J Forensic Sci, Jan. 1972, Vol. 17, No. 1

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Systems Analysts Look at the Crime Laboratory

Systems analysis has emerged as a scientific discipline only in recent times; nonetheless, the study of systems is by no means a new pursuit of the human mind. The development of a set of standards and procedures or a concept of society or even a theory of the universe is as old as history itself. Man has always sought to find relationships that could provide satisfactory explanations for what he sees, hears, or imagines. Indeed, the history of both the physical and social sciences has been a continuing enlargement upon this theme. The scientific method of inquiry, which demands relevant and dependable relationships for its results, is systems analysis in its broadest sense.

The application of systems analysis to the role of the crime laboratory in the entire law enforcement and criminal justice scheme requires a different approach than has heretofore been taken. The scientific crime laboratory has been a part of the criminal justice system for the greater part of this century, and the degree of the exchange of technical information between the practitioners of forensic science is significant. Despite this maturity in the practice of forensic science, a year-long study of crime laboratory operations which we undertook, coupled with an extensive literature search and conferences with outstanding men in the field, revealed a paucity of management information concerning what crime laboratories do or, more properly, what crime laboratories should do [*1*].

There are few or in some cases no data on which to base an evaluation of the performance of a crime laboratory. The answer to the questions What is the crime laboratory's contribution to law enforcement? and Has it had any affect on the crime index? must remain speculative and subjective for the present. The contribution crime laboratories have made toward protecting the innocent, apprehending the accused, and convicting the guilty in specific cases has been significant; these notable accomplishments alone justify their existence. Yet, the involvement of the crime laboratory with the total body of crime has been so minuscule as to preclude any judgment of the impact of criminalistics on the criminal justice system.

If nothing else, the study revealed and documented the fact that a network of crime laboratories does not exist. While many criminalists exchange technical information concerning laboratory procedures, either through professional societies or by personal contact, the relationship of each laboratory to the jurisdiction it serves is unique, that is, a common basis for the exchange of management-type information does not exist. Some crime laboratories operating in a favorable environment of strong support by law enforcement agencies and ready acceptance of expert testimony by the judiciary have elevated their laboratories to a place of prominence and importance within that particular segment

Presented at the Twenty-third Annual Meeting of the American Academy of Forensic Sciences, Phoenix, Ariz., 23 Feb. 1971. Received for publication 6 April 1971; accepted for publication 3 Aug. 1971.

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of the law enforcement system. Others have changed little since their inception decades ago, perhaps owing to a lack of recognition of their capability or a lack of support on the part of the jurisdiction served or perhaps because the criminalist employed there has concentrated on perfecting laboratory techniques rather than promoting the application of his available skills.

If a single finding could be said to have pervaded the study, it is the anomaly that for each hypothesis or concept proposed one could find both support and contradiction from the meager data available. It is this lack of data, collected and compiled on a uniform basis, which has established substantial barriers to a systematic analysis of crime laboratory operations. Wide variations in examiner caseload, distribution of type cases reaching the laboratory, laboratory services offered, cases per sworn officer served, and expert witness testimony lead one to the conclusion that despite complaints of overwork and lack of equipment a vast potential exists in the crime laboratories currently in existence to provide significantly increased aid to law enforcement.

The study was funded by the U.S. Department of Justice, Law Enforcement Assistance Administration, National Institute of Law Enforcement and Criminal Justice, under Grant NI-044.[3] Emphasis was placed on quantifying the knowledge of present experts in criminalistics to allow a structured approach that would both enhance and multiply this expertise to the benefit of all areas of the country. The paper describes the results and significant findings of an analysis of crime laboratory operations by a multidisciplinary team consisting of systems analysts, mathematicians, and research scientists, tempered by the advice and counsel of practicing criminalists. It is not our intent to comment on the scientific techniques used in the various crime laboratories or developed by individual criminalists but, instead, to view the crime laboratory in the context of functional organizations which operate in and serve our society.

The Business of the Crime Laboratory

In one sense, the crime laboratory can be considered and compared with a business operation which has three basic operating elements: production, distribution, and marketing. The crime laboratory's production capacity is more analogous to that of a business which provides services rather than one manufacturing a specific product. If the business is to prosper, it must advertise or market the availability of its services, it must have a location that is convenient to its users (or provide a pickup and delivery service), and it must do quality work on a timely basis if it is to enjoy the confidence and repeat business of its customers.

Nonetheless, one would hardly expect a business intended to serve the entire needs of a state to flourish, even with the most elegant plant and modern scientific equipment, if it were remote from the population centers of that state. Yet many state crime laboratories are located in their states' capitols, far from the population centers of those states. The question of the location of a crime laboratory will be examined in some detail below.

Use of the Crime Laboratory by Law Enforcement Officers

Any analysis of the criminalistic system would be incomplete without due consideration of the use that law enforcement officers make of the crime laboratory. The crime laboratory is not autonomous—it is a tool organized to serve the law enforcement officer. The number of cases that actually reach the laboratory should be in direct proportion to the

[3] The fact that the National Institute of Law Enforcement and Criminal Justice furnished financial support for the activity described in this publication does not necessarily indicate the concurrence of the Institute in the statements or conclusions contained herein.

number of patrolmen and special investigators available for crime scene search and related investigations. Thus, an essential element of any criminalistic system must be the collectors of physical evidence who make requests to the crime laboratory and use its services. The crime lab should be considered a part of the technical support that is available to all sworn police officers.

Since the organization of individual law enforcement departments varies considerably among cities, counties, and states, accurate comparisons of the number of officers actually in contact with the solution of crime would be difficult if not impossible. Still, all sworn officers are empowered to arrest and have the potential to submit evidence to the crime laboratory; thus, gross comparisons of crime laboratory use may be made by measuring the number of cases submitted to the laboratory expressed as annual cases per officer (CPO concept) in the area served. The number of sworn officers in a jurisdiction or community also provides an implied measure of the total amount of crime in the community, since it represents in a very practical sense what the community views as its needs for law enforcement. At the least, it represents how much of the available budget the community is willing to spend for police services. While there are differences in organizations of police departments (sworn officers/civilian ratios, use of evidence technicians, etc.), we considered that the number of sworn officers available has more significance as a gross planning factor than possible differences in organizational structure.

It should be noted at this point, however, that the reason for using the CPO concept is to provide a basis for crime laboratory planning. It should not be construed as being a measure of the effectiveness of a crime laboratory or, for that matter, of the whole criminalistics operation, which would include not only the crime laboratory but also the law enforcement departments served and the prosecutors and courts making use of its expert testimony. The concept of a relationship between laboratory caseload and the number of sworn officers in the jurisdiction which the laboratory serves evolved after extensive review of the literature, analysis of crime laboratory records, and interaction with the criminalist working group.

Table 1 gives the number of laboratory cases per officer for several American cities determined from caseload data reported in the John Jay Study for laboratories in these cities [*2*]. Figure 1 shows a distribution of type cases involving referrals to the laboratory

TABLE 1—*Laboratory cases per officer, selected cities.*[a]

City	Sworn Police Officers	Cases to Laboratory	CPO
1. New Orleans[b]	1 460	3 516	2.4
2. Oakland	651	3 976	6.1
3. Dayton	427	2 314	5.4
4. San Francisco	1 745	6 372	3.6
5. Fort Worth	580	1 877	3.2
6. Chicago	12 000	34 400	2.86
7. Houston	1 577	4 414	2.8
8. Columbus	807	2 067	2.56
9. Cleveland	2 161	5 006	2.3
10. Kansas City	970	1 458	1.5
11. Buffalo[b]	1 400	1 600	1.1
12. St. Louis[b]	2 170	4 500	2.1
13. Newark	1 379	1 300	0.95
14. Philadelphia	7 319	5 223	0.71
15. New York	29 900	20 978	0.7

[a] Source: Ref *25*, except as updated in this study.
[b] Updated.

for selected cities. These cities were selected because of the availability of caseload data and the variations in size and caseload distribution represented. The proportion of drug cases referred to the laboratory varies from 16 to 92 percent, with the average being 54 percent. Drugs have been singled out of the total caseload primarily because of the faster turnaround time normally associated with this type of case. Even though the chemical complexity of certain of the synthetic drugs has increased in recent years, with the result

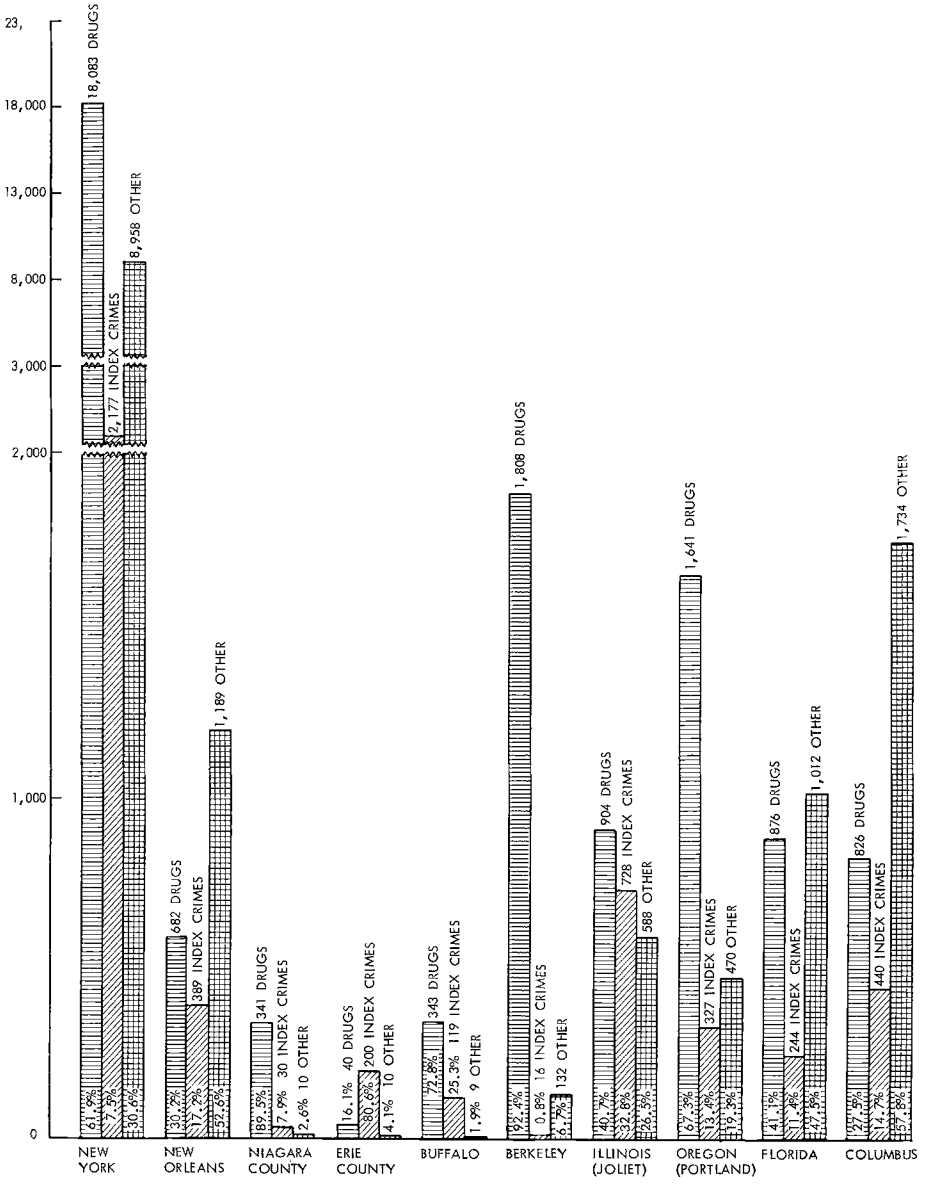

FIG. 1—*Distribution of case types to crime laboratories.*

that more extensive laboratory procedures are now employed to analyze and identify drug samples, by and large the crime laboratory can still process drugs faster than many other kinds of clue materials.

The average number of cases that an examiner can handle varies with the type of analysis that he is performing. The 1967 survey of crime laboratories [*2*] indicated typical examiner caseloads for a number of city laboratories ranging from 150 to 1000 per year. Based on this information and from a survey of caseload data from laboratories around the country, it was concluded that caseload per examiner values should be assigned to reflect the particular distribution of expected cases in a given jurisdiction. Applying this philosophy, numerical values of 125 (one-half case per day), 250 (one case per day), and 500 (two cases per day) were chosen to represent low, medium (normal), and high percentages, respectively, of drugs in the caseload distributions. Consider an area with a total of 3000 cases a year. If this includes the normal percentage of drug cases in the jurisdiction, the planner would select 250 cases per examiner as the expected annual workload of any one examiner in his laboratory and should plan on staffing approximately twelve examiners. Note that, if he anticipated a high percentage of drug cases, he would select the assignment of 500 cases per examiner and plan on staffing only six examiners in his laboratory. More definitive staffing and equipment priorities were given in Ref *1*.

The CPO concept provides a simple, consistent means for determining the approximate demand for criminalistics. It recognizes that the crime laboratory is not an entity unto itself, but that it exists solely to serve the needs of law enforcement and criminal justice and that it must be considered as an integral part of the entire system. Moreover, for planning purposes, data on the police population to be served are more readily available than details on crime itself.

Crime Laboratory Location

The crime laboratories that exist today are where they are for a variety of reasons. The attitudes of law enforcement officials in the area, budgetary considerations, and the availability of qualified criminalists and examiners, all have had bearing on the decision to establish a crime laboratory. The policies and service attitudes of state crime laboratories, where they exist, also influence the decision on local laboratories. With the possible exception of one or two state crime laboratory systems, crime laboratories have not been established as parts of an overall system designed to provide services in accordance with the demand for laboratory support; that is, laboratories have not been established based on a quantitative analysis of need.

Theoretically, it would be possible to serve the needs of the nation from one single crime laboratory, centrally located, and at the same time achieve significant economies in professional manpower, equipment, and processing efficiency. At the other end of the spectrum, using the 50-mile-radius criterion, more than 400 crime laboratories would be required to serve all local areas within the United States. The total cost of these laboratories would be high, but so would the service level achieved. It is easy to visualize the reluctance of an investigator to wrap up a car bumper and mail it to the central laboratory for analysis when the convenience of taking that same item to the local laboratory in a patrol car is available.

Considering the crime laboratory as a technical support for the sworn police officer, the influence or availability of that support appears to vary as a function of the distance of the laboratory from the jurisdiction or police officer served. The relationship is not clearly defined, nor are data available from which to develop a model to analyze quantitatively all

of the factors involved in this phenomenon. There is sufficient evidence, however, to support the hypothesis of convenience, which suggests that law enforcement officers are more apt to request technical support from a nearby local crime laboratory where they have frequent contact with the personnel than to prepare physical clue material for transmission to a distant laboratory which may or may not have a charter to serve their particular jurisdiction.

The factors influencing this diminution or decay of the influence of the laboratory as a function of remoteness or distance are probably complex. The laws of the state, and the attitude of the courts and prosecutors toward the use of physical evidence or expert testimony in court, can have a significant effect on whether or not evidence is sent to the laboratory. Political boundaries can also serve as barriers to sending physical clue material to the laboratory. Jurisdictions outside the city proper are often served by the city laboratory on a second-priority basis, if at all, when the workload is high. While crime laboratories are generally cooperative in providing services to other agencies, their first loyalty is to the jurisdiction which provides their funds and support.

The law enforcement department exercises great influence on the amount of physical clue material that is sent to a laboratory, regardless of the proximity or jurisdiction of the laboratory. Command emphasis on the collection of physical evidence certainly plays a role, as do the level of training of investigators in the collection of physical evidence, the equipment available, the existence of crime scene search teams or evidence technicians, and the amount of time an investigator can spend on each case, among others.

The crime laboratory itself influences its own volume of work. If the laboratory is able to satisfy an investigator's requests for laboratory examinations, then that investigator and others will continue to make similar requests. Conversely, if requests for service are denied, response time is inordinately long, or consistently inconclusive results are provided, the tendency will be to reduce the number of requests for service that the investigators make to the laboratory.

The distance phenomenon does appear to have a characteristic decay curve when cases per officer submitted to the laboratory are plotted against distance from the laboratory. Available data from Florida are shown in Fig. 2. The multitudinous factors which affect decay notwithstanding, it appears that those law enforcement jurisdictions within a 50-mile radius of a laboratory will use the laboratory more frequently than will those beyond the approximate 50-mile radius. The frequency of use drops off sharply as this distance is exceeded.

The Regional Laboratory Approach

Using data for the average number of cases per officer for city laboratories and several state laboratories, one can construct a hypothetical decay curve from which to approximate a CPO value for a regional laboratory concept (see Fig. 3). From this decay curve, hypothetical or planning CPO values can then be determined which can be used for the analysis of several candidate structures for meeting the criminalistics demand. For the purpose of this analysis, a relatively conservative value for city laboratories of three cases per officer per year was selected. Since the counties which comprise a standard metropolitan statistical area (SMSA) are largely within a 50-mile radius of the principal city, the CPO value for the SMSA should be nearly the same as that for the city [*3*]. A CPO value of 1.0 is used as a planning value for state laboratories, whereas a regional laboratory could be expected to draw on the basis of 0.5 cases per officer per year for the regions served. A CPO value of 0.1 is used for the national laboratory.

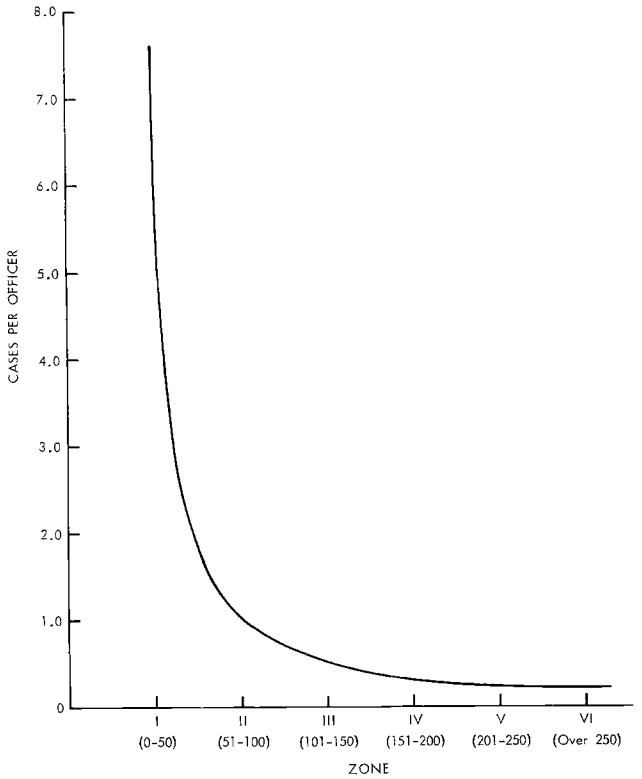

FIG. 2—*Evidence submission decay as a function of distance.*

In the regional crime laboratory concept, the nine law enforcement regions of the Uniform Crime Report [*4*] were used: New England States, Middle Atlantic States, East North Central States, West North Central States, South Atlantic States, East South Central States, West South Central States, Mountain States, and Pacific States. Seven candidate structures or systems of crime laboratories were examined in the analysis, as follows:

1. A single national crime laboratory (CPO 0.1).
2. Nine regional crime laboratories (CPO 0.5) plus one national laboratory (CPO 0.1).
3. Fifty state laboratories (CPO 1.0) plus one national laboratory (CPO 0.1).
4. Sixty city laboratories (CPO 3.0) plus nine regional laboratories (CPO 0.5) plus one national laboratory (CPO 0.1).
5. Sixty city laboratories (CPO 3.0) plus 50 state laboratories (CPO 1.0) plus one national laboratory (CPO 0.1).
6. One-hundred and four SMSA laboratories (CPO 3.0) plus nine regional laboratories (CPO 0.5) plus one national laboratory (CPO 0.1).
7. One hundred and four SMSA laboratories (CPO 3.0) plus 50 state laboratories (CPO 1.0) plus one national laboratory (CPO 0.1).

The difference in those concepts embodying city crime laboratories versus the SMSA crime laboratory is one of including the specific charter of the crime laboratory beyond the city limits of the jurisdiction in which it is established. It is difficult, if not impossible,

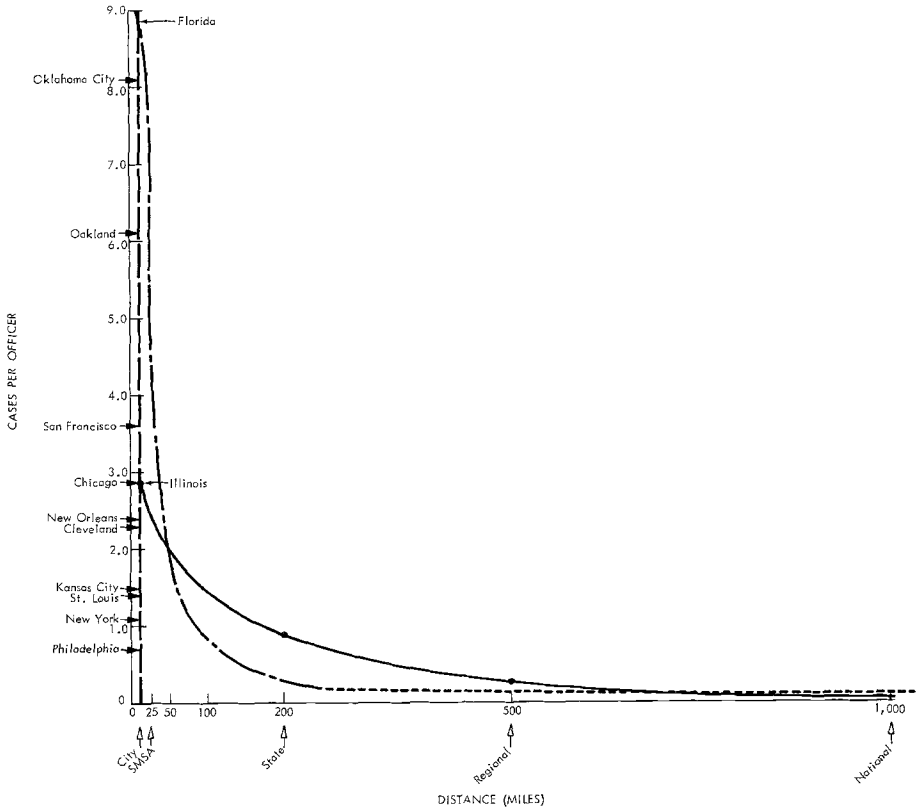

FIG. 3—*Evidence submission decay as a function of laboratory type.*

to separate the city from its surrounding suburbs and dependent counties. The criminal does not recognize these political boundaries and works at his trade freely crossing from one to another. Most communities have cooperative arrangements to meet this problem, but the provision of crime laboratory services is on a convenience rather than authorized basis. The SMSA crime laboratory visualized in this analysis is one which has a specific charter to serve the entire SMSA, is supported financially from all local agencies, and is perhaps supplemented by federal support for this purpose. The advantage of a single open bullet file for the entire SMSA is obvious. The SMSA laboratory would utilize personnel drawn from the many participating departments. Similarly, a regional laboratory would be established to provide services to all of the law enforcement agencies within the states of its region.

For SMSAs, a rank order analysis shows a priority for establishing or augmenting existing crime laboratories by the SMSA under the assumptions contained in the analysis (Table 2). A tabular summary sheet (Table 3) shows the comparison of the seven selected locational strategies. Each strategy is examined under three conditions:

1. In the first case, the cost per examiner is held constant for all size laboratories regardless of location.

2. In the second, the cost per examiner per year is varied with the size of the laboratory, assuming efficiencies resulting from larger laboratory operations.

3. A third analysis is shown using the variable cost per examiner. It includes, in addition, the assumption that city and SMSA laboratories receive a high proportion of routine examination requests such that the caseload per examiner could be considered to be 500 cases per year, whereas examiners in state laboratories average 250 cases per year and regional and federal laboratory examiners only receive 125 cases per year. The reduced figure for state, regional, and federal laboratories reflects the assumption that these laboratories receive the more serious or more complex cases and thus the time demands are greater for each case.

Throughout this analysis, it is assumed that the number of cases per officer sent to the laboratory is characteristic of the CPO decay curve and that law enforcement departments within the city or the SMSA submit 3.0 cases per officer per year, other departments outside of the city or SMSA would average 1 case per year to the appropriate state laboratory, 0.5 case per year to the appropriate regional laboratory, and 0.1 case per year to a national crime laboratory.

Another approach also used was a cost/effectiveness analysis. Each location strategy was measured against a consistent goal to the laboratory of 3 cases per officer for the entire nation's police force. Thus, if a given group of laboratories constituting a location strategy could produce an average of 1.5 cases per officer for the nation's police, it could be said that the performance index of that strategy would be 0.5. Similarly, if the total cost to establish a sufficient number of crime laboratories, each serving a 50-mile radius, to cover the entire United States is assumed, then this cost could be taken as an upper bound of the costs which would be required to provide the 3.0 CPO performance level. Therefore, the total cost for a given set of laboratories constituting a strategy could be measured as that fraction of the maximum cost. A location strategy which provided laboratories at one third of the assumed maximum cost would have a cost index of 0.33.

The effect of varying the number of laboratories within a given strategy, that is, examining the entire range of 10 to 82 city laboratories when considered in terms of performance index and cost index, can produce a curve which is characteristic of that strategy. The results of such an analysis are shown in Figure 4. Strategies X, Y, and Z (I, II, and III of Table 3) are considered static and are shown as single points. Others are varied throughout a feasible range to develop characteristic curves. In establishing cost indices, both annual operating costs and initial startup costs are considered for each laboratory.

Figure 4 demonstrates the application of the location model using certain assumed values. The results should be useful for gross planning purposes and with more refined data could eventually become a more precise planning tool. The purpose of this analysis was to develop the structure for an analysis model and to exercise the model on available data. Refinement of the model and more comprehensive analysis of structures must await the availability of more precise data from which to develop the decay coefficients and laboratory workload capabilities.

Laboratory Planning

From the outset, it was apparent that the planning of a crime laboratory could not be accomplished by a cookbook-type procedure. Characteristics of the area to be served; training and background of available staff; attitudes of law envorcement, prosecutors, and courts; existing capabilities; different priorities; and limitations in budget, all combine to make each laboratory unique.

In recognition of this uniqueness, a planning model designated Laboratory Analysis and Budgeting System (LABS) was developed that would accommodate all of the diverse factors needed to plan for a laboratory. The model uses a planning compiler previously

TABLE 2—*Demand for crime laboratory examiners in standard metropolitan statistical areas based on a yield of three cases per officer.*

SMSA	Estimated Number of Police	Estimated Laboratory Cases	Number of Examiners by Caseload			Cumulative Number of Police	Cumulative Laboratory Cases	Cumulative Examiners by Caseload			Cumulative Percent Index			
			Low	Medium	High			Low	Medium	High	Population	Crimes	Police	Rank
New York, N.Y.	34 119	102 357	819	409	205	34 119	102 357	819	409	205	5.8	12.3	11.1	1
Chicago, Ill.	15 666	46 998	376	188	94	49 785	149 355	1 195	597	299	9.2	16.1	16.2	2
Philadelphia, Pa.-N.J.	10 541	31 623	253	126	63	60 326	180 978	1 448	724	362	11.7	17.8	19.7	3
Los Angeles-Long Beach, Calif.	9 971	29 913	239	120	60	70 297	210 891	1 687	844	422	15.1	25.0	22.9	4
Detroit, Mich.	7 580	22 740	182	91	45	77 877	233 631	1 869	935	467	17.2	28.4	25.4	5
Boston-Lowell-Lawrence, Mass.	6 089	18 267	146	73	37	83 966	251 898	2 015	1 008	504	18.9	30.3	27.4	6
Washington, D.C.-Md.-Va.	4 958	14 874	119	59	30	88 924	266 772	2 134	1 067	534	20.2	32.4	29.0	7
San Francisco-Oakland, Calif.	4 278	12 834	103	51	26	93 202	279 606	2 237	1 118	559	21.7	35.6	30.4	8
Baltimore, Md.	4 183	12 549	100	50	25	97 385	292 155	2 337	1 169	584	22.8	37.6	31.7	9
St. Louis, Mo.-Ill.	3 739	11 217	90	45	22	101 124	303 372	2 427	1 213	607	24.0	39.1	32.9	10
Cleveland, Ohio	3 378	10 134	81	41	20	104 502	313 506	2 508	1 254	627	25.0	40.2	34.0	11
Newark, N.J.	2 939	8 817	71	35	18	107 441	322 323	2 579	1 289	645	25.9	41.7	35.0	12
Pittsburgh, Pa.	2 864	8 592	69	34	17	110 305	330 915	2 647	1 324	662	27.1	42.8	35.9	13
Milwaukee, Wis.	2 593	7 779	62	31	16	112 898	338 694	2 710	1 355	677	27.8	43.3	36.8	14
Buffalo, N.Y.	2 427	7 281	58	29	15	115 325	345 975	2 768	1 384	692	28.5	43.9	37.6	15
Houston, Tex.	2 141	6 423	51	26	13	117 466	352 398	2 819	1 410	705	29.4	45.2	38.3	16
Minneapolis-St. Paul, Minn.	2 079	6 237	50	25	12	119 545	358 635	2 869	1 435	717	30.3	46.3	38.9	17
Dallas, Tex.	2 076	6 228	50	25	12	121 621	364 863	2 919	1 459	730	31.0	47.1	39.6	18

Paterson-Clifton-Passaic, N.J.	1 858	5 574	45	22	11	123 479	370 437	2 963	1 482	741	31.7	47.6	40.2	19
Kansas City, Mo.-Kans.	1 829	5 487	44	22	11	125 308	375 924	3 007	1 504	752	32.3	48.5	40.8	20
New Orleans, La.	1 741	5 223	42	21	10	127 049	381 147	3 049	1 525	762	32.8	49.3	41.4	21
Miami, Fla.	1 698	5 094	41	20	10	128 747	386 241	3 090	1 545	772	33.4	50.4	41.9	22
Seattle-Everett, Wash.	1 675	5 025	40	20	10	130 422	391 266	3 130	1 565	783	34.1	51.3	42.5	23
Cincinnati, Ohio-Ky.-Ind.	1 586	4 758	38	19	10	132 008	396 024	3 168	1 584	792	34.8	51.8	43.0	24
Jersey City, N.J.	1 583	4 749	38	19	9	133 591	400 773	3 206	1 603	802	35.1	52.1	43.5	25
Atlanta, Ga.	1 536	4 608	37	18	9	135 127	405 381	3 243	1 622	811	35.8	52.9	44.0	26
Indianapolis, Ind.	1 532	4 596	37	18	9	136 659	409 977	3 280	1 640	820	36.3	53.5	44.5	27
Denver, Colo.	1 524	4 572	37	18	9	138 183	414 549	3 316	1 658	829	36.9	54.3	45.0	28
San Diego, Calif.	1 496	4 488	36	18	9	139 679	419 037	3 352	1 676	838	37.5	54.9	45.5	29
Prov.-Pawt.-Warwick, R.I.	1 441	4 323	35	17	9	141 120	423 360	3 387	1 693	847	37.9	55.4	46.0	30
Ana.-St. Ana-Gard. Gr., Calif.	1 271	3 813	31	15	8	142 391	427 173	3 417	1 709	854	38.5	56.2	46.4	31
Memphis, Tenn.-Ark.	1 237	3 711	30	15	7	143 628	430 884	3 447	1 724	862	38.9	56.7	46.8	32
Tampa-St. Petersburg, Fla.	1 237	3 711	30	15	7	144 865	434 595	3 477	1 738	869	39.4	57.4	47.2	33
Portland, Ore.-Wash.	1 218	3 654	29	15	7	146 083	438 249	3 506	1 753	876	39.8	58.0	47.6	34
Columbus, Ohio	1 170	3 510	28	14	7	147 253	441 759	3 534	1 767	884	40.3	58.6	48.0	35
Toledo, Ohio-Mich.	1 115	3 345	27	13	7	148 368	445 104	3 561	1 780	890	40.6	58.8	48.3	36
San Bern.-Riv.-Ont., Calif.	1 097	3 291	26	13	7	149 465	448 395	3 587	1 794	897	41.2	59.6	48.7	37
Phoenix, Ariz.	1 079	3 237	26	13	6	150 544	451 632	3 613	1 807	903	41.6	60.3	49.0	38
San Jose, Calif.	1 065	3 195	26	13	6	151 609	454 827	3 639	1 819	910	42.1	60.8	49.4	39
Honolulu, Hawaii	1 054	3 162	25	13	6	152 663	457 989	3 664	1 832	916	42.4	61.3	49.7	40
Huntsville, Ala.	1 051	3 153	25	13	6	153 714	461 142	3 689	1 845	922	42.6	61.4	50.1	41
Louisville, Ky.-Ind.	1 032	3 096	25	12	6	154 746	464 238	3 714	1 857	928	43.0	62.0	50.4	42

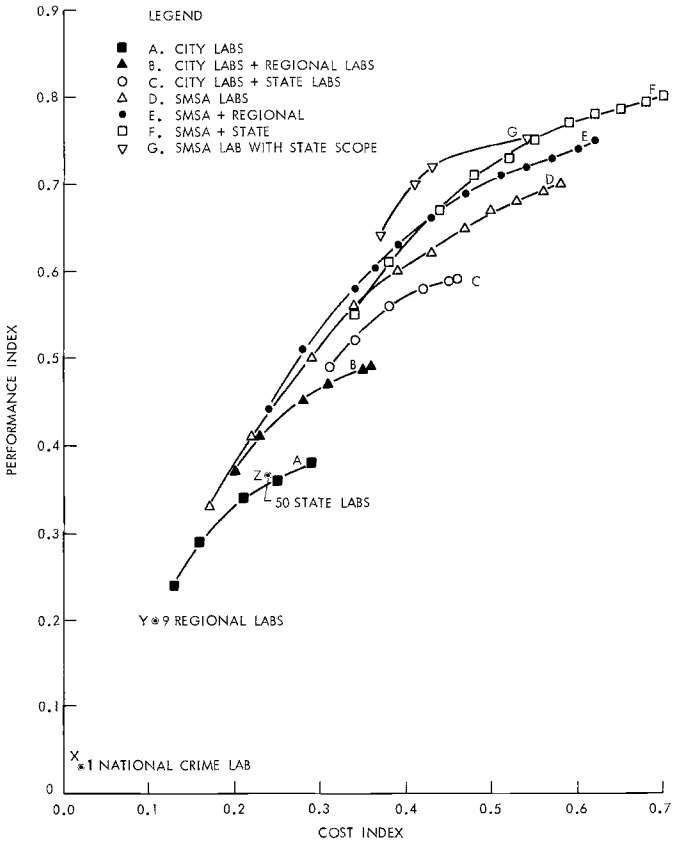

FIG. 4—*Cost/effectiveness of crime laboratory location strategies.*

developed by the Midwest Research Institute and consists of a series of input lines that itemize equipment, staff, and cost elements for a laboratory. Ten time increments in the model (months, quarters, or years) allow phasing the acquisition of staff and equipment and permit use of incremental cost increase factors. Relationships between input lines, as established by the planner, and the arithmetic capability of the compiler allow sums, differences, and ratios to be calculated. Users of the model may exercise complete control over the content and sequence of the resultant reports.

In an actual laboratory planning operation, the planner would start to determine the criminalistics needs of his jurisdiction or region by a study of the environment to be served and a review of sources of planning guidelines. Previous paragraphs of this paper have described methods for determining the relative merit of the several alternatives for the location and service area of a criminalistics operation. The CPO concept, when applied to the area to be served and properly accounting for the decay factors, yields a figure for the total expected caseload to the laboratory. Use of the caseload per examiner averages, properly weighted for factors such as amount of travel and relative degree of the drug problem, will yield a target level of examiners for the laboratory. The skills of the laboratory staff and the equipment required to maintain the proposed laboratory can then be determined using the factors described herein as a guide.

TABLE 3—*Summary, cost/effectiveness analysis.*

						Analysis 1	Analysis 2	Analysis 3	
		Strategy	CPO	Cases to Laboratory	Number of Examiners	Fixed Examiner Cost	Variable Examiner Cost	Number of Examiners	Variable Caseload
I.	1	national lab	0.1	30 700	123	$2.46 × 10^6	$2.09 × 10^6	246	$4.18 × 10^6
II.	1	national lab	0.1	30 700	123	2.46	2.09	123	2.09
	9	regional labs	0.5	153 500	614	12.28	11.05	1 228	20.88
				184 200	737	14.74	13.14	1 351	22.97
III.	1	national lab	0.1	30 700	123	2.46	2.09	246	4.18
	50	state labs	1.0	307 000	1 228	24.56	23.33	1 228	23.33
				337 700	1 351	27.02	25.42	1 474	27.51
IV.	1	national lab	0.1	30 700	123	2.46	2.09	246	4.18
	9	regional labs	0.5	97 655	390	7.80	7.41	780	14.82
	60	city labs	3.0	335 073	1 340	26.80	25.46	670	13.40
				463 428	1 853	37.06	34.96	1 696	32.40
V.	1	national lab	0.1	30 700	123	2.46	2.09	246	4.18
	50	state labs	1.0	195 309	781	15.62	14.84	781	14.84
	60	city labs	3.0	335 073	1 340	26.80	25.46	670	13.40
				561 082	2 244	44.88	42.39	1 697	32.42
VI.	1	national lab	0.1	30 700	123	2.46	2.09	246	4.18
	9	regional labs	0.5	56 991	228	4.56	4.56	456	8.21
	104	SMSA labs	3.0	579 057	2 316	46.32	44.00	1 158	23.16
				666 748	2 667	53.34	50.65	1 860	35.55
VII.	1	national lab	0.1	30 700	123	2.46	2.09	246	4.18
	50	state labs	1.0	113 981	456	9.12	9.12	456	9.12
	104	SMSA labs	3.0	579 057	2 316	46.32	44.00	1 158	23.16
				723 738	2 895	57.90	55.21	1 860	36.46

Forms were developed to be used by the planner as input to LABS. One form provides a line for each item of equipment and requires data on the quantity required, the unit cost, the priority, and the time period in which each should be acquired. The summary section allows the planner to specify cost summaries that are desired, such as Total Equipment Cost—Microanalysis Laboratory. The sum of the cost of each equipment item coded with that summary code would yield that total. Forms that deal with staff, overhead and cost, funds source, and cost share were also developed. These are prepared by the planner in a similar manner to the equipment form above.

These forms, after coding and conversion to machine readable data, are processed on the planning compiler. The resultant computer program edits the input data and performs all calculations that are required. Reports are then generated in accordance with a standard or user specified sequence of lines. Sample reports for one item, the Manning Schedule, generated during the planning of a regional crime laboratory for greater Kansas City are presented in Fig. 5.

The LABS model is intended to be a dynamic planning tool. A plan that does not meet the expectations of the planner or the needs of the agency can be easily regenerated by making only those changes desired in the input. "What if" questions can also be asked and the effect of alternatives can be simulated. LABS can be used by laboratory planners at several levels of sophistication. The forms can serve as a checklist and the reports can serve as a format to guide a manual planning operation.

STAFF PLAN REPORT REGIONAL CRIME LAB L.A.R. MODEL - MAY 1970

MANNING SCHEDULE

PLANNING ITEM	0	1	2	3	4	5	6	7	8	9	10
26 TOTAL NUMBER PROFESSIONALS	-0.0	10.0	15.0	18.0	18.0	18.0	20.0	20.0	20.0	20.0	20.0
27 DIRECTOR	-0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
28 ASSISTANT DIRECTOR-FIELD OP	-0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29 ASSISTANT DIRECTOR-LAB. OP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30 LABORATORY ANALYST I	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31 LABORATORY ANALYST II	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
32 LABORATORY ANALYST III	-0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
33 LABORATORY TECHNICIAN	-0.0	0.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
34 PHYSICAL EXAMINER I	-0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35 PHYSICAL EXAMINER II	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
36 PHYSICAL EXAMINER III	-0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
41 PHYSICAL EXAMINER TECH	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
37 LATENT PRINTS COORDINATOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
38 DOCUMENTS III	-0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
45 DOCUMENTS I	-0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0
39 SECURE EVID TRANSIT OFFICERS	-0.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
40 CRIME SCENE EXAMINER II	-0.0	1.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
43 SATELLITE ANALYST I	-0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
44 SATELLITE SUPPORT OFFICER	-0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
42 TOTAL NUMBER SUPPORT	-0.0	2.0	4.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
46 PHOTOGRAPHIC TECHNICIAN	-0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
47 ADMINISTRATIVE ASSISTANT	-0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
48 STENOGRAPHER	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
49 CLERK/TYPIST	-0.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
23 CLERK/TYPIST SATELLITE	-0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

FIG. 5—*Manning schedule generated during planning of a regional crime laboratory.*

Laboratory Procedures

Each evidence item is normally subjected to a specific test or series of tests depending on the information desired from the item; for example, on a blood sample, questions can range from Is it human blood? to What is its alcohol content? The question can normally be answered by a known number of specific tests, although under certain circumstances, additional tests are required to ensure a result.

We completed flow charts to represent analytical schemes for typical examples of evidence categories. The flow charts were not limited to what was considered to be the one best way for examination but, rather, reflect many optional routes of methods that might be reasonable for the analysis of the particular evidence item. Several representative flow charts representing schemes for the information required (in blocks) are given in Figs. 6, 7, and 8. A system that establishes a code for spatial (dimensional), physical, molecular, or atomic properties of evidence was developed for use in flow charting laboratory methods. A sample page from this coding system is presented in Fig. 9.

The multiplicity of branches within many of the evidence examination flow schemes generally represented some duplication in the acquisition of essentially identical information by different means. The small letter-containing square above the operation block indicates the probability the operation would be used in the given examination. The key is as follows:

A. Used for all samples in all laboratories (based on our working group survey)
B. Used for most samples in most laboratories
C. Used for some samples or in some of the laboratories
D. Occasionally used
E. Seldom or never used (but possibly will be in the future)

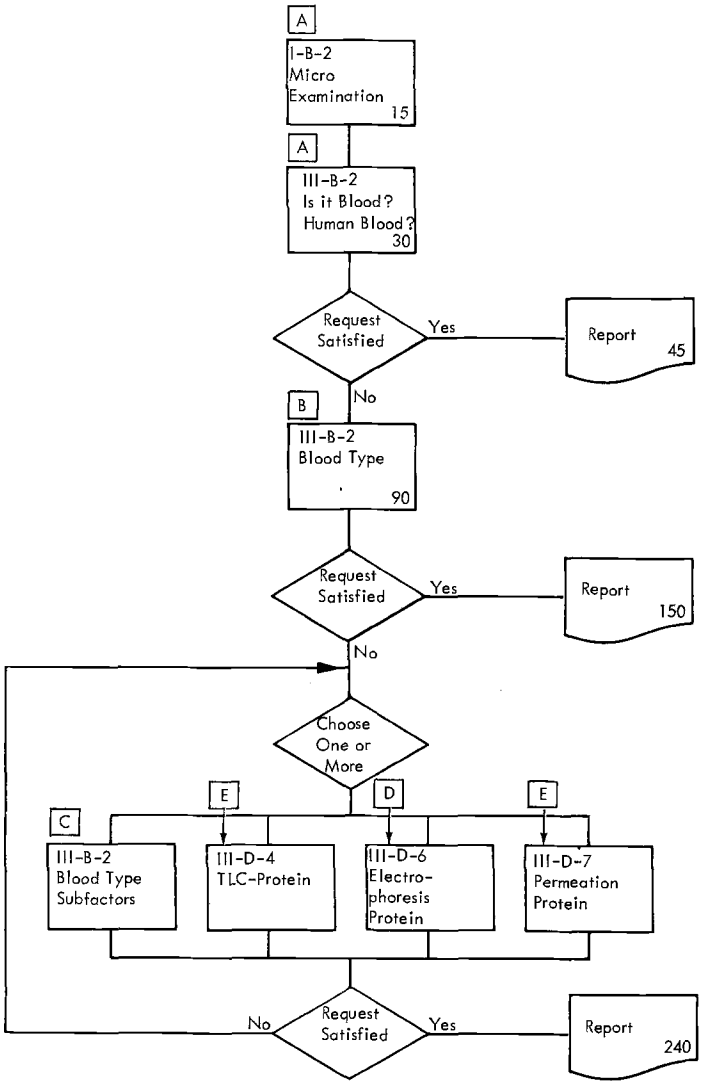

FIG. 6—*Flow chart of an analytical scheme. Evidence item: Stain from crime scene, probably blood. Request: Is the stain human blood; if so, what type?*

The first entry in an operational block, such as 1-B-2, is a reference key to the property coding system previously discussed. Also included in the operational block is an abbreviated description of the operation, for example, Microscopic Examination. The number in the lower right is an estimate of the average time, in minutes, required for the operation. The time in the report blocks indicates the total average time for completion of the examination and may or may not be equal to the total of the times for individual operations. It represents an estimate of the average total time necessary for completion of the optional operations of the scheme.

The above concept of optional examination methods aids in the evaluation of priorities for the acquisition of laboratory equipment. In a large laboratory any concern that an instrument is of value primarily for the examination of only one type of evidence can usually be disregarded, since the frequent utilization of that instrument may make the initial cost of the instrument insignificant. The presence of the same instrument in a small laboratory might be completely unjustified owing to its infrequent use, especially if the examination could be made using a more versatile instrument capable of use in other examinations.

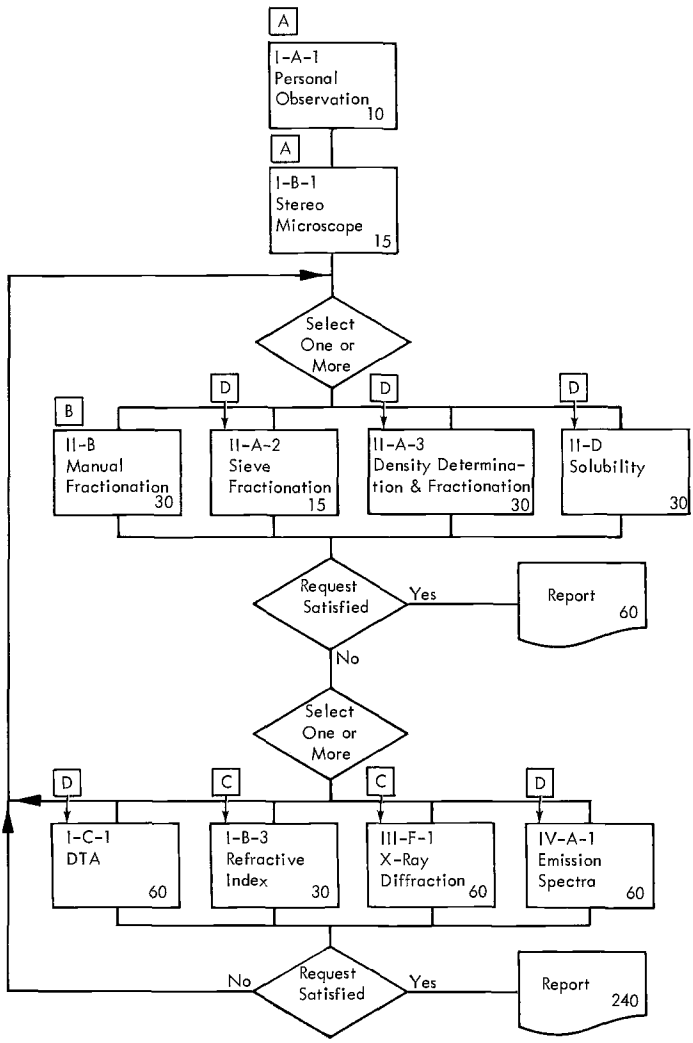

FIG. 7—*Flow chart of an analytical scheme. Evidence item: Building material, fragments and dust. Request: Is material from crime scene; comparison?*

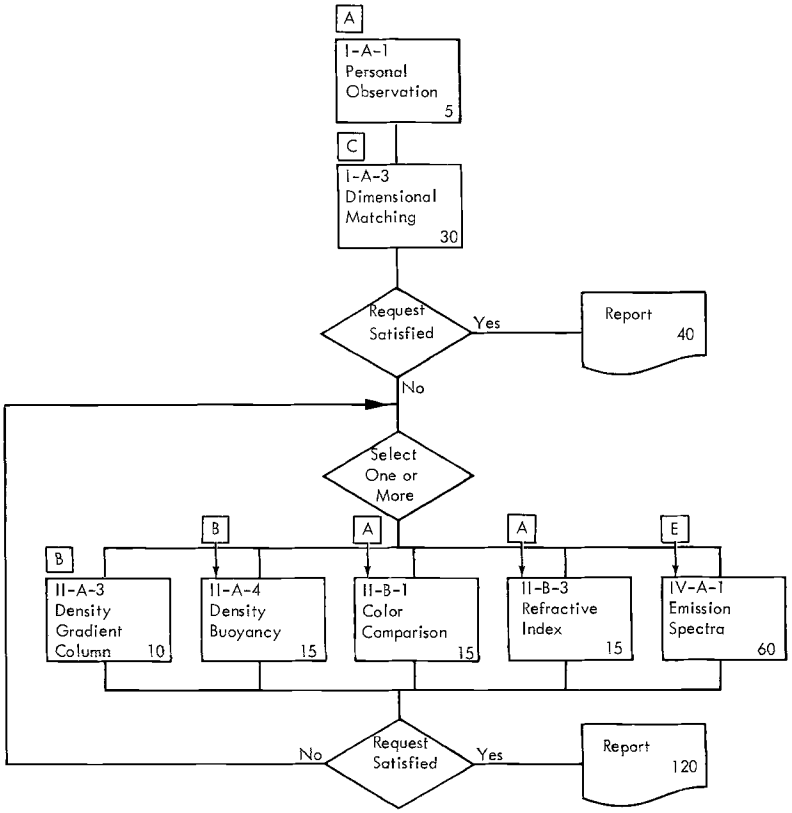

FIG. 8—*Flow chart of an analytical scheme. Evidence item: Piece of glass from hit and run scene. Request: Did fragment come from suspect car?*

Workload Analysis

A generalized computer program developed originally for the analysis of answers to questionnaires was adapted to analyze the existing records of two state crime laboratories. The value of this program was its ability to take existing data in the format of each laboratory and place it in the categories desired by the researcher. The program counts a given code in any card column and compares it to the sum of all entries in that column. For example, it would count all cases coded Murder and calculate the percentage that that crime represents of all cases submitted to the laboratory.

Table 4 presents the results of the application of this technique to the 1969 caseload of the Illinois State Laboratory in Joliet. Of the 2220 cases recorded in 1969, 40.7 percent dealt with violations of narcotic and dangerous drug laws, 16.4 with burglary, 6.9 with auto theft, 3.5 with murder, etc. The table also illustrates three other analyses performed on the data: type of examination, total caseload by month, and caseload by service type. The types of examination performed on each category of offense are detailed. Examples of the application of this technique to the data of the Oregon State Police Crime Laboratory in Portland include a distribution of cases by offense in Table 5 and the evidence categories received in each offense in Table 6.

TABLE 4—*Complete Illinois data analysis.*

Category	Number	Percent
Caseload by Type of Offense	2 220	100.0
Murder	77	3.5
Rape	61	2.7
Robbery	64	2.9
Agg assault	9	0.4
Neg manslaughter	7	0.3
Other assaults	24	1.1
Other sex	21	0.9
Family	1	0.0
Kidnapping	2	0.1
Hit and run	35	1.6
Death investigation	7	0.3
Other persons	1	0.0
Burglary	363	16.4
Larceny 50+	153	6.9
Auto theft	1	0.0
Larceny 50−	0	0.0
Arson	75	3.4
Forgery and counterfeit	10	0.5
Fraud	5	0.2
Embezzlement	0	0.0
Stolen property	1	0.0
Vandalism	37	1.7
Bombing	11	0.5
Pets and livestock	0	0.0
Food and drug	0	0.0
Other property	5	0.2
Weapons	56	2.5
Comm vice	1	0.0
Narcotic and D.D.	904	40.7
Gambling	1	0.0
D.W.I.	18	0.8
Liquor	21	0.9
Drunkenness	0	0.0
Suicide	19	0.9
Abortion	0	0.0
Obscene literature	2	0.1
Conservation	0	0.0
Other acts	4	0.2
Persons Index	211	9.5
Persons I and II	53	2.4
Persons other	45	2.0
Property and com index	517	23.3
Property and com I and II	128	5.8
Property and com other	16	0.7
Illegal acts I and II	1 001	45.1
Illegal acts other	25	1.1
Type of Examination		
Firearms	232	10.5
Blood alcohol	31	1.4
Narcotics	692	31.3
Paint	111	5.0
Glass	21	0.9
Latent prints	425	19.2
Dangerous drugs	350	15.8
Toolmark	148	6.7
Document	2	0.1
Serology	156	7.0
Hair and fiber	49	2.2
Bomb (explosives)	18	0.8
Footwear I.D. (prints)	20	0.9

(*Continued*)

TABLE 4—*Continued.*

Category	Number	Percent
Soil	11	0.5
Arson debris	21	0.9
Alcohol content (liq)	23	1.0
Intoxicating cmpd	5	0.2
Blood exam	1	0.0
Other exam	90	4.1
Total Caseload by Month	2 213	100.0
January	150	6.8
February	232	10.5
March	128	5.8
April	190	8.6
May	149	6.7
June	181	8.2
July	187	8.5
August	250	11.3
September	248	11.2
October	228	10.3
November	158	7.1
December	111	5.0
Caseload by Service Type	2 214	100.0
Laboratory	1 488	67.2
Crime scene	10	0.5
Fingerprint	273	12.3
Polygraph	242	10.9
Phot	1	0.0
Lab and fingerprint	76	3.4
Lab and crime scene	43	1.9
Lab scene finger photo	6	0.3
Lab scene finger	38	1.7
Crime scene finger	27	1.2
Crime scene photo	1	0.0
Lab scene photo	3	0.1
Finger photo	1	0.0
Lab photo	1	0.0
Lab polygraph	1	0.0
Examination by Type of Offense		
Murder	77	
Firearms	47	61.0
Blood alcohol	8	10.4
Narcotics	1	1.3
Paint	2	2.6
Glass	0	0.0
Latent print	17	22.1
Dangerous drug	1	1.3
Tool mark	0	0.0
Document	0	0.0
Serology	31	40.3
Hair and fiber	8	10.4
Bomb (explosive)	0	0.0
Footwear I.D.	1	1.3
Soil	1	1.3
Arson debris	1	1.3
Alcohol content	0	0.0
Intoxicatine cmpd.	0	0.0
Blood	1	1.3
Other	4	5.2
Rape	61	
Firearms	1	1.6
Blood alcohol	0	0.0
Narcotics	0	0.0

(*Continued*)

TABLE 4—*Continued.*

Category	Number	Percent
Paint	0	0.0
Glass	0	0.0
Latent print	6	9.8
Dangerous drug	0	0.0
Tool mark	0	0.0
Document	0	0.0
Serology	30	49.2
Hair and fiber	14	23.0
Bomb (explosive)	0	0.0
Footwear I.D.	1	1.6
Soil	0	0.0
Arson debris	0	0.0
Alcohol content	0	0.0
Intoxicating cmpd.	0	0.0
Blood	0	0.0
Other	1	1.6
Robbery	64	
Firearms	15	23.4
Blood alcohol	1	1.6
Narcotics	0	0.0
Paint	0	0.0
Glass	1	1.6
Latent print	28	43.8
Dangerous drug	1	1.6
Tool mark	2	3.1

A Uniform Criminalistics Management Reporting System

Most laboratories keep records in terms of measurement of total activity which are intended to justify the existence of the laboratory. Frequently, the total number of examinations performed is reported; however, in one laboratory the examination of six samples of handwriting from a suspect may be counted as six examinations, while in another it may be reported as only one. One crime laboratory has even included the urinalyses required for annual physical examinations of department personnel in the total number of examinations conducted. In many instances, only the law enforcement department case record contains the information necessary to relate the crime, clue material, laboratory procedure used, and examination results. The case records of those cases with crime laboratory involvement are filed with all other cases, of course, and to extract such information would require laborious file-by-file retrieval. Some laboratories record and emphasize the number of cases handled rather than the number of examinations performed. Data for longitudinal studies of the effectiveness of crime laboratories, or the impact that the laboratory examination had on law enforcement, are nonexistent. In short, crime laboratories usually keep only those records which are necessary to assure continued existence or desired expansion, with management of the laboratory function being something less than formalized.

A coarse estimate of the magnitude of crime laboratory involvement in the fight against crime indicates that only 2 to 3 percent of all reported cases reach the laboratory. Considering index crimes alone, Parker's [5] data show that in only 4 cases out of 3303 was physical clue material received by the laboratory, indicating approximately 0.1 percent laboratory involvement in index crimes. Clearly, if criminalistics is to have any significant effect on crime, the level of its involvement must increase dramatically. A first step toward this end could be the establishment of a system for collecting information on crime

Property	Equipment
C. MOLECULAR SPECTRA	
1. Colorimeter-Spectrophotometer a. Determination of specific materials b. Quantification of chromogenic reaction	1. Nonrecording Spectrophotometer
2. Visible and UV Spectra a. Quantification of chromogenic reaction b. Determination of inorganics	2. Recording Vis.-UV Spectrophotometer
3. IR Spectra a. Determination of organic and inorganic functional groups b. Comparative, with standard spectra or evidence item c. Can be identifying characteristic	3. Recording IR Spectrophotometer
4. Nuclear Magnetic Resonance a. Determined certain, specific bonds b. Comparative c. Can be identifying characteristic	4. N.M.R. Apparatus
5. Fluorescence Spectra a. Identifying characteristic	5. Spectrophotofluorometer
D. FRACTIONATION OF MOLECULES	
1. Distillation a. Crude separation of large samples b. Approximate boiling points and amounts of components	1. Distillation Glassware
2,3. Gas Chramatography a. Provides number and approximate amount of components b. Pravides ane component characteristic (rentention time) (May be coupled to devices for other characteristics af components) c. Far some evidence may be nearly specific identification	2. Versatile G.C. 3. Dedicated G.C.

FIG. 9—*Sample page from coding system dealing with spatial, physical, molecular, and atomic properties of evidence.*

laboratory operations and effectiveness, performing management analyses on these data, and furnishing the results to all other laboratories.

The impact of this program on criminalistics would be both immediate and far reaching. Participating laboratories will receive early benefit from the project in the collection of more complete data. This improved data base will permit greater insight into each laboratory's own operations and, also, a comparison on a uniform basis with the operations of other laboratories. The results from these analyses would serve as the first step in developing industry standards for laboratory performance. By establishing a mechanism for recording and obtaining results of the use of a laboratory, initial measures of effectiveness could be established. The program would be of further significance in providing planning assistance and operational guidelines for the establishment of new crime laboratories. References *6–19* offer additional informative and useful literature bearing on this and related matters.

TABLE 5—*Distribution of cases to State Police Crime Laboratory, Portland, Ore.*

Category	Number
Caseload by Type of Offense—	
Total Cases Reported	797
Murder	44
Rape	72
Robbery	6
Agg assault	44
Neg manslaughter	2
Other assault	13
Other sex	7
Family offenses	5
Kidnapping	0
Hit and run	90
Death investigation	146
Burglary	133
Larceny 50+	26
Auto theft	2
Larceny 50−	10
Arson	8
Forg and counterfeit	0
Fraud	0
Embezzlement	0
Stolen property	4
Vandalism	37
Bombing	4
Pets, livestock	19
Food and drug	0
Other property	51
Weapons	14
Comm. vice	0
Narcotics and D.D.	0
Gambling	0
D.W.I.	0
Liquor	23
Drunkenness	0
Suicide	2
Abortion	1
Obscene literature	0
Conservation	17
Other illegal acts	14

Conclusions

While the problems of the lack of uniform data have precluded the establishment of quantitative bases on which to make recommendations, several conclusions have emerged as broad principles. Used separately or together, they can be applied to criminalistics operations to increase the involvement of the crime laboratory in the total body of crime and, thus, guarantee a greater significant impact on the law enforcement and criminal justice system.

1. *Improved crime scene search needed.* Clearly, if the crime laboratory is to assume its proper role of increasing technical support capability for the law enforcement officer, there must be a concomitant increase in physical clue material input from the scenes of crimes. While all law enforcement officers should receive training in the preservation of the crime scene and the identification and collection of significant physical clue material, skilled and supervised personnel attached to a laboratory with a primary responsibility for the collection and preservation of evidence appear to offer the greatest potential.

TABLE 6—*Evidence yield by type of offense, State Police Crime Laboratory, Portland, Ore.*

Category	Number	Percent
Murder	44	
Physiological Evid	29	65.9
Narcotics	6	13.6
Firearms	25	56.8
Documents	0	0.0
Clothing and fabrics	13	29.5
Fragments	1	2.3
Trace evidence	4	9.1
Marks and impressions	0	0.0
Explosives	0	0.0
Chemical products	5	11.4
Miscellaneous	1	2.3
Crime scene	23	52.3
Rape	72	
Physiological evid	70	97.2
Narcotics	2	2.8
Firearms	0	0.0
Documents	0	0.0
Clothing and fabrics	16	22.2
Fragments	0	0.0
Trace evidence	2	2.8
Marks and impressions	0	0.0
Explosives	0	0.0
Chemical products	1	1.4
Miscellaneous	1	1.4
Crime scene	28	38.9
Aggravated Assault	44	
Physiological evid	21	47.7
Narcotics	1	2.3
Firearms	26	59.1
Documents	0	0.0
Clothing and fabrics	3	6.8
Fragments	3	6.8
Trace evidence	3	6.8
Marks and impressions	0	0.0
Explosives	0	0.0
Chemical products	2	4.5
Miscellaneous	0	0.0
Crime scene	22	50.0
Hit and Run	90	
Physiological evid	5	5.6
Narcotics	2	2.2
Firearms	0	0.0
Documents	0	0.0
Clothing and fabrics	4	4.4
Fragments	11	12.2
Trace evidence	83	92.2
Marks and impressions	0	0.0
Explosives	0	0.0

2. *Laboratory response must match demand.* The laboratory has a part in influencing the amount of material that it receives. A negative attitude on the part of an examiner, frequent inconclusive results, or slow response to need will reduce or halt input to the laboratory. Since the laboratory does not normally control its size or budget, the managing agency must share responsibility for the level of service that can be offered.

3. *More trained criminalists are needed.* Even the modest goal of three laboratory cases per year per sworn officer would only represent the crime laboratory's involvement

in between 3 percent and 4 percent of the nation's crime. At an average caseload of 250 cases per year, this would require almost 4000 criminalists, or a fourfold increase over the current number of practitioners. If improved crime scene search measures are set in motion, and administrators and command staff reinforce and support the effort, existing crime laboratories would soon be inundated by physical clue material and faced with critical shortages of trained laboratory personnel. Improved crime scene search must be coupled with increases in laboratory capability. Both academic and on-the-job training programs are needed.

4. *Quality of service must be maintained.* There are few sources for training in criminalistics; thus, people with little or no preprofessional training are entering this field, with the potential of endangering the credibility and accuracy of the results of laboratory examinations. Quality control measures of both intra and interlaboratory operations are required. Due to staff shortages, too little attention has been given to individual professional development. Short courses, seminars, and formal academic programs at the graduate level should be encouraged.

5. *Existing crime laboratory resources are largely devoted to non index crime.* Statutory tests (drugs, blood alcohol) reach the laboratory in both high percentage and quantity, pushing other evidence examination into the background. Many laboratories today become deeply involved in platter cases to the point that their heavy workload becomes so well known that it serves as a subtle deterrent to the search for physical evidence in more serious cases. Again, the whole law enforcement system must accept some responsibility for allowing such items to saturate existing capabilities. Drugs should no more be allowed to dominate the laboratory than should all police be devoted to traffic.

One solution can be the development and adoption of automated analyses for commonly recurring materials. The second might be to further encourage the acceptance of laboratory reports at lower levels of the court system and in hearings without live testimony.

6. *The crime laboratory should be in the main stream of law enforcement activity.* Instead of merely being a captive service group, the crime laboratory should have a position in and a rapport with the agencies it supports. The laboratory should be situated in the organization so that it has some voice in its budget, personnel policies, and other management decisions. In organizational structures where the laboratory reports to a nontechnical supervisor, there is often a complete breakdown in ability to translate to the budget-making body the exact needs of the laboratory.

7. *Crime laboratories must be planned and integrated into the criminal justice system.* The development of crime laboratory capabilities must proceed hand in hand with crime scene search and awareness of the existence of this resource. The law enforcement investigator, the prosecutor, and other members of the legal community must be brought into any planning process to assure that the capabilities provided will, in fact, be used. This awareness and use cannot occur overnight, nor should anyone expect a crime laboratory to develop other than through an orderly, phased planning process which integrates the laboratory into the total law enforcement system. The laboratory planning model developed in this study can provide significant assistance in these areas.

8. *A crime laboratory should serve an entire standard metropolitan statistical area.* The physical, economic, and social interdependence of the cities and counties which comprise an SMSA also influences the pattern of crime in that area. A crime laboratory with a specific charter to serve an entire SMSA and multiple-source funding can be responsive to the needs of all of the law enforcement departments in that area.

9. *Crime laboratories should maintain and exchange management information.* Currently, there are few or no data on which to base an evaluation of the performance of a crime laboratory. The development of a system for the exchange of management information would have an impact on criminalistics which would provide greater insight into each laboratory's own operations and also a comparison with the operations of other laboratories. By establishing a mechanism for obtaining results of the use of the laboratory, initial measures of effectiveness could be established.

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