COMMENTS ON THE SYSTEMS AND PROCEDURES SECTION REPORT CONCERNING COMBINING THE TESTING LABORATORY AND THE RESEARCH LABORATORY

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

COMMENTS ON THE SYSTEMS AND PROCEDURES SECTION REPORT CONCERNING COMBINING THE TESTING LABORATORY AND THE RESEARCH LABORATORY

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ABSTRACT

Reasons are presented for the potential harm which would result from combining the acceptance testing and the research functions into one organization or in one integrated laboratory. The premises and conclusions of the Systems and Procedures Section report are discussed and criticized. A review of the literature is presented on the management of research activity in industrial concerns and highway departments to indicate better functional organization for research activities.

In answer to R. L. Greenman's request during the Testing and Research staff meeting of October 17, 1967, we have reviewed the proposed reorganization of separate testing and research laboratories into a combined laboratory under the same physical and administrative organization.

The Research Laboratory takes exception to the study findings and the proposed reorganization for the reasons given below. In each case where a premise, or the logic from the premise to the conclusion, are criticized, later elaboration of each point and the attempts to establish the proper facts and a logical flow from these facts to a correct conclusion are suggested.

CRITIQUE OF SPECIFIC POINTS IN REPORT

1. The "Methods of Study" as outlined in the report, discussions with the Director and Office Manager of Testing and Research, and the review of organizational charts, functional organization charts, equipment inventories, position descriptions, and a review of undocumented previous studies, would appear to be insufficient for a comprehensive reorganization. We would suggest that additional studies should have been made of testing organizations and research organizations in other state highway departments, and industrial concerns, and the literature covering ideal organizations serving these functions. As discussed later, there are important and primary reasons why such a separation between testing and research is advocated by those who have thoroughly studied the matter.

Under "Methods of Study," it is mentioned that: "Personal contact with operating employees was omitted purposely to avoid the possibility of unnecessarily increasing the organizational unrest already present in the Department." This may be a commendable point of view. It would appear, however, that a much better course would have been to get as complete and up-to-date information as possible, even though it might cause some unrest, than to base important conclusions on incomplete or obsolete data.

2. The organization charts (Exhibit I) used in the study (outlining the Sections and Units) were obsolete by a matter of approximately two years, and therefore the analysis made in the report was neither current nor correct. For example, in December 1965, the Concrete and Bituminous Unit was designated "Concrete and Surface Treatment Unit." Also in December 1965, Pavement Evaluation was combined with Field Tests and Surveys Unit and reorganized under the Physical Research Section to "Pavement Evaluation and Field Tests." The functional organization chart (Exhibit II) of September 1962 was used in the analysis. However, a functional organization chart dated March 1966 describing the functions of the current units in line with the organization, rather than a previous obsolete one, was available. Thus, two of the exhibits in the Systems and Procedures Section report were neither correct nor applicable for the last two years.

Third, it should be noted that the Position Descriptions (Exhibit IV) particularly that of Robert C. Mainfort, did not correlate with the Exhibits I and II. This, again, because obsolete organizational and function charts were used. Also, Exhibit IV position descriptions of R. C. Mainfort and C. A. Zapata of the Research Laboratory, and D. F. Malott and R. H. Vogler of the Testing Laboratory, if studied by a technical person, discloses no duplication of effort. What, therefore, was the purpose of Exhibit IV?

3. The last premise was that a great savings in laboratory equipment would be made by combining laboratories. This was based on Exhibit III, a review of equipment inventories and a list of 37 inventory items of over $60,00 assigned value, which were common to both laboratories. In the 37 items listed, it should be noted that general classifications without technical details were used, such as constant temperature ovens, without any indication of range, size, etc.

A study of the equipment involved in each laboratory reduced the actual duplication of equipment to 21, rather than 37, general items listed in the Systems and Procedures Section report. Also it should be noted (Table 1) that of these 21 items each laboratory possesses, in almost every case the individual laboratory has found from experience that from 2 to 20 of these items are now required in each separate laboratory. Therefore, it can not be assumed that because the Research Laboratory now has nine ovens and the Testing Laboratory has twenty ovens, there are 29 items of equipment duplication, and any appreciable savings in ovens could be made by combining the two laboratories. A study of Table 1 will indicate from the type of equipment items and their uses, that combining the two laboratories would result in an insignificant amount of savings. Even if the total equipment duplication is used, i.e., 53 equipment items for the Research Laboratory and 64 for the Testing Laboratory (inventory value of $60.00 or over), it represents only 53 out of 729 items for the Research Laboratory and 64 out of 500 items for the Testing Laboratory of over $60.00. This represents 7 and 13 percent, respectively (The Systems and Procedures report states that about 40 percent of the equipment is available in both laboratories). The current total inventory value of these 53 items in the Research Laboratory is $22,120.57 out of a total inventory value of 507,399.06 dollars, or less than five percent of the Research Laboratory equipment inventory. Since many of these 53 items are quite old and the inventory value is not adjusted for depreciation, we have made a current estimate of their value as $10,394.60.

Under study findings, the first statement that both laboratories are basically testing organizations is incorrect and misleading. The Research Laboratory has at least three basic approaches to research studies or evaluation of materials for specification development as follows: (1) theoretical analysis; (2) laboratory research testing; (3) field trial and performance evaluation. The second of these, if obscurely defined, could be considered testing, but it is a different type of testing than that done for acceptance testing. For acceptance testing, generally standardized tests are conducted to determine if the material

TABLE 1

EQUIPMENT DUPLICATION IN TESTING AND RESEARCH LABORATORIES

Equipment Iten	Number in labs. Research	Testing	Explanation of Duplication within Research Laboratory
Mixer, cement	2	2	One new model in 1965 cost $125. One older model (16 yrs old) has current value of about $25.
Ovens 110/220	9	20	Required in each lab for different temperatures, required in ASTM tests, different sizes and locations within the building for various labs.
Balances, analytical	7	8	This includes a range in sizes, types, and order of precision.
Muffle Furnace	2	6	One 1944 oven; other purchased 1959.
Distilled Water	2	1	For two lab areas - one in basement, one on third floor.
Voltmeter	3	1	Three required; one for lab, one for electronic scales, one for the GM profilometer.
Sieve Shaking Machine	3	5	Two in concrete lab for small and large samples, one in soils lab.
Splitter, sample	5	4	Range of sizes for different gradations. Several employees simultaneously splitting samples.
Hygrometer	2	1	One is obsolete (22 yrs old) but still retained; other is 6 yrs old.
Water Bath, constant temp.	2	3	One in chem lab, one in paint lab.
Gage, strain, mechanical	5	1	Three 2-in length; one 8-in length; one 10-in length. These are needed when strain over different lengths is required.
Bandsaw, metal	2	1	One vertical, one horizontal.
Centrifuge	2	2	One for large, one for small samples.
Potentiometer	2	2	One 21 yrs old, one 27 yrs old.
Circular Saw, 18-in masonry	1	3	
Roll-A-Meter	1	1	
Degreaser	1	1	
Capper, conc. cyl, vertical	1	1	
Microscope, stereo.	1	1	
TOTAL	53	64	

meets the specification requirements. For laboratory research testing, it is necessary to first determine what physical properties are necessary to the satisfactory performance, testing procedures are generally not defined, and a range of physical properties must be used in order to determine a limiting physical property which is necessary for satisfactory performance. Thus, the so-called testing conducted by the two laboratories is basically different in purpose and content.

CRITIQUE OF THE SYSTEMS AND PROCEDURES SUMMARY

The Systems and Procedures Section study recommends, on the basis of their previous premises, that serious consideration be given to combining the Testing Laboratory Section with the Research Laboratory Section. They also list the advantages and disadvantages of combining the two laboratories as follows:

"Disadvantages to combining laboratories-

1. Possible distance involved for consultation with university personnel.
2. The relocation of present laboratory personnel.

Advantages that should accrue to the Department-

1. Possible reduction in testing equipment.
2. Elimination of reproduction equipment that is necessary when activity is located in other than Lansing area.
3. Possible staffing reductions as overlapping of operations could be reduced.
4. Shorter lines of communication should result in an increase in efficiency because of nearness to management. Mr. Greenman stated that there has been no problem in this area under present organization."

We feel that there are several very serious and much more major disadvantages which have not been covered. These disadvantages are as follows:

1. In combining acceptance testing and research in one organization, experience in other states, as well as our own, has shown that acceptance testing preempts priorities because the requirements for answers to acceptance testing are always immediate, while research generally caters to a future or less immediate demand. Thus, the timing is such that regardless of value judgements concerning priorities, the acceptance testing phase must be handled first, thus, research is carried-on only if there is sufficient slack time from the demands of acceptance testing.

2. In combining laboratory facilities for testing and research, the same preempting of space and equipment occurs. Since acceptance testing must be carried out immediately, its purposes are paramount and, again, research must be carried-on in a combined facility only if excess space or equipment is available after the demands of acceptance testing are fulfilled.

As will be shown later in a discussion of industrial and governmental research organizations and facilities, personnel, space and equipment must be specifically designated for research work if an effective program of research is to be maintained. If a combined laboratory for testing and research were constructed, but if personnel and facilities are designated specifically for acceptance testing or research, then the advantages of a combined facility are very

small and consist of more direct lines of communication and perhaps some sharing of very specialized or expensive equipment.

The four advantages given in the Systems and Procedures Section study can be discussed as follows:

1. Possible reduction in testing equipment: This has been discussed before and a possible maximum savings which would be realized for this would not exceed $15,000.

2. Elimination of Reproduction equipment: The maximum savings to be effected by this would not exceed $2,000.

3. Possible staffing reductions as overlapping operations can be reduced: First, it must be stated that, currently, overlapping of operations does not exist. While acceptance testing is conducted in both laboratories, the sphere of acceptance testing of the Research Laboratory has been determined as only that area where the personnel or facilities of the Testing Laboratory cannot currently handle the material or product. Reduction of staffing by having all personnel assigned the dual capacity of acceptance testing and research is not a satisfactory arrangement. First, it requires different types of training and personality to handle acceptance testing and research. A good research worker will not long be satisfied in conducting acceptance testing and, in turn, a good employee for acceptance testing will rarely have the inquisitive mind and initiative to be a good researcher.

4. Shorter lines of communication should result in an increase in efficiency because of nearness to management. Some benefits might possibly be realized from this source, but the procedures and the administration of acceptance testing have been rather firmly established over the years and, therefore, the management of the acceptance testing can be conducted without constant or immediate control from the Lansing office of the Testing and Research Division.

While some of the advantages of combining the testing and research laboratories are real, they are not collectively of sufficient importance to offset the major loss in research productivity which would result, or the gradual demise of any major research effort.

The past few years of the Research Laboratory history indicate how acceptance testing displaces research when the two are combined in one organization. In 1964, five percent of the Research Laboratory effort was confined to acceptance testing (4 percent) and specification writing (1 percent). By March and April of 1967, acceptance testing and specification writing was taking 15 percent of our effort. During August and September, the most current tabulation indicates that 20 percent of our effort is in this area (acceptance testing— 17 percent; specification writing— 3 percent). In addition, a significant part of the time is spent in specification review and commenting on changes. This geometric progression in the amount of acceptance testing and specification writing is not accidental, nor is it likely to be reversed without major organization changes. Over the same time period, our efforts on Highway Planning and Research projects conducted cooperatively with the Bureau of Public Roads, and largely Federally financed, have decreased progressively from 31 to 11 to 10 percent of our total effort for the same time periods. This supplanting of research with acceptance

testing and specification writing is a real problem. Whenever, within a given organization, both roles must be satisfied, the immediate and most pressing one will receive the attention regardless of the intrinsic value of the two roles.

RESEARCH OPERATIONS IN INDUSTRY AND GOVERNMENTAL AGENCIES

A study of the literature on research operations in industry and governmental agencies indicates that from experience, certain general rules have been established for organizing an effective research program.

Industrial Organizations

Research in industrial organizations was first developed as a marginal activity performed somewhere in the orbit of the manufacturing function. "In recent years, though, the rate of innovation has increased, the mechanics have been replaced by engineers and scientists, and the tinkering has been replaced by systematic scientific inquiry. ... Among the 76 large, divisionalized companies analyzed for this study, 53 have research and development units on their corporate staff... In most (40) of the companies, this unit, most often research and development (21 companies), but sometimes simply designated research (10 companies) encompasses all of the company's corporate research and development activities" (1) Industrial research and development expenditures now range in excess of 20 billion dollars and by 1970 it is expected to reach 30 billion dollars.

"It is a matter of management sophistication, rather than corporate size, that is the determinant of R&D involvement. Of 11,800 firms, identified in 1961 as maintaining some degree of R&D function, nearly 90 percent had fewer than 1000 employees ... Even small business (companies with a payroll of fewer than 500 employees) earmarks funds for research and development, either carried out in the company's shop or in outside facilities - independent commercial and non-profit laboratories, colleges, universities, and other institutions." (2)

A study of a great number of large industrial companies indicates that in every instance the research functions of such a concern is clearly and distinctly separated from the quality control or acceptance testing functions. Most industrial concerns with a research group have a Vice-President in Charge of Research who reports directly either to the President of the company or the executice Vice-President. Examples of this are: American Optical Co., Atlantic Refinery Co., Continental Can Co., Corning Glass Works, DuPont, General Electric, Gulf Oil Co., Johnson's Wax, Koppers Co., Dow Chemical, and the Upjohn Co. In one organization, Research reports directly to the Board of Directors (General Mills). (3)

In SCIENCE AND SOCIETY it is stated: "...that the degree of productivity evidenced by laboratory personnel will depend on the degree to which optimum climate for professional research work has been developed and maintained by research management. There are many differences between the ideal working atmosphere of a research laboratory and that expected (or even desired) in other parts of an industrial organization." (4) In the discussion of optimum climate for industrial research

the following points are made:

1. Research personnel should be evaluated by different criteria than operational employees.

2. A permissive, low-pressure atmosphere is a characteristic of a good research organization. (This is one fundamental reason why the acceptance testing and research roles, side-by-side in the same organization are incompatible.)

3. A desire for intellectual development and achievement.

4. A basic element for research involves the need for:
   (a) First class facilities for whatever work is to be done in the lab.
   (b) Colleagues of a high professional stature.
   (c) Work assignments of real interest to scientists on the professional staff.

   These three needs are difficult to supply by combining testing and research, organizationally or physically, into an integrated laboratory facility.

5. "The essential element for creation of a good climate is a belief on the part of management that the basic product of a research laboratory is the creativity of research personnel, plus a willingness among managers to revise their traditional attitudes so that their behavior, while inter-acting with scientists, will reflect this belief." (5)

Highway Departments

A study of highway research organizations and administrations indicates that there is a definite trend to centralized research within the departments in contrast with non-centralized research where each Division conducts its own experimental tests. (6) (7) In 1953, thirty state highway departments were conducting non-centralized research. In 1966, there were only fifteen. Thirty-three states now have a designated research unit. Although this unit is in all cases responsible for the execution of research projects, it may not do this with its own personnel but may assign all or part of a project to outside agencies. Thirty of these thirty-three states have research units having the capability of conducting research, generally physical or planning research and sometimes both, within the research unit. Half of these states (15) separate their research work from other activities such as materials or planning but may also include in the title of this unit "Research and Development" or "Research and Evaluation." Five states combine research with planning in a joint organization. Five states, including Michigan, combine Research with Materials (some may be titled "Testing and Research" or "Materials and Research"), and finally five states indicate that responsibility for research is split by having separate physical research units and planning research units. A single division of the highway organization was responsible for both physical and planning research functions in sixty percent of the states while the responsibility for physical research was assigned to one division and planning research to a different division in thirty percent of the states.

All thirty-three states having research units indicate that they also have cooperative research programs or projects with universities. It is also interesting to note that of the thirty-three states now having designated research units, only seven had such organizations in 1952. Michigan was one of these seven, having established a research organization in 1939. A recent report on highway research organizations gives some of the disadvantages of a designated research unit within the department (8):

1. "Personnel and equipment limitation priorities go to activities pointing directly to completion of Highway and Bridge Construction Program.
2. There is a reluctance of the researchers to find fault with their own organization and there was a fear of reprisals by supervisors.
3. They may be so far removed from actual operations that it requires special effort to get the research findings into practice or to bridge the gap between research and operations.
4. The regular employment of specialists is difficult because such highly trained people are highly paid and difficult to retain in the Department."

Despite these noted disadvantages, the majority of the states (30) feel that the advantages more than offset the disadvantages.

Thirty-five of the fifty states have some form of research advisory group; many of them, as the name implies were advisory only. In almost every case, the research advisory group was composed of the staff engineers of the department and, in the majority of cases, the chief administrative officer or the chief engineer was a member of the group. A study of organization charts of state highway departments available indicated that when "Research" or "Research and Development" or "Research and Special Studies," units are separate units--uncombined with "Planning" or "Materials"--they are generally of Division status or higher. A few examples of this are Virginia, West Virginia, Alabama, Kentucky, Oklahoma, and Illinois.

Research Facilities

The same recent report noted that research employees engaged in planning research are most frequently housed in the same office building. The physical research employees, on the other hand, are most frequently housed in outlying buildings (48 percent) and again about half as often, they have space both in outlying areas and in the main office building (25 percent), while seventeen percent use the mainbuilding only and ten percent did not report where physical research employees are housed. Of the total of 300,000 sq ft of floor area reported by states as being allocated for research projects, thirty percent was allocated for planning research and sixty-one percent for physical research.

Forty-eight states report a total of 41,000,000 dollars expended in 1965 on research activities, with ninty percent of this covered under the Highway Planning and Research cooperative program with the Bureau of Public Roads which is largely Federally financed. The New Jersey Highway Department is planning to construct new testing and research facilities and they are planning to keep both the organization and the facilities for testing and research separate, although materials testing and research will be housed in the same building.

SUMMARY

A review of the literature on research organizations, a study of state highway departments, and discussions with personnel of highway agencies has indicated the following:

1. Research and acceptance testing (quality control and reliability) in industrial organizations are universally separated. The reasons for this are basically different objectives for the two groups, different types of environment, and different types of employees are required.

2. Testing and research combined in either one organization or one facility will result in a progressive increase in the testing aspect and a proportionate decrease in research when competing under limitations in personnel and facilities regardless of management's evaluation of the relative value of these two activities. The reason for this is that the one area, acceptance testing, requires immediate answers or solutions while the research can be deferred without the immediate pressure and displeasure of management. The effects of deferring research are not noted for some time, but failing to carry out the acceptance testing results in delays for contractor, construction, and opening dates for pavements or bridges.

3. For this reason, there is a definite trend, even among highway departments, for research to be a separate unit, divorced from operational aspects of acceptance testing. If combined with another group, a study of the literature suggests that a more ideal arrangement is to combine physical research with transportation and planning research rather than with materials or acceptance testing because the objectives and outlook of the two groups are more compatible and require personnel with like discipline and training. Both groups are anticipating future needs and trying to meet them before a critical problem arises.

4. Almost universally in industry, and generally in highway departments, research is at the staff level, reporting directly to management. There are two reasons for this: 1) research results in suggestions for change and this organizational structure is most conducive to a climate where suggestions are not inhibited; 2) research and the resulting recommended changes, to be useful, must be implemented. Resistance to change which may occur in operating divisions must be overcome and this cannot be readily accomplished by suggestions from a lower level of management.

REFERENCES

1. Studies in Personnel Policy. National Industrial Conference Board. Personnel Policy Study No. 195. p. 74.

2. Stanley, A. D. and White, K. K., "Organizing the R&D Function," American Management Association. p. 15.

3. Studies in Personnel Policy. National Industrial Conference Board. Personnel Policy Study No. 195. p. 74.

4. Orth, Charles D. III "The Optimum Climate for Industrial Research." Science and Society. Norman Kaplan, ed. p. 194.

5. Ibid. p. 209.

6. Highway Research Organization. Highway Research Board Special Report No. 15. 1953.

7. Analysis of State Highway Organization and Administration. Subcommittee on Highway Research Policy and Administration, Department of Economics, Finance and Administration. Highway Research Board. 1966.

8. Ibid.

SUGGESTED FURTHER READING

Morison, Simon, "The Scientist in American Industry." Harper Bros. 1962.

"Research Operations in Industry," Third Annual Conference on Industrial Research. Columbia University. 1953.

Kaplan, Norman, ed. Science and Society. Rand McNally & Co. 1965.