20	11.2	28.6
25	15.1	34.7
30	19.2	40.7
35	23.3	46.5
40	27.5	52.3
45	31.9	58.1
50	36.1	63.8
55	40.3	69.6
60	44.8	75.1
65	49.1	80.8
70	53.5	86.3
75	58.0	91.9
80	63.0	97.9
85	66.9	103.0
90	71.8	108.0
95	75.8	114.0
100	80.3	119.5

Source: Analysis Division, Bureau of Field Operations.

radio Dispatch Ticket data. The system makes predictions for one hour for a given area. If periods longer than one hour are of interest, the system still predicts one hour at a time and adds the results for the specified period. The basic variables predicted are the number of calls for service and the associated workload. The total workload is then derived by multiplying the number of calls by the corresponding mean service time and totaling the results.

During Phase II, the basic prediction periods used were the following set of four-hour periods:

Period 1	7:00 a.m. - 11:00 a.m.
Period 2	11:00 a.m. - 3:00 p.m.
Period 3	3:00 p.m. - 7:00 p.m.
Period 4	7:00 p.m. - 11:00 p.m.
Period 5	11:00 p.m. - 3:00 a.m.
Period 6	3:00 a.m. - 7:00 a.m.

The predictions were made for each of the seven days of the week — 42 separate predictions for each 21-day rotation period. The first prediction contained the averages for the period 7:00 a.m. - 11:00 a.m. for three consecutive Mondays and, in general, each of the predictions contained averages from the same periods of the same days of three consecutive weeks.

Evaluation of the Call-For-Service Predictions

Both workload (measured by number of minutes of work) and number of calls for service per period were used in scheduling. Table 35 contains the actual and predicted number of such calls for the 42 scheduling periods for the Ninth District for the rotation period starting March 6, 1967. Table 36 contains similar data for workload. In both cases, the predictions and the observations were substantially within the limits which can be expected from these types of data. In order to develop an objective measure of the relationship, the regression function was calculated, using the predicted value as the independent observation and the corresponding observed value as the dependent variable. The regression summary for the number of events is given in Table 37.

Table 35

PREDICTED AND ACTUAL NUMBER OF CALLS FOR SERVICE IN THE NINTH DISTRICT, MARCH 6-26, 1967

Hours	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Total	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
07:00-11:00	46	38	52	60	53	59	48	41	50	55	50	52	55	64	354	369
11:00-15:00	64	45	68	74	66	56	66	58	64	77	70	60	84	77	482	447
15:00-19:00	69	60	93	105	87	81	90	81	85	83	96	94	108	104	628	608
19:00-23:00	66	77	85	109	79	74	77	80	77	88	98	112	106	121	588	661
23:00-03:00	41	42	50	44	46	38	48	31	57	37	96	112	86	94	424	398
03:00-07:00	23	13	22	16	20	9	24	14	29	19	42	37	35	33	195	141
Total	309	275	370	408	351	317	353	305	362	359	452	467	474	493	2,671	2,624

Source: Analysis Division, Bureau of Field Operations.

The variation in the predicted number of calls for service accounts for about 90% of the variation in the corresponding observed values. The standard error of estimate for this equation is 9.42. Thus, the predicted values are closely related to the actual values. The predicted values on which the equation is based range from a low of 20 to a high of 108. If these are substantiated in the regression equation, the values of the equation are 10.73 and 116.44, respectively. Literally interpreted, they represent the expected values for the actual number of calls using the predicted values of 20 and 108. The differences of –9.27 (10.73-20.00) and 8.44 (116.44-108.00) are in effect the systematic errors in the predictor. These values at the upper and lower ends of the observed range are the largest negative and positive values respectively within the data on which the regression is based. Since the entries in Table 35 are totals for 12-hour periods, the maximal systematic errors in the predictor are of the magnitude of 0.7 - 0.8 of an event per hour. For this application this is a negligible bias. There is apparently no material bias in the predictions for the data tested.

The predicted workload is not as closely related to actual workload as the predicted number of calls is to the actual number of calls. Variation in predicted workload accounts for about 73% of the variation in actual workload, and the standard error of estimate for this regression is 518.16. The range of predictions runs from a low of 669 to a high of 3408. The expected systematic error runs from –22.3 to +1.4 minutes of work per hour over the range of observation. This is also small enough to be negligible for this application.

In general, the predictions of both the number of events and workload appear to be satisfactory for the purpose for which the programs were developed.

The use of the split function patrol facilitated the evaluation of the call-for-service reports from the Resource Allocation prediction programs. The number of beats was varied to deploy a patrol

Table 36

PREDICTED AND ACTUAL MINUTES REQUIRED TO ANSWER CALLS FOR SERVICE IN THE NINTH DISTRICT, MARCH 6-26, 1967

Hours	Sunday		Monday		Tuesday		Wednesday	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
07:00-11:00	1,527	1,105	1,801	2,448	1,790	1,972	1,605	1,431
11:00-15:00	2,069	1,086	2,281	1,899	2,199	1,707	2,182	2,078
15:00-19:00	2,194	1,989	3,012	3,245	2,808	2,347	2,914	2,686
19:00-23:00	2,168	2,512	2,811	4,140	2,554	1,549	2,508	2,160
23:00-03:00	1,351	997	1,616	1,929	1,497	1,032	1,558	983
03:00-07:00	749	373	746	496	669	246	795	255
Totals:	10,058	8,062	12,267	14,157	11,517	8,853	11,562	9,593

	Thursday		Friday		Saturday		Total	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
07:00-11:00	1,668	2,601	1,669	1,939	1,822	2,011	11,882	13,507
11:00-15:00	2,121	2,173	2,336	1,710	2,711	3,044	15,899	13,697
15:00-19:00	2,754	2,404	3,116	2,746	3,408	2,643	20,206	18,060
19:00-23:00	2,502	1,914	3,169	2,742	3,402	3,650	19,114	18,667
23:00-03:00	1,839	936	3,062	3,692	2,775	3,530	13,698	13,099
03:00-07:00	948	548	1,360	1,461	1,152	972	6,419	4,351
Totals:	11,832	10,576	14,712	14,290	15,270	15,850	87,218	81,381

Source: Analysis Division, Bureau of Field Operations.

Table 37

REGRESSION SUMMARIES OF PREDICTIONS AND ACTUAL OBSERVATIONS IN THE NINTH DISTRICT, MARCH 6-26, 1967

Variables	Equation	Standard Error Of Coefficient	R^2
Number of Calls (Y actual, X predicted)	$Y = 1.19 X - 13.10$	0.06	0.90
Workload (Y actual, X predicted)	$Y = 1.09 X - 328.84$	0.11	0.73

Source: Data from Tables 35 and 36.

force of sufficient size to provide a given level of service. The level of service was measured in terms of the percent of events and workload that the call-for-service units could service without assistance. When required, assistance was obtained from the preventive units. The level of service was initially set at almost 100%, then gradually decreased as experience was gained until, by July 1967, the level of service was reduced to almost 90%. Tables 38 and 39 show how the calls for service were divided between the call-for-service and preventive patrol units, in terms of both numbers of events and workload, as a result of decisions to reduce the level of service provided by the former units. Table 38 shows that through the first six rotation periods of the test period in the Ninth District, the percent of calls taken by the call-for-service units gradually decreased as schedules increasing the work per unit were implemented. During the first rotation period these units handled 98.4% of the calls for service, but then declined to a low of 91.0% during the fifth rotation period. For the first six rotation periods, call-for-service units handled 93.4% of calls for service.

The percent of total workload (hours of work) taken by call-for-service units is given in Table 39. These percents seem to be less stable than the corresponding percents for number of calls. The workload taken by the call-for-service units decreased from 98.1% in the first rotation period to 90.4% in the second rotation period. The workload duties by the call-for-service units changed very little in the remaining four periods. Over the six rotation periods, the call-for-service units processed 91.2% of the call-for-service workload.

One area of concern during the Project was whether the level of answering calls for service could be met during periods of high workload, when preventive patrol activities are most likely to be productive. The involvement of preventive patrol units in assignments to directed incidents was examined for 12 busy hours during the sixth rotation period of Phase II. During these hours, the call-for-service units performed 92.3% of the workload for directed incidents, compared with 92.2% for the entire rotation period. Apparently, the service units handled the same percent of the workload during peak hours.

The foregoing tables indicate that the Police Department was able to control the application of resources to the call-for-service function on the basis of the data supplied by the Resource Allocation prediction programs. The scheduled resources provided the level of service predicted. There was no tendency for the call-for-service workload to interfere with the preventive effort during peak hours, and at no time did a serious shortage of manpower develop.

This is probably the single most important result of the Project. It shows that not only does the predictive system for calls for services oper-

Table 38

CALLS HANDLED BY TYPE OF UNIT IN THE NINTH DISTRICT, JANUARY 2 - MAY 8, 1967

	Directed Incidents		Directed Assists		Total		Percent	
Period Beginning	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units
January 2, 1967	24	1,996	12	288	36	2,284	1.6	98.4
January 23, 1967	96	1,897	29	265	125	2,162	5.5	94.5
February 13, 1967	126	1,896	54	252	180	2,148	7.7	92.3
March 6, 1967	131	2,058	50	243	181	2,301	7.3	92.7
March 27, 1967	180	2,262	74	315	254	2,577	9.0	91.0
April 17, 1967	138	2,223	82	297	220	2,520	8.0	92.0
Total	695	12,332	301	1,660	996	13,992	6.6	93.4

Source: Analysis Division, Bureau of Field Operations.

Table 39

WORKLOAD HANDLED BY TYPE OF UNIT IN THE NINTH DISTRICT, JANUARY 2 - MAY 8, 1967

	Directed Incidents		Directed Assists		Total		Percent	
Period Beginning	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units	Preventive Patrol Units	Call-For-Service Units
January 2, 1967	16	1,075	8	149	24	1,224	1.9	98.1
January 23, 1967	80	952	40	176	120	1,128	9.6	90.4
February 13, 1967	95	1,003	28	103	123	1,106	10.0	90.0
March 6, 1967	84	1,058	33	116	117	1,174	9.1	90.9
March 27, 1967	105	1,175	46	141	151	1,316	10.3	89.7
April 17, 1967	102	1,201	68	131	170	1,332	11.3	88.7
Total	482	6,464	223	816	705	7,280	8.8	91.2

Source: Analysis Division, Bureau of Field Operations.

ate satisfactorily in a statistical sense, but the output can be implemented in practical patrol policies.

In addition to predicting patterns in time associated with call-for-service operations, the Resource Allocation prediction programs also predicted their distribution in space. This is important in the construction of beats, since the beats are used to deploy the call-for-service units. A beat structure with an equal distribution of workload among the individual beats is highly desirable. During the rotation period of March 6-March 26, 1967, five beat pattern maps were used, each corresponding to a different beat structure. In this instance, each map contained a different number of beats. (In some few instances during the Project, different beat designs were used which had an equal number of beats.) Tables 40 and 41 show respectively the predicted and actual number of calls for service, and the

Table 40

PREDICTED AND ACTUAL NUMBER OF CALLS FOR SERVICE, BY MAP AND BEAT, IN THE NINTH DISTRICT, MARCH 6-26, 1967

Map and Beat		Predicted[a]	Actual[b]
Map 1	Beat A	41.8	41
	Beat C	27.7	28
	Beat D	31.1	30
	Beat E	37.9	42
	Beat G	48.9	56
	Beat H	36.5	33
	Beat I	36.3	37
Total		260.2	267
Map 2	Beat A	190.6	167
	Beat C	83.5	82
	Beat E	103.2	78
	Beat G	133.9	117
	Beat H	99.1	112
	Beat I	99.3	85
Total		709.6	641
Map 3	Beat A	126.6	130
	Beat B	171.8	163
	Beat C	97.2	128
	Beat E	118.4	124
	Beat F	135.1	116
	Beat G	82.2	62
	Beat H	144.6	151
	Beat I	129.8	118
Total		1,005.7	992
Map 4	Beat A	87.0	51
	Beat C	53.5	35
	Beat E	52.8	37
	Beat G	68.4	64
	Beat H	99.5	116
Total		361.2	303
Map 5	Beat A	55.7	38
	Beat C	36.0	33
	Beat D	39.2	35
	Beat E	39.3	41
	Beat F	45.4	24
	Beat G	26.5	24
	Beat H	23.4	20
	Beat I	32.2	16
	Beat J	34.2	28
Total		331.9	259

[a] Radio Dispatch Tickets are processed on a weekly basis through an update system to obtain new averages (see the Appendix). Since predictions can be made after any particular update, the total predicted value in this table differs from the total in Table 35.

[b] The coded address of the incident provided the means of obtaining the correct beat by using a computer program. Since the coding was subject to error, some data were lost and the total number of calls in this table differs from the total in Table 35.

Source: Analysis Division, Bureau of Field Operations.

Table 41

PREDICTED AND ACTUAL WORKLOAD IN MINUTES, BY MAP AND BEAT, IN THE NINTH DISTRICT, MARCH 6-26, 1967

Map and Beat		Predicted[a]	Actual[b]
Map 1	Beat A	1,251.5	1,321
	Beat C	958.3	855
	Beat D	1,000.3	777
	Beat E	1,375.9	1,196
	Beat G	1,518.0	2,130
	Beat H	1,180.3	1,396
	Beat I	1,332.0	1,431
Total		8,616.3	9,106
Map 2	Beat A	5,885.4	5,503
	Beat C	2,918.8	2,345
	Beat E	3,693.4	2,638
	Beat G	4,136.9	3,615
	Beat H	3,198.7	3,935
	Beat I	3,650.2	2,878
Total		23,483.4	20,914
Map 3	Beat A	3,602.9	3,503
	Beat B	5,468.2	3,552
	Beat C	3,345.1	3,668
	Beat E	3,916.5	3,481
	Beat F	4,118.2	3,266
	Beat G	2,875.0	2,031
	Beat H	4,589.5	6,307
	Beat I	4,685.7	3,459
Total		32,601.1	29,267
Map 4	Beat A	2,568.2	1,689
	Beat C	1,860.5	1,283
	Beat E	1,863.5	1,085
	Beat G	2,083.6	2,175
	Beat H	3,392.2	3,546
Total		11,768.0	9,778
Map 5	Beat A	1,629.3	1,144
	Beat C	1,211.6	601
	Beat D	1,271.6	833
	Beat E	1,291.2	1,219
	Beat F	1,365.7	722
	Beat G	923.9	787
	Beat H	694.3	526
	Beat I	1,193.8	404
	Beat J	1,127.2	724
Total		10,708.6	6,960

[a] Radio Dispatch Tickets are processed on a weekly basis through an update system to obtain new averages (see the Appendix). Since predictions can be made after any particular update, the total predicted value in this table differs from the total in Table 36.

[b] The coded address of the incident provided the means of obtaining the correct beat by using a computer program. Since the coding was subject to error, some data were lost and the total number of calls in this table differs from the total in Table 36.

Source: Analysis Division, Bureau of Field Operations.

predicted and actual workload in minutes, for each map and beat for the foregoing rotation period. The maps were in effect for differing numbers of hours during a rotation period.

Tables 40 and 41 show the total number of calls and workload (both observed and predicted) for each map and beat set, for March 6-26, 1967. Some of the difference between the predicted and actual data can be attributed to records with defective addresses which appear in district totals but which cannot be associated with a specific beat.

The sampling fluctuations for the beat data within maps are a larger consideration than they are for district totals, where the numbers predicted are larger. Even so, the beats within a map which have higher predicted calls for service and workload tend to have higher actual calls for service and workload.

A comparison was made of the location of a call for service, and the beat of the units responding covering the rotation periods of November 14, 1966 - December 5, 1966 and April 17, 1967 - May 8, 1967 in the Ninth District. During the latter rotation period the call-for-service units answered a higher percent of calls within their own beat than the units in the Phase I rotation period. It should be noted that the workload was higher in Phase II. This would tend to reduce the percent of calls taken within a unit's own beat. Thus the Project output and method were judged to lead to a satisfactory beat structure.

It has been noted that the quality of a prediction depends on the size of the mean which is being predicted. The quality of a prediction also depends on the "time horizon," the interval between the most recent data entered in the data base and the start of the prediction period.

The capacity to predict from one season of the year to another depends on the existence of satisfactory estimates of the seasonal patterns themselves. For Phase II, the seasonal patterns were based on data from two preceding years. As more data are processed, the seasonal pattern estimates should become more stable, and provide more certain bases for predictions over intermediate and longer time horizons.

During the Project, a time horizon of one or two weeks was used, but larger horizons may be required for different applications or different police departments. Thus, some estimate of the effective limit on the time horizon is desirable. To provide these estimates, the workload and number of events for periods of the day and week were made for the rotation period of March 27 - April 16, 1967, from a number of preceding dates. These predictions were then compared to the actual observations. Predictions were made on January 21, February 11, March 4, and March 25, 1967. Because of changes in operations introduced at the start of Phase II, longer horizons could not be tested. Table 42 contains these predictions and the ultimate actual observations. The data for each watch, number of calls and workload are shown in Figure 10.

Both the table and figure show that, in general, predictions did not improve substantially as the time horizon became shorter. One possible exception was the predicted workload for the third watch, where there was some improvement between the nine- and six-week horizons. Apparently the existing seasonal patterns are stable enough to produce predictions over a horizon of at least nine weeks.

Evaluation of Crime Data

The Resource Allocation prediction programs, insofar as can be evaluated, functioned satisfactorily. The Police Department was able to release resources to meet the problem of crime prevention and still maintain a satisfactory level of service. By planning separately to meet resource requirements for service and prevention, the Department should be able to schedule available resources to meet foreseen problems.

In addition to the data related to calls for service, the Resource Allocation Research Unit provided data about crime. Computer-supported crime analysis techniques were used to produce

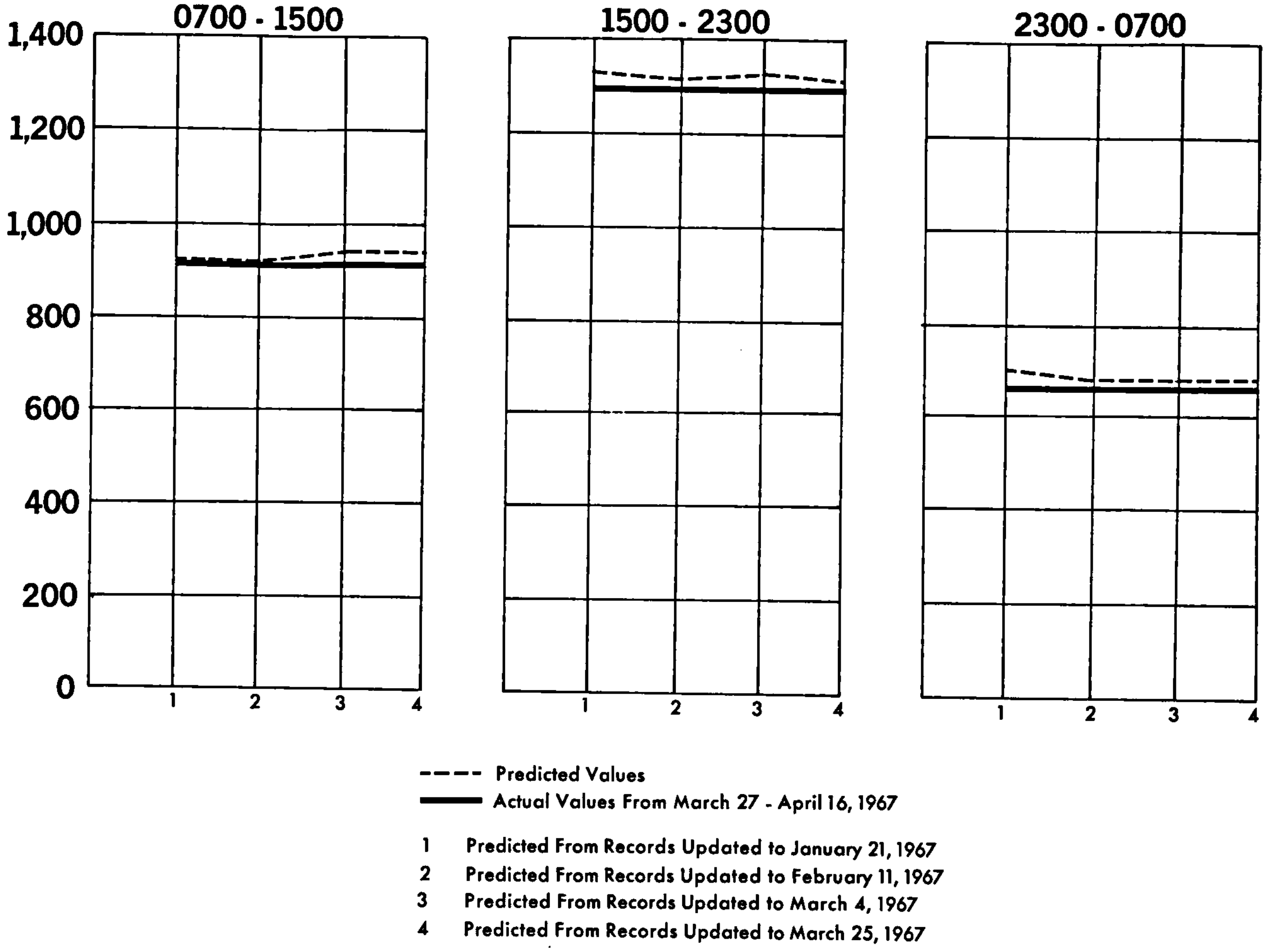
Table 42

PREDICTED CALLS FOR SERVICE AND WORKLOAD, AND ACTUAL OBSERVATIONS IN THE NINTH DISTRICT FOR MARCH 27 - APRIL 16, 1967

	Calls for Service			Workload (in minutes)		
Prediction	0700-1500	1500-2300	2300-0700	0700-1500	1500-2300	2300-0700
January 21, 1967	925.2	1,330.9	700.9	31,347.9	43,567.7	23,017.7
February 11, 1967	924.4	1,315.8	685.1	31,113.1	42,834.1	22,338.2
March 4, 1967	942.7	1,326.7	674.5	31,615.1	43,051.1	21,940.2
March 25, 1967	953.3	1,324.0	682.3	31,512.8	42,558.4	21,915.7
Actual						
March 27 - April 16, 1967	916.0	1,297.0	656.0	30,589.0	47,648.0	21,113.0

Source: Analysis Division, Bureau of Field Operations.

PREDICTED AND ACTUAL NUMBER OF CALLS IN NINTH DISTRICT



PREDICTED AND ACTUAL WORKLOAD (IN MINUTES) IN NINTH DISTRICT

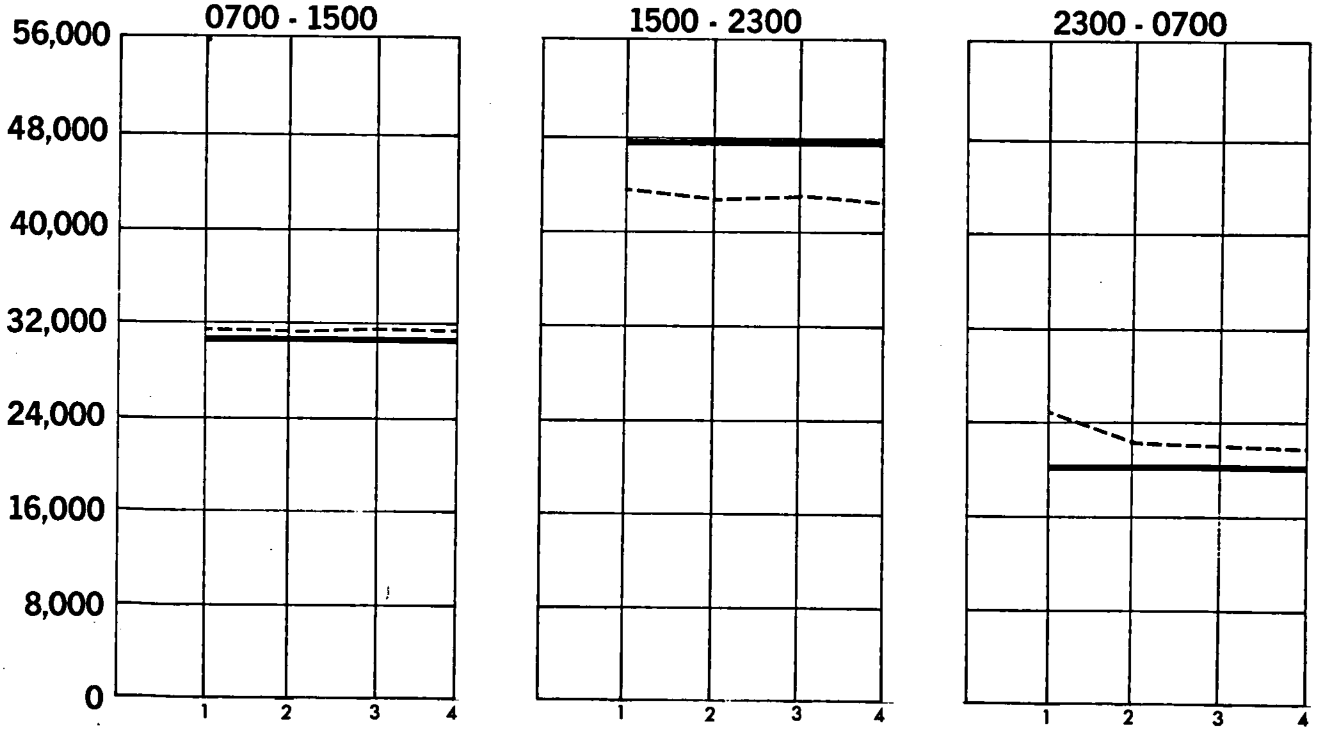


Figure 10. Predicted Calls for Service and Workload, and Actual Observations in the Ninth District for March 27-April 16, 1967

two basic types of reports, the SYMAP output and the Selected Part I Crimes Report. These were produced simultaneously every 9 days and contained data for 21 consecutive days of Index Crime reports, the period ending one day before the report. Both reports show crime by the following classes for each Pauly Area in the Ninth District:

1. Highway robbery;
2. Aggravated assault;
3. Residence burglary—day;
4. Residence burglary—night;
5. Business burglary;
6. Larceny from automobile;
7. Automobile theft; and
8. Total of the above.

The Selected Part I Crimes Report is designed to support scheduling and assignment of the preventive effort. It can be tested to see how well it in fact predicts crime trends, by comparing Pauly Area data from a past 21-day period with the data for a subsequent 9-day period. Table 43 contains this information.

There is a tendency for areas which have the higher crime rates in the 21-day period also to have higher crime rates in the subsequent 9-day period. One measure of how well the 21-day period data predict these crimes by Pauly Area for the subsequent 9-day period is the correlation coefficient. These coefficients were calculated for the three periods and were 0.73, 0.76, and 0.78, respectively. Overall, at least, the 21-day data

Table 43

SELECTED PART I CRIMES PATTERNS FOR THREE PAIRS OF TIME PERIODS BY PAULY AREAS IN THE NINTH DISTRICT

	Period 1		Period 2		Period 3	
Pauly Area Number	21 Days March 8- March 28	9 Days March 29- April 6	21 Days March 7- April 6	9 Days April 7- April 15	21 Days March 25- April 15	9 Days April 16- April 24
442	5	1	4	1	2	2
443	1	0	1	6	4	2
444	5	1	3	3	4	2
445	22	9	19	5	15	9
446	5	5	7	0	5	3
447	3	0	3	0	2	1
448	11	2	9	4	7	3
461	10	3	6	2	5	1
462	9	5	2	2	9	5
463	17	7	13	4	9	7
476	20	11	23	10	19	10
477	22	5	21	11	15	6
478	17	6	17	6	15	5
479	4	3	3	1	3	2
519	1	1	2	2	3	0
520	3	1	4	1	4	0
521	3	3	2	0	1	1
523	2	2	3	1	2	0
524	27	14	30	13	35	13
525	3	1	4	1	2	1
526	6	3	7	2	6	2
527	4	6	7	5	8	2
528	10	12	20	7	22	0
529	7	9	15	8	15	3
530	16	11	16	6	17	7
531	24	10	28	19	27	18
532	30	9	26	9	18	6
533	35	21	38	11	33	19
534	28	16	35	17	37	14
535	19	13	21	17	23	11
536	15	10	20	13	22	14
537	5	9	6	11	3	7
538	5	7	4	11	2	3
539	13	13	17	11	14	3
540	5	13	10	9	12	9
545	15	4	14	5	19	10
807	6	5	5	4	6	7
808	6	4	3	4	4	3
901	11	4	7	5	7	5
902	9	0	14	8	14	9
Total	459	259	489	255	470	225

Source: Analysis Division, Bureau of Field Operations.

provide a fairly good prediction of the subsequent 9-day experience.

The primary purpose of the SYMAP output is to indicate areas with relatively high crime concentrations. In these problem areas, additional preventive effort should be productive. Thus, special attention should be directed to how well the 21-day data predict the highest crime incidence areas for the subsequent 9-day period.

In order to have a measure of this aspect of the problem, the 10 Pauly Areas with the greatest number of Selected Part I Crimes during the 21-day period March 8-28, 1967 and the 9-day period March 29 - April 6, 1967, were identified and ranked, as shown in Table 44. An analysis of this table revealed six Pauly Areas common to the two listings: Areas 476, 524, 531, 533, 534, and 535. Similar tables constructed for the other two sets of data in Table 43 showed seven Pauly Areas common to each set of data. Thus, 20 of the 30 Pauly Areas studied in the 21-dav rankings reappeared in the analysis of the 9-day rankings.

Table 44

TEN HIGHEST SELECTED PART I CRIMES AREAS IN THE NINTH DISTRICT FOR MARCH 8 - MARCH 28, 1967 AND MARCH 29 - APRIL 6, 1967

	March 8 - March 28		March 29 - April 6	
Rank	Pauly Area	No. of Crimes	Pauly Area	No. of Crimes
1	533*	35	533*	21
2	532	30	534*	16
3	534*	28	524*	14
4	524*	27	535*	13
5	531*	24	539	13
6	477	22	540	13
7	445	22	528	12
8	476*	20	476*	11
9	535*	19	530	11
10	463	17	531*	10

*Denotes that the Pauly Area is among the highest 10 crime areas in both periods.

Source: Data from Table 43.

This method of analysis disregards information conveyed by the SYMAP output, which shows that high crime areas generally cover several Pauly Areas. The high crime areas form clusters, thus making the areas which require special preventive effort more stable over time and easier to identify.

It was possible to test directly the utility of the call-for-service data by examining the policies adopted by the Department. Thus, the call-for-service program output could be judged satisfactory, since the number of such units assigned, the overflow workload, and the workload by beat which resulted from use of the data were consistent with predictions. Similar tests were not possible with the crime data. The patrol assignments for preventive activity were made by the Ninth District. Important crime data sources, in addition to those provided by the Resource Allocation Research Unit, were available to district command personnel, so that the preventive patrol schedules and assignments adopted reflected input data which are not easily interpreted for evaluation.

To summarize, the Information System supporting the Resource Allocation Project worked satisfactorily in those areas which could be tested. Within the constraints on scheduling, a controlled application of manpower met the call-for-service requirements. The Police Department was able to maintain approximately the combination of level of service (calls served without delay by call-for-service units) and workload at which it aimed. At no time did a serious shortage of units occur. The crime information on Selected Part I Crimes portrayed clearly the problem areas within the Ninth District. The past crime data used in the reports served as a satisfactory predictor of the future crime experience at the Pauly Area level. The Department did make resources available at the times required to meet the crime problem.

Evaluation of Patrol Operations

The Resource Allocation Project was primarily concerned with the effective control of the resources devoted to patrol — in particular, the scheduling and assignment of manpower. During the course of the Project, many other problems arose, were discussed, and solved. These decisions, and those taken in connection with scheduling and assignment of manpower, substantially changed many aspects of operation in the Ninth District. In this section, the results of some of these changes will be considered.

This part of the evaluation, unlike the preceding, is quite dependent upon the structure and operations of the St. Louis Police Department. The changes in operations between Phase I and Phase II of the Project have been described previously. The most important involved the "split function" concept, and variable call-for-service beats.

The particular decisions were selected from a wide range of options. Since the Project officially ended, the Department has tested other choices. Resource Allocation scheduling techniques have been utilized in four of the nine St. Louis police districts, with different methods of implementation in effect in each. Evaluation of each method will be made by District and Area commanders prior to a final decision on more general implementation. The method of implementation selected for the Resource Allocation Project did, in fact, work. Thus, at least one satisfactory method of implementation has been found.

Objective evaluation of the Project's effect on patrol operations is quite difficult because of the number of material factors which changed during Phase I and Phase II. In a preceding section on the assessment of the problem, seasonal patterns in the demands for police services of all kinds were noted. These operated during Phase I and Phase II of the Project. The manpower available for the patrol function in the Ninth District changed substantially, not only between Phases I and II but also within both periods. The changes in operation induced some changes in the data recorded, both quantitatively and qualitatively.

One of the most basic variables was manpower strength. Tables 45 and 46 show the actual strength for the Seventh and Ninth districts, respectively, by month during Phase I and Phase II. Seventh District data are included since, at the start of the Project, it was planned to use the Seventh District as a standard by which to evaluate changes in the Ninth District.

Table 45

COMMISSIONED STRENGTH AND ASSOCIATED INDEX IN THE SEVENTH DISTRICT, BY MONTH, PHASE I AND PHASE II

(July 1966 Strength = 100.0)

Pretest Period

Month	Strength[a]	Index
July, 1966	210	100.0
August	204	97.1
September	205	97.6
October	204	97.1
November	201	95.7
December	208	99.0

Test Period

Month	Strength	Index
January, 1967	208	99.0
February	214	101.9
March	213	101.4
April	214	101.9
May	214	101.9
June	213	101.4

[a] As of last day of each month.

Source: Commissioned Strength Report of the St. Louis Police Department.

During Phase I, commissioned strength in the Seventh District declined gradually from 210 men in July 1966 to a low of 201 in November, but rose to 208 in December. During Phase II, strength increased from 208 men in January 1967 to 214 in February, and remained at this level through July.

The actual strength in the Ninth District, 195 men in July 1966, rose to a peak of 197 men in September, then declined to 195 men in November and remained at this figure through December 1966. In January 1967, 13 men were transferred to the Ninth District to replace the pro rata strength of special units which did not operate in the Ninth District in Phase II. Some allowance can be made for the services of these units by not counting them in either Phase I or Phase II in either the Seventh District or the Ninth District. The adjusted strength in the Ninth District then declines each month of Phase II from 191 men in January to 177 men in June 1967, as shown in Table 47.

Table 46

COMMISSIONED STRENGTH AND ASSOCIATED INDEX IN THE NINTH DISTRICT, BY MONTH, PHASE I AND PHASE II

(July 1966 Strength = 100.0)

Pretest Period

Month	Strength[a]	Index
July, 1966	195	100.0
August	195	100.0
September	197	101.0
October	195	100.0
November	193	99.0
December	193	99.0

Test Period

Month	Strength	Index
January, 1967	204	104.6
February	203	104.1
March	200	102.6
April	197	101.0
May	193	99.0
June	190	97.4

[a] As of last day of each month.

Source: Commissioned Strength Report of the St. Louis Police Department.

Table 47

ADJUSTED COMMISSIONED STRENGTH AND ASSOCIATED INDEX IN THE NINTH DISTRICT, BY MONTH, PHASE I AND PHASE II

(July 1966 Strength = 100.0)

Pretest Period

Month	Strength	Index
July, 1966	195	100.0
August	195	100.0
September	197	101.0
October	195	100.0
November	193	99.0
December	193	99.0

Test Period

Month	Adjusted Strength	Adjusted Index
January, 1967	191	97.9
February	190	97.4
March	187	95.9
April	184	94.4
May	180	92.3
June	177	90.8

Source: Table 46.

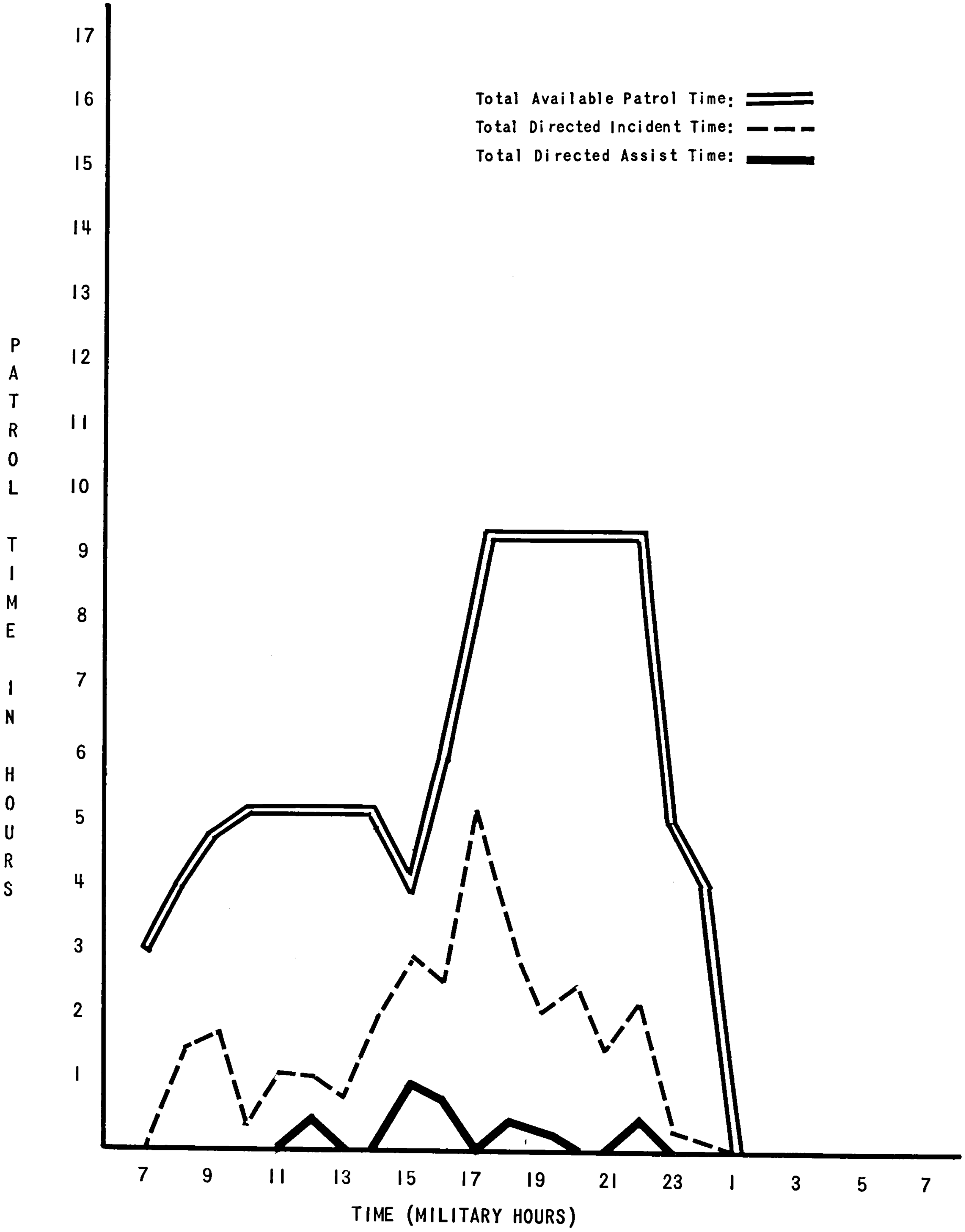


Figure 11. Patrol Time of Ninth District Preventive Units for Friday, April 21, 1967

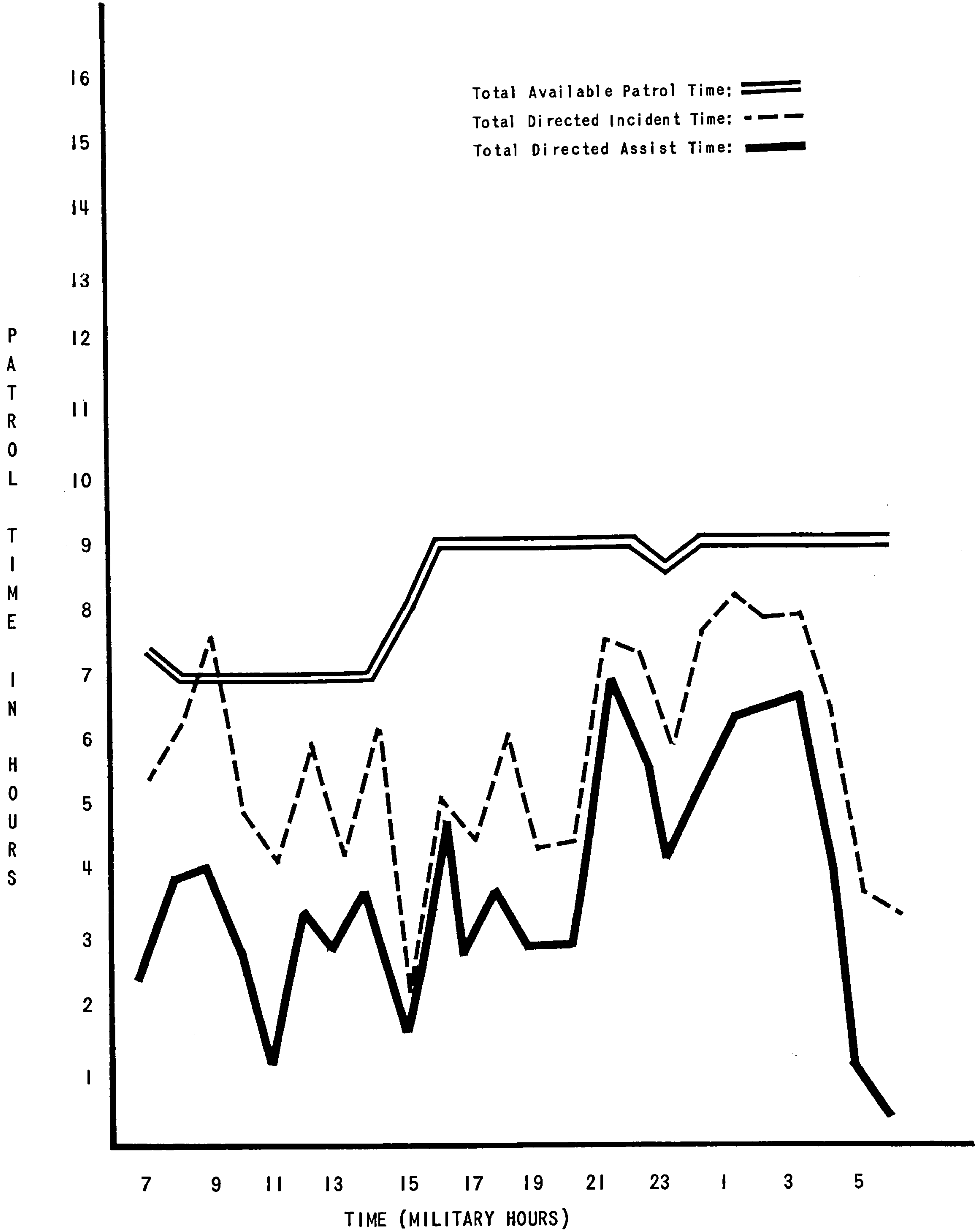


Figure 12. Patrol Time of Ninth District Call-for-Service Units for Friday, April 21, 1967

Figure 13. Seventh District Patrol Time for Friday, April 21, 1967

It should be noted that this decrease in manpower will have different impacts on various activities. Within each district there are a number of administrative and other positions which are not affected by these fluctuations in available resources. However, any variation in patrol strength affects a district's capacity to carry out preventive activities. Relatively small fluctuations in total strength may be amplified into relatively large fluctuations in preventive capacity.

To investigate the effect of Project methods on the distribution of patrol effort, data for Friday, April 21, 1967, for the Seventh and Ninth districts were examined in detail.

Figure 11 shows, in hours, the available unit hours, call-for-service time, and directed incident time for the preventive patrol units in the Ninth District. Figure 12 shows similar data for the call-for-service units in the Ninth District; and Figure 13 shows the same data for all units in the Seventh District. One result of the Project methods is evident from these Figures: the distribution of patrol strength in the Ninth District makes a larger proportion of preventive strength available in what were determined to be the problem hours on Friday. Again, to the extent that this is a good measure of scheduling efficiency, the Resource Allocation procedures proved effective.

Experience gained during the Resource Allocation Project has raised a number of questions about patrol operations. One of the most bothersome has been the problem of the "mix" of patrol units. In Phase II, two-man patrol units were assigned to call-for-service duty in the Ninth District. This had several consequences. First, the mean service time on directed incidents was reduced by about one-fourth from Phase I to Phase II. Second, the number of directed assists was reduced. Third, a technique was worked out where, after responding to a call for service, one officer could remain at the scene to handle a minor incident, while the second officer could proceed to handle, or assist in, a subsequent call. The two-man unit was able to carry out preventive activities such as building checks, vehicle checks and pedestrian checks, without going out of service. With the split function patrol technique, the two-man call-for-service units were kept occupied a substantial part of the time so that the loss of the extra preventive coverage provided by an alternative of two one-man units was not prohibitive.

The problem of one- versus two-man units is complex, and much has been written about it. The St. Louis experience appears to indicate that the optimal solution is likely to be a mix of both one- and two-man units, with the proportion depending on unit function, area, and time.

Tables 48 and 49 contain measures of the levels of preventive activity, measured by counts of selected reports for eight rotation periods for both the Seventh and Ninth districts, for Phase I and Phase II. In the Seventh District, during Phase II the activity per rotation period declined for Field Interrogation Reports and Curfew Notices, and increased for Adult Arrests, Insecure Building Reports, and Hazardous Summonses. In the Ninth District, during Phase II activity declined for Adult Arrests, Insecure Building Reports, and Hazardous Summonses, and increased for Field Interrogation Reports and Curfew Notices.

These major statistical series indicate that basic variables, including the resources used and measured output, changed substantially from Phase I to Phase II in both districts. Examination of these gross data does not show whether implementation of the Resource Allocation Project procedures during Phase II led to more efficient patrol operation than would have been realized under the previous methods.

There is also another problem in connection with the evaluation. The judgment which is most important to reach is not how well the Resource Allocation methods worked in a given six-month period, but whether, in the long run, those methods will work better than alternative methods. The only observations available at this time pertain to the initial six-month period (Phase II), where lack of experience with the data, methods of implementation, and continuing changes in operations, played important roles. Thus, Phase II data may not reflect either what can or will be done using the Resource Allocation Project methods.

At the same time, some evaluation is possible. First, the Resource Allocation Project methods were designed to provide adequate resources for the call-for-service function. This was discussed in the preceding section. The schedules developed during Phase II in the Ninth District were feasible; responses to calls for service were provided as required without significant delay. The overflow workload from the calls for service was of the magnitude planned. The schedules for Phase I, before the introduction of Project methods, were also feasible. Thus, the schedules for Phase II probably would be judged as superior or inferior to those of Phase I depending upon the distribution of preventive effort.

Comparison of the Test and Control District Operations

The evaluation of patrol operations, in general, and the effectiveness of the preventive effort, in particular, presented serious difficulties during the Resource Allocation Project. The level of crime depends on many factors outside the direct control of a police department. Reported crime

Table 48

PREVENTIVE ACTIVITY BY PHASE AND PERIOD IN THE SEVENTH DISTRICT

Rotation Period Beginning	Adult Arrests	Field Interrogation Reports	Insecure Building Reports	Curfew Notices	Hazardous Summonses
Pretest					
July 11, 1966	301	262	3	18	391
August 1	307	444	3	49	355
August 22	393	372	2	43	429
September 12	365	574	3	32	312
October 3	428	507	1	17	440
October 24	382	492	2	30	310
November 14	385	448	7	14	382
December 5	419	451	6	40	446
Total	2,980	3,550	27	243	3,065
Test					
January 2, 1967	379	217	6	4	259
January 23	393	165	2	13	360
February 13	455	259	4	16	495
March 6	425	234	6	16	412
March 27	390	155	6	14	337
April 17	360	419	5	16	478
May 8	371	360	3	30	495
May 29	352	276	6	24	455
Total	3,125	2,085	38	133	3,291

Source: Analysis Division, Bureau of Field Operations.

Table 49

PREVENTIVE ACTIVITY BY PHASE AND PERIOD IN THE NINTH DISTRICT

Rotation Period Beginning	Adult Arrests	Field Interrogation Reports	Insecure Building Reports	Curfew Notices	Hazardous Summonses
Pretest					
July 11, 1966	435	307	7	42	489
August 1	421	349	5	107	626
August 22	469	398	5	36	556
September 12	326	449	15	51	548
October 3	325	348	21	25	455
October 24	374	459	8	62	479
November 14	370	591	15	34	520
December 5	450	536	13	71	505
Total	3,170	3,437	89	428	4,178
Test					
January 2, 1967	298	429	3	49	297
January 23	366	290	3	15	332
February 13	371	381	4	15	495
March 6	303	391	4	17	306
March 27	304	533	1	75	348
April 17	312	605	0	109	485
May 8	366	470	4	82	516
May 29	384	360	2	123	459
Total	2,704	3,459	21	485	3,238

Source: Analysis Division, Bureau of Field Operations.

rates exhibit, in addition to trends, cyclical and seasonal patterns and random fluctuations. Thus, it is not possible to evaluate policies easily by examining either crime rates or changes in crime rates. At the same time, it is desirable to have some objective measures of the effect of selecting specific patrol policies. To assist in this process, the Seventh District was selected to serve as a standard, in the hope that Seventh District data would yield a basis of comparison from which inferences could be drawn. It is not sufficient merely to compare corresponding data in the Seventh and Ninth districts for Phase II. For example, the districts generally started at different levels. The effect of such differences can be reduced by comparing changes in the value of a series from Phase I to Phase II within each district.

The changes between the two Phases in the Ninth District were caused by both changing conditions and the new policies introduced during the Project. In the Seventh District the changes reflected only changing conditions. If the changes in the measured variables were proportioned in the two districts between Phase I and Phase II, then inferences about the effects of the Resource Allocation Project could be made.

For this purpose, the basic statistical test selected was the Chi-Square test using, for most variables, the 2 x 2 contingency table (Table 50).

Table 50

SAMPLE 2 X 2 CONTINGENCY TABLE

	Pretest	Test	Total
Test District (Ninth)	a	b	a + b
Control District (Seventh)	c	d	c + d
Total	a+c	b+d	a+b+c+d

Note: The program to perform the Chi-Square analysis on the 2 x 2 tables was derived from the IBM System/360 Scientific Subroutine Package (Subroutine CHISQ). The code for subroutine CHISQ was modified for execution on the St. Louis Police Department IBM 7040 computer and input and output code were added.

If the entries in a 2 x 2 table are labeled as in the table above, the Chi-Square statistic has the following formula:

$$\text{Chi-Square} = \frac{(a+b+c+d)\;(|ad\text{-}bc| - 0.5\;(a+b+c+d))^2}{(a+b)\;(c+d)\;(a+c)\;(b+d)}$$

This statistic under the null hypothesis associated with the 2 x 2 analysis has one degree of freedom.

A complete description of CHISQ can be found in:
System/360 Scientific Subroutine Package
(360A — CM — 03X)
Application Description
H20-0166-2

The assumption behind this approach is that, in repeated observations, the ratio of the test district observation to the corresponding control district observation will be approximately the same for both Phase I and Phase II, in the absence of deliberately-introduced effective changes. In other words, if minor fluctuations could be eliminated, a:c = b:d.

This test essentially answers the question: Would the numbers observed occur more frequently than 1 time in 20 if these ratios were in fact the same in the two periods? A particular test is said to be 'significant at the .05 level' if the answer to the question is "No." That is, the observations, given the null hypothesis, are sufficiently unlikely that it is concluded that the two ratios differ. With this part of the logic of the test, the results are not in question. The observations are tested against a theoretical distribution, and from theory it is known precisely how the observations should be related, if the null hypothesis is true. The logical problem arises in the attempt to extend the argument from the hypothesis that the ratios in Phase I and Phase II differ, to the conclusion that they differ only because of the activities associated with the Resource Allocation Project. Here a very strong assumption is being made about the nature of the data, unsupported by any theory. There is an unknown risk that these ratios would have been different whether or not the Resource Allocation Project was undertaken. To a limited extent this risk can be assessed by examining past data.

The proposed test essentially involves the comparison of data for the last half of 1966 (Phase I) with equivalent data for the first half of 1967 (Phase II). The last half of 1965 and the first half of 1966 are another pair of periods which are related in a similar way, except for the absence of the Resource Allocation Project methods. If the Seventh District is a satisfactory control for the Ninth District, then in the earlier period most tests of data should turn out to be 'not significant.' That is, the data collected during the last half of 1965 and the first half of 1966 can be used as a blank test.

Unfortunately, many of the relevant series were not recorded before the start of Phase I. For these, little testing of the statistical methodology is possible. Some series which are of particular interest to the Department do exist on a district basis for several years and these can be tested.

Crime data are an important series to all police departments. Table 51 shows the results of the Chi-Square tests applied to crime data for the Seventh and Ninth districts for the last six months of one year against the first six months of the next year. Each category was tested four times, once for each of the pairs of the half-year periods, from June 1962 through June 1965. The table indicates whether the test results were significant at the .01 or the .05 level, or were not significant.

Ten classes of crime were tested. Since the number of observations for murder from June through December 1962 was too small to test, the test was applied in 39 cases. Of these, 28 were not significant, 11 were significant at the .05 level and 5 were significant at the .01 level (the five cases significant at the .01 level are included among the 11 significant cases at the .05 level). If the Seventh District crime data provide a good standard for those in the Ninth District, then about 1 in 20 of these tests (2, all together) would be significant at the .05 level, and either none or 1 of the tests at the .01 level. Evidently, there are significant differences in the crime experience of the Seventh and Ninth districts over consecutive pairs of six-month intervals. The Total Index Crime series was a little worse than most of its sub-indexes. Only two of the four possible tests on the Total Index Crime were not significant.

As an alternative to the Seventh District alone, the City of St. Louis, excluding the Ninth District, could have been used as a control. Since the city is more heterogeneous than the Seventh District, it is consequently more stable. Table 52 shows the results of the Chi-Square test comparing pairs of six-month crime data for the Ninth District and the rest of the city. Of these 40 tests, 32 were non-significant at the .05 level and 4 were significant at the .01 level. Thus the remainder of the city also provides a standard of limited value for crime in the Ninth District, although it is a better standard than the Seventh District.

Despite the indications that the Chi-Square test utilizing the Seventh District as a control is suspect, the data and the test results are presented below for Phases I and II of the Project. The Chi-Square test was carried out for 10 crime series with data from the Seventh and Ninth districts for Phases I and II of the Project. Of these series, the relative changes in the categories of murder, rape, aggravated assault, auto theft, robbery, residence burglary, and business burglary were not significant at the .05 level. As shown in Figure 53, the categories of Total Index Crime, larceny over $50, and larceny under $50 were significant at the .05 level.

The relative increase in both the number of larcenies and in Index Crimes in the Ninth District during Phase II was both statistically signif-

Table 51

CHI-SQUARE TEST RESULTS FOR CONSECUTIVE SIX-MONTH PERIODS IN SEVENTH AND NINTH DISTRICTS, JUNE 1962 - JUNE 1965

Variable	First Period Starts			
	June 1962	June 1963	June 1964	June 1965
Total Index Crime	**	ns	*	ns
Murder	—	ns	ns	*
Rape	ns	ns	**	ns
Aggravated Assault	ns	ns	ns	ns
Auto Theft	ns	ns	ns	*
Total Robbery	*	ns	*	ns
Residence Burglary	ns	ns	ns	ns
Business Burglary	**	ns	ns	*
Larceny over $50	ns	ns	ns	ns
Larceny under $50	ns	**	**	ns

— Not enough observations for Test.
ns Not significant at .05 level.
* Significant at .05 level but not at .01 level.
** Significant at .01 level.
Source: Analysis Division, Bureau of Field Operations.

Table 52

CHI-SQUARE TEST RESULTS FOR CONSECUTIVE SIX-MONTH PERIODS IN THE NINTH DISTRICT, AND THE CITY EXCEPT IN THE NINTH DISTRICT, JUNE 1962 - JUNE 1965

Variable	First Period Starts			
	June 1962	June 1963	June 1964	June 1965
Total Index Crime	ns	ns	**	ns
Murder	ns	ns	ns	ns
Rape	ns	ns	**	ns
Aggravated Assault	ns	ns	ns	ns
Auto Theft	ns	ns	ns	**
Total Robbery	ns	ns	ns	ns
Residence Burglary	**	*	*	ns
Business Burglary	ns	ns	ns	ns
Larceny over $50	ns	ns	ns	ns
Larceny under $50	ns	*	ns	**

ns Not significant at the .05 level.
* Significant at the .05 level, but not at the .01 level.
** Significant at the .01 level.
Source: Analysis Division, Bureau of Field Operations.

Table 53

CHI-SQUARE TEST RESULTS FOR TOTAL INDEX CRIME, LARCENY OVER $50, AND LARCENY UNDER $50 IN THE SEVENTH AND NINTH DISTRICTS, PHASE I AND PHASE II

	Total Index Crime		
	Phase I	Phase II	Total
Seventh District	2,582	2,365	4,947
Ninth District	2,142	2,369	4,511
Total	4,724	4,734	9,458

Chi-Square Statistic: 20.74
Significant at the .05 level

	Larceny Over $50		
	Phase I	Phase II	Total
Seventh District	224	165	389
Ninth District	279	390	669
Total	503	555	1,058

Chi-Square Statistic: 24.24
Significant at the .05 level

	Larceny Under $50		
	Phase I	Phase II	Total
Seventh District	1,900	1,709	3,609
Ninth District	1,987	2,593	4,580
Total	3,887	4,302	8,189

Chi-Square Statistic: 69.07
Significant at the .05 level

Source: Analysis Division, Bureau of Field Operations.

icant and substantial. Part of the increase in Index Crimes can be attributed to the change in larcenies over $50.

Table 54 shows the results of the analysis of five major categories of preventive activity in the two districts. The Ninth District showed relative decreases between Phase I and Phase II in the areas of arrests, hazardous summonses, and Insecure Building Reports, while the Seventh District showed relative increases in these categories.

The number of Field Interrogation Reports and Curfew Notices decreased in the Seventh District and increased in the Ninth District.

Table 54

CHI-SQUARE TEST RESULTS FOR PREVENTIVE ACTIVITIES IN THE SEVENTH AND NINTH DISTRICTS, PHASE I AND PHASE II

	Adult Arrests		
	Phase I	Phase II	Total
Seventh District	2,980	3,125	6,105
Ninth District	3,170	2,704	5,874
Total	6,150	5,829	11,979

Chi-Square Statistic: 31.63
Significant at the .05 level

	Hazardous Summonses		
	Phase I	Phase II	Total
Seventh District	3,065	3,291	6,365
Ninth District	4,178	3,238	7,416
Total	7,243	6,529	13,772

Chi-Square Statistic: 90.09
Significant at the .05 level

	Field Interrogation Reports		
	Phase I	Phase II	Total
Seventh District	3,550	2,085	5,635
Ninth District	3,437	3,459	6,896
Total	6,987	5,544	12,531

Chi-Square Statistic: 216.43
Significant at the .05 level

	Insecure Building Reports		
	Phase I	Phase II	Total
Seventh District	27	38	65
Ninth District	89	21	110
Total	116	59	175

Chi-Square Statistic: 26.60
Significant at the .05 level

	Curfew Notices		
	Phase I	Phase II	Total
Seventh District	243	133	376
Ninth District	428	485	913
Total	671	618	1,289

Chi-Square Statistic: 3.99
Significant at the .05 level

Source: Analysis Division, Bureau of Field Operations.

Table 55 shows the analysis of directed incidents and directed assists in the two districts. There was very little change in the number of directed incidents in either district between Phase I and Phase II. Although the number of directed assists decreased substantially in both districts during Phase II, the decrease in the Ninth District was striking — a very positive result of the Project. A directed assist occurs when two patrol units (both usually one-man) are dispatched on a call for service, and one unit is directed by the radio dispatcher to assist the other. Since the Ninth District was operating during the Project with only two-man call-for-service units, the number of occasions in which another patrol unit was required was kept to a minimum.

Table 55

CHI-SQUARE TESTS FOR DIRECTED INCIDENTS AND DIRECTED ASSISTS IN THE SEVENTH AND NINTH DISTRICTS, PHASE I AND PHASE II

	Directed Incidents		
	Phase I	Phase II	Total
Seventh District	19,082	17,381	36,463
Ninth District	13,746	13,027	26,773
Total	32,828	30,408	63,236

Chi-Square Statistic: 6.02
Significant at the .05 level

	Directed Assists		
	Phase I	Phase II	Total
Seventh District	8,232	7,838	16,070
Ninth District	7,143	1,961	9,104
Total	15,375	9,799	25,174

Chi-Square Statistic: 1811.99
Significant at the .05 level

Source: Analysis Division, Bureau of Field Operations.

The foregoing comparisons of operations in the Seventh and Ninth districts during Phase I and Phase II of the Resource Allocation Project do not show a consistent picture of either success or failure for the Project. Ultimately, better methods of scheduling and assigning manpower should provide some help in containing crime. If these new methods are productive enough, in principle, at least, the changes should be measurable. Whether they should be detectable in a situation where so many fundamental factors have changed is a question.

Despite this uncertainty, the Project was successful in terms of its immediate objectives. The St. Louis Police Department was able to use the programs developed by the Project to control the application of resources devoted to calls for service, to balance workloads with levels of service, and to concentrate preventive resources at times when they could be most productive.

Chapter 2

THE IMPACT OF RESOURCE ALLOCATION ON OFFICER MORALE

One aspect of the evaluation of the Resource Allocation Project involved the impact on officer morale of the new methods for allocating patrol manpower and establishing patrol beat patterns.

Since no appropriate attitude scales were available, steps were taken to determine measurable dimensions of the patrol officer's morale and to develop appropriate instruments with which to assess them. A preliminary pool of items was drawn from several sources, including "Dimensions of Airman Morale," by Edward E. Cureton.[1] An attempt was made to envisage as many different aspects as possible of patrolman morale and to see that these aspects were covered by appropriate items. It was found necessary to revise items from existing sources extensively and to supplement these with new items especially devised for use with patrolmen.

A preliminary group of 25 items was administered to 25 patrolmen in in-service training at the Police Academy. These officers were comparable to those to be tested in the actual study. Responses to each item were analyzed. A tabulation was made for each question to show the distribution of choices among the five possible answers. On the basis of this analysis, choices were revised in order to obtain better item dispersion. When the revised instrument was administered to a second group of 23 patrolmen from in-service classes, item responses were analyzed anew. The response distributions were found to be more satisfactory, in that the dispersions were increased.

In order to enlarge the scope of the questionnaire and to have enough items to measure reliably several aspects of patrolman morale, a new group of 41 items was developed and administered to a third group—this time 38 in-service patrolmen. Again, the choices were revised on the basis of counts of men selecting the various alternatives. One item was dropped from further consideration.

Matrices of intercorrelations were obtained for both the 25- and the 40-item group, thereby permitting tentative distribution into scales. Emerging categories seemed to relate to the overall management of the Police Department, satisfaction with immediate supervisor, and satisfaction with the actual job performed by the patrolmen. A smaller number of items seemed to cluster around reaction to discipline, satisfaction with role in the community, and satisfaction with the unit to which assigned.

Final assignments to clusters were made through an extensive homogeneity analysis of 64 items administered to a group of 46 patrolmen receiving in-service training.

In the type of homogeneity analysis used in the study, items are considered to measure a characteristic if they have relatively high correlations among themselves and relatively low correlations with other clusters. The formula for saturation, proposed originally by Loevinger, Gleser, and DuBois,[2] is the proportion of the total variance of the cluster which can be attributed to item covariances.

In practice, a tentative cluster is selected, usually through inspection of the item covariances.[3] The covariance between each item and the cluster is then determined by summation. If an item within the cluster would increase the saturation by being removed, it is removed. If an item outside the cluster would increase the saturation by being added to it, it is added. Changes in the composition of the item cluster are made in cycles until it stabilizes with maximum homogeneity.

Actually, saturation is closely related to internal consistency reliability. Kuder-Richardson Formula 20 for the coefficient of rational equiv-

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[1] Edward E. Cureton, "Dimensions of Airman Morale," WADD-TN-60-137, Personnel Laboratory, Wright Air Development Division, Air Research and Development Command, United States Air Force, Lackland Air Force Base, Texas, June 1960.

[2] Jane Loevinger, Goldine C. Gleser, and Philip H. DuBois, "Maximizing the Discriminating Power of a Multiple Score Test," Psychometrika, 18, 309-317, 1953. See also Philip H. DuBois and Arnold H. Hilden, "A P Scale for the Rorschach; A Methodological Study," Journal of Consulting Psychology, 18, 333-336, 1954.

[3] In the development of the present scales, item intercorrelations were used instead of gross score item covariances. All item variances were taken as unity. Since inspection of the distributions of the distractors indicated reasonable equality of dispersion, the assumption of equal variances was considered tenable. Accordingly, the use of the intercorrelation matrix, which was more readily available than the covariance matrix, is believed to have introduced relatively little error.

alence can be written as [n/(n-1)]S, in which n is the number of items and S is the saturation coefficient as defined by C/V, where C is the sum of the item covariances and V is the total variance.

A preliminary correlational analysis yielded the results shown in Table 1.

In Table 1, the number of items selected for each scale is given in the first column, headed n. The following six columns give the intercorrelations of the scales, while the last column gives the internal consistency as estimated by Kuder-Richardson Formula 20.

Since the correlational analysis showed considerable overlap among the variables, it was decided to give chief attention to the three with the highest internal consistency reliabilities: Satisfaction with Department Management (SDM), Satisfaction with Immediate Supervisor (SIS), and Job Satisfaction (JS). These scales, with minor rearrangement of items, were subdivided into two forms each, A and B. Intercorrelations of these divided scales, together with K-R #20 internal consistency reliabilities, are reported in Table 2.

Inspection of this matrix shows reasonably good reliabilities, as follows:

	Alternate Form	K-R #20	
		A	B
Satisfaction with Department Management	.56	.67	.71
Satisfaction with Immediate Supervisor	.86	.87	.87
Job Satisfaction	.70	.77	.74

Table 1

INTERCORRELATIONS OF MORALE VARIABLES

(Preliminary Study, N=46)

	n	RTD	SDM	SIS	JS	SRC	SU	K-R #20
Reaction to Discipline	7		.68	.44	.60	.63	.16	.42
Satisfaction With Department Management	11	.68		.43	.63	.66	.40	.78
Satisfaction With Immediate Supervisor	20	.44	.43		.59	.55	.40	.93
Job Satisfaction	19	.60	.63	.59		.66	.55	.81
Satisfaction With Role in Community	3	.63	.66	.55	.66		.38	.70
Satisfaction With Unit	4	.16	.40	.40	.55	.38		.35

Table 2

INTERCORRELATIONS AND RELIABILITIES OF DIVIDED SCALES

	n	SDM-A	SDM-B	SIS-A	SIS-B	JS-A	JS-B	K-R #20
SDM-A	5		.56	.37	.34	.40	.53	.67
SDM-B	5	.56		.36	.24	.56	.50	.71
SIS-A	8	.37	.36		.86	.52	.45	.87
SIS-B	8	.34	.24	.86		.53	.53	.87
JS-A	10	.40	.56	.52	.53		.70	.77
JS-B	10	.53	.50	.45	.53	.70		.74

Table 3

COMPOSITION OF ATTITUDE MEASURES

	Independent Items		Common Items	Total Items
	Form A	Form B		
Satisfaction With Department Management (SDM)	5	5	1	6
Satisfaction With Immediate Supervisor (SIS)	10	10	0	10
Job Satisfaction (JS)	11	11	1	12
Satisfaction With Role In Community (SRC)	3	3	0	3
Satisfaction With Unit (SU)	0	0	4	4

Other correlations show fair independence, although both Satisfaction with Department Management and Satisfaction with Immediate Supervisor have an overlap with Job Satisfaction, as might be anticipated.

Development Of The Operational Measures

Following the foregoing analysis, three forms of the final operational attitude measures were prepared—Forms A, B and C. All items of both Form A and Form B were included in Form C. Six items in Form A were also included in Form B. Composition of the five subscales is shown in Table 3.

The attitude measures were administered twice in three districts, as shown in Table 4.

Table 4

ADMINISTRATION OF ATTITUDE MEASURES IN TEST DISTRICT (DISTRICT NINE) AND IN TWO CONTROL DISTRICTS (DISTRICTS SEVEN AND FOUR)

	Original		Retest
	N	Test	(6 Months Later)
District 9 (Test)	85	A	C(A+B)
District 7 (Control)	87	B	C(A+B)
District 4 (Control)	84	A	C(A+B)

The attitude measures were administered anonymously. However, each police officer had an identification number, known only to himself, with which he identified test and retest, so that results could be matched. It is seen from Table 4 that a major comparison was intended to be made with Form A in Districts 4 and 9.

In reporting results on the subscales, the five choices on each item were weighted from 1 (unfavorable) to 5 (favorable) and the total score was divided by the number of items in each scale. Means, standard deviations, and differences between means are reported in terms of these reduced values. Such reductions, of course, have no effect upon significance tests, such as those reported in Tables 5, 6 and 7.

Tables 5, 6 and 7 present test-retest comparison of morale scales. In the Ninth District, in which Resource Allocation concepts were introduced experimentally, scores on all scales increased slightly, but no increase was statistically significant. In the control districts, there were seven increases and three decreases in morale scores. Here again, no change was statistically significant.

Scale differences for the Ninth District and the Fourth District, and a fully comparable control district, are presented in Table 8.

At the beginning of the study, three differences favored the control district and two the test district, but no difference was statistically significant. In the retest phase, one difference was statistically significant; Satisfaction with Immediate Supervisor (SIS) on Form B was better for the test district than for the control.

The conclusion is clear. There is no evidence whatever that Resource Allocation had an adverse effect on morale as measured by any of the five morale sub-tests. Conceivably, Resource Allocation improved morale somewhat, but such a possibility was not clearly demonstrated.

Final reliabilities of the five sub-scales may be of interest, and are reported in Table 9. Because of the overlap of one item in the two forms of Satisfaction With Department Management (SDM) and Job Satisfaction (JS), alternate form reliabilities of these two variables are partly spurious. Test-retest interval was five months, and test-retest reliabilities may have been affected by changes in attitudes in the samples.

To investigate morale changes that might be related to the introduction of Resource Allocation concepts into the Ninth District, Test A, consisting of 35 items, was administered to 84 patrolmen in the test district (Ninth District) before the introduction of the new procedures, and again five months later. The same test was given twice to a control district (Fourth District), again using an interval of five months between administration.

In Table 10 each of the 35 questions is followed by two scatter diagrams, the first for the Ninth District, the second for the Fourth District. Consistency of response over the five-month period is shown by the Pearson product moment r associated with each diagram. For the experimental group these r's range from .14 to .61 with a median of .38, while for the control group the range is from .25 to .72 with a median of .47. As might be expected, individual morale items are slightly more consistent in the control than in the test district.

The t-test reveals that, in the experimental group, two items increased reliably (at the .05 level of significance) and five decreased. In the control group there were three items increasing reliably and eight decreasing reliably. One item increased reliably in both groups, namely:

20. Considering its assigned tasks, do you feel your unit has the right number of men in it?

Another item increased reliably in the test district and decreased reliably in the control:

4. How well do you like to work in the District or Division where you are presently assigned?

Table 5

COMPARISON OF MORALE SCALES (Form A) FOR THE NINTH DISTRICT (TEST)

N = 85

	M_1	s_1	M_2	s_2	D	t
Satisfaction With Department Management	2.09	.96	2.10	.92	+.02	+.11
Satisfaction With Immediate Supervisor	1.75	.96	1.93	1.01	+.18	+1.44
Job Satisfaction	2.34	1.19	2.41	1.14	+.07	+.67
Satisfaction With Role In Community	2.11	1.05	2.27	1.07	+.17	+1.39
Satisfaction With Unit	2.20	.98	2.29	.94	+.09	+.80

M_1 = Original mean.
M_2 = Mean approximately six months later.
No difference (D) is statistically significant.

Table 6

COMPARISON OF MORALE SCALES (Form B) FOR THE SEVENTH DISTRICT (CONTROL)

N = 87

	M_1	s_1	M_2	s_2	D	t
Satisfaction With Department Management	1.90	.94	1.95	.97	+.06	+.46
Satisfaction With Immediate Supervisor	1.91	.99	1.94	.98	+.02	+.20
Job Satisfaction	1.79	.86	1.88	.87	+.09	+.85
Satisfaction With Role in Community	2.44	1.06	2.40	.96	-.04	-.30
Satisfaction With Unit	2.08	.97	2.10	1.01	+.02	+.15

M_1 = Original mean.
M_2 = Mean approximately six months later.
No difference (D) is statistically significant.

Table 7

COMPARISON OF MORALE SCALE (Form A) FOR THE FOURTH DISTRICT (CONTROL)

N = 84

	M_1	s_1	M_2	s_2	D	t
Satisfaction With Department Management	2.16	.94	2.24	.93	+.08	+.56
Satisfaction With Immediate Supervisor	1.84	.95	1.84	.91	-.03	-.38
Job Satisfaction	2.24	1.12	2.38	1.11	+.14	+1.38
Satisfaction With Role In Community	2.07	1.06	2.20	1.11	+.14	+1.20
Satisfaction With Unit	2.34	1.08	2.30	.97	-.05	-.40

M_1 = Original mean.
M_2 = Mean approximately six months later.
No difference (D) is statistically significant.

The five morale items showing reliable decreases in the test district were:

3. How much effort does your sergeant make in looking after the welfare of his men?
10. Does the neighborhood you live in respect the Police Department's ability to enforce the law?
11. Does your sergeant go to bat for you and back you up if something goes wrong that was not your fault?
18. Are the men in your unit willing to do their share of the work?
29. How many other sergeants would you prefer to the one you have now?

In addition to item 20, the two items showing significant improvement in the control district were:

5. Do you have more than your share of overtime assignments?
34. Does the Department provide a better future for its disabled personnel than other employers in the community?

Other than item 4, the seven items that decreased reliably in the control district were:

1. How secure is your future in the Police Department, compared with what it would be in civilian life?
7. If you were just starting your career, would you still choose police work?
16. Within reason, are you free to do your job the way you think best?
21. Are you generally as contented now as you were before you joined the Department?
22. Do you enjoy talking about your work as a police officer to people not connected with the Department?
27. How well do you think your precinct or unit functions?
32. How interesting is your job?

There is no incompatibility of the results based on correlational analysis and those based on differences in item means. Means can increase or decrease without in any way affecting the correlation between the two variables. The r's are in the nature of item reliabilities. Item by item, what is measured is reasonably consistent over the five month period.

Analysis of the item means showed no consistent contrast between the two districts, except that the patrolmen in the test district showed improvement in how well they liked their work following introduction of the experimental procedures.

Table 8

COMPARISON OF MORALE SCALES IN TEST AND CONTROL DISTRICTS

Original Scores (Form A)

	Test—Ninth District (N=85)	Control—Fourth District (N=84)		
	M	M	D	t
SDM	2.09	2.16	–.07	–.72
SIS	1.75	1.84	–.09	–.91
JS	2.34	2.24	.10	.81
SRC	2.11	2.06	.12	.36
SU	2.20	2.35	–.15	–1.23

Retest Scores (Form A)

	Test—Ninth District	Control—Fourth District		
	M	M	D	t
SDM	2.10	2.24	–.14	–1.39
SIS	1.93	1.82	.11	1.10
JS	2.41	2.38	.03	.26
SRC	2.27	2.20	.07	.58
SU	2.29	2.30	.01	.08

Alternate Form Final Scores (Form B)

	Test—Ninth District	Control—Fourth District		
	M	M	D	t
SDM	2.00	2.07	–.07	–.71
SIS	2.15	1.94	.21	2.06[a]
JS	2.04	2.05	–.01	–.07
SRC	2.46	2.54	–.08	–.70
SU	2.29	2.30	–.01	–.08

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[a] Statistically significant at the .05 level.

Table 9

RELIABILITIES OF FINAL SCALES

Ninth District - Test

	Test-Retest Form A	Alternate Form A vs. B in C	K-R #20 Final A
Satisfaction with Department Management (SDM)	.07	.65	.80
Satisfaction with Immediate Supervisor (SIS)	.33	.81	.85
Job Satisfaction (JS)	.64	.82	.87
Satisfaction with Role in the Community (SRC)	.44	.62	.37
Satisfaction with Unit (SU)	.39	a	.33

Fourth District - Control

	Test-Retest Form A	Alternate Form A vs. B in C	K-R #20 Final A
SDM	–.03	.78	.80
SIS	.73	.91	.85
JS	.63	.80	.76
SRC	.52	.51	.38
SU	.49	a	.40

Seventh District - Control

	Test-Retest Form B	Alternate Form A vs. B in C	K-R #20 Final B
SDM	.30	.74	.77
SIS	.54	.86	.89
JS	.40	.79	.85
SRC	.28	.58	.42
SU	.38	a	.40

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[a] Not pertinent because of overlap.

Table 10

This Table shows each of the 35 questions followed by two scatter diagrams, the first for the Ninth District, the second for the Fourth District. Item responses are coded from 1 (unfavorable) to 5 (favorable).

M_1 and s_1 refer to the mean and standard deviation of the item when originally administered; M_2 and s_2 to the mean and standard deviation for the retest five months later.

For each diagram, the difference in terms of coded scores is indicated by D, together with the value of t. For significance at the .05 level with 83 degrees of freedom, a t of ±1.97 is required (two-tailed test).

For each scatter diagram, number of increases in favorability, number of responses unchanged and number of decreases in favorability, are indicated.

1). How secure is your future in the Police Department compared with what it would be in civilian life?

5. Much more secure
4. Somewhat more secure
3. Somewhat less secure
2. About the same
1. Less secure

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	2	0	5	15
4	1	6	1	16	14
3	1	0	0	0	0
2	0	10	1	6	4
1	1	1	0	0	0
	EARLIER RESPONSE				

M_1 = 3.81　　M_2 = 3.68
s_1 = 1.29　　s_2 = 1.18

D = -.11　　Increases 16
　　　　　No Change 42
t = -.95　　Decreases 26

r = .46

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	2	0	6	19
4	0	5	0	11	11
3	0	1	1	1	0
2	0	9	1	7	3
1	1	2	0	3	1
	EARLIER RESPONSE				

M_1 = 3.89　　M_2 = 3.56
s_1 = 1.20　　s_2 = 1.37

D = -.33　　Increases 14
　　　　　No Change 41
t = -2.28　　Decreases 29

r = .47

2). How do you feel after your sergeant has talked to you about a mistake in your work?

5. Not badly at all - he is always helpful
4. Not badly - he just shows me what I did wrong
3. Just as I would if any other sergeant talked to me
2. He always talks as though I should have known better
1. He makes me feel stupid

Experimental (District 9)

LATER RESPONSE

	1	2	3	4	5
5	0	0	2	12	16
4	0	0	1	24	9
3	1	1	1	9	4
2	0	0	0	3	1
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 4.25 M_2 = 4.07
s_1 = .77 s_2 = .86

D = -.18 Increases 17
No Change 41
t =-1.69 Decreases 26

r = .25

Control (District 4)

LATER RESPONSE

	1	2	3	4	5
5	0	0	2	12	15
4	0	2	5	22	8
3	0	1	4	7	1
2	1	2	0	1	0
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 3.96 M_2 = 4.06
s_1 = .93 s_2 = .89

D = .10 Increases 23
No Change 44
t = 1.05 Decreases 17

r = .59

3). How much effort does your sergeant make in looking after the welfare of his men?

5. All he possibly can
4. Quite a lot
3. An average amount
2. Not very much
1. Hardly any

Experimental (District 9)

LATER RESPONSE

	1	2	3	4	5
5	0	1	2	4	24
4	0	0	3	6	9
3	1	1	7	9	12
2	0	1	2	1	0
1	0	0	0	0	1

EARLIER RESPONSE

M_1 = 4.27 M_2 = 3.88
s_1 = 1.11 s_2 = 1.00

D = -.39 Increases 12
No Change 38
t =-3.22 Decreases 34

r = .35

Control (District 4)

LATER RESPONSE

	1	2	3	4	5
5	0	2	3	10	27
4	0	1	4	8	4
3	0	2	10	6	3
2	1	0	2	1	0
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 4.02 M_2 = 4.16
s_1 = .99 s_2 = .96

D = .14 Increases 23
No Change 45
t = 1.24 Decreases 16

r = .51

4). How well do you like to work in the District or Division where you are presently assigned?

5. Tops
4. Very well
3. Pretty well
2. Not very well
1. Definitely is a poor place to work

Experimental (District 9)

LATER RESPONSE

	1	2	3	4	5
5	2	0	0	11	13
4	2	1	6	25	8
3	0	3	4	6	0
2	1	1	0	1	0
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 3.83 M_2 = 4.08
s_1 = 1.16 s_2 = .59

D = .25

t = 2.23

Increases	26
No Change	43
Decreases	15

r = .41

Control (District 4)

LATER RESPONSE

	1	2	3	4	5
5	0	0	0	9	15
4	0	0	8	22	5
3	0	1	5	10	4
2	0	0	1	0	2
1	0	0	0	1	1

EARLIER RESPONSE

M_1 = 4.13 M_2 = 3.90
s_1 = .72 s_2 = .93

D = -.23

t =-2.01

Increases	18
No Change	42
Decreases	24

r = .25

5). Do you have more than your share of overtime assignments?

5. Never
4. Rarely
3. Once in awhile
2. Occasionally
1. Frequently

Experimental (District 9)

LATER RESPONSE

	1	2	3	4	5
5	0	1	2	1	1
4	0	5	9	8	4
3	1	9	12	5	4
2	0	9	7	3	0
1	0	2	1	0	0

EARLIER RESPONSE

M_1 = 3.08 M_2 = 3.13
s_1 = 1.31 s_2 = .95

D = .05

t = .38

Increases	28
No Change	30
Decreases	26

r = .31

Control (District 4)

LATER RESPONSE

	1	2	3	4	5
5	0	2	2	3	5
4	0	5	7	9	3
3	2	8	14	7	1
2	2	7	3	3	0
1	0	1	0	0	0

EARLIER RESPONSE

M_1 = 3.11 M_2 = 3.37
s_1 = 1.07 s_2 = .97

D = .26

t = 2.21

Increases	31
No Change	35
Decreases	18

r = .44

6). When your unit performs well, does the sergeant give most of the credit to your unit?

5. Always
4. Usually
3. Sometimes
2. Rarely
1. Never

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	1	0	2	7	22
4	1	0	1	23	10
3	0	0	3	6	5
2	1	0	0	0	0
1	0	0	0	1	1

EARLIER RESPONSE

$M_1 = 4.27$ $M_2 = 4.11$
$s_1 = .88$ $s_2 = .93$

$D = -.16$ Increases 13
No Change 48
$t = -1.39$ Decreases 23

$r = .27$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	1	0	2	8	21
4	0	0	3	22	5
3	1	1	5	8	1
2	0	1	4	1	0
1	0	0	0	0	0

EARLIER RESPONSE

$M_1 = 4.04$ $M_2 = 4.05$
$s_1 = .89$ $s_2 = .92$

$D = .01$ Increases 16
No Change 49
$t = .12$ Decreases 19

$r = .53$

---

7). If you were just starting your career would you still choose police work?

5. Definitely would
4. I think I would
3. I am not sure
2. I think I would not
1. I definitely would not

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	3	8	25
4	1	1	3	10	10
3	0	2	8	5	2
2	0	2	0	0	2
1	2	0	0	0	0

EARLIER RESPONSE

$M_1 = 4.07$ $M_2 = 4.06$
$s_1 = 1.09$ $s_2 = 1.02$

$D = -.01$ Increases 18
No Change 47
$t = -.11$ Decreases 19

$r = .58$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	1	0	0	2	28
4	0	0	1	15	14
3	0	0	9	3	7
2	0	0	1	0	0
1	1	1	0	1	0

EARLIER RESPONSE

$M_1 = 4.36$ $M_2 = 4.01$
$s_1 = .92$ $s_2 = 1.98$

$D = -.35$ Increases 4
No Change 53
$t = -3.58$ Decreases 27

$r = .57$

8). Are you ever confused by the feeling that you have more than one boss?

5. Never
4. Seldom
3. Usually
2. Almost always
1. Always

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	5	11
4	0	3	6	20	7
3	2	1	9	5	2
2	0	1	0	0	2
1	3	0	2	3	2

EARLIER RESPONSE

M_1 = 3.79 M_2 = 3.54
s_1 = 1.10 s_2 = 1.19

D = -.25		Increases	17
		No Change	44
t =-1.82		Decreases	23

r = .41

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	1	0	0	5	10
4	2	1	8	23	14
3	0	1	3	7	0
2	1	1	0	1	0
1	1	0	2	3	0

EARLIER RESPONSE

M_1 = 3.88 M_2 = 3.77
s_1 = 1.05 s_2 = .97

D = -.11		Increases	19
		No Change	38
t = -.85		Decreases	27

r = .38

9). What opportunity do you have to learn more about the job you are doing?

5. Plenty of chance
4. Good chance to learn
3. Fair chance to learn
2. I have to find out for myself
1. Not much chance to learn anything

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	8	19
4	1	1	3	14	11
3	1	0	7	10	3
2	0	2	2	0	1
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 4.08 M_2 = 3.92
s_1 = 1.00 s_2 = .95

D = -.16		Increases	14
		No Change	43
t =-1.67		Decreases	27

r = .57

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	7	14
4	0	1	7	29	8
3	0	0	5	6	3
2	0	1	0	0	1
1	0	0	1	0	0

EARLIER RESPONSE

M_1 = 4.10 M_2 = 4.01
s_1 = .75 s_2 = .79

D = -.09		Increases	16
		No Change	49
t = -.90		Decreases	19

r = .40

10). Does the neighborhood you live in respect the Police Department's ability to enforce the law?

5. Very much
4. To a considerable extent
3. To some extent
2. Only a little
1. Not at all

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	3	6	16
4	0	3	5	11	13
3	0	2	4	5	6
2	0	1	1	3	0
1	0	2	1	0	2

EARLIER RESPONSE

M_1 = 4.08 M_2 = 3.80
s_1 = .99 s_2 = 1.11

D = -.28 Increases 19
No Change 32
t =-2.15 Decreases 33

r = .34

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	6	4	20
4	1	1	7	11	10
3	0	0	5	4	4
2	0	4	3	3	0
1	0	0	1	0	0

EARLIER RESPONSE

M_1 = 3.99 M_2 = 3.93
s_1 = 1.11 s_2 = 1.04

D = -.06 Increases 19
No Change 40
t = -.51 Decreases 25

r = .45

11). Does your sergeant go to bat for you and back you up if something goes wrong that was not your fault?

5. Always
4. Usually
3. About half of the time
2. Occasionally
1. Hardly ever

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	6	27
4	1	1	0	20	16
3	0	0	1	1	5
2	0	0	0	1	1
1	2	0	0	0	1

EARLIER RESPONSE

M_1 = 4.44 M_2 = 4.17
s_1 = .89 s_2 = .94

D = -.27 Increases 9
No Change 50
t =-2.51 Decreases 25

r = .41

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	0	7	45
4	0	1	0	11	9
3	0	2	0	1	3
2	0	1	0	2	0
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 4.52 M_2 = 4.45
s_1 = .87 s_2 = .86

D = -.07 Increases 11
No Change 58
t = -.83 Decreases 15

r = .59

12). Are the work assignments in your district made fairly?

5. Always
4. Almost always
3. Usually
2. Seldom
1. Never

Experimental (District 9)

LATER RESPONSE					
5	0	0	2	3	8
4	1	0	12	10	7
3	0	3	12	11	8
2	1	0	1	3	0
1	1	0	0	1	0
	1	2	3	4	5

EARLIER RESPONSE

$M_1 = 3.77$ $M_2 = 3.56$
$s_1 = 1.00$ $s_2 = .90$

$D = -.21$ Increases 22
No Change 31
$t = -1.75$ Decreases 31

$r = .32$

Control (District 4)

LATER RESPONSE					
5	0	0	2	2	13
4	0	0	15	11	3
3	0	2	10	16	4
2	0	1	3	1	1
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

$M_1 = 3.82$ $M_2 = 3.68$
$s_1 = .85$ $s_2 = .88$

$D = -.14$ Increases 21
No Change 35
$t = -1.37$ Decreases 28

$r = .39$

13). How often does your sergeant ask you to do things for which you do not see a good reason?

5. Hardly ever
4. Seldom
3. Occasionally
2. Often
1. Very frequently

Experimental (District 9)

LATER RESPONSE					
5	0	2	4	10	20
4	1	0	3	8	13
3	0	0	6	6	5
2	1	0	0	1	2
1	0	0	0	1	1
	1	2	3	4	5

EARLIER RESPONSE

$M_1 = 4.21$ $M_2 = 4.06$
$s_1 = .95$ $s_2 = 1.02$

$D = -.15$ Increases 21
No Change 34
$t = -1.09$ Decreases 29

$r = .14$

Control (District 4)

LATER RESPONSE					
5	1	0	5	9	21
4	0	0	8	12	8
3	1	0	8	9	1
2	0	0	0	0	1
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

$M_1 = 4.05$ $M_2 = 4.18$
$s_1 = .91$ $s_2 = .82$

$D = .13$ Increases 24
No Change 41
$t = 1.18$ Decreases 19

$r = .32$

14). Do you feel you can get ahead just as fast or faster in the Police Department than you could in civilian jobs?

5. Very much faster
4. Somewhat faster
3. Possibly a little faster
2. About the same
1. Slower in police work

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	0	3
4	0	3	2	1	1
3	2	1	1	5	1
2	9	14	2	1	3
1	25	6	2	1	1

EARLIER RESPONSE

M_1 = 2.17 M_2 = 1.98
s_1 = 1.35 s_2 = 1.33

D = -.19 Increases 17
No Change 44
t =-1.51 Decreases 23

r = .58

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	0	2	3
4	2	0	3	1	1
3	0	5	2	0	1
2	5	16	4	3	1
1	28	5	1	0	0

EARLIER RESPONSE

M_1 = 2.06 M_2 = 2.07
s_1 = 1.21 s_2 = 1.21

D = .01 Increases 18
No Change 50
t = .11 Decreases 16

r = .67

15). How much does the Department tell the men about the new things which may affect their job, such as new equipment, new policies and new operating procedures?

5. The Department tells us everything it can as soon as they can
4. The Department tells us about most of the new things that will affect our work
3. The Department gives us some idea of what to expect
2. The Department tells us very little about the new things that are coming to the Department
1. The Department tells us practically nothing

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	8	6	25
4	0	2	6	7	9
3	0	0	8	3	5
2	0	1	0	1	2
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 4.12 M_2 = 4.14
s_1 = .71 s_2 = .97

D = .02 Increases 22
No Change 42
t = .19 Decreases 20

r = .34

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	6	2	18
4	0	4	4	8	16
3	0	1	7	5	4
2	0	2	4	2	0
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 4.01 M_2 = 3.93
s_1 = 1.04 s_2 = .95

D = -.08 Increases 18
No Change 35
t = -.68 Decreases 31

r = .37

16). Within reason, are you free to do your job the way you think best?

5. Always
4. Almost always
3. Usually
2. Seldom
1. Never

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	2	3
4	0	3	13	17	4
3	1	0	8	17	5
2	1	3	4	1	0
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 3.58 M_2 = 3.45
s_1 = .94 s_2 = .82

D = -.13 Increases 21
No Change 32
t =-1.20 Decreases 31

r = .37

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	1	4
4	0	1	6	19	10
3	0	1	13	14	5
2	0	0	4	4	0
1	1	0	0	0	0

EARLIER RESPONSE

M_1 = 3.86 M_2 = 3.45
s_1 = .83 s_2 = .81

D = -.42 Increases 10
No Change 37
t =-3.23 Decreases 37

r = .41

---

17). How well are Department policies and the reasons for them explained to you?

5. We get a complete explanation of both the policies and the reasons
4. We get a fairly complete explanation of policies and the reasons
3. We get some explanation of the policies
2. Policies are explained a little, but reasons are not
1. No explanations of policies or their reasons are given

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	13	9
4	1	1	8	25	11
3	0	1	3	5	1
2	1	0	0	1	2
1	0	1	0	1	0

EARLIER RESPONSE

M_1 = 4.00 M_2 = 3.98
s_1 = .87 s_2 = .89

D = -.02 Increases 25
No Change 37
t = -.21 Decreases 22

r = .32

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	0	4	5
4	0	3	4	30	8
3	0	3	6	6	2
2	0	2	2	4	1
1	1	2	0	0	0

EARLIER RESPONSE

M_1 = 3.75 M_2 = 3.60
s_1 = .95 s_2 = .95

D = -.14 Increases 15
No Change 44
t = -.93 Decreases 25

r = .47

18). Are the men in your unit willing to do their share of the work?

5. Always
4. Almost always
3. Usually
2. Some goldbricking
1. Quite a lot of goldbricking

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	1	4	8	15
4	0	0	1	15	8
3	0	1	6	10	7
2	0	1	2	2	3
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 4.17 M_2 = 3.86
s_1 = .81 s_2 = .99

D = -.31   Increases 15
No Change 37
t =-2.46   Decreases 32

r = .21

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	2	3	8	20
4	0	1	7	11	10
3	0	2	8	2	2
2	0	2	2	2	2
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 4.00 M_2 = 4.04
s_1 = .99 s_2 = .97

D = .04   Increases 23
No Change 41
t = .30   Decreases 20

r = .39

19). Is it easy for you to do things the Department way?

5. Always
4. Almost always
3. Usually
2. Difficult on rare occasions
1. Occasionally fairly difficult

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	2	3	3
4	1	2	7	20	9
3	0	4	14	6	3
2	2	2	1	0	0
1	1	1	2	0	1

EARLIER RESPONSE

M_1 = 3.52 M_2 = 3.48
s_1 = 1.06 s_2 = .96

D = -.04   Increases 21
No Change 40
t = -.41   Decreases 23

r = .46

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	4	7
4	0	4	4	18	4
3	2	2	14	13	2
2	0	3	0	1	1
1	0	1	2	1	0

EARLIER RESPONSE

M_1 = 3.61 M_2 = 3.49
s_1 = .98 s_2 = .97

D = -.12   Increases 17
No Change 42
t =-1.03   Decreases 25

r = .42

20). Considering its assigned tasks, do you feel your unit has the right number of men in it?

5. Strength inadequate
4. Way under strength
3. Somewhat under strength
2. About right
1. Somewhat over strength

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	7	7	4	6
4	0	0	2	3	6
3	0	8	20	3	5
2	1	7	4	0	0
1	0	0	1	0	0

EARLIER RESPONSE

$M_1 = 3.24$ $M_2 = 3.54$
$s_1 = 1.09$ $s_2 = 1.08$

$D = .30$ Increases 29
No Change 36
$t = 2.13$ Decreases 19

$r = .32$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	7	5	2	3
4	0	2	4	0	5
3	2	14	9	0	3
2	1	22	1	0	3
1	1	0	0	0	0

EARLIER RESPONSE

$M_1 = 2.73$ $M_2 = 3.19$
$s_1 = 1.16$ $s_2 = 1.13$

$D = .46$ Increases 37
No Change 35
$t = 3.20$ Decreases 12

$r = .33$

21). Are you generally as contented now as you were before you joined the Department?

5. Much more contented now than I was before I joined
4. Somewhat more contented
3. About the same
2. Less contented
1. Not satisfied

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	1	1	2	7	15
4	0	1	5	10	10
3	1	1	10	5	4
2	0	1	3	2	1
1	1	2	0	0	1

EARLIER RESPONSE

$M_1 = 3.88$ $M_2 = 3.75$
$s_1 = 1.10$ $s_2 = 1.12$

$D = -.13$ Increases 19
No Change 37
$t = -.99$ Decreases 28

$r = .41$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	2	3	14
4	0	1	2	15	13
3	0	2	11	8	1
2	0	2	3	4	2
1	1	0	0	0	0

EARLIER RESPONSE

$M_1 = 3.99$ $M_2 = 3.67$
$s_1 = .96$ $s_2 = 1.00$

$D = -.32$ Increases 10
No Change 43
$t = -3.16$ Decreases 31

$r = .55$

22). Do you enjoy talking about your work as a police officer to people not connected with the Department?

5. Always
4. Most of the time
3. Sometimes
2. Seldom
1. Never

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	2	2	15
4	1	1	3	10	6
3	2	7	12	6	3
2	0	5	3	1	0
1	2	0	1	0	2

EARLIER RESPONSE

$M_1 = 3.57$ $M_2 = 3.48$
$s_1 = 1.24$ $s_2 = 1.13$

D = -.09 Increases 18
No Change 44
t = -.77 Decreases 22

r = .55

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	3	17
4	0	0	8	10	10
3	0	2	8	6	3
2	1	7	5	2	0
1	1	0	0	0	0

EARLIER RESPONSE

$M_1 = 3.81$ $M_2 = 3.63$
$s_1 = 1.11$ $s_2 = 1.08$

D = -.18 Increases 15
No Change 43
t =-1.99 Decreases 26

r = .72

23). How often do you get conflicting orders?

5. Never
4. Seldom
3. Occasionally
2. Fairly often
1. Very often

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	1	3
4	2	0	10	24	5
3	0	4	17	9	1
2	1	1	3	0	1
1	0	0	0	2	0

EARLIER RESPONSE

$M_1 = 3.54$ $M_2 = 3.46$
$s_1 = .91$ $s_2 = .79$

D =-.08 Increases 18
No Change 45
t =-.66 Decreases 21

r = .33

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	4	3
4	0	0	11	28	3
3	0	2	14	16	1
2	0	1	0	0	0
1	0	0	0	1	0

EARLIER RESPONSE

$M_1 = 3.71$ $M_2 = 3.63$
$s_1 = .66$ $s_2 = .70$

D =-.08 Increases 17
No Change 46
t =-1.00 Decreases 21

r = .39

24). How often are you told ahead of time about changes in your working procedures?

5. Almost always
4. Most of the time
3. About half of the time
2. Not very often
1. Hardly ever

Experimental (District 9)

LATER RESPONSE					
5	1	1	0	9	13
4	1	1	3	23	12
3	1	0	2	6	0
2	0	2	1	5	1
1	0	0	0	2	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.04 M_2 = 3.89
s_1 = .94 s_2 = 1.01

D = -.15 Increases 17
No Change 40
t =-1.10 Decreases 27

r = .27

Control (District 4)

LATER RESPONSE					
5	0	2	2	7	12
4	0	0	6	22	14
3	0	1	0	5	2
2	2	4	1	0	2
1	0	0	0	1	1
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.02 M_2 = 3.89
s_1 = 1.01 s_2 = 1.00

D = -.13 Increases 20
No Change 38
t =-1.04 Decreases 26

r = .34

---

25). Does your sergeant usually expect you to do more than your share of the work?

5. Never
4. Once in awhile
3. Occasionally
2. Usually
1. Always

Experimental (District 9)

LATER RESPONSE					
5	0	1	3	8	36
4	0	2	2	9	10
3	0	0	1	6	5
2	0	0	0	1	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.46 M_2 = 4.40
s_1 = .78 s_2 = .77

D = -.06 Increases 16
No Change 46
t = -.56 Decreases 22

r = .22

Control (District 4)

LATER RESPONSE					
5	0	0	0	9	38
4	0	0	3	11	9
3	0	0	6	6	2
2	0	0	0	0	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.48 M_2 = 4.39
s_1 = .68 s_2 = .76

D = -.09 Increases 12
No Change 55
t =-1.19 Decreases 17

r = .61

26). How well are you kept informed about what is going on in the Department?

5. Very well
4. Pretty well
3. Well enough
2. Not very well
1. Not at all well

Experimental (District 9)

LATER RESPONSE					
5	0	1	2	7	11
4	1	0	8	21	10
3	0	3	4	3	2
2	1	4	1	4	1
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 3.85 M_2 = 3.85
s_1 = 1.02 s_2 = .94

D = .00 Increases 23
No Change 40
t = 0.00 Decreases 21

r = .43

Control (District 4)

LATER RESPONSE					
5	0	1	1	3	8
4	0	2	6	23	7
3	0	3	6	8	0
2	0	6	8	1	0
1	0	1	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 3.62 M_2 = 3.56
s_1 = .95 s_2 = .99

D = -.06 Increases 16
No Change 43
t = -.64 Decreases 25

r = .62

27). How well do you think your precinct or unit functions?

5. Excellently
4. Very well
3. About as well as most
2. Poorly
1. Very poorly

Experimental (District 9)

LATER RESPONSE					
5	0	0	2	8	6
4	0	1	2	28	11
3	0	1	9	11	5
2	0	0	0	0	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.06 M_2 = 3.88
s_1 = .71 s_2 = .70

D = -.18 Increases 14
No Change 43
t = -1.89 Decreases 27

r = .25

Control (District 4)

LATER RESPONSE					
5	0	0	0	5	7
4	0	0	6	32	14
3	0	0	10	9	1
2	0	0	0	0	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.00 M_2 =3.90
s_1 = .67 s_2 = .61

D = -.10 Increases 11
No Change 49
t =-2.33 Decreases 24

r = .48

28). When you do an unusually good job do you receive proper recognition from your sergeant?

5. Always
4. Usually
3. Sometimes
2. Hardly ever
1. Never

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	2	6	20
4	0	3	7	12	16
3	0	0	2	6	3
2	1	1	0	2	0
1	1	0	0	1	1

EARLIER RESPONSE

M_1 = 4.18 M_2 = 4.00
s_1 = .99 s_2 = .99

D = -.18 Increases 19
No Change 36
t =-1.50 Decreases 29

r = .40

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	1	0	1	7	17
4	0	1	6	14	7
3	1	2	6	11	3
2	1	2	1	3	0
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 3.93 M_2 = 3.87
s_1 = 1.02 s_2 = .95

D = -.06 Increases 20
No Change 39
t = -.53 Decreases 25

r = .47

29). How many other sergeants would you prefer to the one you have now?

5. None
4. One or two
3. A few
2. Several others
1. Almost any other

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	3	4	39
4	1	0	1	5	10
3	0	1	0	5	3
2	1	0	1	5	1
1	1	0	0	1	2

EARLIER RESPONSE

M_1 = 4.46 M_2 = 4.11
s_1 = .93 s_2 = 1.21

D = -.35 Increases 11
No Change 45
t =-2.77 Decreases 28

r = .42

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	3	11	32
4	0	2	3	8	11
3	0	2	4	3	0
2	1	0	0	1	0
1	1	0	1	0	0

EARLIER RESPONSE

M_1 = 4.19 M_2 = 4.33
s_1 = 1.03 s_2 = .93

D = .14 Increases 23
No Change 45
t = 1.47 Decreases 16

r = .59

30). What are your chances of working on a number of different jobs in order to get more kinds of experience?

5. Quite good
4. Fair
3. I'm not sure
2. Poor
1. None at all

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	2	1	7	15
4	0	2	4	9	13
3	2	1	10	3	3
2	0	1	4	3	1
1	0	1	0	0	2

EARLIER RESPONSE

$M_1 = 3.94$ $M_2 = 3.75$
$s_1 = 1.08$ $s_2 = 1.10$

$D = -.19$ Increases 19
No Change 35
$t = -1.38$ Decreases 30

$r = .34$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	4	11	7
4	1	1	2	12	8
3	1	3	6	7	1
2	1	4	7	2	2
1	2	0	1	0	0

EARLIER RESPONSE

$M_1 = 3.58$ $M_2 = 3.57$
$s_1 = 1.11$ $s_2 = 1.18$

$D = -.01$ Increases 25
No Change 31
$t = -.09$ Decreases 28

$r = .48$

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31). Are you given enough advance notice and explanation of new special orders and changes in special orders and the manual?

5. Always
4. Most of the time
3. About half of the time
2. Not very often
1. Never

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	1	1	9	10
4	0	4	2	38	10
3	0	0	0	3	0
2	2	1	0	3	0
1	0	0	0	0	0

EARLIER RESPONSE

$M_1 = 3.99$ $M_2 = 4.07$
$s_1 = .88$ $s_2 = .75$

$D = .08$ Increases 19
No Change 49
$t = .85$ Decreases 16

$r = .42$

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	1	0	8	12
4	0	4	6	28	7
3	0	0	3	6	0
2	0	4	0	5	0
1	0	0	0	0	0

EARLIER RESPONSE

$M_1 = 3.90$ $M_2 = 3.93$
$s_1 = .87$ $s_2 = .88$

$D = .03$ Increases 19
No Change 47
$t = .23$ Decreases 18

$r = .44$

32). How interesting is your job?

5. Fascinating
4. Very interesting
3. Interesting
2. So-so
1. Dull

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	1	5	6
4	0	2	3	30	4
3	0	0	12	12	1
2	0	1	4	1	0
1	1	1	0	0	0

EARLIER RESPONSE

M_1 = 3.76 M_2 = 3.63
s_1 = .78 s_2 = .90

D = -.13 Increases 11
No Change 50
t =-1.59 Decreases 23

r = .61

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	3	7
4	0	0	7	33	8
3	0	1	10	12	1
2	0	1	1	0	0
1	0	0	0	0	0

EARLIER RESPONSE

M_1 = 3.93 M_2 = 3.89
s_1 = .70 s_2 = .67

D = -.04 Increases 11
No Change 51
t =-2.04 Decreases 22

r = .57

33). Do your superiors embarrass you by criticizing you in the presence of others?

5. Never
4. Sometimes
3. Usually
2. Almost always
1. Always

Experimental (District 9)

LATER RESPONSE	1	2	3	4	5
5	0	0	0	11	33
4	0	1	2	23	10
3	0	0	0	0	1
2	0	0	0	0	0
1	1	0	0	1	1

EARLIER RESPONSE

M_1 = 4.45 M_2 = 4.40
s_1 = .71 s_2 = .83

D = -.05 Increases 14
No Change 57
t = -.53 Decreases 13

r = .45

Control (District 4)

LATER RESPONSE	1	2	3	4	5
5	1	0	0	9	43
4	0	0	1	21	7
3	0	0	1	0	0
2	0	0	0	0	0
1	0	0	0	0	1

EARLIER RESPONSE

M_1 = 4.55 M_2 = 4.58
s_1 = .66 s_2 = .64

D = .03 Increases 11
No Change 65
t = .43 Decreases 8

r = .31

34). Does the Department provide a better future for its disabled personnel than other employers in the community?

5. Always
4. Most of the time
3. Sometimes
2. Very seldom
1. Never

Experimental (District 9)

LATER RESPONSE					
5	0	0	2	7	7
4	0	1	6	24	3
3	1	1	11	9	6
2	0	0	4	1	0
1	0	1	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 3.81 M_2 = 3.70
s_1 = .82 s_2 = .88

D = -.11

t =-1.04

Increases	18
No Change	42
Decreases	24

r = .40

Control (District 4)

LATER RESPONSE					
5	1	0	0	5	14
4	0	3	10	16	9
3	4	11	5	2	0
2	0	1	1	2	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 3.55 M_2 = 3.88
s_1 = 1.23 s_2 = .82

D = .33

t = 3.10

Increases	34
No Change	36
Decreases	14

r = .61

35). How much pride do you take in being a member of the Police Department?

5. A very great deal
4. Quite a lot
3. A fair amount
2. Some but not much
1. None at all

Experimental (District 9)

LATER RESPONSE					
5	0	0	1	8	37
4	0	0	2	12	11
3	1	0	6	2	2
2	0	0	1	0	1
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.45 M_2 = 4.37
s_1 = .79 s_2 = .80

D = -.08

t =-1.00

Increases	12
No Change	55
Decreases	17

r = .55

Control (District 4)

LATER RESPONSE					
5	0	0	0	7	39
4	0	0	4	12	14
3	0	0	1	3	3
2	0	0	1	0	0
1	0	0	0	0	0
	1	2	3	4	5

EARLIER RESPONSE

M_1 = 4.60 M_2 = 4.44
s_1 = .62 s_2 = .70

D = -.16

t =-2.07

Increases	11
No Change	52
Decreases	21

r = .47

Chapter 3

DATA COLLECTION SYSTEMS

I. St. Louis Police Department Computer Hardware Equipment

The computer system of the St. Louis Police Department consists of four basic elements: a main computer, a communications computer, a group of remote terminals, and a set of peripheral I/O equipment (Figure 1).

The Main Computer is an IBM 7040. It consists of a 32K 7106 processing unit, 7904 data channel, 7631 file control, 2302 disc file and two 1414 I/O synchronizers. The 7040 processes real-time inquiries on a priority interrupt basis while processing production programs. The 7904 data channel provides the connection with the 7741 processing unit; with the 1414 MOD II I/O synchronizer, which is connected to five 7330 tape drives; and with the 7631, which controls the 2302 disc file. The 1414 MOD IV I/O synchronizer ties directly from the 7106 to the 1402 card reader and the 1403 printer.

The Communications Computer is an IBM 7740, consisting of a 16K 7741 processing unit and a 1311 disc file. The 7740 interprets message headers and routes each to either the appropriate terminal, if it is an administrative message, or to the main computer, if it is a real-time inquiry. The 1311 disc file is used for temporary storage of messages when terminals are busy, and for maintenance of a daily log of teletype messages.

The Communications Terminals are IBM 1050 teleprocessing terminals and teletype (83 B2 MOD 28 ASR) machines, all of which are half duplex, i.e., they can send or receive.

1050 units have been installed in offices at Police Headquarters which require direct and frequent use of the system. Card reader and punch accessories have been installed on the 1050's whenever these aid an office's operation. All district stations have teletype machines which permit preparation of punched tape at the operator's leisure. A terminal remains open to receive messages. The punched tape is transmitted at 100 words per minute.

Several "receive only" teletypes have been installed in those Headquarters offices which need only this type of equipment.

The Peripheral I/O Equipment connected to the main computer consists of five 7300 magnetic tape drives, a 1402 card reader and a 1403 printer. An optional feature which has been added to the 1403 printer allows "space suppression." The result is that one line can be superimposed on another line.

II. Initial Processing of Source Documents

Radio Dispatch Ticket

The radio Dispatch Ticket (Figure 2) is a 2½" x 5½" card which is used to record all pertinent information concerning each radio call, whether call-for-service or self-initiated.

In a call for service, the Dispatch Ticket is prepared by a radio clerk, to whom a citizen calling the Department to request police assistance is transferred by the telephone switchboard operator. Upon receiving the call, the clerk first stamps the date and time on the back of a Dispatch Ticket; then seeks to obtain from the caller all pertinent information concerning the type and location of the occurrence; and then enters this information on the Ticket, including any information of special value to the patrol unit to be assigned—e.g., "suspect has gun."

The radio clerk then forwards this ticket, by conveyor belt, to the radio dispatcher. In assigning the call to an available patrol unit, the dispatcher relays the required information from the Dispatch Ticket, stamps the time at which the assigned unit went out of service, and enters the

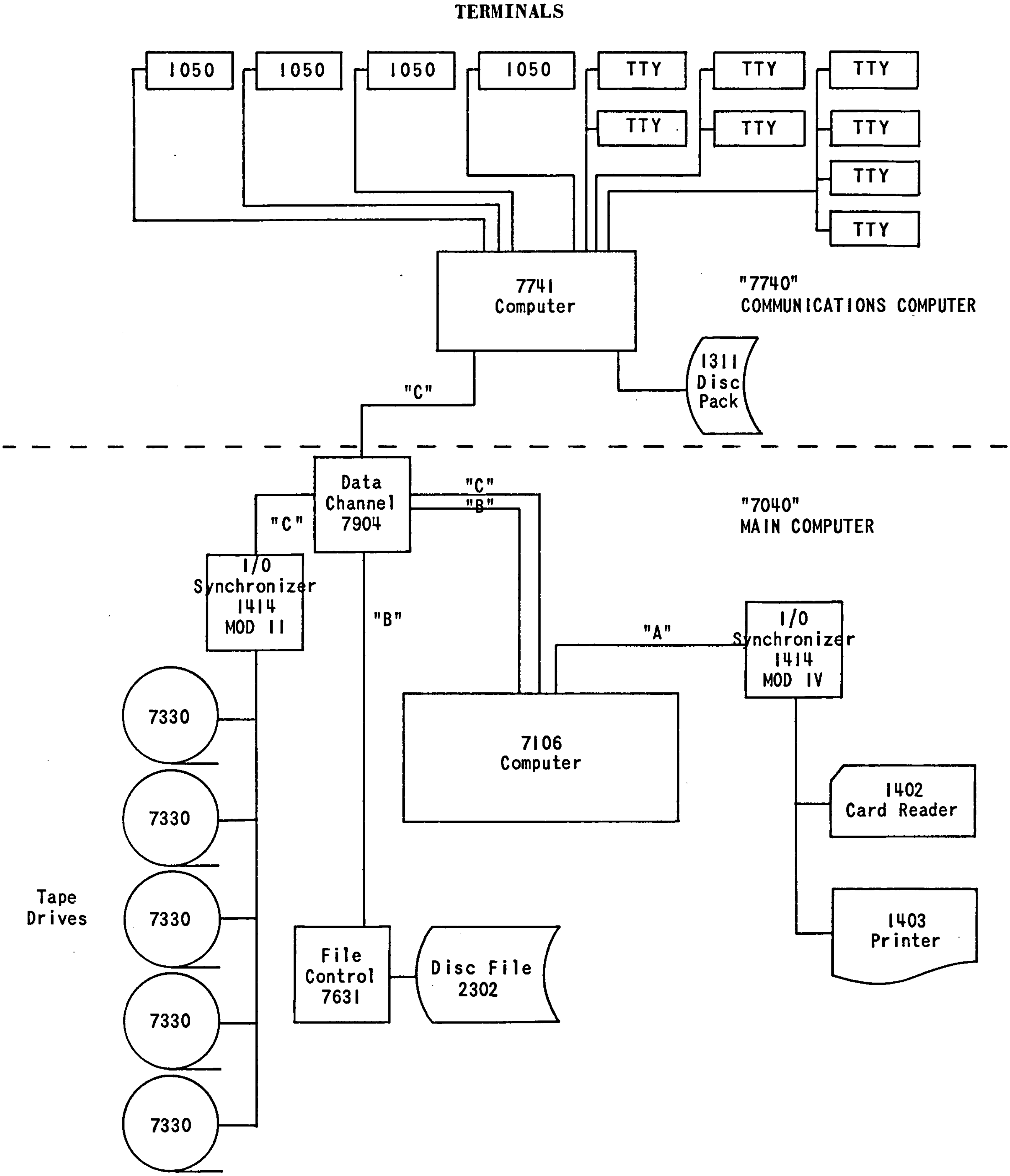


Figure 1 — St. Louis Police Department Computer System

patrol unit assigned and the district in the appropriate space on the Ticket. When the patrol unit has completed its assignment, it calls back in service and indicates the disposition of the assignment, which the dispatcher notes on the ticket. He also stamps the time and Complaint Number in the proper spaces on the Ticket and gives the patrol unit the Complaint Number of the assignment, if this information is necessary.

Self-initiated calls occur when a unit contacts the dispatcher and requests permission to go out of service. On such calls, the Dispatch Ticket is not time-stamped on its reverse side, nor is the location at which the unit is going out of service entered on the Ticket.

To summarize, the pertinent information contained on the radio Dispatch Ticket for calls for service is as follows:

1) the date and time at which the call requesting police service was received by the Department;
2) the patrol unit assigned;
3) the type of call, and any subsequent reclassification thereof;
4) the time at which a patrol unit was assigned—by month, day, year, and time in hours and minutes — and the subsequent time back into service;
5) the location of the incident;
6) the Complaint Number;
7) the name of the citizen who reported the incident, if given, and the name of the person involved in it;
8) any pertinent remarks or comments; and
9) whether the assignment resulted in an arrest and/or the dispatching of an ambulance or cruiser; whether it was of a nature requiring the preparation of a police report; and, if not, the code assigned.

Each morning, the Tickets for the previous day are given to the keypunching section of the Computer Center. Keypunching of the documents begins immediately; by noon the punched cards have been given to the console operators for processing. A program edits the punched cards and creates the "daily radio tape," which serves as input for all systems dealing with radio tickets. Generally, these tapes are combined at the end of a month to form a monthly radio tape, which is kept in a tape library for two years.

Crime Slip

The Crime Slip (Figure 3) is a 3″ x 8″ form prepared by the Crime Classification Section at Police Headquarters, and contains the following information taken from the police offense reports:

1) the type of report for which the Crime Slip is prepared. This includes an original report of a crime, an additional or "supplementary report" to a prior report on a given criminal incident, notification that a crime on which an offense report had been prepared was unfounded, a report of property recovery, a report that a crime has been "cleaned up" or solved, and a report reclassifying a crime from its original classification to another type;
2) the name and address of the victim of, or the person reporting, the crime;
3) the File Number and Complaint Number of an offense, its nature, and the district in which it occurred;
4) the Location Code assigned the location of the incident, and the date and time of occurrence;
5) the estimated value of the money, jewelry, furs, clothing, automobile, or miscellaneous articles stolen, and the total value of all property stolen;
6) if stolen property recovered, the date and location of recovery; who recovered it and how; and the value, both by category and total, as above;
7) if a crime solved, the date and location of cleanup, who solved it, and how;
8) the name of offender(s);
9) the reporting officer's Department Serial Number; and
10) the name of the person coding the Crime Slip.

A Master Crime File on disc was maintained by the Resource Allocation Research Unit by the following update programs (Figure 4):

1) Card to Disc of Crime Cards. This program accepts the crime cards of the seven main Part I Crimes categories (Murder, Rape, Robbery, Aggravated Assault, Burglary, Auto Theft, and Larceny) and writes the records on disc.
2) Sort by New Location Code. The records are placed in street order by this sort.
3) Get Pauly Area and City Block. This program obtains the Pauly Area and city block from the Street File.
4) Sort of Crime by District-Pauly-Offense.

This sort places the records into district, Pauly Area, and offense order.

5) Merge. The Master Crime File and the records just processed are combined by this merge.
6) Delete Records. This program deletes records older than 126 days from the Master Crime File.

SFTIC (Summons, Field Interrogation Reports, Truancy Noticeŝ, Insecure Building Reports, Curfew Notices)

These documents are grouped because a common format was developed to process information from them.

Summons information is obtained from an "enforcement" tape maintained by the Computer Center. This tape is updated daily and therefore provides an easy means for obtaining data for all systems. The Computer Center also maintains a Field Interrogation Report (FIR) system on a real-time basis; thus the Research Unit can gather information on FIR's at any time.

The Truancy Notices, Insecure Building Reports, and Curfew Notices required special processing by the Research Unit. These reports were coded by the Unit's coding clerks using special coding sheets.

The Missouri Uniform Traffic Ticket (Summons). The Missouri Uniform Traffic Ticket, a traffic summons (Figure 5), is issued for all violations of city traffic ordinances or state statutes except parking and pedestrian violations. The summons is issued to a person in lieu of a physical arrest and bond requirement. The violator is required either to pay a fine or appear in court. A court appearance is required for violations such as speeding in excess of 10 miles per hour over the posted limit, passing or overtaking a stopped school bus, defective brakes, interference with electric control devices, and cases where a violator was convicted of a speeding offense within the past two years.

Officers submit all summonses they wrote during their tour of duty to their supervisors. After examining them for accuracy, completeness and legibility, the supervisors then place all the Summonses in a transmittal envelope, list each one in numerical order on the envelope, and indicate the disposition of those copies not enclosed. The summonses are forwarded to the Data Processing Section of the Computer Center, where they are keypunched and verified.

Field Interrogation Report (FIR). The Field Interrogation Report (Figure 6) is a 5″ x 8″ card which is filled out by police officers on persons acting in a suspicious manner, especially in a high crime area. Its primary purpose is to build a reference file on persons whose conduct is open to suspicion, who are frequenting high crime areas without a legitimate reason, or who are found associating with known criminals. The Report shows:

1) the given name, nickname or alias, and residence address of the person questioned;
2) the district, location, date, and time of questioning;
3) parents' names and address, if questioned subject is a juvenile;
4) subject's occupation, employer, and business address;
5) subject's birthdate, birthplace, race, sex, age, height, weight, complexion, color of hair and eyes; and any unusual physical features;
6) type of clothing;
7) color, year, make, body style, and license of vehicle (if any);
8) the driver's license number, and the vehicle's serial and motor numbers;
9) the names of any persons with the questioned subject, and whether an FIR was made on them;
10) previous arrests and convictions on subject;
11) actions leading to interrogation; and
12) the name, Department Serial Number, and district of the officer submitting the Report.

Police Truancy Notice. The Police Truancy Notice (Figure 7) is a 3″ x 5″ form completed by an officer on youths illegally absent from school. This Notice is sent to the parents, guardians, or other adult in charge of the offending juvenile, to notify them that they are liable to prosecution and fine for allowing the truancy. One copy each is sent to the Juvenile Division, the Juvenile Court, and the Board of Education.

The Notice contains the following information:

1) the name, address, and birthdate of the juvenile;
2) the name and address of the adult who is responsible for the juvenile;
3) the date, time, and location at which the juvenile was encountered;
4) the school in which he is enrolled;
5) notification that the adult is liable to prosecution and fine for permitting absence from school; and

6) the name, Department Serial Number, and assignment of the reporting officer.

Insecure Building Report. The Insecure Building Report (Figure 8) is a 3″ x 8″ slip prepared by a patrol officer when he finds an improperly-secured business premise, i.e., one with a door left ajar or an open window. The officer, after attempting to notify the owner of the establishment of this condition, enters the following information on the slip, which must be approved by his supervising sergeant, the District desk sergeant, and the oncoming Watch Commander:

1) date, time, district, watch, and location;
2) the owner's name and whether he was notified;
3) any comments; and
4) the name, Department Serial Number, and assignment of the reporting officer.

Police Notice (Curfew Notice). The Police Notice (Figure 9) is a 3″ x 5″ form prepared by an officer who observes a juvenile roaming the streets after the curfew hours for juveniles. One copy of the Notice is sent to the parents, guardians, or other adult in charge of the juvenile, informing them that a second such violation will make them liable to prosecution and a fine. A second copy is forwarded to the Juvenile Court, and a third copy is sent to Police Headquarters for record processing.

The Police Notice contains the following information:

1) the name, address, and birthdate of the subject juvenile;
2) the name and address of the adult who is to receive the report;
3) the date, time, location and nature of the violation;
4) warning of prosecution and fine for further such violations; and
5) the name, rank, and assignment of the reporting officer.

Processing of SFTIC Information. The updating procedures for processing SFTIC information are accomplished on a weekly basis by using the following programs (Figures 10-11):

1) Card to Disc of Data. The SFTIC data are written on disc by this program.
2) Sort by New Location Code. This sort places the data in street order.
3) Get Pauly Area and City Block. This program obtains the Pauly Area and city block from the street file and places this information on the record.
4) Sort by Date, Time and Type. The records are placed in date, time and type order (the type refers to whether the incident is a Summons, Field Interrogation Report, Truancy Notice, Insecure Building Report, or Curfew Notice).
5) Merge of Data. The information is combined with the Master tape to form a New Master Tape. The final tape record has the following format:

Column (s)	Information
1	The code for the type of record being processed: Blank = Summons; 1 = FIR; 2 = Curfew; 3 = Insecure Building Report; 4 = Truancy;
2	Day of the week on which the incident occurred: Sunday=1, Monday=2, etc.;
3 - 6	Time (military) of the incident;
7	Designation of whether the time is a.m. or p.m.;
8 - 13	Month, date, and year (two columns for each) on which the incident took place;
14 - 23	The location code of the incident;
24 - 29	The type of summons issued. The first two columns contain either a 61 (for hazardous summons) or a 62 (for non-hazardous summons);
30 - 35	A sequence number associated with the document (Complaint Number, Ticket Number, etc.);
36 - 38	Pauly Area;
39 - 44	City Block; and
45 - 84	Blank.

Activity Report

Officers assigned to preventive patrol units in the Ninth District during Phase II were required to complete an Activity Report at the end of a tour of duty. The form contains the following pertinent information: beginning and ending time of the tour of duty; date; Pauly Areas patrolled; number of arrests, Field Interrogation Reports, and occupied and unoccupied car checks made; number of hazardous and non-hazardous summonses, parking tags, Truancy Notices, and Curfew Notices issued; auto tows ordered; and auto recoveries made.

The Activity Report file was updated every two weeks by the following programs (Figure 12):

1) Card to Tape. This program creates a tape from the punched data cards.
2) Sort by Date and Car. The records are placed in date and car order by this sort.
3) Merge of Data. The records just processed are combined with the Master Activity Tape to create a new Master Activity Tape. The final output record has the following format:

Columns	Information
1 - 6	The date of the report in month, day, and year (2 digits each);
7 - 9	Car designation (09M, 09N, etc.);
10 - 13	Beginning time of the tour of duty (military time);
14 - 17	Ending time of the tour of duty (military time);
18 - 19	Number of arrests;
20 - 21	Number of FIR's;
22 - 23	Number of unoccupied car checks;
24 - 25	Number of occupied car checks;
26 - 27	Number of pedestrian checks;
28 - 29	Number of hazardous summonses;
30 - 31	Number of non-hazardous summonses;
32 - 33	Number of parking tags;
34 - 35	Number of Truancy Notices;
36 - 37	Number of Curfew Notices;
38 - 39	Number of automobile tows;
40 - 41	Number of automobiles recovered;
42 - 71	Pauly Areas patrolled (maximum of 10); and
72 - 80	Blank.

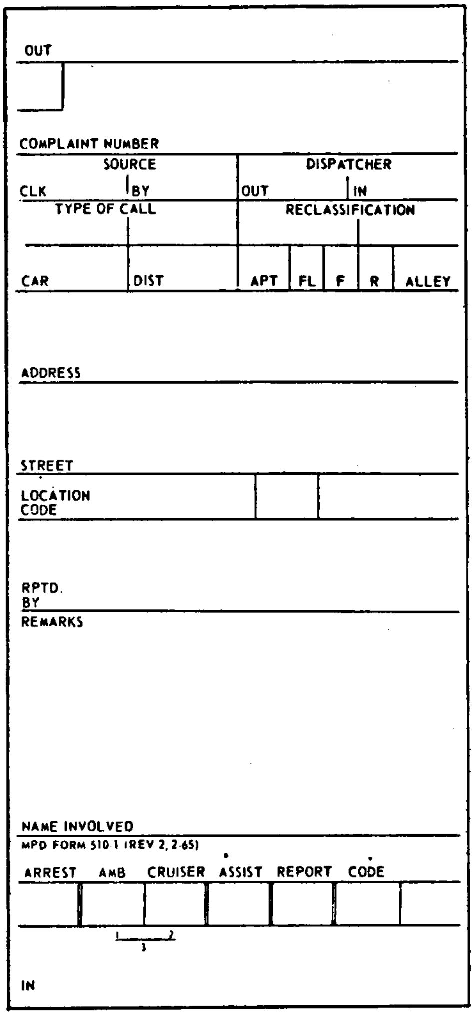
Arrest Information

Arrest information is obtained from a real-time adult arrest file maintained by the Computer Center. The programs developed by the Research Unit to process this information are as follows (Figure 13):

1) Adult Arrest Disc to Tape. This program obtains arrest information from the disc file for the Seventh and Ninth districts for given date parameters.
2) Sort by Date and Complaint Number. The tape is then sorted by date and Complaint Number.
3) Sort Crime by Date and Complaint Number. The crime data on the Master Crime File are sorted by date and Complaint Number and written on a tape.
4) Arrest-Crime Tape. This program matches the two tapes just sorted and creates a new record containing information on types of arrest, type of offense, etc.

The final record has the following format:

Columns	Information
1	District (7 or 9);
2	Type;
3 - 8	Arrest Register Number (a unique number assigned to each arrest report);
9 - 12	Time of arrest (military);
13 - 18	Month, day, and year of arrest (2 digits each);
19	Sex of person arrested (M or F);
20 - 25	Date of birth by month, day, and year (2 digits each);
26 - 31	Complaint Number;
23 - 41	Location code of arrest;
42 - 47	Six digit charge code;
48 - 54	Blank;
55 - 57	Pauly Area of arrest;
58 - 83	Blank; and
84	Indication as to whether arrest was on view.



OUT

COMPLAINT NUMBER

SOURCE
CLK BY

DISPATCHER
OUT IN

TYPE OF CALL
CAR DIST

RECLASSIFICATION
APT FL F R ALLEY

ADDRESS

STREET

LOCATION CODE

RPTD. BY

REMARKS

NAME INVOLVED

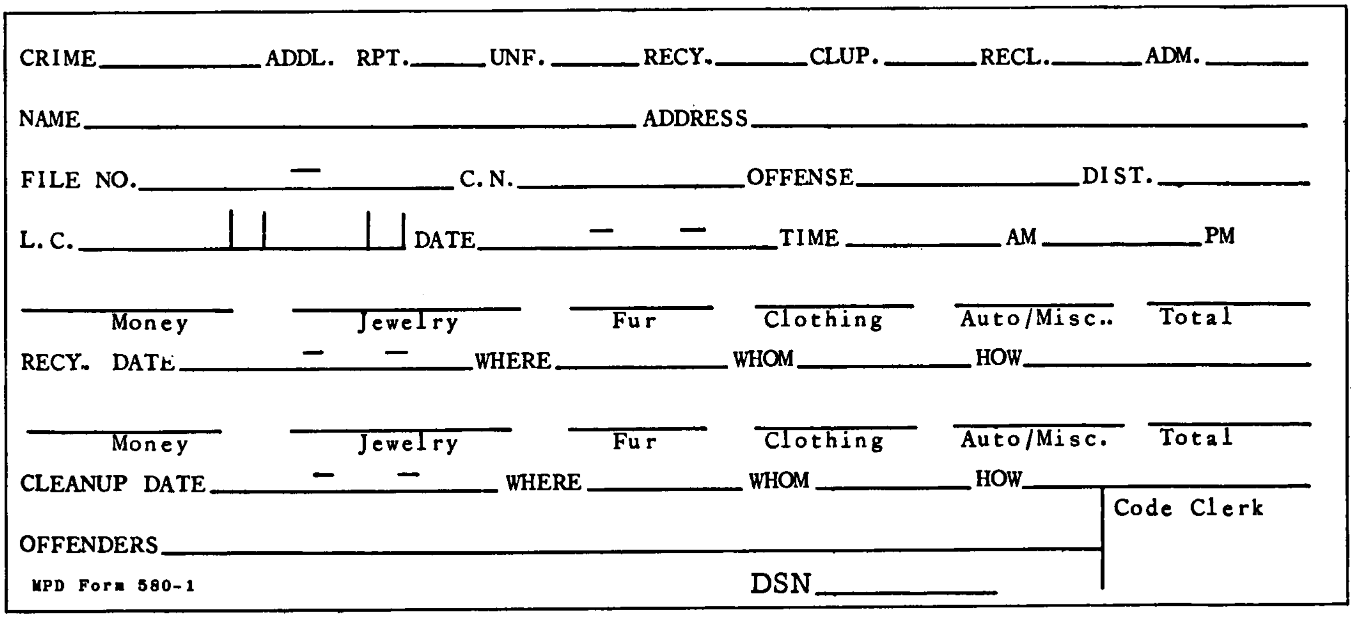
MPD FORM 510.1 (REV 2, 2-65)

ARREST AMB CRUISER ASSIST REPORT CODE

1 2 3

IN

Figure 2 — Radio Dispatch Ticket



CRIME ADDL. RPT. UNF. RECY. CLUP. RECL. ADM.

NAME ADDRESS

FILE NO. — C.N. OFFENSE DIST.

L.C. DATE — — TIME AM PM

Money Jewelry Fur Clothing Auto/Misc.. Total

RECY. DATE — — WHERE WHOM HOW

Money Jewelry Fur Clothing Auto/Misc. Total

CLEANUP DATE — — WHERE WHOM HOW

Code Clerk

OFFENDERS

MPD Form 580-1

DSN

Figure 3 — Crime Slip

CRIME UPDATE

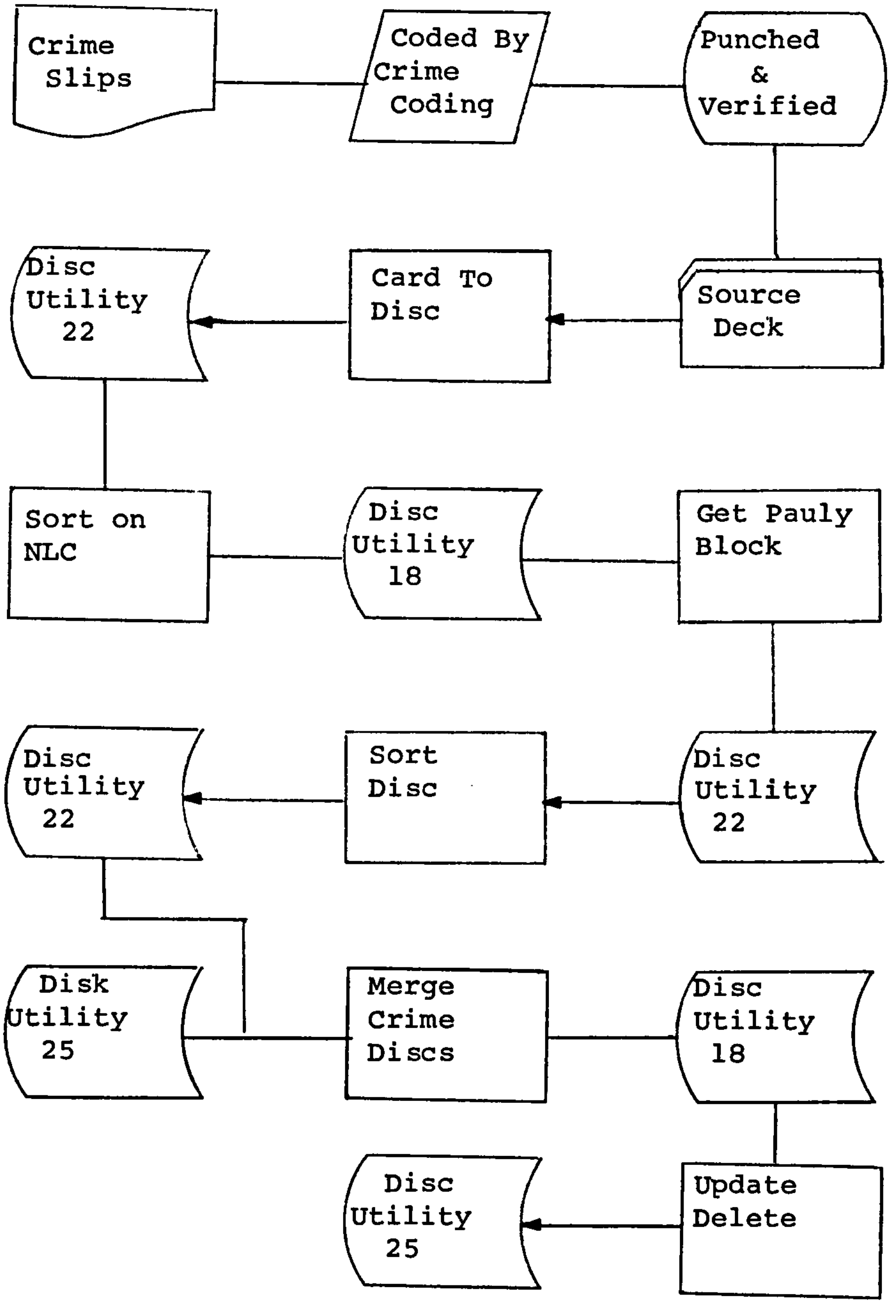
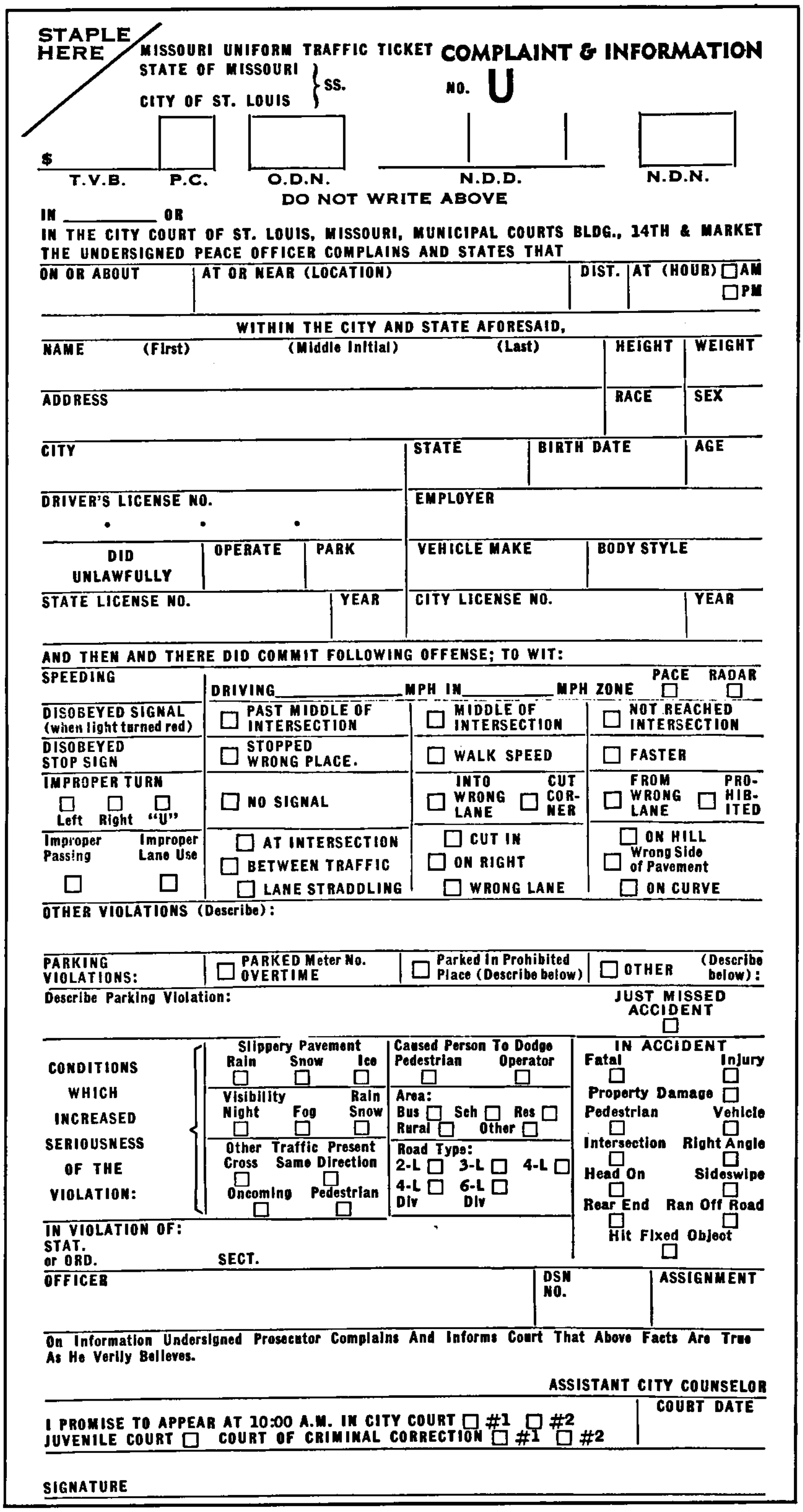


Figure 4 — Crime Update



STAPLE HERE

MISSOURI UNIFORM TRAFFIC TICKET **COMPLAINT & INFORMATION**

STATE OF MISSOURI } SS.
CITY OF ST. LOUIS }

NO. U

$ T.V.B. P.C. O.D.N. N.D.D. N.D.N.

DO NOT WRITE ABOVE

IN __________ OR
IN THE CITY COURT OF ST. LOUIS, MISSOURI, MUNICIPAL COURTS BLDG., 14TH & MARKET
THE UNDERSIGNED PEACE OFFICER COMPLAINS AND STATES THAT

ON OR ABOUT	AT OR NEAR (LOCATION)	DIST.	AT (HOUR) ☐ AM ☐ PM

WITHIN THE CITY AND STATE AFORESAID,

NAME (First) (Middle Initial) (Last)		HEIGHT	WEIGHT
ADDRESS		RACE	SEX
CITY	STATE	BIRTH DATE	AGE
DRIVER'S LICENSE NO. • • •	EMPLOYER		
DID UNLAWFULLY	OPERATE	PARK	VEHICLE MAKE	BODY STYLE
STATE LICENSE NO.	YEAR	CITY LICENSE NO.	YEAR

AND THEN AND THERE DID COMMIT FOLLOWING OFFENSE; TO WIT:

SPEEDING	DRIVING__________MPH IN__________MPH ZONE	PACE ☐	RADAR ☐
DISOBEYED SIGNAL (when light turned red)	☐ PAST MIDDLE OF INTERSECTION	☐ MIDDLE OF INTERSECTION	☐ NOT REACHED INTERSECTION
DISOBEYED STOP SIGN	☐ STOPPED WRONG PLACE.	☐ WALK SPEED	☐ FASTER
IMPROPER TURN ☐ Left ☐ Right ☐ "U"	☐ NO SIGNAL	☐ INTO WRONG LANE ☐ CUT CORNER	☐ FROM WRONG LANE ☐ PROHIBITED
Improper Passing ☐ Improper Lane Use ☐	☐ AT INTERSECTION ☐ BETWEEN TRAFFIC ☐ LANE STRADDLING	☐ CUT IN ☐ ON RIGHT ☐ WRONG LANE	☐ ON HILL ☐ Wrong Side of Pavement ☐ ON CURVE

OTHER VIOLATIONS (Describe):

PARKING VIOLATIONS:	☐ PARKED Meter No. OVERTIME	☐ Parked in Prohibited Place (Describe below)	☐ OTHER (Describe below):

Describe Parking Violation:

JUST MISSED ACCIDENT ☐

CONDITIONS WHICH INCREASED SERIOUSNESS OF THE VIOLATION:

Slippery Pavement Rain ☐ Snow ☐ Ice ☐	Caused Person To Dodge Pedestrian ☐ Operator ☐	IN ACCIDENT Fatal ☐ Injury ☐ Property Damage ☐ Pedestrian ☐ Vehicle ☐ Intersection ☐ Right Angle ☐ Head On ☐ Sideswipe ☐ Rear End ☐ Ran Off Road ☐ Hit Fixed Object ☐
Visibility Night ☐ Fog ☐ Rain Snow ☐	Area: Bus ☐ Sch ☐ Res ☐ Rural ☐ Other ☐	
Other Traffic Present Cross ☐ Same Direction ☐ Oncoming ☐ Pedestrian ☐	Road Type: 2-L ☐ 3-L ☐ 4-L ☐ 4-L Div ☐ 6-L Div ☐	

IN VIOLATION OF:
STAT. or ORD. SECT.

OFFICER	DSN NO.	ASSIGNMENT

On Information Undersigned Prosecutor Complains And Informs Court That Above Facts Are True As He Verily Believes.

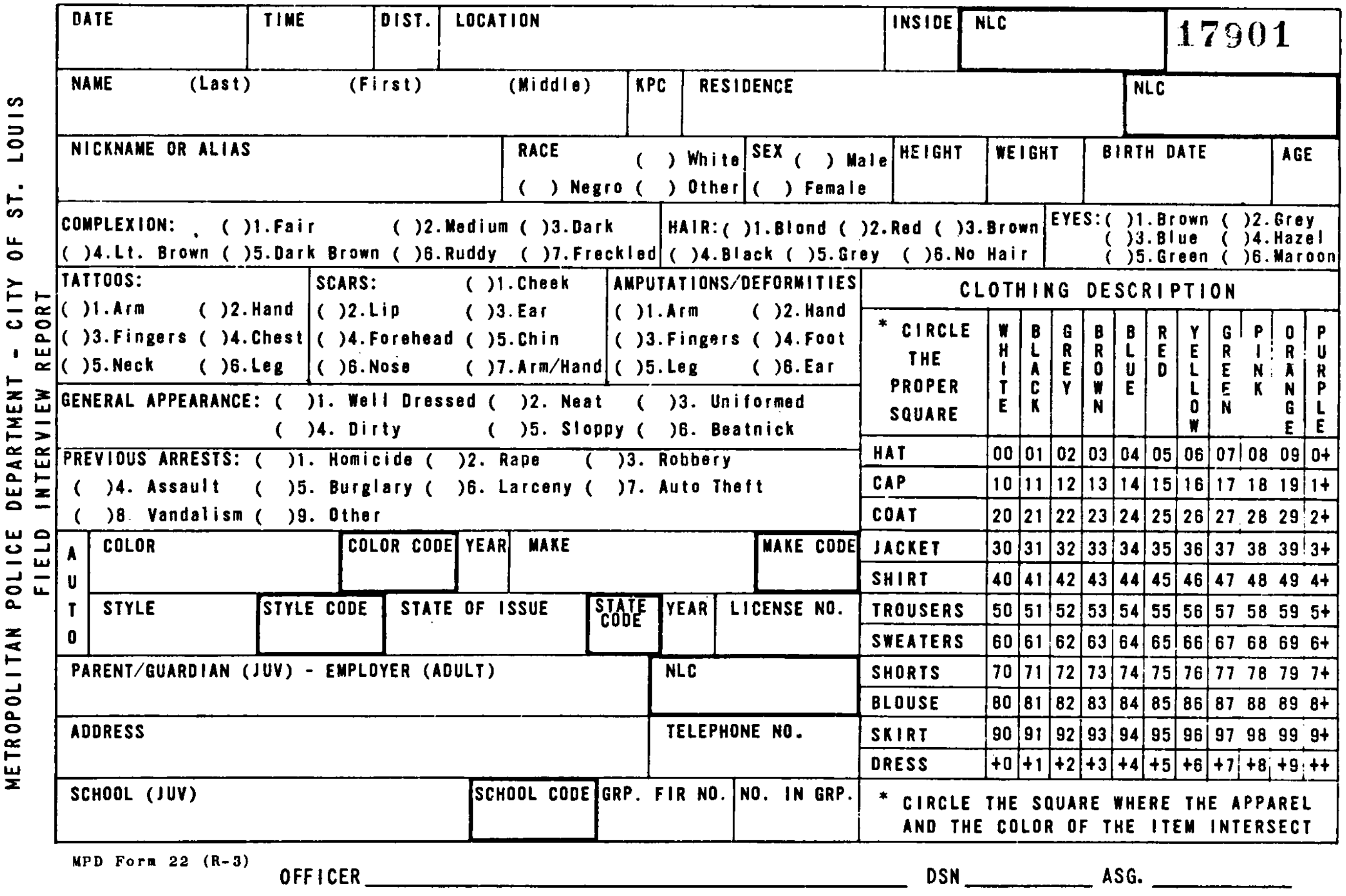
ASSISTANT CITY COUNSELOR

I PROMISE TO APPEAR AT 10:00 A.M. IN CITY COURT ☐ #1 ☐ #2
JUVENILE COURT ☐ COURT OF CRIMINAL CORRECTION ☐ #1 ☐ #2

COURT DATE

SIGNATURE

Figure 5 — The Missouri Uniform Traffic Ticket



METROPOLITAN POLICE DEPARTMENT - CITY OF ST. LOUIS
FIELD INTERVIEW REPORT

DATE | TIME | DIST. | LOCATION | INSIDE | NLC | 17901

NAME (Last) (First) (Middle) | KPC | RESIDENCE | NLC

NICKNAME OR ALIAS | RACE ( ) White ( ) Negro ( ) Other | SEX ( ) Male ( ) Female | HEIGHT | WEIGHT | BIRTH DATE | AGE

COMPLEXION: ( )1.Fair ( )2.Medium ( )3.Dark ( )4.Lt. Brown ( )5.Dark Brown ( )6.Ruddy ( )7.Freckled

HAIR: ( )1.Blond ( )2.Red ( )3.Brown ( )4.Black ( )5.Grey ( )6.No Hair

EYES: ( )1.Brown ( )2.Grey ( )3.Blue ( )4.Hazel ( )5.Green ( )6.Maroon

TATTOOS: ( )1.Arm ( )2.Hand ( )3.Fingers ( )4.Chest ( )5.Neck ( )6.Leg

SCARS: ( )1.Cheek ( )2.Lip ( )3.Ear ( )4.Forehead ( )5.Chin ( )6.Nose ( )7.Arm/Hand

AMPUTATIONS/DEFORMITIES ( )1.Arm ( )2.Hand ( )3.Fingers ( )4.Foot ( )5.Leg ( )6.Ear

GENERAL APPEARANCE: ( )1. Well Dressed ( )2. Neat ( )3. Uniformed ( )4. Dirty ( )5. Sloppy ( )6. Beatnick

PREVIOUS ARRESTS: ( )1. Homicide ( )2. Rape ( )3. Robbery ( )4. Assault ( )5. Burglary ( )6. Larceny ( )7. Auto Theft ( )8 Vandalism ( )9. Other

AUTO

COLOR | COLOR CODE | YEAR | MAKE | MAKE CODE

STYLE | STYLE CODE | STATE OF ISSUE | STATE CODE | YEAR | LICENSE NO.

PARENT/GUARDIAN (JUV) - EMPLOYER (ADULT) | NLC

ADDRESS | TELEPHONE NO.

SCHOOL (JUV) | SCHOOL CODE | GRP. FIR NO. | NO. IN GRP.

CLOTHING DESCRIPTION

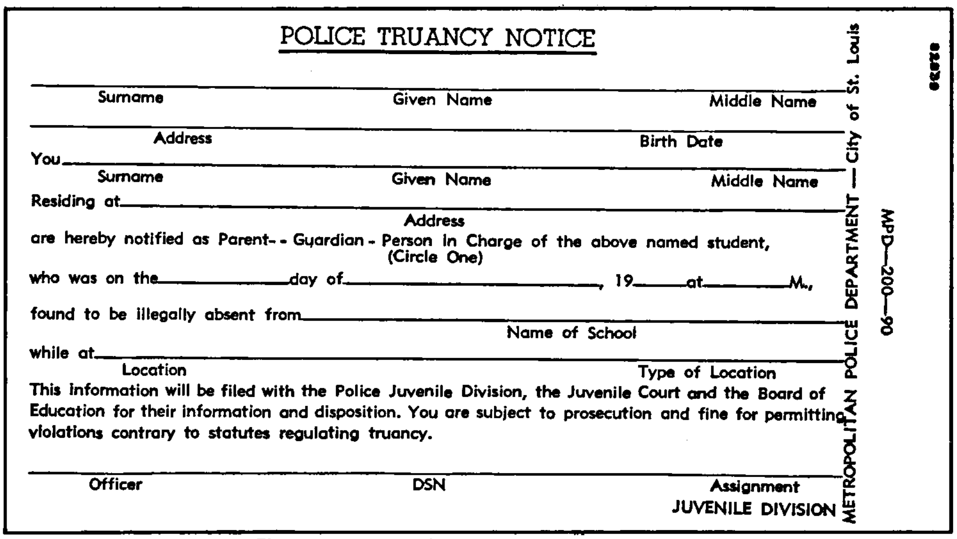
* CIRCLE THE PROPER SQUARE	WHITE	BLACK	GREY	BROWN	BLUE	RED	YELLOW	GREEN	PINK	ORANGE	PURPLE
HAT	00	01	02	03	04	05	06	07	08	09	0+
CAP	10	11	12	13	14	15	16	17	18	19	1+
COAT	20	21	22	23	24	25	26	27	28	29	2+
JACKET	30	31	32	33	34	35	36	37	38	39	3+
SHIRT	40	41	42	43	44	45	46	47	48	49	4+
TROUSERS	50	51	52	53	54	55	56	57	58	59	5+
SWEATERS	60	61	62	63	64	65	66	67	68	69	6+
SHORTS	70	71	72	73	74	75	76	77	78	79	7+
BLOUSE	80	81	82	83	84	85	86	87	88	89	8+
SKIRT	90	91	92	93	94	95	96	97	98	99	9+
DRESS	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	++

* CIRCLE THE SQUARE WHERE THE APPAREL AND THE COLOR OF THE ITEM INTERSECT

MPD Form 22 (R-3)

OFFICER ______ DSN ______ ASG. ______

Figure 6 — Field Interrogation Report



POLICE TRUANCY NOTICE

____
Surname Given Name Middle Name

____
Address Birth Date

You ______________________________
Surname Given Name Middle Name

Residing at ______________________________
Address

are hereby notified as Parent- - Guardian - Person in Charge of the above named student,
(Circle One)

who was on the ________ day of ______________, 19____ at ________ M.,

found to be illegally absent from ______________________________
Name of School

while at ______________________________
Location Type of Location

This information will be filed with the Police Juvenile Division, the Juvenile Court and the Board of Education for their information and disposition. You are subject to prosecution and fine for permitting violations contrary to statutes regulating truancy.

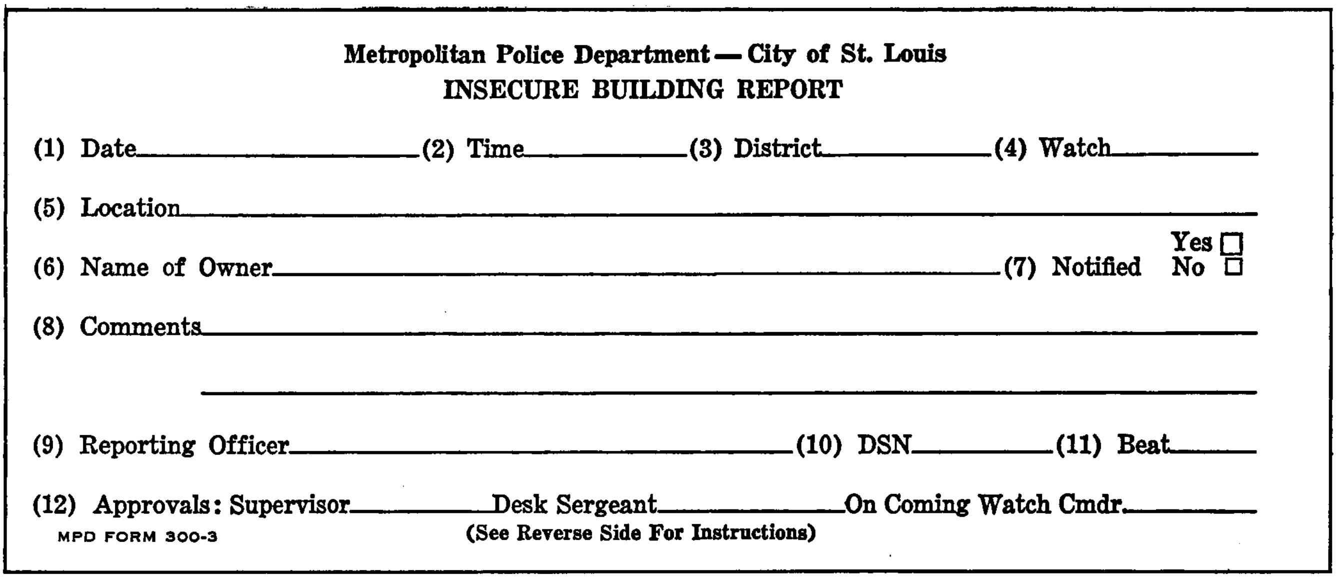
____
Officer DSN Assignment

JUVENILE DIVISION

METROPOLITAN POLICE DEPARTMENT — City of St. Louis

MPD—200—90

Figure 7 — Police Truancy Notice



Metropolitan Police Department — City of St. Louis
INSECURE BUILDING REPORT

(1) Date ______________ (2) Time ________ (3) District ________ (4) Watch ________

(5) Location ______________________________

(6) Name of Owner ______________________________ (7) Notified Yes ☐ No ☐

(8) Comments ______________________________

____

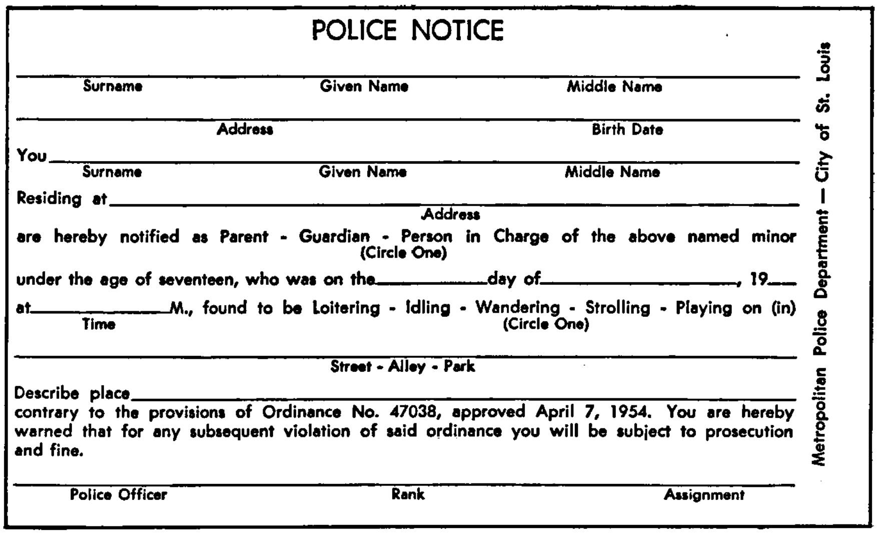
(9) Reporting Officer ______________________________ (10) DSN ________ (11) Beat ________

(12) Approvals: Supervisor ________ Desk Sergeant ________ On Coming Watch Cmdr. ________

MPD FORM 300-3

(See Reverse Side For Instructions)

Figure 8 — Insecure Building Report



POLICE NOTICE

____
Surname Given Name Middle Name

____
Address Birth Date

You ______________________________
Surname Given Name Middle Name

Residing at ______________________________
Address

are hereby notified as Parent - Guardian - Person in Charge of the above named minor
(Circle One)

under the age of seventeen, who was on the ________ day of ______________, 19____

at ________ M., found to be Loitering - Idling - Wandering - Strolling - Playing on (in)
Time (Circle One)

____
Street - Alley - Park

Describe place ______________________________

contrary to the provisions of Ordinance No. 47038, approved April 7, 1954. You are hereby warned that for any subsequent violation of said ordinance you will be subject to prosecution and fine.

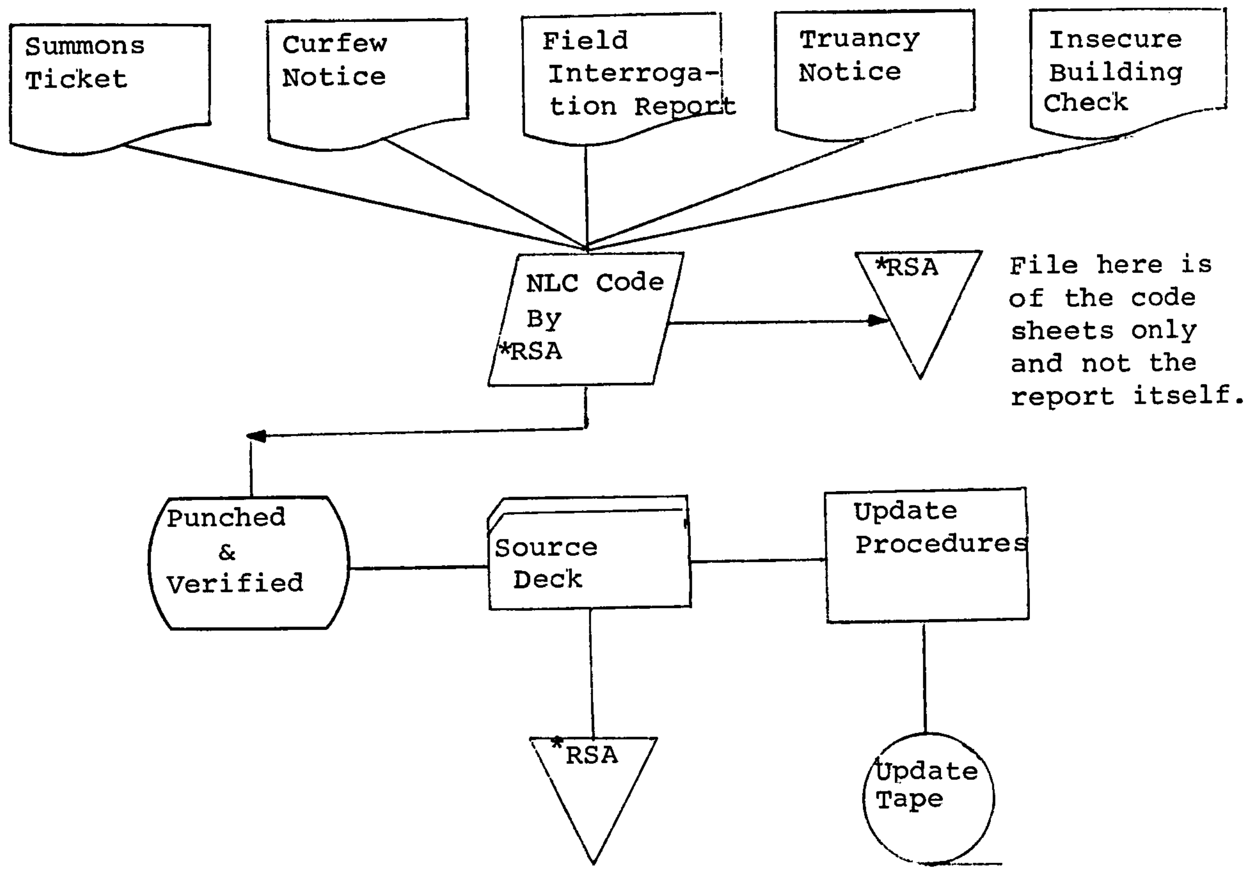
____
Police Officer Rank Assignment

Metropolitan Police Department — City of St. Louis

Figure 9 — Police Notice (Curfew Notice)

St. Louis Police Department
Information System Flowchart

SFTIC PROCESSING



File here is of the code sheets only and not the report itself.

*Research Unit

Figure 10 — SFTIC Processing

SFTIC UPDATE

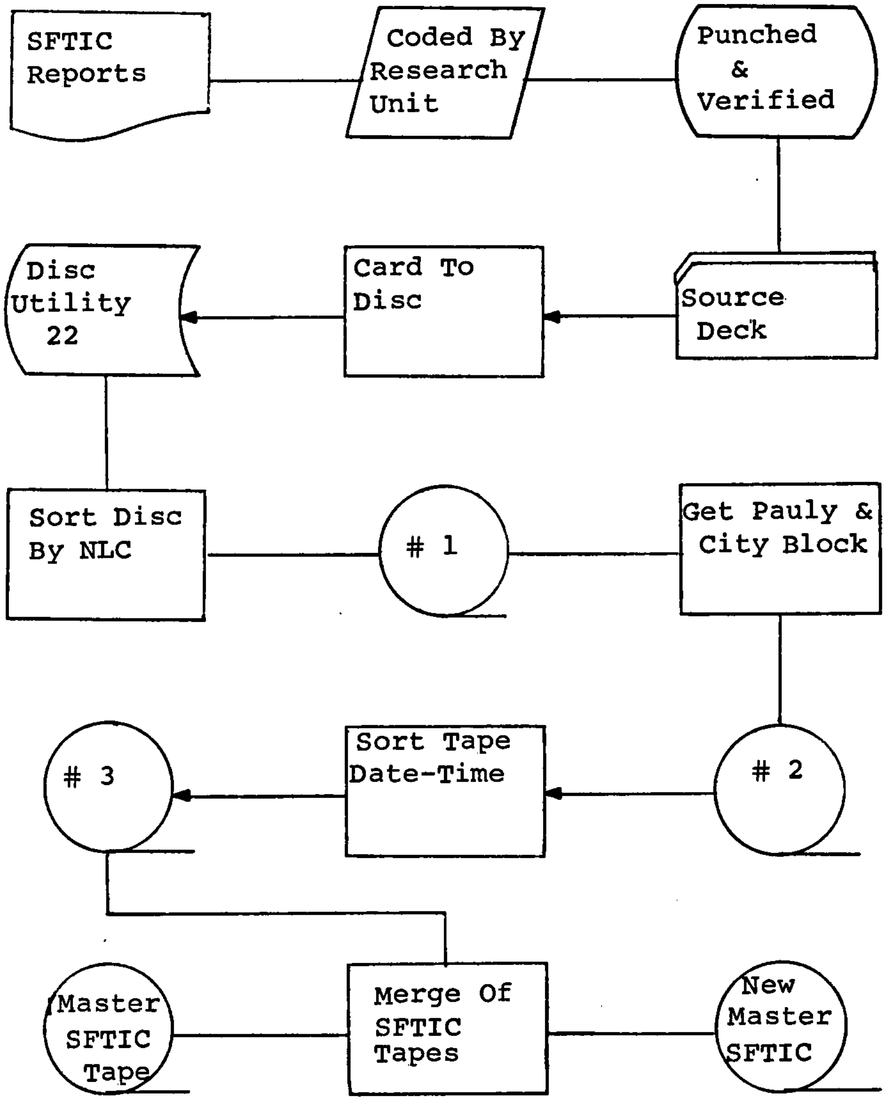


Figure 11 — SFTIC Update

III. Systems

Prediction Systems

The following reports were produced from these systems: Radio Event Maps for Predictions, Queueing Table of Service Levels, Summary Queueing Table by Day of Week, and Pauly Log for Predictions.

The first system involved the processing of radio Dispatch Tickets to produce new smoothed averages in accordance with the mathematical model (see the Appendix for a discussion of the model). A week of Dispatch Tickets were processed at one time. The following programs accomplished this updating (Figure 14):

1) Sort by Location Code. The records are placed in street order by this sort.
2) Radio Ticket Edit. This program edits each Dispatch Ticket and obtains geographic information from the Street File. The information added to the record includes the city block, the Pauly Area, the district and the beat of occurrence of the incident.
3) Sort/Modification for Assists. In the St. Louis Police Department, the address of a directed incident is placed only on the original Dispatch Ticket and not on the "assist" Ticket if an "assist" unit is dispatched. In order to obtain the geographic areas for the latter Ticket, a sort modification program was written. The Tickets are first sorted by Complaint Number; thus the original and the "assist" Tickets are placed next to each other. A program is then read into core which reads the records and transfers the geographic information to the "assist" Ticket when necessary.
4) Sort by Geographic Area. This sort places the records in block number and Pauly Area order. The amount of reading from disc and writing on disc of the next program is thereby reduced to a minimum.
5) Update Program. The averages for the geographic areas are maintained on a disc file. This program has the responsibility of updating the smoothed averages for each geographic area by processing the week's Dispatch Tickets.
6) Sort by Day of Week. This sort places the Tickets in day-of-week order.
7) Update Hour-of-Week Totals. The mathematical model requires the distribution of calls by hour of the week. This program processes the Dispatch Tickets and develops the necessary distribution. (Core limitations prevented this procedure in the Update Program.)
8) Adjust Summaries. If no calls for service occur in a particular Pauly Area, the summaries must still be adjusted. This program makes the necessary adjustments to the geographic summaries.

The Radio Event Maps for Predictions are produced by using the disc file as input. Processing is accomplished by the following programs (Figure 15):

1) Prediction Programs. Using the disc file as input, this program creates a tape with prediction information for each Pauly Area. The program requires a group of special control cards which give the beginning date of the predictions, the number of weeks in the prediction period, the days of the week and hour of the day to be considered, and the geographic area of the prediction. Thus there is a good deal of flexibility in the program. Predictions can be produced for one year in advance and for any combination of Pauly Areas.
2) Ten Periods Program. Predictions are produced for one hour at a time. This program was written in order that various hour groupings could be obtained in the final output. In the case of the Radio Event Maps, the groupings were for each watch. A period number is assigned to each watch by the Ten Periods Program as follows:

Period	Time
1	0700 - 1500
2	1500 - 2300
3	2300 - 0700

As the name indicates, up to 10 different time segments may be considered. This processing becomes particularly important when using a sort to place data in date and watch order.

3) Sort for Radio Events Maps. The prediction tape is placed in day of week, period, and Pauly Area order by this sort.
4) Prediction Event Map Program. The Prediction Event Maps are produced by this program. An internal table contains the coordinates (based on row and column) of each Pauly Area in the district. A subroutine of the program uses a blank matrix and places the prediction information in the proper location. At each change of watch, the matrix is printed and cleared for the

next watch. The report is produced with the printer set for eight lines per inch instead of the normal six.

The Pauly Log for Predictions is produced using the output of the Ten Periods program discussed above. In this case, the tape is sorted by period, Pauly Area, and day of week. The program which produces this report is merely a reproduction of the basic information on the tape.

Both of the queueing programs are produced from one program. The same control cards for giving time and geographic information as used in the above prediction programs are employed in this program. The Appendix gives a discussion of the mathematics for these reports.

Systems Providing "Actual" Statistics

The reports which are produced from these systems are the Radio Event Maps for Actuals, the Pauly Log for Actuals, the In Beat/Out Beat Report, and the Daily Radio Reports.

The Radio Event Maps for Actuals are produced by the following programs (Figure 16):

1) Fourteen-Five Program. This program uses the radio Dispatch Ticket tape for input and creates a new tape with only the pertinent information on it. It also formats the tape so that programs from the Prediction System can be used. The name of the program is derived from the fact that the information is reduced from 14 computer words to five computer words.
2) Ten Periods Program. As in the Prediction System, this program assigns a period number using the actual time of the Dispatch Ticket. The period numbers correspond to the watch.
3) Sort for Radio Event Maps. The actual tape is placed in day of week, period, and Pauly Area order by this sort.
4) Actual Event Map Program. The Actual Event Maps are produced by this program. The same table of coordinates as used in the Prediction Event Map Program is employed by this program.

The Pauly Log for Actuals is produced using the output from the Ten Periods Program. The tape is sorted by period, Pauly Area, and day of week and the program sums the data for each Pauly Area to produce the report.

The production of the In Beat/Out Beat Report requires only one program. It is based on a comparison of the beat on which a call for service occurred and the regular beat of the patrol unit assigned to handle the call. Thus, information must be gathered and keypunched on the beat structures employed.

The Car Activity Report by Car, the Time Analysis Report, and the Chronological Car Activity Report are produced by the same system. The daily radio tape is first sorted by the date and patrol car fields. The Car Activity Report by Car and the Time Analysis Report are then produced from the same program. At the same time, a tape is created with each record representing one line of the Car Activity Report. This tape is then sorted by the date and time fields, and the Chronological Car Activity Report is basically a printout of this tape.

Crime Systems

The reports which are produced from these systems are: Crime Maps (Contour and Flat-Tone), Selected Part I Crimes Report, and Selected Part I Crimes Listing.

The disc file maintained for crime information has been previously described in Part II of this chapter. This file serves as input to the crime systems (Figure 17). To produce the crime maps, a program titled Map Prep is run, using a control card which gives the beginning and ending dates of the desired crime information. The tape is then used as input to the SYMAP program, which produces the contour and flat-tone maps.[1]

The Selected Part I Crimes Report and Listing are produced directly from this disc file. The programs which produce these reports use a control card which gives date and time parameters. For the Selected Part I Crimes Report, the program sums the information for each Pauly Area between the dates and times on the control card. The information is then printed. The Selected Part I Crimes Listing is produced by finding the crime information between the given dates and times on the control and printing the desired information.

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[1] A full explanation of the SYMAP program is not feasible in this report. Interested persons should contact Mr. Howard T. Fisher, who heads the Department of Computing Graphics, Harvard University.

ACTIVITY REPORT UPDATE

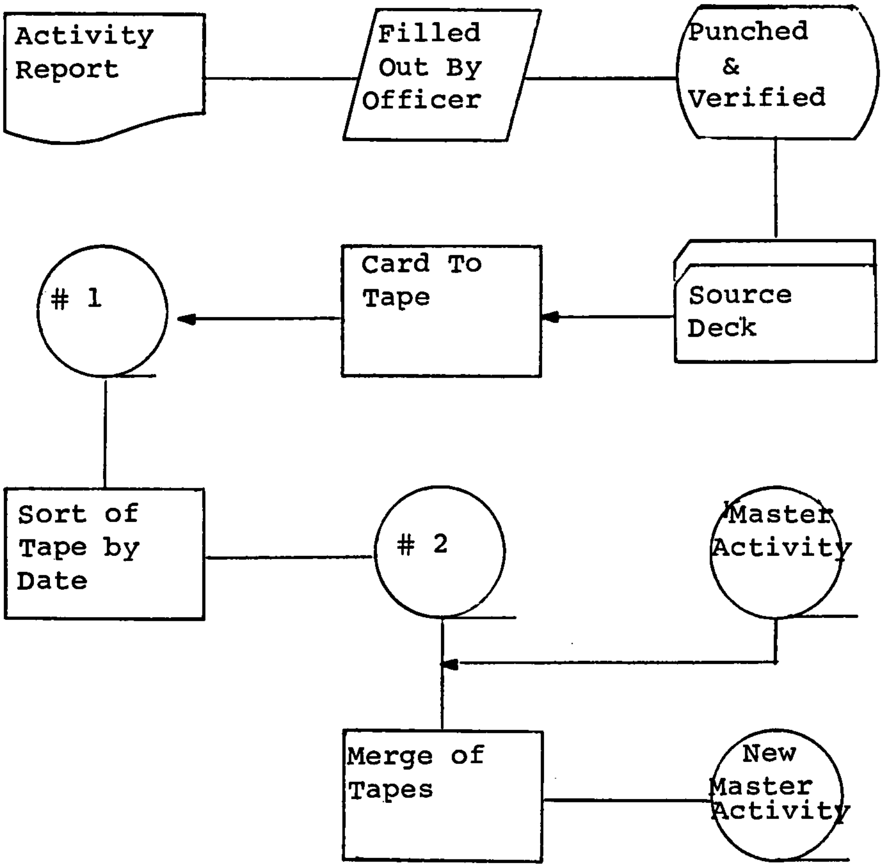

Figure 12 — Activity Report Update

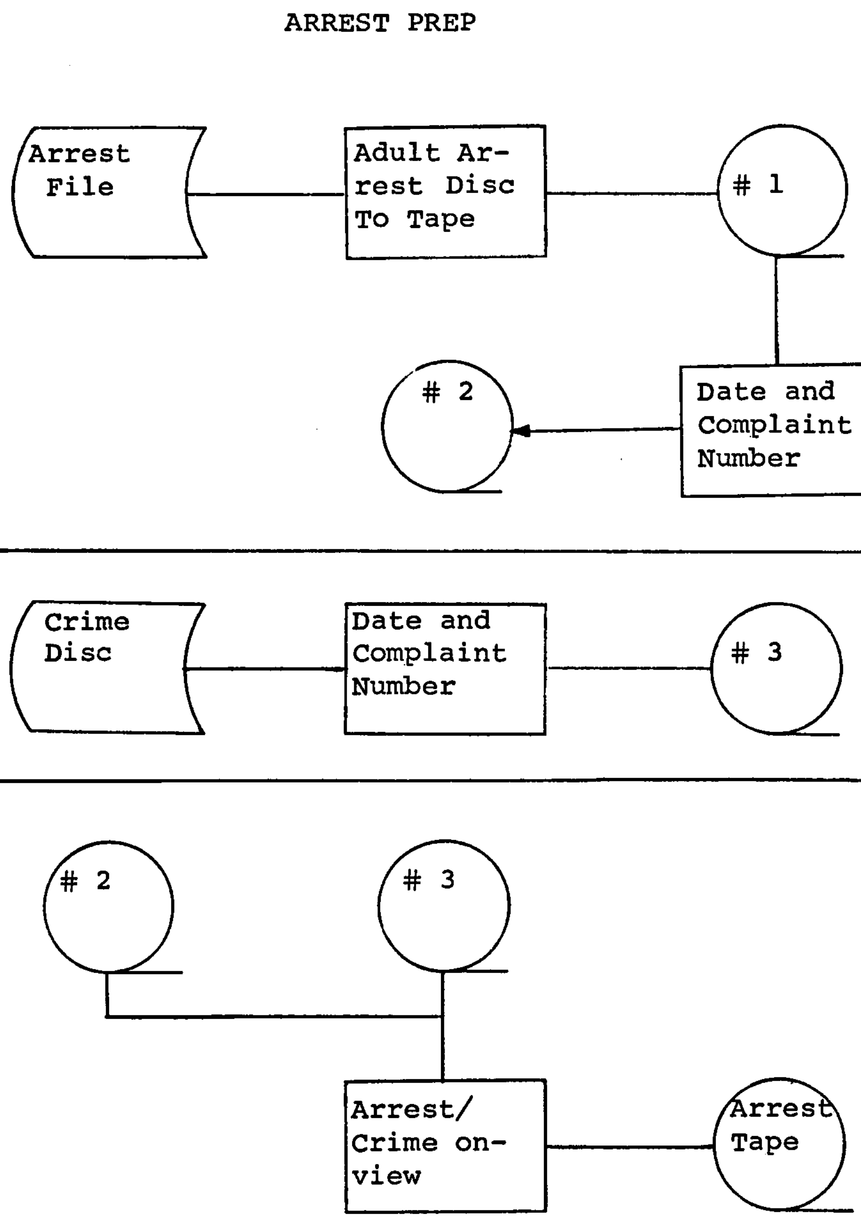

Figure 13 — Arrest Preparation

St. Louis Police Department
Information System Flowchart

UPDATE SYSTEM

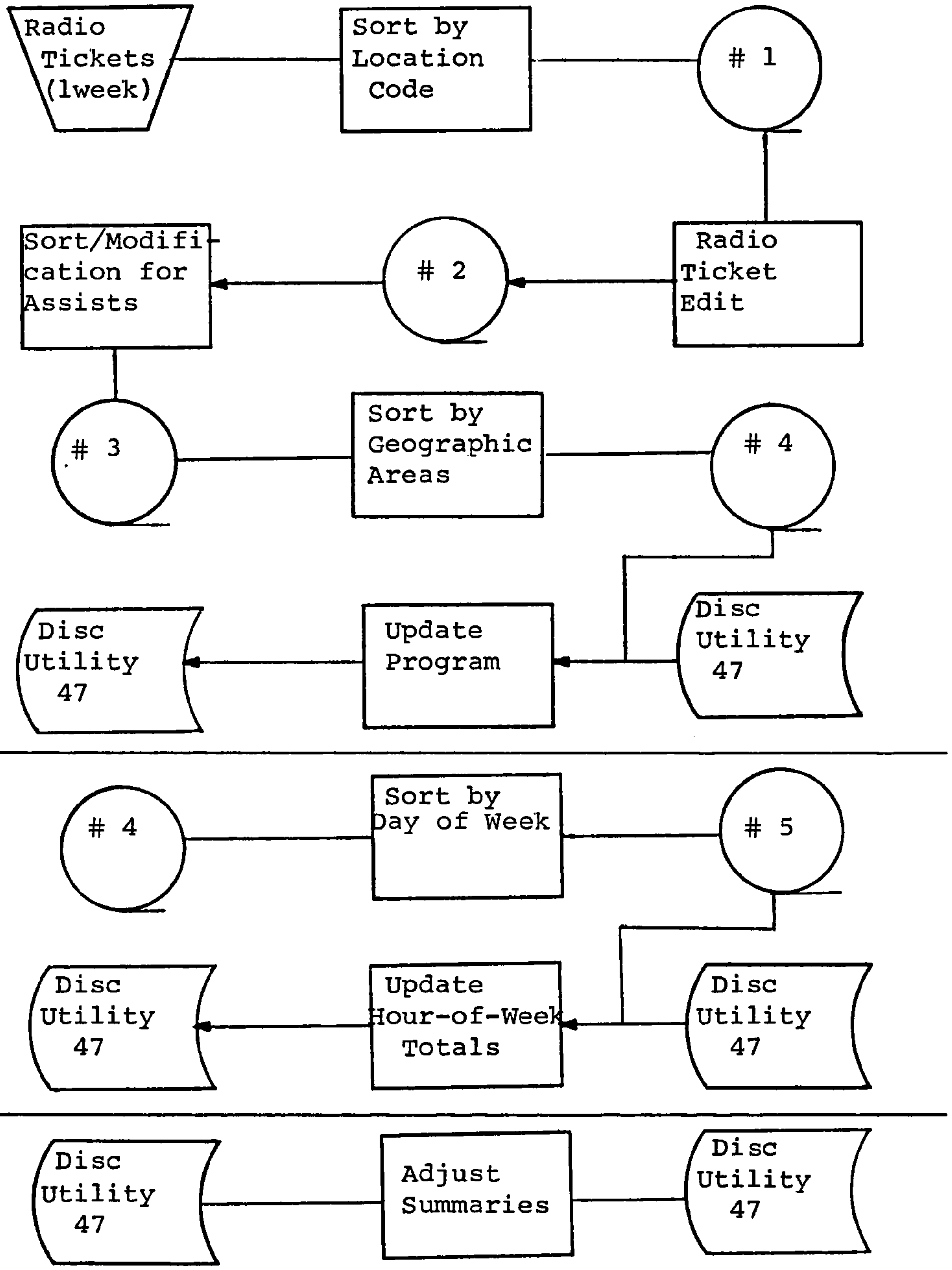

Figure 14 — Update System

PREDICTION SYSTEMS

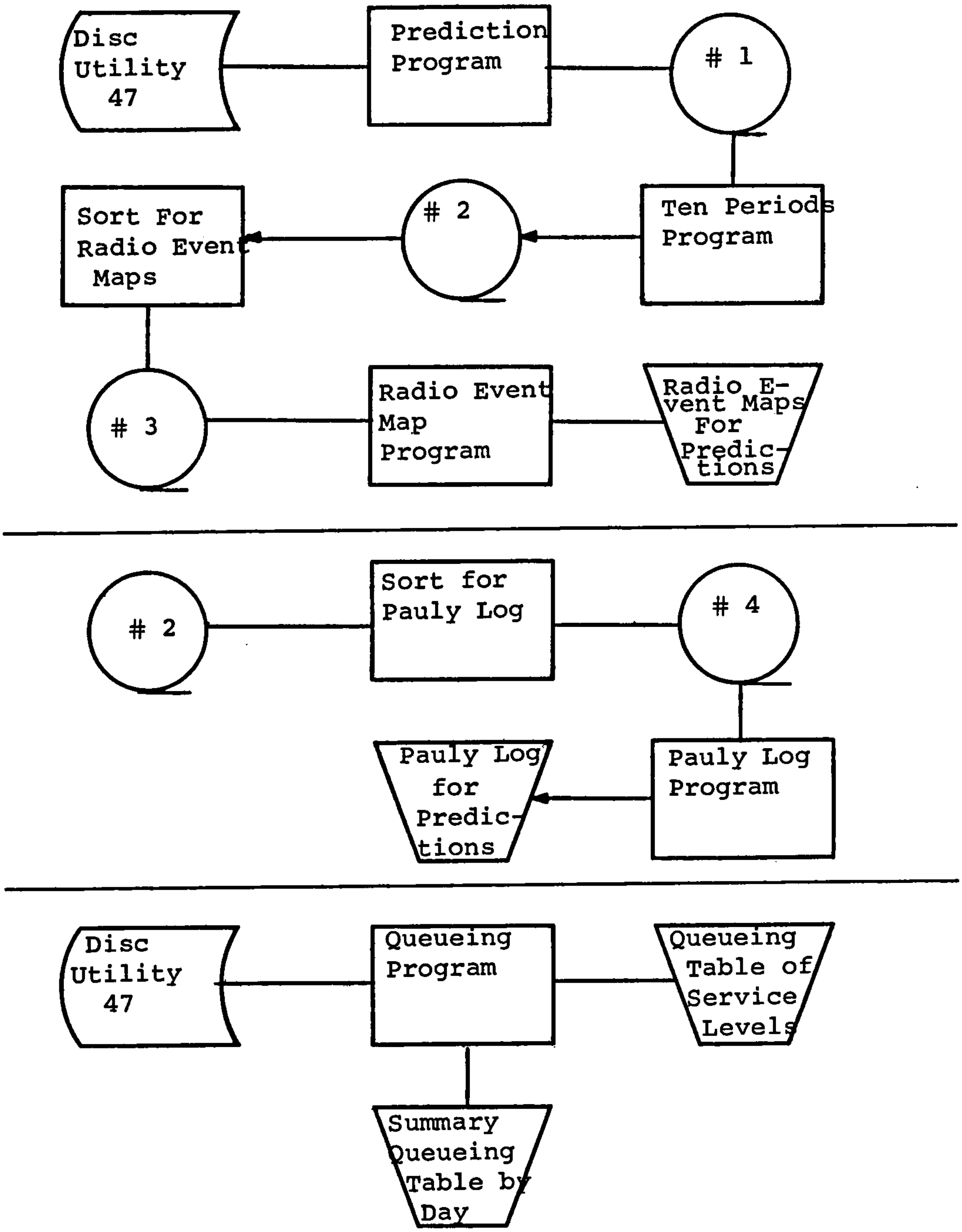

Figure 15 — Prediction Systems

St. Louis Police Department
Information System Flowchart

ACTUAL SYSTEMS

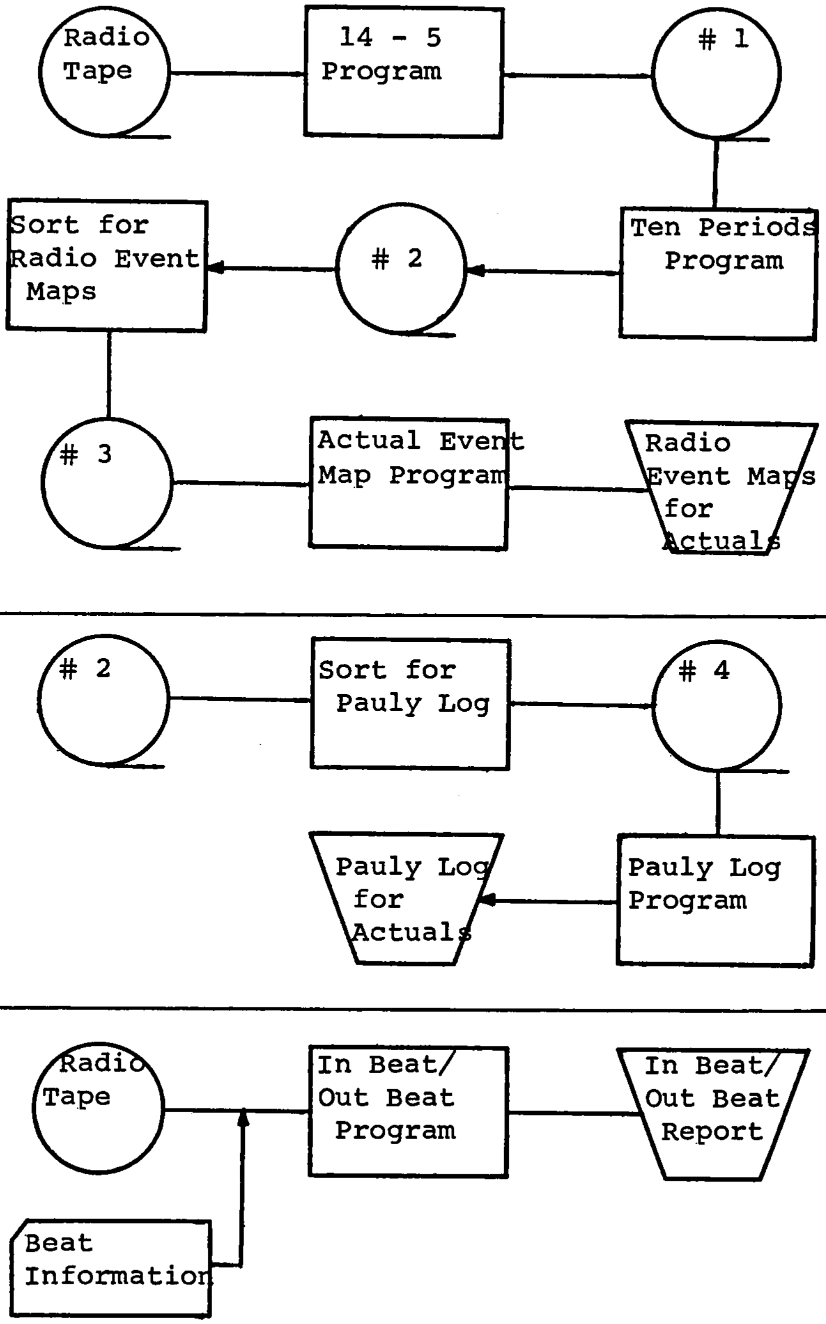

Figure 16 — Actual Systems

ACTUAL SYSTEMS (continued)

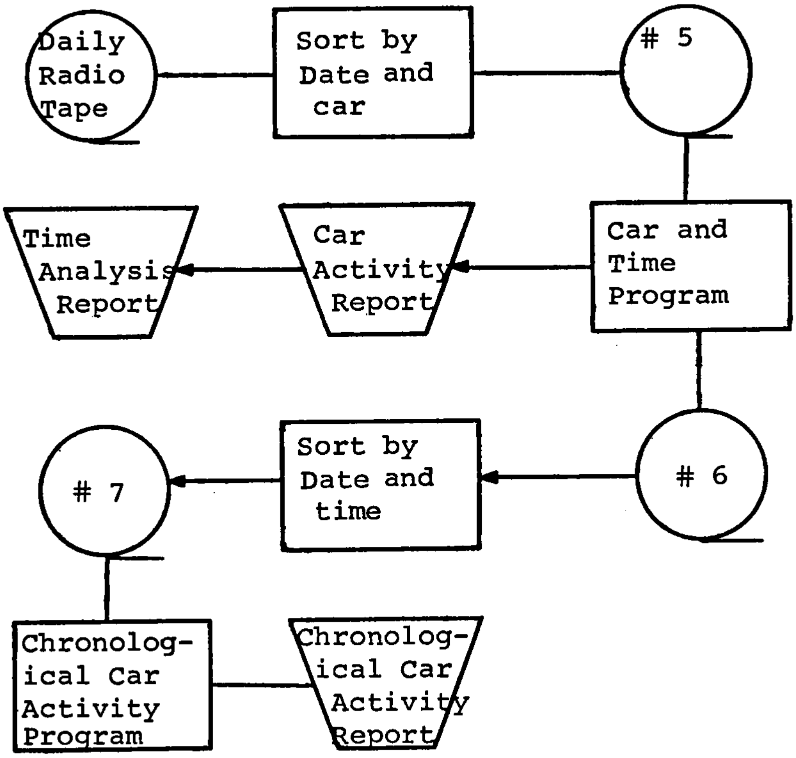

Figure 16 — Actual Systems (continued)

CRIME SYSTEMS

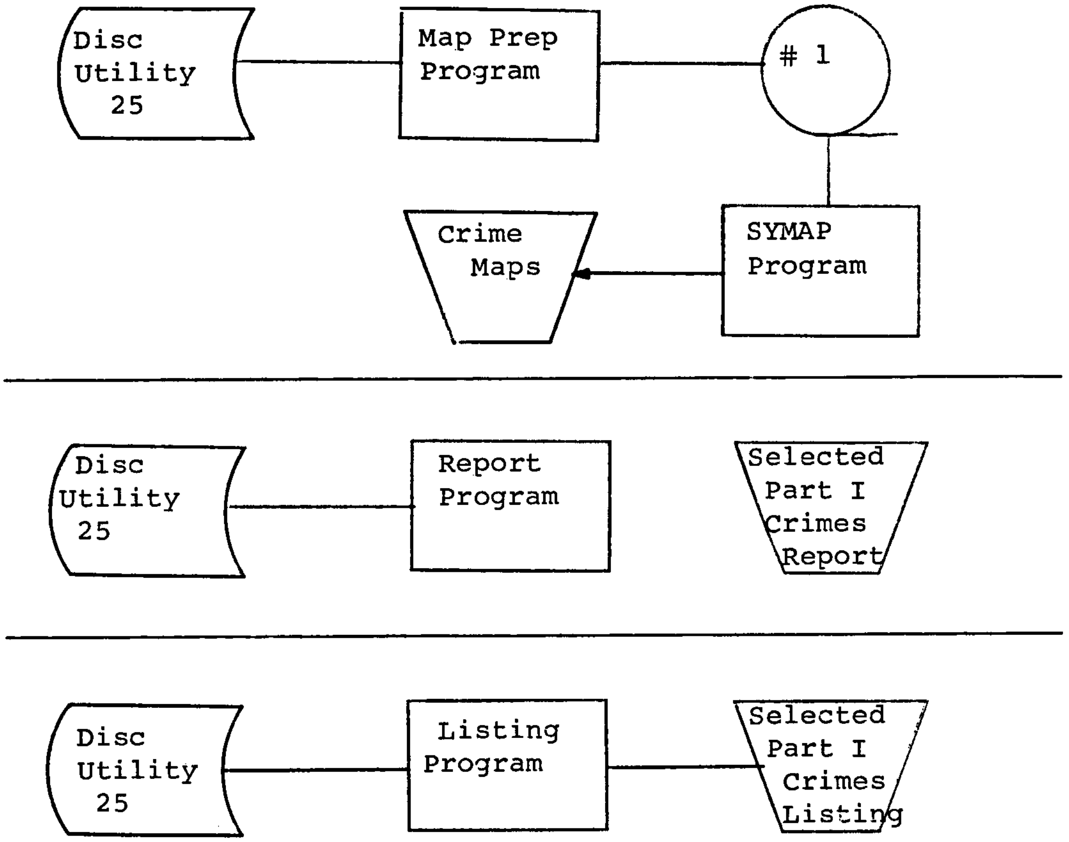

Figure 17 — Crime Systems

Appendix

MATHEMATICAL MODEL

General Discussion of Exponential Smoothing

The fundamental definition of an exponentially-smoothed series is

$$S_t(x) = \alpha x_t + (1-\alpha) S_{t-1}(x) \quad ,$$

where

$S_t(x)$ = the smoothed average obtained after processing data from the t^{th} period;

α = the smoothing coefficient $(0 < \alpha < 1)$;

and

x_t = the actual number of events in period t.

The new smoothed average depends, in part, on the smoothed average from the previous period, S_{t-1}. Then, since

$$S_{t-1}(x) = \alpha x_{t-1} + (1-\alpha) S_{t-2}(x) \quad ,$$

we may write

$$S_t(x) = \alpha x_t + (1-\alpha)[\alpha x_{t-1} + (1-\alpha) S_{t-2}(x)] \quad .$$

Continuing this process, $S_t(x)$ can be expressed as an average based on M periods of data by:

$$S_t(x) = \alpha \sum_{k=0}^{M-1} (1-\alpha)^k x_{t-k} + (1-\alpha)^M x_0 \quad ,$$

where x_0 is the initial value of $S_t(x)$. It can be shown that this is an unbiased estimator of a stationary series since

$$E[S_t(x)] = \alpha \sum_{k=0}^{\infty} (1-\alpha)^k E(x_{t-k}) = E(x) \alpha \sum_{k=0}^{\infty} (1-\alpha)^k$$

$$E[S_t(x)] = E(x) \quad .$$

The series can be developed to take into consideration either multiplicative or additive seasonal effect. It has been suggested [4] that a multiplicative effect be employed if the amplitude of the seasonal effect is proportional to the level of the series. If L denotes the periodicity of the seasonal effect, the smoothed series becomes

$$S_t = \alpha \frac{x_t}{W_{t-L}} + (1-\alpha) S_{t-1} \quad ,$$

and

$$W_t = \beta \frac{x_t}{S_t} + (1-\beta) W_{t-L} \quad .$$

where W_t is the seasonal effect and is itself a smoothed series using its own smoothing coefficient, β. A forecast of the first period after t would then be

$$S_{t,1} = S_t W_{t-L+1} \quad .$$

More generally, to forecast for the T^{th} period based on the series as of the period t would be

$$S_{t,T} = S_t W_{t-L+T} \quad .$$

The choice of the smoothing coefficient is dependent upon the nature of the series itself. If it is desired to give a great amount of weight to the most recent data, then the coefficient is chosen close to one. On the other hand, a coefficient chosen close to zero gives more weight to older data and in effect averages more terms. Observation of prediction errors gives an indication of whether the coefficient should be adjusted. A more systematic examination can be made by using various coefficients on the series and choosing the one which produces the minimum mean square forecast error [4 and 5].

Application to Resource Allocation Project

The application of exponential smoothing is relatively straightforward in this case. As described in Volume I, the radio calls have been divided into 10 categories. In the model each of these categories may be considered a separate series; in practice, predictions are made for each category separately and merely summed to produce the prediction. This division gives some flexibility to the system since any combination of the categories may be considered.

A smoothed series is maintained for each category for both the number of calls for service and the required service time. In this discussion only the call-for-service series for one category will be considered (expansion to a group of categories is obvious). Then the smoothed series for the number of calls for service is an application of the above discussion, i.e.,

$$S_t = \alpha \frac{x_t}{W_{t-L}} + (1-\alpha) S_{t-1} \quad ,$$

where

x_t = the actual number of calls for service during week t $(1 \leq t \leq 53)$;

W_{t-L} = the weekly (seasonal) factor for week t where L = 53;

S_t = the smoothed average number of calls for service after processing the calls for service from period t; and

α = the smoothing coefficient $(0 < \alpha < 1)$.

A forecast of the number of calls for service for the entire week T after updating to the end of t weeks of data is found by

$$S_{t,T} = S_t W_{t-L+T} \quad .$$

At this point an addition to the normal model was necessary. It was desired to produce predictions for each hour of the week, rather than for the entire week itself. To produce hour-of-the-week predictions, hourly factors were developed based on exponential smoothing. In this case, data are gathered for each hour of the week. The resultant data are then maintained as an exponentially smoothed series based on **normalized** values:

$$H_K = \gamma \frac{Y_K}{\bar{Y}} + (1-\gamma) H_{K-M} \quad ,$$

where

H_K = the normalized value for hour of the week k, $(1 \leq k \leq 168)$;

Y_K = the actual number of calls for the k hour of the week, $(1 \leq k \leq 168)$;

$\bar{Y}$ = the average number of calls per hour;

M = 168; and

γ = the smoothing coefficient $(0 < \gamma < 1)$

Then the prediction for the r^th hour of the T^th week after processing data through week t is given by $P_r = \frac{S_{t,T}}{168} H_r$

Note that the prediction for the entire week has not been changed, since

$$\sum_{r=1}^{168} P_r = \frac{S_{t,T}}{168} \sum_{r=1}^{168} H_r = S_{t,T} \quad .$$

It should also be noted that the original model deseasonalized by hour of the week. That is, the contribution of one event from x_t occurring during the k^th hour of the week was $\frac{1}{W_{t-L} H_{K-M}}$, where W_{t-L} is the weekly factor and H_{k-M} is the hourly factor. The model then became

$$S_t = \alpha \frac{x_t}{W_{t-L} H_{K-M}} + (1-\alpha) S_{t-1} \quad .$$

However, one or two of the 10 categories of calls for service generally contained very few actual occurrences during one week (for example, the category containing bogus check calls). The resultant effect was that some of the hourly factors for these categories became on the order of 10^{-4}. This situation had a particularly destabilizing effect on the smoothed series; hence the deseasonalizing by hour of week was eliminated.

The advantages of exponential smoothing [1] in this application are obvious. First, the amount of information required is relatively small. Two tables are maintained: the weekly adjustment factors (10x53) and the hourly adjustment factors (10x168). A disc file is maintained for various geographic areas of the city. One number (the smoothed series) for the calls for service and one number for the associated workload are kept for each category for each geographic area. Second, the computations are simple. The production of a forecast as described above is accomplished by a few computer instructions and contains no difficult operations. Third, the weight which is given to past data can be easily adjusted by changing the value of the smoothing coefficient. This property is particularly useful for avoiding bias in the smoothed series caused by the extra activity of certain holidays.

Application of Queueing Theory

The previous sections described the approach which was developed to determine the expected number of calls for service and associated workload. The information which results from this system must now be put to use. One approach which was developed during the Project views the problem as a delay or queue phenomenon.

Queueing processes are classified according to:

1) Input distribution — the distribution of the pattern of entries into the system (more specifically, the distribution of time between entries);

2) Service distribution — the distribution of time required to service the entry; and

3) Queue discipline — the number of servers and the organization of waiting line and service.

The simplest and most extensively developed queueing processes are those in which the input process is Poisson and the service distribution is exponential. This system is generally referred to as M/M/C[1].

In studying this delay phenomenon, the determination of the probability law, P(n), describing the number of entries in the system is essential. Many results can be obtained from this law.

Consider the queue phenomenon described by M/M/1. In this case, the probability of having n entries in the system is expressed as

$$P(n) = \left(1-\frac{\lambda}{\mu}\right)\left(\frac{\lambda}{\mu}\right)^n \qquad 0<\frac{\lambda}{\mu}<1$$

where $n = 0, 1, 2, \ldots$

λ = average rate of arrival of entries into the system; and

μ = average rate of service.

The quantity

$$\rho = \frac{\lambda}{\mu}$$

is called the utilization factor. Then we may write

$$P(n) = (1-\rho)\rho^n \, .$$

In many cases, the significant question concerns the determination of the number of servers needed to maintain various levels of service. For example, it may be known that 15 servers (patrol units in this case) are required to have a very low probability of delay in services. However, it may be that 12 servers can maintain an approximately 80% level of service; that is, service to approximately 20% of the entries into the system will be delayed.

In this case the system under study is M/M/C. As a preliminary result, the probability that there are no calls in the system can be expressed as

$$P(n=0) = P(0) = \frac{1}{\frac{\rho^c}{c!\left(1-\frac{\rho}{c}\right)} + 1 + \rho + \frac{\rho^2}{2!} + \frac{\rho^3}{3!} + \cdots + \frac{\rho^{c-1}}{(c-1)!}} \, .$$

Note that the utilization factor remains the same as in M/M/1. There is also an additional restriction that $\rho < c$; otherwise the waiting line theoretically becomes infinite.

Using this result, the probability that there are k units in the system becomes

$$\rho(k) = \frac{\rho^k}{k!} P(0) \qquad \text{if } 1 \leq k \leq c$$

$$P(k) = \frac{\rho^k}{c!\,c^{k-c}} P(0) \qquad \text{if } k \geq c \, .$$

The probability of a delay is the probability that k is greater than or equal to c; that is, $P(k \geq c)$. This result is called Erlang's Formula and is expressed as

$$P(k \geq c) = \frac{\rho}{c!\left(1-\frac{\rho}{c}\right)} P(0) \, .$$

The calculations for the two queueing reports (Queueing Tables of Service Levels and Summary Queueing Table by Day of Week) are direct applications of Erlang's Formula. Suppose that n calls have been predicted for some future hour and that these calls require w hours of work. Then the average service rate is $\frac{n}{w}$. The utilization factor is then calculated as

$$\rho = \frac{n}{\frac{n}{W}} = W \, .$$

Thus, in this application, the utilization factor is a function of the predicted hours of work.

Knowing this utilization factor, the probability of a delay, given that c units are available, is easily calculated by Erlang's Formula. After this probability is found, the expected number of delayed calls is obtained by multiplying the probability by the predicted number of calls.

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[1] A standardized notation has been developed for identifying many queueing processes. In the symbol A/B/C, A and B indicate the arrival and service distributions, respectively, and C is the number of servers.