APPENDIX B--DETERMINATION OF THE NUMBER OF COMPLAINT OPERATOR AND DISPATCH TERMINALS REQUIRED FOR A CAD SYSTEM

In a study [1] conducted in 1975 by the Jet Propulsion Laboratory (JPL) for the Law Enforcement Assistance Administration, a model was developed for determining the number of complaint board operator and dispatcher terminals required for a CAD system. The model was developed from information obtained by direct observation of the CAD system operations of two police departments--Huntington Beach and San Diego. At Huntington Beach, the researchers obtained voice tapes of the dispatchers along with the corresponding case logs. The taped voice messages were timed with stop watches and elapsed time clocks and compared with the case logs to establish correlations between cases, cars on patrol, message rates, and operator utilization. In San Diego, the voice channel was recorded and videotapes were made of the dispatcher's incident display. These were analyzed for relationships between the keyboard and screen operations and the voice messages. The discussion below is a summary of the calculations which were developed from the observations of the JPL study.

Primary Complaint Board Operator Position

The key criteria for determining the number of primary complaint board operator positions are the number of calls which must be processed before a caller waiting in the queue is connected to a primary operator (delay unit) and the number of calls per hour during the peak hour(s). The delay unit is obtained from:

$$\text{delay unit} = \frac{\text{mean waiting time in seconds}}{\text{mean operator service time in seconds}}$$

The mean waiting time is the average time it takes for a caller to be connected with an operator and is an optimum value based both on the observations discussed earlier and the kind of service which the department would like to provide the public. Mean operator service time is the average time it takes to process a call and pass it along to the dispatcher, and is based on the observations.

The operator workload units, based on the peak call rate per hour, are then calculated:

$$\text{operator workload units} = \frac{\text{peak call rate [calls per hour during the peak hour(s)] x mean service time, s}}{3600}$$

The intersection of these two parameters on figure B1 will indicate how many primary operators will be required. For example, consider the following information and performance requirements:

1) Average waiting time in the queue shall not exceed 2.5 s;
2) average service time per call is 100 s; and
3) peak call rate is 200 calls per hour.

The number of delay units is:

$$2.5 \text{ s}/100 \text{ s} = 0.025 \text{ unit.}$$

The operator workload units are:

$$(200 \times 100)/3600 = 5.56 \text{ workload units.}$$

It can be seen from figure B1 that where these two values intersect indicates that 10 operators would be required to handle the complaint board under the conditions described above.

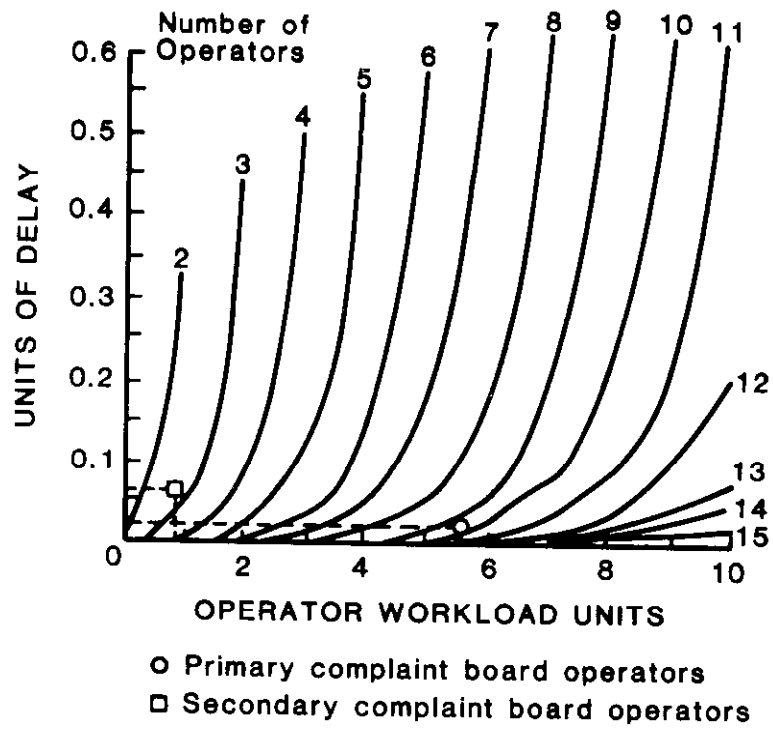

Figure B1. Complaint board operator position design (from Sohn, et al.).

Secondary Complaint Board Operator Position

The duty of a secondary complaint board operator is to handle longer incoming calls and calls which do not require dispatching. Although not all departments use them, it has been found to be an efficient way to improve service to the public and reduce the work load of the primary operators. The number of secondary operators needed is calculated in the same way as described in the Primary Complaint Board Operator Position section, except the data used would be different due to the different nature of the job. As an example, the following information applies:

1) Maximum average waiting in the queue is 20 s;
2) average service time per call is 300 s; and
3) number of "long" calls during the peak call rate time is 10.

The number of delay units is:

$$20 \text{ s}/300 \text{ s} = 0.066 \text{ unit.}$$

The operator workload units are:

$$(10 \times 300)/3600 = 0.83 \text{ workload units.}$$

In figure B1, the intersection for these two values is between two and three operators. This would indicate that three secondary operators are needed if the average call waiting time is not to exceed 20 s.

Dispatcher Positions

The dispatcher is the heart of the command and control center operations as it is his responsibility to coordinate the patrol force to meet the many and varying demands for police service. Dispatcher duties fall into five main areas:

1) messages involving initial assignment of cases,
2) messages supporting cases in progress,
3) messages supporting units on patrol,
4) messages involving case dispositions, and
5) messages relaying queries to remote data banks (e.g., Department of Motor Vehicles, National Crime Information Center) and the answers to these queries.

In observations made of the dispatch activities of the San Diego Police Department, the following distribution of activities was found:

Type of activity	Percent of total
Initial assignment	26
In-progress case support	44
Patrol support	15
Case dispositions	15

In addition, queries to data bases were added in proportion to the number of patrol units deployed at a rate of one query per 2 h per on-duty patrol unit. From the observations, two things are especially worthy of mention. First, when dispatchers have to handle remote data base queries in addition to their other duties, it significantly reduces the number of cases each dispatcher can handle. Secondly, it was observed that when the dispatcher is busy 60 percent or more during the peak call time, the stress becomes severe and he/she begins (1) to defer action on calls perceived to be of low priority, (2) to shorten messages, (3) waiting times become excessive, and (4) patrol units cannot communicate with the dispatcher satisfactorily. The stress results because the dispatcher is faced with simultaneous and conflicting demands that cannot all be met at once and with which he/she must make critical decisions. The observers felt that when the dispatchers were busy 65 percent or more of the time, the peak limit of the system has been exceeded. They drew the conclusion that sufficient terminals and operators should be provided to keep the busy time to approximately 30-50 percent during peak periods.

Based on the observations, a computer simulation of a dispatcher work station under three different conditions was conducted. These conditions were:

1) separate complaint board operator and dispatcher; dispatcher does not handle queries to remote data bases (System A);
2) separate complaint board operator and dispatcher; dispatcher handles queries to remote data bases (System B); and
3) dispatcher takes calls from public, but does not handle queries to remote data bases (System C).

To determine the number of dispatchers needed under each system is a relatively simple matter. The system should be sized to handle the heaviest load--that is, the number of cases in progress during one or more of the busiest hours should be counted. Then the maximum allowable case load per dispatcher is determined. From these, the total number of dispatcher stations is determined as follows:

$$\text{Number of dispatchers needed} = \frac{\text{Total case load during peak hour(s)}}{\text{Case load per dispatcher}}$$

Based on the observations made at the San Diego Department, it was determined by computer simulation (in which the dispatcher's channel utilization rate during the peak hour(s) was 30 percent,* and the type of case handled was varied according to the percentages given above) the critical case loads for each system were:

System	Cases per hour
A	21
B	11
C	8

With this information, it is then an easy matter to determine the number of dispatchers needed. For example, under System A, assume the peak case load is 80 cases per hour. The number of dispatchers needed would be:

$$\text{Number of dispatchers needed (System A)} = \frac{80}{21} = 3.8,$$

which means four dispatcher stations will be required. Similar calculations can be done for System B and C.

Based on the results of the observations, the following general conclusions were confirmed:

1) Separating the complaint board operator position from the dispatcher position increased the capacity of the dispatcher position; and,
2) removing remote data base queries from the dispatcher position increases dispatcher capacity.

For a more detailed discussion of the calculations and simulations referred to and summarized above, the reader is referred to reference 1 of the basic report.

*If the channel utilization rate was above 30 percent, it was found that the waiting time to use a channel became too high.