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INDUSTRIAL AND COMMERCIAL RESEARCH: FUNCTIONS, FINANCES, ORGANIZATION

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AUTHOR'S NOTE

In this attempt to deal comprehensively with some problems which are common to both the natural-science and the social-science types of research in industry, the author has fortunately secured materials, advice and criticisms from a considerable range of people having intimate knowledge of various phases of the subject.

Many of these informants were found on the staff of the University of Michigan. Professor C. N. Schmalz and Dean C. E. Griffin gave assistance on commercial research, Professor C. B. Gordy, on industrial engineering, and Professor C. S. Yoakum, on personnel research. An outstanding obligation is felt toward the University's Department of Engineering Research. Director Albert E. White assisted in making contacts with business establishments and placed his own comprehensive knowledge at our disposal; and his colleagues, Professors Alfred H. White and W. L. Badger, were sources of constant information and encouragement.

Among the numerous persons in the business world who co-operated, three must be specifically mentioned. Mr. John Mills, of the Bell Telephone Laboratories, has assisted the author's studies in industrial progress for several years. The following pages bear witness, also, through frequent references, to the helpful publications and letters of Dr. C. E. K. Mees, of the Eastman Kodak Company and to the remarkable co-operation of Rowntree and Company, Limited. Major L. Urwick, late Organizing Secretary of the latter firm (now Director of the International Management Institute) has been most generous, indeed, in his help.

Thanks are due to the American Management Association and its Managing Director, Mr. W. J. Donald, for making valuable material accessible and for giving the author opportunity to present a shorter paper, based on this study, at their convention in Chicago, November, 1928. The papers given there and remarks made are being published by the Association and those relating to research will be useful to anyone interested in the following study.

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INDUSTRIAL AND COMMERCIAL RESEARCH: FUNCTIONS, FINANCES, ORGANIZATION

SUMMARY AND CONCLUSIONS

This study analyzes the functions and methods of practically-directed research—not only the strictly scientific sort but the more nearly routine types of systematic development of products and methods, as well. Apparently over one hundred millions of dollars are now spent annually by American business for such work. Standard budgets based on expenditures of various companies for research and development are not yet available, partly because terminology is not yet uniform. A few examples are given, such as the annual outlay of Rowntree and Company, Limited, estimated at about 1.2 percent of net sales, and that of Leeds and Northrup Company, which has approximated 3 per cent during the past ten years.

On the basis of this study, the following conclusions seem justified:

1. How much money an individual firm may prudently spend on research depends upon such factors as its size, scope of operations (integration), and educational needs, as well as upon the co-operative research services available.
2. Companies carrying on numerous types of business have special inducements to undertake research work because their fields of possible applications of scientific discoveries are relatively large.
3. Consolidations seem not to have been much influenced by gains expected from centralized research, but they probably will be in the future.
4. Co-operative arrangements are increasing rapidly. One of these, the ordinary consulting relationship between commercial laboratory or practitioner and client, has some special advantages where secrecy and unrestricted ownership of results is essential. The universities and government departments, which often possess superior equipment and personnel, are also co-operating with individual business in many ways, for example, through the fellowships maintained

by various firms. Large and limited trade associations, too, support fellowships, maintain laboratories, and exchange statistical data for business research. Small concerns may find this development a means of survival, but thus far large ones seem to co-operate better than small.

5. The difficulties of measuring returns from research are partly diplomatic. Research people have to avoid antagonizing the operating personnel by seeming to claim too much credit for savings due to improved methods. Some degree of measurement, however, is often practicable.

6. Organization of research involves problems of selecting, training, and stimulating the workers in this field, and of making research organs assist in the training of experts and executives as well. But the matter most considered here is centralization. Complete centralization of research and development, of all kinds and degrees is very rarely found, but some tendencies are working in this direction. Engineering and technical laboratories are frequently under the jurisdiction, not of the production manager, but of a special director; and commercial research, too, is often supervised by a chief who reports to the president. All research has something in common: the questioning spirit, and the use of basic statistical and historical methods. Some central services may well be advisable, as is the case in office and personnel management. But, as the major executives become increasingly familiar both with the necessity of continuous planning for progress and with research methods, each may be held increasingly responsible for progress within his own department, organizing for it in his own way, subject to central services and criticism. Something of the research spirit can perhaps be conveyed to all workers high and low.

AGENCIES FOR PROGRESS-WORK: STAFF AND LINE

Research methods are rapidly finding new footholds in all manner of industrial and business concerns. Not less than one hundred million dollars a year is now spent by American business for this purpose; and this figure may be multiplied or divided almost at will, depending on one's definition of "research." When properly used, these

activities in the long run are highly profitable, and any concern which lags behind competition by failing to provide for premeditated progress is simply inviting bankruptcy. No industry can now rely safely on the "alibi," "Our business is different." Whatever is being done can always be done better; and systematic investigations or fact-finding studies, consciously designed to improve on the present methods, are usually more dependable sources of improvement than are hit-or-miss inspirations. "Research is perhaps the greatest gamble in the world for a single venture or for one person," as Dr. L. V. Redman of the Bakelite Corporation recently told the Institute of Chemistry, "but it is the surest thing in the world when spread over a whole nation." Likewise, it is a greater gamble for a small concern than for a large one, but through a widening variety of co-operative, educational, and commercial agencies small businesses are becoming able to buy what service they need as they find it necessary.

Investors are beginning to realize all this. A New England executive is quoted as saying; "For some years I have maintained the policy of investing in no establishment which does not maintain a research department, either as an integral part of its organization or by retaining adequate scientific services in such a manner as to keep in close contact with new developments which might have a bearing on the company's prosperity." A few banking institutions are taking a similar view; for instance, a Detroit trust company has retained the University of Michigan's Department of Engineering Research as a sort of appraiser of the research situations of clients.

The present study differs from most of the enormous literature on practical research, in that it attempts to view as a whole the various research and development types. Commonly the discussions are confined to but one part of the field—usually either the natural-science, laboratory, technical, engineering type ("industrial" research in the narrow sense), or the social-science, economic-statistical, business-management type (sometimes broadly called "commercial" or "management" research). We attempt, in these pages, to bring out some of the fundamental problems of finance and direction which are common to all sorts of practically directed research, giving just enough attention to methods employed to make clear what we are talking

about, and how the various types may be provided. These materials, it is hoped, may be helpful toward answering questions like these: What sort of systematic research and creative planning work, if any, does a given concern need? How much money can it profitably spend on such activities? Which of them should be provided through internal departments? Which done outside, and where? In what ways is it expedient to subsidize practical research, by public or philanthropic funds? For the purpose of securing the needed information numerous inquiries were made, by personal visits and correspondence. Some experiments were made with questionnaires, in the hope of presenting information in quantitative form; but both the breadth of our inquiry, and the unsettled state of vocabulary relating to it, make useful results of this sort appear unduly expensive at the present time.¹

Definitions. "Research" is a somewhat slippery term and thought too "high-brow" by some business people. How shall we use it and related terms in the following discussion? In the narrower sense, research means the impartial, critical, carefully controlled, and (where possible) quantitative study which extends the frontier of a science. Ordinarily the earmark of such work is publication of results in the scientific journals. Research of this fundamental type is carried on increasingly in industry; and few sciences, if any, have not felt the impact of profit-motivated investment in it. But from the economic and business standpoints, such research has much in common with many less dignified sorts of pioneering and "fact-finding". We need often to keep in view the whole array of specialized workers who continuously and systematically investigate either practical or theoretical problems for the benefit of their employers, and who only incidentally perform other functions, such as carrying on production routines or creating propaganda. For the sake of brevity we may sometimes stretch the expression "industrial and commercial research" to include a confusing variety of departmental names; for example,

¹Some directories of research agencies and publications are cited below, especially on pp. 16 and 17. In addition see "Business Research Activities" in *The Management Review*, December, 1927, pp. 399-401, and the series on *Better Business Through Research* by The New England Council and Metropolitan Life Insurance Company.

Laboratory, Development, Progress, Statistical, Engineering, Planning, Standards, Methods, and Market Analysis. Many or most of the people working in these systematic-improvement jobs, indeed, do not have advanced scientific training, and their problems are so narrow or common place as to have no general significance for science. "Development" or "progress" are doubtless more accurate terms for them. The scientific researchers are the higher officers; the development workers are the non-commissioned officers, of the army of progress.²

And we must not overlook the indispensable privates of this progress-army. The current literature of industrial research often exaggerates the part of formal research in the totality of industrial progress, sometimes by unduly extending the concept "research" to include bright ideas of all sorts, however they are hit upon. Yet the "line" organization, from general manager to common laborer must always contain brains of a highly creative order, otherwise the day-to-day operating and marketing resistances would not be promptly overcome. These people, of course, outnumber, by hundreds to one, the "staff" people whose primary specialty is creation of new products and methods. Consequently, in the aggregate, the contributions to progress

²"Doubtless you are accustomed to thinking of research as an adventure into the realms of the absolutely unknown. A department capable of research in this sense will only be possible in a small business when that business happens to have in it a real scientist. But every technical business (and what manufacturing business is not technical?) is continually confronted with the need of more information than is possessed by its regular staff in regard to processes, characteristics of materials, etc., and if it is to develop realizes that it must find new fields for its product and find new products to sell. The most advantageous solution of problems of this character can not be left to people who are busied with the routine problems of sales and production. They can best be handled by a staff, even if a very small one, set aside for this purpose. I want to suggest that any department having such functions may be called a research department, and that industrial research may be defined for any given establishment as all that class of work which enlarges the technical horizon of the establishment beyond what is necessary for the routine production and test of its product. And I should want to have it called a research department even if the research be chiefly carried on in libraries or other places for the purpose of bringing information, elsewhere well known, to an establishment to which that information happens to be new." M. B. Leeds, "Industrial Research in Small Establishments," *Science*, N. S., L (November 14, 1919), 445-448.

Compare p. 10 below.

of the line and of the non-research staff are bound to be very great. It is clear, then, that the manager's development and research policy, broadly considered, should include all feasible methods of energizing the whole force to think more continuously and effectively toward finding better ways—by means of an employees' suggestion plan, for example, but it should also provide for setting some people at creative work, with special facilities, for all or most of their time.

FUNCTIONS: THE KINDS OF INDUSTRIAL AND COMMERCIAL RESEARCH

The foregoing general view of development, progress, and research-planning specialists may now be supplemented by a more detailed analysis of their functions and methods. For this purpose any or all of several points of view may be adopted, especially

- a. that of departmental lines of business organization—production, sales, etc.;
- b. that of peculiarities of industries, such as manufacturing, mercantile;
- c. that of fundamental research methods and principles employed; and
- d. that of agencies through which research is financed and organized, such as internal departments, consulting specialists, trade associations.

In the present section we shall make some use of each of these standpoints and the materials thus made available will be applied in the following sections to problems of finance and organization.

Departmental lines; production research and development: The major functions which have been recognized by means of distinct departments, in substantially all but the smallest businesses, are (a) Production (or operating); (b) Sales; (c) Offices and Accounting; and (d) Finance. Among mechanical industries, a division of (e) Engineering is practically universal. The newer major divisions, now struggling for places in the sun, include (f) Personnel or Employment or Industrial Relations, (g) Purchasing, (h) Credits and Collections, and (i) Traffic. In connection with all such types of work,

and their numerous sub-types, we may find specialized research units, internal or external. The laboratories and other research units in the service of production are more conspicuous, and have had a longer history than the progress-units of other divisions; but these facts do not necessarily indicate that this type of industrial research is more important for a business today than any of the other types mentioned.

Chart 1 shows the location of units which perform the research and development functions in Rowntree and Company, Limited, of York, England, manufacturers of cocoa products employing about 7000 people. In the Appendix (p. 65) are given notes indicating further the nature of these units. This organization is scarcely "typical" of medium-sized manufacturing enterprises. It is rather unusually elaborate on the research and progress side, but for that reason it is especially helpful in supplying us concrete examples, as our description in more general terms proceeds.

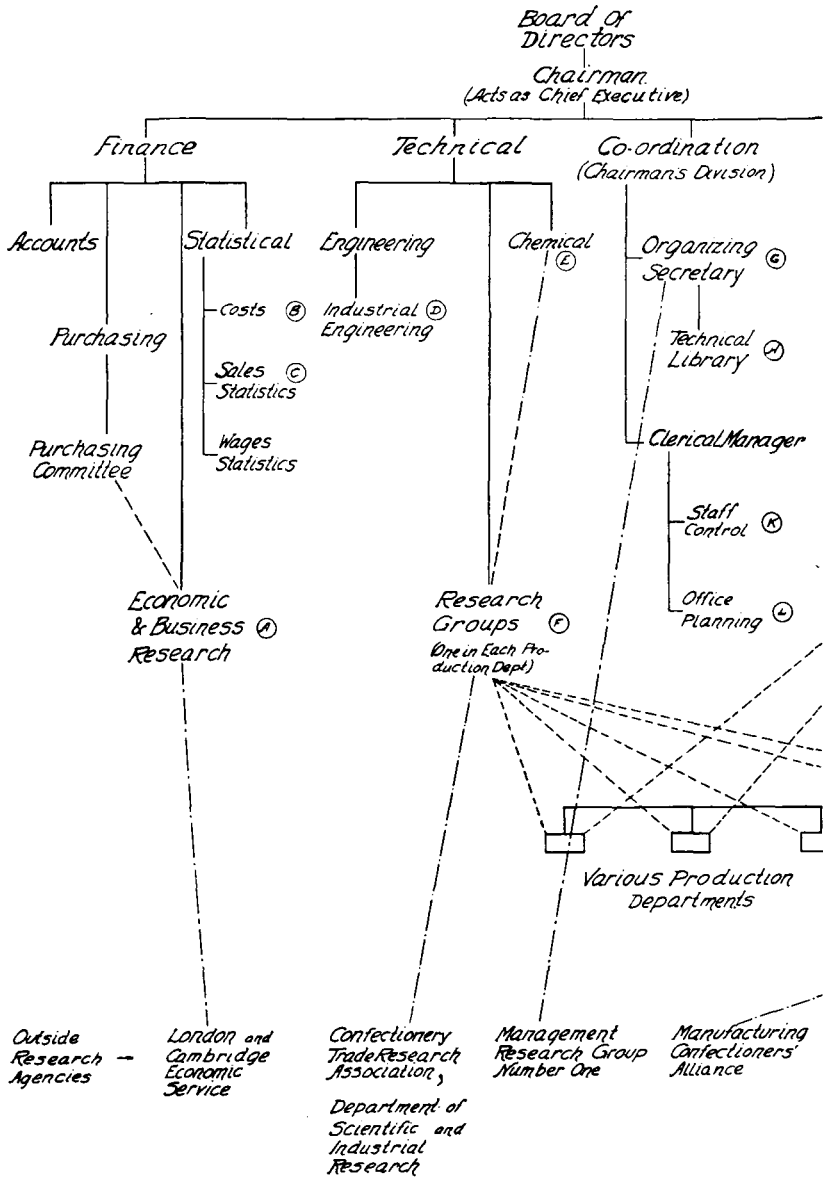
Starting on the natural-science and engineering side of the main fence running through the research world, we may notice first the ordinary testing or control laboratories, whose operations are almost purely routine. These departments test samples of molten metal, corn flakes, coal, or what not, in order to see whether the batch is ready for pouring, or whether a seller has delivered materials up to specifications. Such work is clearly not research, yet it is not unusual (as in Chart 1, E) to use some of the control laboratory's apparatus and personnel in the service of really creative work—finding comparative values of experimental products, or at least improving the testing routines. A rubber company's research manager has said that "the factory control is never quite distinguishable from research."

At the other extreme from the purely control laboratory is the laboratory which is devoted mainly to fundamental or pure science research. Among the statements made recently by nearly 1000 American companies to the National Research Council, giving data concerning their "industrial research laboratories", one finds not infrequent mention of fundamental research on the properties of metals, gases, electric forces, etc., which are important to the employer's art in the long run, but hold out no promise of immediate profit.³ Inter-

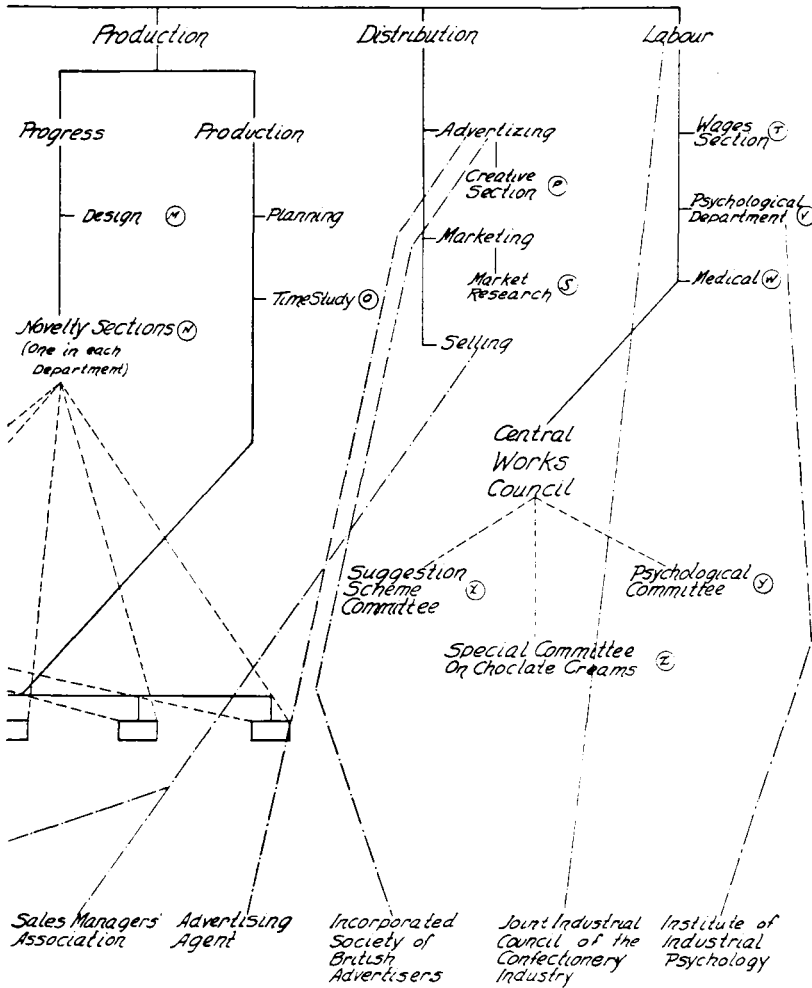
³National Research Council, Washington. Bulletin No. 60, July, 1927.

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CHART I—LOCATION OF UNITS DEVOTED TO RESEARCH AND PROGRESS
ROWNTREE AND COMPANY, LIMITED



- ⊙ Circles and capitals indicate location of Research and Progress work.
(See Appendix for further description)
- - - - - Broken lines indicates co-operative or committee relations within company.
- . - . - Chain lines indicate liaison with outside research organizations.



mediate between the purely control laboratory and the purely research laboratory are the departments often styled *development*, whose job is ordinarily schematized as the reduction to commercial practice of discoveries made in the scientific laboratories. In the outstanding industrial research organization, like those of the big electrical and chemical companies, actual organization lines conform in some degree to the above distinctions. Bell Telephone Laboratories, Incorporated, for instance, contains departments designated Research, Apparatus Development, Systems Development, Outside-plant Development. Their other principal unit—the Inspection Department—is also devoted to development of the manufacturing inspection art in their industry. The Eastman Kodak Company maintains separate divisions of scientific and developmental research within its laboratories.

The distinction we have just made is elaborated by Dr. Mees, director of the Eastman Kodak Company's laboratories, in the following excerpts:

"[Development] is founded upon pure research done in the scientific department, which undertakes the necessary practical research on new products or processes as long as they are on the laboratory scale, and then transfers the work to special development departments which form an intermediate stage between the laboratory and the manufacturing department [They are] really small scale manufacturing departments

"The commonest mistake is to transfer laboratory work to the manufacturing department too soon; experimenting in a manufacturing department is a costly matter, and the experimental work should be done on a small scale under control of the laboratory before any attempt is made to transfer it to a full scale manufacturing department."

"The development department will study all proposals for new methods, processes, or products, which may be submitted to the company, and will report on them. . . . [It should] be able to survey the whole of the industry every few years, thus keeping fully in touch with all the developments which are taking place, and directing the flow of invention and experimental work into those channels which seem most likely to be profitable."⁴

This function of keeping in touch with the art outside the firm often involves study of the patent records and literature. In the General Motors Corporation the patent branch of the legal staff plays a prominent rôle in this look-out work.

⁴C. E. K. Mees, *The Organization of Scientific Industrial Research*, pp. 79, 80.

The conventional distinction just noticed, between pure science investigation and applied science, we shall find of great importance in our discussion of the financing of research; but we must hasten to recognize that it seldom comes out sharply and obviously in actual research units. Laboratories like Dr. Whitney's, in the General Electric Company, carry on pure science researches in an outstanding way; yet small divisions working on specially troublesome operating problems, and even units manufacturing in a small way products like molybdenum or cathode tubes, are to be found in them. The most theoretical scientists in industry are naturally more alert to make practical applications of their discoveries than are the same order of scientists who are in university posts. On the other hand, as the last paragraph quoted from Dr. Mees shows, the conception of development as merely *applying* the science previously produced by simon-pure scientists, is quite inadequate. The developers often start with practical needs, then hunt for whatever scientific data gives promise of assisting them, and often in the end have to create whatever science did not exist ready-made for their problems. Thus, during a visit to a laboratory of the type of Dr. Whitney's, the writer inquired what part of its work is initiated by its own staff, and what part is done at the request of other units of the company. An administrator obligingly made a rough tabulation from the enormous budget, showing that about half the number of projects, and half the expense involved, had originated in requests from other departments of the corporation.

The foregoing paragraphs outline the main types of the industrial research carried on in natural-science laboratories of the physical, chemical, and biological sorts. These practically directed laboratory studies are often called electrical engineering, chemical engineering, engineering research, and so on; for engineering is the meeting ground of theory and practice. The Bell System laboratories, for a number of years prior to their incorporation, were operated as the Engineering Department of the Western Electric Company, which is the System's manufacturing unit.

Having inspected the scientific laboratories, we next take stock of other groups of specialized improvers. The older branches of engineering, and some of their newer offshoots, serve in this capacity, notably the engineering design departments and the sections of industrial or efficiency engineering (see Chart 1—D, M, and O). None of these divisions is as close as the laboratories considered above, to the frontiers of the maturer and well-recognized sciences; they are, however, well suited to interpret the shop men and the research scientists to each other. Recently an operating superintendent told how his factory's large inspection costs had been greatly reduced, partly by the application of the theory of probability by "highbrow mathematicians" from the research laboratories. The "design" engineers, who create (partly by routine methods) plans for new or special machines, products, structures, etc., often have to deal with currents of consumers' tastes and preferences which are not yet reduced to exact measurements; hence a new motor car design is a work of fine art as well as of practical art and science. To this design the sales and financial managers of the concern contribute ideas, based largely on what they think would "go over big" in an advertising and sales campaign. The machine designer has to depend on guesses to a great extent, on many factors not yet well understood scientifically, such as fatigue in the machine operator. Fundamentally, however, design and development are both types of creation; in both cases a new form in the objective, and rule-of-thumb must be used where a scientific foundation is not at hand. Whatever the nature of the materials dealt with, the scientific foundations for design may be extended by careful study.

In the Rowntree firm, as Chart 1 shows, prominent organs for systematic improvement of products and methods are the "Research" and "New Products" groups (F and N). Each of the main commodity departments of production contains such groups, which are described by the management in the following terms:

"The Production Division (headed by an officer of the company) consists of two functions: (1) the Production Function,⁵ which is directly responsible for

⁵"Function" is used by this company to designate a main unit within a "Division". The "functions" are composed of "departments", which in turn contain "sections".

the day-to-day management of all Production sections concerned with output and (2) the Progress Function, which is specifically concerned with the improvement of Production methods and the introduction of new products. In each production department there is a Novelty Section (J) consisting of [confectioners] with special capacity for thinking of new sweets, whose work is co-ordinated and linked up with the requirements of the Merchandising Function by the head of the Progress Function. In addition, the head of the Progress Function co-operates with the research groups in pressing for the introduction of improvements in machinery and processes. He controls the time study department. Under Technical Division is also listed The Research Group Function (F), which does not control any Department, but is the connecting link between the Engineers especially engaged on Research and improvement work, the technical side of the laboratory, and the production departments.

"Each production section is under constant investigation, process by process, by a group composed of chemists, engineers, and the practical men in charge of the department. The group works through the whole of the processes, examining possible alternatives, and suggesting improvements or alterations once in every 3 years."

No doubt the New Products unit is much more active in some specialty lines, like confectionery, in which consumers are accustomed to frequent novelties, than in divisions turning out staples, like soda biscuits.

The industrial engineering or scientific management movement is still in a state so fluid, so much influenced by consultants who advise on all phases of management problems, that we find difficulty in characterizing it accurately, even for our limited purposes.⁶ Within a factory (especially in mass production industries like automobile manufacture), the department called industrial engineering, efficiency, or some equivalent term is often found functioning like a control laboratory, computing daily labor costs, in order to detect promptly any lapses in efficiency that may occur within any department. Time-study of repeated operations, in order to assist scheduling and to set standard times for piece-rates, is a staple function of this type of engineering. The scheduling operation is often called *planning*; though the latter term is occasionally applied to units whose function includes industrial engineering or other original investigations.⁷ The latter

⁶See, for example, C. E. Knoepfel & Co., Inc., *What Industrial Engineering Includes* (New York, 1921).

⁷See papers of B. Eugenia Lies, Director of Planning of R. H. Macy & Co., Inc., on "Scientific Management Applied to Department Store Practice" read to

sort of department is usually engaged in something like research, whereas the mere scheduling department is not. It would not be possible to schedule production or sales or office operations satisfactorily, however, without preliminary studies to determine standard times. Another significant name sometimes used for the industrial engineering type of department is *methods*. Research toward determining standard times easily involves studies to find what methods, equipment, layouts, etc. are most economical. F. W. Taylor and other scientific management people have always insisted on the importance of this standardization of the working situation, before using the stop-watch for rate-setting. If it is seldom done in thorough-going fashion, apparently it is usually done to some extent where any pretence of industrial engineering is made at all. Still other cohorts in the forces of industrial engineering or scientific management are the interest in organization relationships, the emphasis on economic considerations, and use of cost accounting techniques. Not all departments marching under these various colors are doing any research or development worthy of the name, but a number of them are; and in the aggregate they make up an important wing of the industrial and commercial research and development movement.

Marketing, management, and other social-science types. The foregoing varieties of research and near-research in industry, for the most part, bear mainly upon production. They depend on natural-science techniques; they deal primarily with *things*. We have now to examine briefly the social-science types, which deal more largely with *people*, or with socially-determined facts. This sort of research also influences production, but its main connections are with sales, finance, and personnel management (See Chart 1—A, B, K, L, M). The germs of analysis of a firm's own records for finding causal relations were seen in accounting, long ago. But it remained for the business statistician in recent times to elaborate internal records, to collect external data, such as production in his industry, population in various areas, indicators of business conditions, and to analyze all these more thor-

the Taylor Society (New York, 1925), and "The Technique of Determining the 'One Best Way'," *Measuring Office Output*, American Management Ass'n., 1926.

oughly for the sake of better predictions. The term "statistical department" is not accurately descriptive; for all research, even chemical and electrical, increasingly employs statistical analysis. The various sorts of units which are rapidly multiplying on the social-science side are often rather out of touch with one another, because they are controlled by the corresponding line executives, such as sales manager, treasurer, purchasing manager, or personnel manager. This situation creates one of our main problems—that of co-ordination of research activities. Some main sub-divisions within this field of business statistical, commercial, and management research were outlined a few years ago by Weld then statistician for Swift and Company, and by Folsom, of the Eastman Kodak Company, in similar terms; namely, analysis of sales results and sales methods; market analysis; analysis of advertising results; study of business conditions and business cycles; analysis of raw material markets; determination of sales quotas; new uses for products; and labor relations.⁸ Both these companies have made studies in the subjects named, through central business-statistical departments. Sometimes the analysis of internal data relating to a single problem reaches gigantic proportions and involves the most intricate mathematical technique. An example is the study, by an associated group of public utility companies, of the effect of price-changes on traffic. In fact, any company of even moderate size is bound to accumulate considerable internal data regarding its sales, by territories, price-classes, and product-groups, as well as data relating to its selling costs, advertising returns, wages, ratings of employees, and so on, which a research worker can analyze to any degree of elaborateness that may appear profitable. This research analysis will ordinarily require the supplementing of the internal data by information from outside, on such matters as the general price-level, income and wealth of the various territories, as well as sales and wages of competitors and of other industries.

⁸L. D. H. Weld, "The Progress of Commercial Research," *Harvard Business Review*, I, 175-186; M. B. Folsom, "The Organization of a Statistical Department," *ibid.*, II, 178-192. Folsom's article discusses and illustrates methods of analysis and presentation; Weld's gives more attention to the agencies and tendencies throughout the whole field.

Agencies; comparative studies. In both the natural-science and social-science types of research, numerous outside agencies, as well as individual-business internal departments, are rapidly developing. A rough index of this movement in one field is furnished by the compilation of the United States Department of Commerce, entitled *Market Research Agencies, a Guide to Publication and Activities Relating to Domestic Marketing*. In this directory an attempt is made to include all organizations which are publishing or mimeographing any materials which are useful for market research. Hence many offices are included whose data-collecting activities are of a rather mechanical nature, and on the other hand doubtless many organizations which are doing high-grade commercial and financial research, but are keeping it confidential, are not included. In the 1927 edition, the 737 agencies in the United States entered as engaged in market research are divided as follows:

Federal Government	209
States and Municipal Governments.....	31
Colleges, Universities, and Foundations.....	134
Book Publishers	17
Commercial Organizations:	
Advertising Agencies	6
Business Services	12
Chambers of Commerce.....	63
Co-operative Marketing Associations.....	6
Individual Business	25
Magazines	48
Newspapers	87
Trade Associations	99
	—
Total Commercial	346
	—
Grand Total	737

The list appears to be reasonably complete as to departments publishing economic and business research work; and some technical investigations (like the study of "Harvesting and Storing Sweet Potatoes", in an agricultural experiment station), which have some bearing on marketing problems, are also included. The United States Department of Agriculture, within the last year or two, has prepared long

mimeographed lists of researches in progress on agricultural engineering, agricultural economics, and doubtless other fields of interest to the Department.

We have, too, some indication of the corresponding proportions of agency-types in personnel (labor management, industrial relations) research, which, except for its economic branches relating to wages, cost of living, etc., is now becoming distinguishable from the commercial research mentioned above. In 1921 the United States Bureau of Labor Statistics published a bulletin (No. 299) on *Personnel Research Agencies*, on a plan somewhat similar to that of the market research directory just noticed, though much more diluted with mere college courses in the field. In this volume one searches in vain among the hundreds of government departments, universities and other institutions (besides a few trade associations), for references to more than two or three individual businesses. No doubt the studies in departments like those described by Weld and Folsom should have been included. Nevertheless, the inclusion of nine individual firms, among the forty or fifty organizations which were actively supporting the Personnel Research Federation in 1927,⁹ seems to indicate both that private business is now a larger part of the spear-head of real research on labor relations, and that the bulk of the fundamental work is still being done elsewhere.

Space is lacking to illustrate the subjects, methods, and accomplishments of these main types of research (the titles listed in the directories mentioned give a good idea of their scope), but we must call special attention to the co-operative exchange of information, within trades, which is an outstanding characteristic of present-day, practical research. By interchanging certain data with each other, managers are setting up better standards of good performance in their various operations (as to unit-costs, labor turnover, etc.) than they could form on the basis of merely their own experience. Certain trade associations, such as canners and gas makers, have co-operated somewhat in this fashion, for technical research, during two or three decades. And trade associations among merchants—for example, grocers, clothiers, jewelers, wholesale and retail—have supported the

⁹See inside cover of *The Personnel Journal*, for list.

pioneer comparative studies of operating expenses and the like, by university bureaus of business research.

These co-operative comparative studies are statistical, so far as quantitative measurements are feasible. Exchange of non-statistical information also plays a rather important research rôle. The statistical type, exemplified by the Harvard series on operating expenses in various mercantile trades in specified years, involves promulgation of a uniform system of recording or accounting, so that the data supplied by each co-operator will refer, as nearly as possible, to the same things as the corresponding figures supplied by others. In these trades, hundreds and even thousands of firms have used the standard recording schemes, and have reported their figures to the central agency (under safeguards against disclosure of their identity). Doubtless many others, without contributing, have been glad to compare their own data with the published reports, to see whether their labor costs, advertising, rent, rate of turnover, and so on, are "high", "low", or "common". Co-operative interchange of labor turnover and other personnel data has had a somewhat slower development. (The University of Pennsylvania's Department of Industrial Research started its work in this field in 1921, about a decade after the operating-expense studies, above mentioned were begun.) It is now, however, well under way in a number of quarters, including our own Bureau.

Exchange of non-statistical information also has been engineered by various research agencies, who digest the replies of co-operating firms to make a single report on such a topic as methods of paying salesmen. The numerous "case studies" of the schools of business administration, and the research reports of the American Management Association and National Retail Dry Goods Association, will serve as examples.

In addition to the extensive trade association and university types of co-operative interchange of data, there are several more limited forms which serve a similar purpose, and are still distinct from internal departments of individual concerns. In this connection we must observe that consultants who serve more than one firm on the same type of problem are *ipso facto* comparative researchers in some degree. Naturally the studies of consultants are often so superficial and rule-

of-thumb as to be of no scientific consequence; but many others, of a more serious nature, are to be found. A representative of a big firm of public accountants writes:

"We maintain a large statistical department which constantly accumulates information derived from the thousands of audits we make each year. We have done a great deal of work on market analysis, feeling that the so-called public accountant's responsibility to his client goes beyond the mere matter of audit detailed.

"We have in our organization specialists in all of the phases of business management and control, who use our audits principally as a basis from which we can constructively criticize our client's operations and assist and guide them in laying down a policy for the future."

Similar claims, of course, are constantly made by counselors on industrial management, engineering, marketing, and so on.¹⁰

Another, and perhaps more significant, development of recent years is the co-operative research association, organized by a small group of non-competing firms. Groups of about a dozen each, of large department stores, only one in a city, have been conspicuous in this movement. One such group of stores has supported the Research Bureau of Retail Training in conjunction with the University of Pittsburgh, in which special attention is paid to personnel problems.¹¹ The Life Insurance Sales Research Bureau (now at Hartford, Connecticut) has been supported co-operatively by most of the American life insurance companies for several years, and seems to have accomplished some significant results in spite of competition among the sponsors. Sixty-seven companies contribute comparable sales data to this agency, which also specializes on inquiries concerning qualities required for success in selling.¹² Another example is the Manufacturers' Research

¹⁰Mr. John D. Rockeiler, Jr., is understood to be underwriting, in a non-commercial way, the research activities in labor matters of Industrial Relations Counselors, Inc., which also collects fees for a consulting practice. This step recognizes that commercial service and scientific research in this field do supplement each other, yet that much research which is socially desirable cannot at present be commercially self-supporting.

¹¹This organization has just announced the publication of a volume, *Personnel Research in Department Stores*, a report of its studies, 1918-1925.

¹²A favorable comment on it is given by J. A. Stevenson, of the Equitable Life Assurance Company, in American Management Association pamphlet entitled *Co-operative Research in Sales Management*, 1924. The pooling of data on sales and prices, etc., for an industry, through a central bureau of any kind,

Association in Massachusetts, composed of about ten non-competing concerns in the Boston area. It may be that the data on prices and quantities sold, now collected from members by a number of trade associations, are being used in some cases for research as well as for mere circulation among members.

Finally, reference should be made to the staff specialists who devote themselves to special functions like operation and advertising, and who are found in the head offices of many businesses, especially in large combinations or chains. As we shall see when these functionaries are discussed below (pp. 49-60), their work exhibits some of the essentials of research.

This review of the principal types of specialized progress-work, by business departments, may now be supplemented by a glance at the total research-situations of a few other sample companies, in order that we may realize more clearly how these activities ramify and dove tail.

Our first example is supplied by the "Universal Office Appliance Company" (fictitious name) which employs some 8000 to 10000 people. The data supplied by this company for the National Research Council's bulletin on industrial research laboratories mention only the director, 12 chemists, 3 electrical engineers, 5 mechanical engineers, and 2 metallurgists. The company's organization chart, however, shows a number of other workers engaged in specialized creative work. Nearly 200 people are employed in the engineering division, including sections of inventors and designers of new models, and experimental mechanics. A staff of 10 is listed in the "future demands" section. This company maintains a suggestion-reward system, as well as some provisions for economic-statistical studies on markets and business conditions. Committees of high and low executives on future needs and new materials are chartered. We have here, then, a rather complex organization for deliberately insuring that the organization keeps

has had an uncertain legal status, as many prosecuting attorney and judges have held that it violated our laws against monopoly and restraint of trade. Recent decisions of the United States Supreme Court (Maple Flooring and Cement cases, 1925), however, gave sanction to interchange of information of the sort we have been considering. See I. L. Sharfman, "The Trade Association Movement," *American Economic Review, Supplement*, March, 1926, pp. 211, 212.

abreast of the times—it is decidedly more complex than one would suppose who looked merely at the scientific laboratory. This “overhead” appears to outsiders remarkably heavy (as compared with the Rowntree situation, for example), in that there is no regular seasonal style element in the product.

The General Electric Company interests maintain, in addition to the famous scientific and development laboratories at Schenectady, Cleveland, and Lynn, a number of separate engineering, experimental, and testing laboratories. They have also a small army of other specialized engineers, connected with the various product-divisions (such as railway equipment, or central station apparatus). A co-ordinated suggestion system extends through all the factories. Some important researches in vocational tests have been reported from the company’s “Human Engineering Laboratory” at Lynn. There is, moreover, a Bureau of Methods in the comptroller’s staff, which Bureau plays a purely research and advisory rôle in regard to office equipment and operations throughout the corporation. Undoubtedly further inquiries would reveal several other real research units, especially on the marketing and economic side.¹³

The General Motors Corporation’s central laboratories in Detroit, employing some 250 people, and the widely advertised Proving Ground, are certainly major factors in improving the motor-car art; but they also are supported by a great array of other specialized creators. The Advisory Staff of the parent corporation carries on economic research and business analysis; and the subsidiary divisions do a vast amount of pioneering, through their own engineering and laboratory organizations. The Cadillac division, in fact, reported to the National Research Council a research staff of 24 technical men, with as many assistants. The Eastman Kodak Company’s research and development laboratories are widely known; and in this company, too, may be found several other active creative units: the plant engineering organization, the suggestion plan, the industrial economy department, and the statistical department, are all of this character. As a last

¹³General Electric Company and General Motors Corporation are listed in the Department of Commerce publication, *Market Research Agencies* (1927), p. 98.

illustration, notice how much more extensive is the total of systematic improvement-studies in the Bell Telephone System, than appears on the surface. Bell Telephone Laboratories, alone, employs nearly four thousand people at an expense of fifteen millions or more a year. Like the other leading industrial laboratories, its activities range from investigations in atomic theory to the routine drafting of final designs and small-scale manufacture of novel apparatus. Yet the parent American Telephone and Telegraph Company carries on a large amount of other systematic creative work, through its divisions of Development and Research, of Operation and Engineering, and through a staff department in charge of personnel problems. Where one draws the line as to what is research, indeed, in a central body like this, is quite arbitrary. In the Western Electric Company, a subsidiary of the System, one may also find hundreds of graduate engineers, scientists, and other specialists engaged in design, development, cost-reduction, and methods-improvement, throughout all the main branches of the business, including purchasing.

Some further illustrations of actual combinations of research-units will be cited in the following sections, in connection with the special topics therein discussed.

FINANCE: HOW MUCH SHOULD A COMPANY SPEND FOR RESEARCH?

We have now analyzed and illustrated the principal types of research and other systematic progress-work in industry or business, from the standpoint of functions performed. The chief problems which we are now to consider—of finance and organization—are very closely intertwined. On the whole, it seems most convenient to deal first with the size of the total research-budget.

Problems similar to this have been studied by several of the agencies we have just considered. They have inquired how much may reasonably be spent for advertising, for example, first, by checking returns from specific advertising, so far as possible, and second, by collecting actual advertising expenditures from a number of concerns, in relation to their respective industries and volumes of sales. This latter method is immediately indicated for developing something like "standard" research and development budgets. But it is doubt-

ful if the time is quite ripe for this application, because so few concerns as yet keep accounts in such fashion that the cost of all their specialized creative work can be even approximately segregated, without prohibitive expense.

Among the numerous difficulties standing in the way of standardized statistics of this sort is the question whether or not expenditures for patent protection and litigation should be included—presumably separately earmarked. Patent protection is a necessary expense in connection with many kinds of research and development work: on the other hand, some large concerns have notoriously used their legal resources to infringe upon the patent rights of other people. It is difficult to regard the latter activity as a member of the research and development family.

Fortunately the firm of Rowntree and Company, Limited have taken the considerable pains necessary to make an estimate of the sort just considered, and we are enabled to present in Table I the resulting figures.

TABLE I—EXPENDITURE ON RESEARCH AND DEVELOPMENT OF ROWNTREE AND COMPANY, LIMITED, EXPRESSED AS A PERCENTAGE OF NET SALES¹

Unit	Year	Year
	1926	1927
	%	%
A. Economic and Business Research Department.....	.037	.037
B. Costs ($\frac{1}{8}$) .....	.009	.008
C. Sales Statistics ($\frac{1}{4}$).....	.058	.045
D. Industrial Engineering .....	.174	.185
E. {		
F. { Chemical .....	.314	.397
G. Organizing Secretary .....	.041	.036
H. Technical Library .....	.007	.063
I. {		
K. { Staff Control ($\frac{1}{4}$).....	.023	.021
M. Design ($\frac{1}{3}$) .....	.020	.025
N. Novelty Sections .....	.210	.222
O. Time Study ($\frac{1}{2}$).....	.023	.020
P. Advertising—Creative ($\frac{1}{3}$) .....	.038	.034
S. Market Research .....	.093	.057
T. Wages Section .....	.021	.018
V. Psychological Department .....	.061	.069
W. Medical ($\frac{1}{4}$) .....	.016	.014
X. Suggestion Scheme .....	.008	.008
Total	1.195	1.159

¹See Chart I, p. 8 above, for location of these units, and Appendix for notes giving further information about them.

It is explained that the total expenditure is a lower percentage in 1927 than in 1926, not because research work was cut but because sales increased. The chemical laboratory, research groups, novelty sections, and industrial engineering, taken together, account for over half of the total which these people consider they are spending on work of a research nature, within their own organization. The firm also contributes substantially to the British Confectionery Trade Research Association started with a government subsidy. This is one of the bodies which we discuss below (p. 45). Many or most of the numerous other trade associations and the professional societies to which this concern pays dues have some research significance actual or potential.

Leeds and Northrup Company, of Philadelphia, manufacturers of electrical measuring instruments, have kindly supplied data on the percentage which their development expense has formed of their shipments, which are presented in Table 2.

TABLE 2—DEVELOPMENT EXPENSE OF THE LEEDS AND NORTHRUP COMPANY,
EXPRESSED AS A PERCENTAGE OF SHIPMENTS

Year	Percentage of Development Expense to Shipments
1912	11.6
1913	7.6
1914	10.6
1915	7.1
1916	5.2
1917	5.0
1918	3.0
1919	2.0
1920	3.2
1921	3.8
1922	4.4
1923	2.2
1924	2.8
1925	3.2
1926	2.9
1927	2.5

The ordinary development expense for 1928, some \$81,000, forms 2.5% of the sales. If \$40,000 of unusual expenses incurred in this

year are included, the total becomes 3.8% of sales. Shipments in 1912 were \$108,000; the last two years they have run over \$3,000,000. Further material from this company is given below (p. 36), also in the address of Mr. C. S. Redding, Vice President in charge of development and engineering, to the American Management Association, November 13, 1928. These expenditures are all for technical development, not for improvement of sales, personnel, or office methods.

Some conception may be formed of the expenditures of each of the one thousand companies listed in the National Research Council's *Industrial Research Laboratories of the United States* (1927), for the natural-science and engineering type of work. The number of equivalent full-time physicists, chemists, and engineers is usually given in each case, as well as the number of assistants. The salaries of the trained research men probably follow those of engineering graduates generally, data from about 6000 of whom have recently been collected by the Society for the Promotion of Engineering Education.¹⁴ The top ten percent, from the standpoint of earnings, of those who graduated in 1924, started at around \$1,800 a year. In the top ten per cent of those who had graduated five years earlier, the minimum income in 1924 was \$4,200 a year; of those graduated ten years earlier, \$7,500 a year. Other tables in the bulletin give the impression that graduates of five years' standing, or less, predominated in the personnel of engineering research departments; nevertheless a considerable sprinkling of older and generally higher-priced men are quite necessary. Additional expenses in the way of assistance, materials, equipment, and overhead usually amount to as much as the salaries of the technically trained people, if not more.

The annual sales and profits of many of these concerns are matters of public record, so that it might be possible to work out some very broad ratios along these lines and make some tabulations of companies by size, by industry, by geographical situation, etc. Standard, or at least average, research budgets will undoubtedly be compiled in this fashion, and will be valuable, but only when data are collected which are really comparable. It is not clear whether the National

¹⁴*Journal of Engineering Education*, October, 1926, pp. 172-216.

Research Council attempted to define "industrial laboratories", in the questionnaire on which their bulletin is based. In the present circumstances, therefore, the statements we often see, that Companies A, B, or C are spending so much annually for "research", or even more specifically for chemical research, market research, and so on, are of some interest, but they are sure not to be comparable with similar estimates for other firms. What A calls research B will call engineering, or perhaps planning, or mere supervision.

In the face of these difficulties, we must be content with very meager data on budgets, but it is worth while to consider in somewhat general terms the larger factors which economically influence expenditures for research and development. By research, development, and progress-work (it should be recalled) we mean any specialized investigations toward improving any phase of the art (including the routine work subsidiary to the progress-function), as distinguished from carrying on operations according to the present art. The very same operations, therefore, are properly in the research budget, while they are in the experimental stage, and in the production or sales budget when they have passed into standard practice. The factors influencing research expenditures, to be discussed here, are nature and size of business, integration, educational needs, availability of research services, and possibilities of measuring profits derived from research.

Nature of industry. Everyone has noticed that the chemical and electrical industries (manufacturing and public utility) are outstanding for their scientific work. Why? Doubtless these industries—and the optical and other scientific-instrument concerns which are also prominent, in proportion to their size—have been peculiarly dependent on research for their origin and continuance. But several other factors may also be discerned. Personalities within the dominant houses of these industries are probably significant. For example, would General Motors have its present large research staff if the DuPonts had not come into control? Again, the comparatively recent origin of chemical and electrical industries gives them a position different from industries with older, handicraft, rule-of-thumb traditions; and the still more extreme youth of the motor companies prob-

ably makes them progressive, by comparison with older trades. In the latter, so long as no strong competitor (in the same or a competing industry) utilizes research in a practical and highly profitable way, all of the firms in the field can straggle along in their customary relative positions. Until recently the textile industry, pioneer in mass production, apparently has been rather static in regard to systematic research.¹⁵ The same comment is sometimes made with reference to other veterans, like the iron and steel, mining, railroad, mercantile, newspaper, and financial businesses. It must be remembered, however, that the older types of civil and mechanical engineers, in the railroads, mines, and equipment shops, have long performed many of the functions which are now carried on (with more leisure and precision) in research laboratories. Hence the progress-function was not so much neglected in the old industries as seems the case at first sight. Also, there are differences among industries in the proportions of research which are financed through trade associations and by government or philanthropy, as compared with internal work by individual concerns. Agricultural research, for example, in this country has been generously supported by the state; medical research by both public funds and donations; and railway research to some extent by co-operative action. Finally, it is claimed that the railroads were long handicapped, as to research expenditures, by too drastic regulation of rates.

When all these factors are taken into account, it remains remarkable that manufacturing is so far the leader in all types of research which get into published lists. Only one railroad appears in the National Research Council's list of industrial research laboratories,

¹⁵Beginnings were made, to be sure, some time ago; particularly, perhaps, by certain machinery manufacturers, consulting chemists, and management corporations. In Britain the state-subsidized trade research associations have been operating for a decade; and in 1926 the Cotton-Textile Institute, Inc., was organized by the American industry, under the presidency of Mr. Walker D. Hines. In this organization, according to its circular, "A new Uses Section is in charge of the development of new outlets for cotton products, of work in standardization, simplification and applied research. A Statistician and a Cost Engineer are in charge of the work relating to statistics and cost accounting respectively." The organization maintains a research associate in the United States Bureau of Standards.

while most of the big public utility companies are represented. Aside from these utilities, and a couple of mail order houses (which are also manufacturers), this list appears to contain only manufacturers. Manufacturing also predominates in the list of 25 "Individual Businesses" given in *Market Research Agencies* (1927), published by the United States Department of Commerce (which also mentions three railroads, and several banks and insurance companies). More than three-fourths of the 81 trade associations listed by the Chamber of Commerce of the United States (1925) as conducting co-operative research (economic as well as technical) are of manufacturers.¹⁶ (The remainder of the last-named list consists mainly of a few extractive industries, like the wood, asphalt, and walnut industries; and groups of small industries, notably the printing, laundry, and bakery groups.)

But in spite of this semi-statistical evidence that research has thus far found its place principally in manufacturing, it is difficult to believe that such a state of affairs will long persist. The competition among industries is now so intense, and the process of integration brings new methods into old industries so fast (witness Ford's coal-mining methods) that any sizable business apparently must become scientific if it is to survive even in an ancient craft like building construction.

We have seen that manufacturers are engaging in economic research in considerable numbers. It may also be that concerns which seem non-technical, like mercantile and financial, will soon find attractions in technical research. Most large merchants are already using routine testing laboratories. It is only a step toward more constructive study to see what new commodities, packages, or combinations, will better serve their own and their customers' needs. And large concerns in most lines of business have operating routines and equipment which give scope to industrial engineering—planning layouts, labor-saving devices, and methods of work, for economy.

Besides the concern's own business operations, the nature of its relations to its customers is a factor worth considering. Giving

¹⁶Chamber of Commerce of the United States, Department of Manufacture, *Cooperative Industrial Research, a constructive activity of trade associations* (Washington, 1925), p. 38.

research-services to customers, without obligation, is a recent development—part of the “service” movement, so conspicuous in modern selling. The publications of banks on the business outlook are in point, and a remarkable case is the Policyholders Service Bureau of the Metropolitan Life Insurance Company. Here is found a staff of experts, not only in industrial hygiene and safety, but in other features of personnel administration, and even in production, sales, and problems of general management. Though this seems a new trend, the manufacturers of equipment for other lines of industry (not of consumers’ goods) have long been accustomed to giving engineering services to customers, as a normal sales expense. A street-railway system, for example, would ask an electrical equipment manufacturer if the latter could design some improved type of ticket-taking apparatus. The equipment-maker’s engineers would take the leading part in this study (assisted by engineers and experts on the traction company’s staff), and presently electrically-operated turnstiles would replace “ticket-choppers” in the subways.

Size of business. It appears that the type of industry may have a less important influence on research, in the long run, than has the scale of operation. Obviously a big company can afford a degree of specialization in research, as in all other functions, which a little one cannot. In turn, the efficiency which results from such specialization is a leading cause of the steady increase in the scale of industry; though always the forces of conscious co-operation among smaller units, and of unconscious co-operation through the commercial supply of special services (e.g. consulting laboratories or marketing counselors) offer resistance to this increasing-size movement.

“Scale of operation” is an ambiguous term. It may be conceived in terms of finance or of employees. It is enterprises which are large in terms of man-power which have exhibited most strikingly the tendencies toward specialization of human function; manufacturing, of course, is the leading example. But financial and wholesale mercantile businesses are often large-scale in terms of capital employed; and consequently they have opportunities to make large aggregate savings out of small unit-economies. A business which is large, in either of these senses, has strong provocation toward specialized

research for finding unit-savings. This chance apparently is harder for managers to see, when the number of workers is relatively small, than when it is large. The big banks, for example, have all acquired the habit of publishing statistical letters on the current business outlook; and they, as well as stores and insurance companies, are beginning to do some industrial engineering on their office equipment, routines, and management organization.¹⁷ It would seem that they have made rather less progress toward separating research and planning from executive and detail work on functions really peculiar to their own business, such as demonstrating the worth of new types of service, or improving the loaning and investing functions.

The lack of satisfactory statistical measures makes it impossible to learn just how research expenditures vary by industries with total sales, employees, profits, or any other measure of size; but the general indications are that small concerns may obtain a foothold by venturesome expenditures on research, and that the larger the company, the more may profitably be spent in this direction. The following statement, written to us by a scientist who has been an outstanding leader in industrial research, is a valuable bit of testimony:

"With regard to the expenditure of a company on research, this depends upon two factors, (1) the necessity for the production of new methods in the company—that is, on the competition and the state of the market, and (2) the nerve of the directors. My first adventure in research was in a very small company, where our necessities were as great as our poverty, and our nerve was unequalled. We spent 10% of our gross sales on research—an amount more than equal to our profits. At the end of two years we were very near to showing a deficit because we were spending all our margin on research, but at the end of six years we sold our shares for three times their par value. I never heard of a firm going bankrupt because of reckless expenditure on research, and provided research is well directed I am not sure that it is possible to spend too much on it from a financial point of view. There is of course a limit to the amount of research that can be utilized by the manufacturing and sales departments in a given time, and too much expenditure might result in an expansion of the business into other fields and a consequent spreading out too thin of the executive ability in the company; also it is not wise to spend too much on research at the beginning. It is easy to make great plans which result in little profits. Research must grow gradually like any other section of

¹⁷See H. A. Hopf, "Problems of Bank Organization." *Bulletin of the Taylor Society*, XII (No. 2, April, 1927).

a business, but I am fairly certain that no company has yet explored the limits of expenditure on research in the way for which, for instance, the limits of expenditure on advertising have been tested."

Somewhat similar in effect is the reply, from another pioneer in the budgeting of industrial research, to one of our inquiries:

"We do budget the work of our Research Department and the expenses have a tendency to grow with the business, but we have never made any conscious effort to relate them. In general, I should think that the size of a Research Department would always depend on the size of the business, but I see no reason for a very definite relationship."

CONSOLIDATIONS AND RESEARCH

If, as we have suggested, research is generally a more secure investment for large businesses than for small, and if it yields the fabulous returns in profits that are often claimed, then it may be a powerful impulse toward industrial consolidation. We have made some inquiries as to whether the provision of centralized research has been a leading motive in the formation of big business combinations, but have found no evidence that it has.¹⁸ In some cases, of course—conspicuously the telephone situation—the economies of centralized research are urged strongly by the officials, and it may have been an important factor in the growth of the Bell System, which has maintained active research organs from its very beginning. It may be, however, that their large expenditures for research are to some extent the *results* of quasi-monopoly profits, as well as the *cause* of increasing efficiency.

It is likely, none the less, that consolidations have real and special opportunities to profit by research, though their promoters may not yet be fully aware of them. Consider, in this connection, a paper

¹⁸One economist who has participated, as an important stockholder, writes us on this point: "I think there is no evidence of this in the business consolidations with which I am intimately familiar. No central engineering laboratory or market research division has emerged from the consolidation of" Another economist, who has made a special study of trust problems and has collected first-hand data on a large scale, writes, "Not to my knowledge has any recent or established consolidation been organized with the primary end in view of centralizing research work, or even of promoting it upon a more liberal scale."

by Halford Erickson, formerly a prominent state public utility commissioner, now vice-president in charge of operations of the Byllesby Management and Engineering Corporation, on Principles of Group Utility Management.¹⁹ Mr. Erickson, in recounting the various economies which a combination of scattered gas, electric, and railway companies makes possible, refers to the specialized overhead services provided by his concern in these terms:

"Following are the principal operating functions as they are carried out in the central organization: 1. Operating efficiency; 2. Purchasing; 3. Insurance; 4. Valuation; 5. Rates and contracts; 6. Advertising; 7. Merchandise sales; 8. Accounting.

"The operating force on each of the individual properties is similar to that usually found on independent properties, with the important exception that the personnel need be sufficient only to carry out routine work in accordance with the policies and methods prescribed by the central operating and engineering organization."

He proceeds to describe and illustrate these overhead services in detail, beginning with

"Operating efficiency. The engineers in this division specialize on the operation of electric generating stations, gas plants, transmission systems, distribution systems and general operating methods. They have their headquarters in Chicago, but spend a large part of their time traveling over and inspecting the subsidiary properties. They are at the service of each local operating force for the purpose of assisting in the solution of the various problems that may arise and they also take the initiative in checking up on local operating practices and remedying undesirable conditions."

This case throws a new light on our subject, since these people do not call their work research, development, progress, or planning. Two, at least, of the Byllesby operating subsidiaries have research laboratories, duly listed by the National Research Council, but at headquarters there is (or was, in 1927) no division ostensibly devoted to research. The specialized supervisors mentioned, however, have opportunities for study, through comparative statistics from all subsidiaries, the company library, and travel, which give their activities much of the essence of research. We found the same situation at

¹⁹*Electrical World*, May 28, 1927. That central engineering and management services are sometimes a cloak for excessive profits in the public utilities is charged by M. R. Scharff, "The Public and Their Utilities," *Atlantic Monthly*, September, 1928.

the headquarters of a large chain of retail stores; no research or even statistical department, but a number of supervisors over the various functions common to all the stores. This type of specialist, clearly, must be considered in relation to the total research-picture of industry and commerce.

Whatever may be thought of the total social import of giant business combinations, there is no doubt that by spreading its cost over a large volume of sales they make possible very expensive research, whose benefits may not mature until a distant future. But may not the same result be obtained by the voluntary co-operation of a great number of small concerns? Everyone has heard how little it costs each orange-grower (or consumer) to maintain the valuable co-operating marketing agency in California. Undoubtedly co-operative research has a great future, and so in the following section we shall discuss it at some length; but here it must be noticed that a complete ownership-combination has the definite advantage of being able to *enforce* payments from subsidiaries for the central research. The Ford Motor Company or General Motors Corporation can virtually levy an assessment for the central services against every unit sold throughout these organizations. In a trade association, on the other hand, members tend to shrink from paying for co-operative research, partly from fear that their competitors, who have refused to support it, will share equally in benefits with those who have paid. The possibility of collecting research and development expense from beneficiaries is one of the limiting factors in the financing of any research. In this matter, large business units have a distinct advantage.

Another factor, also related to the trust problem, has been suggested by Dr. Mees: the factor of integration. An integration of various supplying and using industries, like the United States Steel Corporation, has a better chance of harvesting **profit-returns from** research than does a "horizontal" combination (like sugar-refining, in which all units do the same thing), of the same aggregate financial size. This greater probability of returns results from the fact that all the practical uses which will emerge from any one research are impossible to predict; and the greater the variety of business fires in which the financial backer of research has irons, the greater is the

probability that his research will turn up some sort of discoveries which he can use for profit.

Other factors; measuring output of research. Two further factors which are to be considered in relation to the research budget (availability of research services in the outside market, and the personnel-training functions which a research unit may supply) will be developed somewhat in the following sections on Co-operative Research and Organization respectively. But before leaving the cost-and-profit point of view let us notice possibilities of checking up on past research activities, to obtain some quantitative indications whether they are worth their keep. Obviously the problem is even more difficult than the corresponding questions regarding institutional advertising and certain personnel activities (in which function, indeed, research units sometimes have a share); yet some progress has been made toward its solution.

The first step toward improved judgments in this field is a cost accounting system, adapted to research administration. Commercial research agencies, of course, find something of the sort indispensable, since they must charge clients with some relation to the cost of work done for them. Internal research departments, too, often find this "unproductive" labor worth while. It enables the cost of a given investigation to be compared with its fruits, so far as the latter can be measured or estimated; and especially are the cost records useful in forecasting the expense required for a proposed new research. The essentials of such a cost system are fairly simple. Each project is given a number, and a record is kept of all expenditures of labor and materials directly used on it. It is also charged an "overhead" for administrative and general costs of the research unit. In Mr. Caswell's system, we are told, "The amount of overhead (charged against each hour of direct work) will vary very much according to the work done in the Laboratory; in an analytical laboratory it may be as low as 100%, in a laboratory engaged in pure research it may reach twice that figure."²⁰

²⁰Mees, *Organization of Industrial Scientific Research*, pp. 127-29.

Industrial engineering sections in industry are prone to accumulate records of the cost-saving which they claim to be mainly attributable to their efforts. The annual report of such a division, in a certain large factory, looked something like this:

I. Projects Recommended after investigation.	
Estimated savings	\$1,300,000
Estimated costs of new equipment required.....	400,000
Average time required to pay cost of change.....	3.3 months
Actual savings on projects of this class put into operation this year.....	\$ 400,000
Actual savings on projects initiated last year.....	300,000
	\$700,000
II. Projects studied but not recommended—would not pay out within one year.	
Estimated savings in one year.....	\$ 50,000
Estimated costs	100,000
Average time to pay.....	2 years
III. Projects studied but not recommended, showed operating loss.	
Total estimated loss.....	\$130,000

The payroll of this industrial engineering division was about \$12,000 a year, in relation to which the actual and prospective savings listed above are very impressive. Probably the section would not claim exclusive credit for these results, since some of the studies were doubtless suggested and assisted by production units. In this case, as in most others of the sort for obvious reasons, the originators' estimates of savings are supposed to be checked and validated by the accounting department. Sometimes they must also be checked by the line heads in whose departments the changes have been made. Similar routines are often found in connection with rewards to employees for suggestions: the rewards being proportioned to savings estimated in the above fashion.

From the natural-science laboratory types of research often emerge patents, products, and processes whose value is comparatively easy to determine. Naturally the administrators of the research do not allow the aggregate returns thus indicated to be lost from view by the owners of the business. In mass production like the telephone industry, the cost reductions effected by improved methods and designs

soon run into staggering totals, as Professor Pupin's published calculations of the millions saved by his own inventions indicate. The figures of this sort which we have seen cited appear to be somewhat inflated, in that the unit cost reduction effected by the invention is multiplied by the new scale of production, and the resulting figure is called the aggregate saving. We are not told whether or not the enlarged output was made possible by a reduction in price per unit realized by the employing company. Clearly the proper measure of aggregate commercial benefit to the employer is the increase in his net profit on this unit, from the old method and output, to the new method and output. If other factors, such as competitive developments or labor costs, also change so as to cancel part of the advantage from the invention, then the invention is simply that much less of a commercial success.

A concrete example of an actual attempt to measure both cost and value of a research department is fortunately supplied us by the Leeds and Northrup Company. After describing their research organization and cost scheme, Mr. Leeds says:²¹

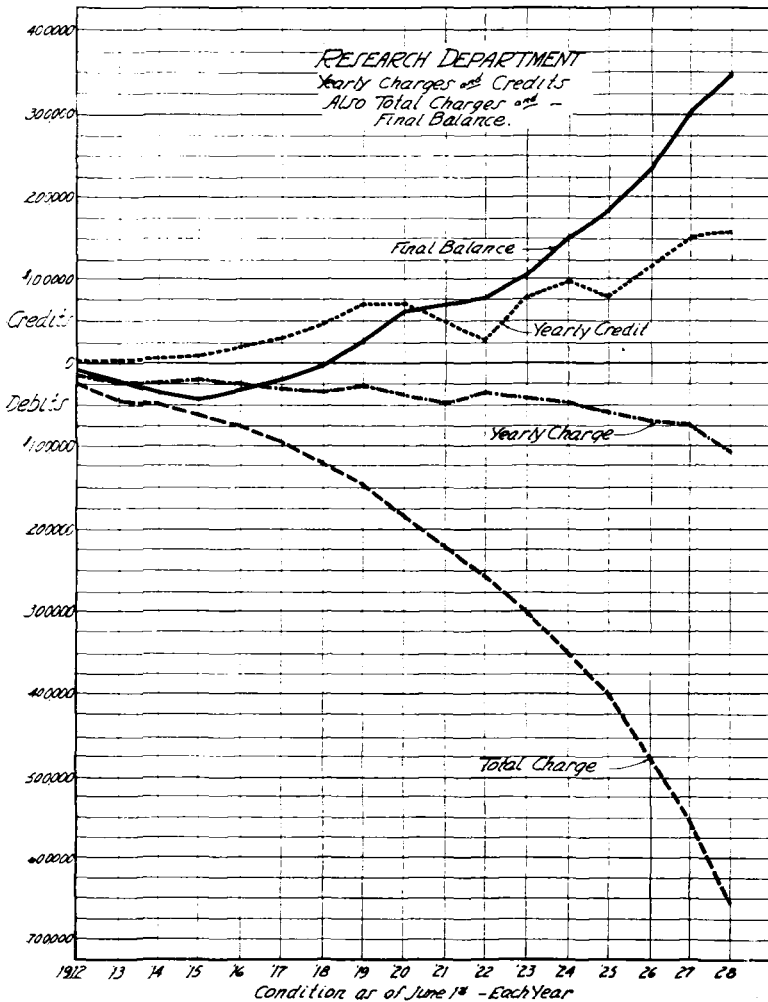
"... when an investigation is closed its total cost is determined. If it happens to be one that has to do with manufacturing processes, such as test of new materials, etc., or development of new methods, it is either charged to general expense or to the expense of some particular product. If, however, it is a piece of work which results in the development of a new instrument or product for sale, it is treated in the same way that a new instrument developed and brought in by an outsider would be. The research committee decides how much royalty can properly be charged to the cost of the instrument, and then as each instrument is made the royalty is added to its cost and is credited against its cost account in the research department. In that way a continuous record of the usefulness of the research to the business is available. In cases of minor importance it is customary to discontinue credits when the cost has been covered. In cases where new products result they are allowed to run on indefinitely. Successful developments accumulate royalties that more than pay for the cost of their research and offset the costs of work that leads to nothing. The diagram shows the relation of annual and accumulated costs of research to the annual and accumulated credits since the department was given a distinct place. In a little over six years the total credits had equaled the total charges and the balance went to the credit side. On the books the account is closed out each year to profit and loss. It is carried forward as a

²¹*Science*, N. S., L. (1919) 445-448. Apparently in this case "research" does not include commercial or personnel or industrial engineering investigations.

memorandum account only. In the earlier years of the record the total volume of business done by the company was but a few hundred thousand dollars per year."

Chart 2 gives a picture of the financial status of this company's development (formerly called research) department for each of the seventeen years 1912-28. The "Total Charge" line at the bottom is cumulative, as is also the top line labelled "Final Balance." The cumulation

CHART 2—RESEARCH ACCOUNT OF LEEDS AND NORTHRUP COMPANY



of total credits is not shown, but evidently in 1928 it had reached about \$1,000,000, since the net balance figure stands at \$350,000 on the credit side, while the total charges aggregate some \$650,000.

When Mr. Redding (Vice President of the company in charge of Development and Engineering) exhibited this chart at a recent meeting of the American Management Association, he made some interesting comments (which will soon be published by the Association). He said that the favorable present showing is made possible by development work done in the first few years, while the development department was showing a net expense. The financial outcome of development work done in the later years is still uncertain.

The foregoing historical record, therefore, illustrates the proposition that some time must usually elapse before commercial returns from a research program actually come in. One of our correspondents says that the attempt to find just what the product of research is worth, though feasible, is not usually made "because the research director shrinks in the early stages from the knowledge that he cannot justify his expenditure; and in later years from an appearance of over-assertion of the value of his laboratory as compared with the contributions made by the other departments of the company (such as production and sales) whose co-operation he is very anxious to retain."

This last point is also emphasized by the head of industrial engineering in the same company with the correspondent just quoted. The engineer tells us:

"While we started out originally with periodical reports of savings, it was soon found that it was frequently better to give full credit to production officials, even though the idea was not of their initiative but had to be sold to them, and the reports occasioned some question, so that they have now been discontinued."

Another correspondent testifies:

"We have had a Research Department in this store for a great many years. In the initial stages there was an attempt made to estimate the savings attributable to its work, but this was eventually given up. . . . The Research Department had a tendency to go out and make a name for itself, and as a result antagonized other divisions of the store."

Perhaps these diplomatic considerations are more important in the early days of the research unit than later, when it has been accepted as part of the natural order of things by the other department heads. But if diplomatic considerations must still be taken into account estimates of savings accomplished through various projects might be made for the purpose of determining what types of study are paying best returns, without raising the question as to division of responsibility for initiating and carrying through the project. The example cited above serves to illustrate this possibility. Determination of relative values, after all, is the prime question on which research-accounting should throw light. Though many of the returns are bound to be intangible, this fact should not excuse us from making what use we can of the measurements that are feasible.

In this section we have made some progress on the problem "How much can a company afford to spend for research?" by examining the influence of nature and size of industry, integration, and the means available for measuring returns. We have seen that standard budgets are not yet available because sufficiently comparable records have not been kept and collected, although a few actual expenditures can already be given, and furthermore, some notion of the expenditures of various companies can be gathered from reports as to number of workers in their research laboratories.

CO-OPERATIVE RESEARCH. SUBSIDIES

The shopping problem in research involves also another prominent item: the types of service available in the market. We can never quite decide what we are willing to pay, in any buying-situation, until we know what alternatives are offered. The research market is increasingly offering co-operative and commercial arrangements. The characteristics of these are worth some attention by the largest companies, and still more by smaller concerns.

Notice first certain remarks of Dr. Mees:

"The success of private industrial laboratories has led to a belief that co-operative laboratories would be equally successful, but this belief ignores certain essential aspects of the matter.

"When an industrial research laboratory is supported by a single manufacturer it will be part of the competitive system of the industry, so that the manufacturer will be stimulated by competition against rival manufacturers in the same industry to use his laboratory to the utmost extent. Moreover, to a single manufacturer a laboratory has a considerable advertising value, and its possession is commonly used to instill confidence among his customers in the products of the factory. It also serves as a school for the training of skilled technical employees who can be transferred to other branches of the business when necessary. Even when employees are not so transferred, the presence of a number of men acquainted with the industry, but with specialized scientific training, in daily close association with the other employees of the company cannot fail to be of value. Finally, a private laboratory can be entrusted with trade secrets of great value and can often take a valuable part in the executive direction of the business, especially where new products or methods are being considered.

"None of these advantages exist in the case of a co-operative laboratory. It cannot by its very nature aid one manufacturer in competition with another, it has an advertising value only for the industry as a whole and not for the individual firm, it may train men for the industry but this is as likely to assist his competitors as any individual manufacturer. Furthermore, great difficulties attend the carrying out of work which involves trade secrets in any co-operative laboratory, and few manufacturers would care to discuss their plans for the future with the officials of such a laboratory."²²

What, then, can be done by co-operation? Dr. Mees goes on to argue that trade association financing and management of research is most likely to be successful in regard to work on raw materials and uses of products, since these subjects are of very general interest in a trade. Processes and designs of products, on the other hand, are by nature much more competitive; they tend to develop trade secrets. Fundamental scientific research offers still another resistance to trade association operations, for it

". . . is a difficult and slow business, from which little can be expected for many years, and the only product from such a laboratory at the beginning would be therefore a number of papers published in the scientific press and written in language which would quite possibly be incomprehensible to many of the business men who had each year to pay their assessment for the support of the work. At first, no doubt, they would feel a certain amount of pride in the publications from their own laboratory, but this feeling is much less than would be the case if the work had been done in a private laboratory, . . . and one cannot help feeling that before long there would be a strong demand

²²*Organization of Industrial Scientific Research*, pp. 46, 47.

from the industry that the laboratory should do something 'practical', and that work on theory should be left to somebody else."²³

The latter tendency, he thinks, is also exhibited by the industrial fellowships of universities and other non-profit institutions—though these, to be sure, are free from some of the difficulties of research conducted independently by trade associations. Co-operation with governmental and other institutions, moreover, has certain disadvantages of its own, in the way of red tape, divided responsibility, and, in many cases, in lack of assurance that the companies contributing to the financing of a research shall have prior use of its results. In view of all these facts Dr. Mees gave his approval more strongly to the purely commercial consulting laboratory, in which the client's wishes as to secrecy, property, etc., are most readily satisfied.

The difficulties enumerated are real difficulties; and it is evident that co-operative arrangements are not likely to supply all the research needs of large companies. They are not fitted to take the place of internal research departments in medium or large concerns; in fact any firm needs internal specialists, in order to apply to its own work effectively the discoveries made outside, by a trade association or otherwise. But co-operative research organizations do supplement the internal divisions in many ways, especially through the temporary use of expensive facilities and expert personnel. Thus, many of our largest concerns are found co-operating directly, for research, with institutions like the United States Bureau of Standards, Mellon Institute, Forest Products Laboratory, and with professional organizations like the American Society of Mechanical Engineers. The Detroit Edison Company, for example, finances a number of projects annually, through the University of Michigan's Department of Engineering Research and other outside agencies. All these are supervised by the chief of the Company's internal Research Department.²⁴

²³*Organization of Industrial Scientific Research*, pp. 48, 49.

²⁴Professor G. A. Young, of Purdue University, recently stated that about 50 American engineering colleges are carrying on organized research. Fifteen of these, he said, during 1924-25 received more than \$500,000 through co-operative relations with industry. Much of this is supplied by trade associations; for instance, the American Railway Association has spent some hundreds of thousands in co-operation with Purdue and Illinois. The university bureaus

Co-operation appears at first sight to be pre-eminently the resource of small concerns; and the remarkable activities of the associations of bakers, printers, and laundrymen, for example, may seem to show that in fact they are turning to it. But we gather that even in these trades it is the larger establishments who are most interested; for the smaller are less likely to realize the need, or know when and how to use the result of co-operative research. The engineering and business research departments of the University of Michigan have received material encouragement from local associations of gas makers, foundrymen, retailers, realtors, and the general manufacturers' association; but the interest of trade associations has increased rather slowly.²⁵

Scientific property. Questions relating to property in the commercially-valuable results of co-operative research are puzzling, and clear analysis of them is indispensable to the latter's full development. The principles involved come out most sharply in regard to *patentable* discoveries or inventions. Treatment of the individual researcher who is fortunate enough to make a saleable discovery is a large question in itself, but we are here concerned rather with the equities between the interests who underwrite the research (the business co-operator) and the public, in whose behalf the university or other institution is conducted.

The Mellon Institute's industrial fellowship system has been operated for some twenty-two years, on the basis of allowing to the donor of each fellowship, if he so desires, exclusive knowledge and use of

of business research have been assisted by many trade associations, especially of the mercantile sort, and to some extent by individual firms. (See their individual publications, most of which are listed in the United States Department of Commerce's *Market Research Agencies*).

The pamphlet on *Co-operative Industrial Research* of the Chamber of Commerce of the United States (1925) lists 81 trade associations and the projects on which each has conducted research. Over half of these mention co-operation with non-profit institutions, government and educational.

The advantage of such co-operation to the latter institutions are also very considerable, in the way of contributions to science, more realistic teaching, and service to people who are in a position to influence grants of educational or governmental funds.

²⁵See Report of the Department of Engineering Research for 1924 (mimeographed), p. 18.

results secured by the researchers on his project, for a brief term of years. If patents are taken out, they are assigned by the research fellow to the donor. In this respect, then, the research fellow bears practically the same relation to the donor as would a salaried worker in the donor's own experimental laboratory. There is the important difference, however, that within three year (normally) the Institute publishes a monograph embodying the scientific results of the fellow's work. The system has been very attractive to industrialists, especially as to chemical problems. Over 130 fellows are now at work, supported by some \$800,000 annually from donors; and the list of publications and patents for the whole period is impressive.²⁶

The tax-supported institutions have not generally given terms so favorable as these, to their business-concern co-operators. Research associates, paid by firms or trade associations to work co-operatively in the United States Bureau of Standards, Forest Products Laboratory, etc., are required, like the regular employees of these institutions, to publish their important findings immediately, and without any reservation of private patent rights. Under this plan a considerable number of research associates (67 in 1928; the system was started only a few years ago) have been placed in the Bureau of Standards, mostly by industrial concerns and trade associations. Over 10% (or \$70,000) of the budget of the United States Department of Agriculture's Forest Products Laboratory has come, on the average, from commercial co-operators.²⁷ The engineering research bureaus of state universities appear usually to be guided by principles like those laid down by the trustees of the University of Illinois in 1918. These trustees hold title to all patents resulting from such work, and preferential licenses "may be" granted to the business concerns helping to finance a given investigation, with respect only to the fruits of the studies to which they have contributed.²⁸ Under present conditions,

²⁶The above statements are based on the text of the blank fellowship agreement, the abstract of the *Fifteenth Annual Report* of the Director, and the Institute's *Bibliographic Series* (Bulletin No. 1, 1922).

²⁷Based on private communications from both institutions, as well as their printed circulars.

²⁸University of Illinois Engineering Experiment Station, *Circular No. 9*, pp. 18, 19.

such preferential licenses (supposing the trustees grant them) are not of much business value. Business concerns do not like to depend on the trustees for the unfamiliar tasks of defending the patents in court, in case of attack, and of taking the offensive in prosecuting infringers. If the "preferential" licensee bears these heavy costs of litigation, he benefits all other licensees almost equally with himself. The upshot is that these public institutions are somewhat handicapped in securing co-operators for research work from which there is any serious chance that valuable patents will emerge. But even in these instances, their peculiar resources often overcome this handicap.²⁹

Problems like these have not arisen so definitely in connection with co-operative commercial or business-economic research, doubtless mainly because no patents can normally be secured from such work. That is, when no patentable results are involved, there is no clear focal point as to what sort of special advantage (if any) the donor should derive from the research which he assists. Nevertheless, the problem of equitable division of benefits will need constant attention in this field, as contributions from firms on a business-like, rather than philanthropic, or propagandist basis are increasingly solicited.³⁰

But the larger range of co-operative research which is really worthy of non-profit institutions, will yield the private donor a very different sort of special advantage—and one whose legitimacy is not to be questioned. This advantage is the quicker use he can make of the research-results, as compared with his competitors, because his connection with the research is both result and cause of his unusual

²⁹One part of the Mellon Institute plan could be adopted by other institutions with less difficulty than the patent policy; that is, the guarantee that the donor's private data, revealed to the fellow to aid his research, shall not be disclosed without the former's consent. Referring to the scientific monograph which is to be published after three years, the agreement specifies: "The subject matter of such monograph shall not contain specific information regarding the processes or methods of the Donor, but it shall be confined to a statement of new discoveries of scientific fact obtained by this Fellowship [It] shall not contain data or information in regard to the cost of manufacture by any process revealed in such monograph."

³⁰Some discussion of this topic with reference to university bureaus of business research, is reported in the *American Economic Review Supplement*, March, 1923, pp. 223-236.

comprehension of its problems. A good deal of the co-operative business research done, to date, seems to be of this character. The firm which furnishes contributions for studying labor turnover, or operating expenses of a trade, is likely to be better able to apply the results to its own business than is a non-contributor, because the former knows better "what it's all about". Perhaps this condition is due largely to the lack of much internal research on these lines. It may be that as internal research develops, problems of trade secrets and property in results of co-operative commercial research will become increasingly formidable.

In some co-operative researches, also, the difficulty of property does not arise, because the widest possible use of the results is to the business advantage of the donor. A number of the fellowships in the University of Michigan's Department of Engineering Research, such as those supported by gas and electric power companies, are of this character. They are directed toward new uses, or new apparatus and processes, which in some degree will increase the market for gas and electric power.

British subsidized co-operative research. British experience during the past decades throws some valuable sidelights on co-operative research, as well as on many other aspects of the problems we are considering. The Government, through new agencies like the Industrial Fatigue Research Board of its Medical Research Council, and the Department of Scientific and Industrial Research, has subsidized and co-ordinated research relating to industry (principally of the natural-science and engineering variety) on a national scale. The annual reports and other documents published by these bodies give comprehensive views of what is going forward in the whole Empire, always of course from the official standpoint. A few new laboratories have been built wholly or in part by the Government in the course of this campaign (for example, for studies on fuel, food, forest products, and building construction); but the principal expenditures have been made in other ways, as through the National Physical Laboratory (analogous to our Bureau of Standard), and under direction of advisory committees on such subjects as radio, fabrics, adhesives, and dental materials.

A most interesting part of this program, from our present point of view, is the subsidies to trade research associations. In 1926 some 25 of these associations (photographic, scientific instrument, woolen and worsted, motor vehicles, etc.) were operating. In general, they have been subsidized for five-year incubation periods on the "pound for pound" basis; i.e., the government contributes an amount equal to that which members of the association supply. These subsidies range from \$5,000 to \$50,000 a year. Firms belonging to such an association may have individual work done at cost, may "use without charge or on reduced terms any patents resulting from research", and "receive confidentially, in convenient form, such results of research as the Association decides not to publish openly".³¹

A few extracts from the Department's 1925-26 report will make its teaching more concrete:

"The Railways In our opinion a central research organization, under the joint control of the railway groups and equipped to study scientifically the technical problems of railway transport, would do much to maintain efficiency at a high level. It is too much to expect those railway engineers who have important routine duties to undertake in their spare time to give detailed study to the introduction of new methods and equipment which may be suggested by advances in science. The value of co-operative research on railway problems can be illustrated very well by the results of the work carried out under a scientific committee of the Department on the stresses set up in railway bridges by moving loads With the full co-operation of the railways, the chief civil engineers of which are members of the committee, many experiments have been carried out, and the report of the committee, which we believe will prove of first-class importance, will owe its value primarily to the close co-operation of practical men with scientific men of the first rank It has been shown that the stresses in bridges depend closely on the design of a locomotive, and perhaps for the first time in history locomotive and bridge engineers have been brought together in the attack on what is a common problem. The railway companies have borne half the direct cost of the investigations, and also provided the rolling stock and labor needed for the full scale experimental work."³²

³¹Quotations are from the pamphlet on *Co-operative Industrial Research*, published in 1927 by the Department of Scientific and Industrial Research, p. 2. This pamphlet, (illustrated, 46 pp.) which may be obtained from the British Library of Information, New York, gives a resumé of this whole subsidized-trade-research-association experiment, to date. See Dr. Mees' criticisms of the scheme, written in 1919, on pp. 43, 44 of his book previously cited; and various comments in *Nature*, e.g. Editorial on Team Work, April 7, 1928.

³²Report of the Department of Scientific and Industrial Research (1925-26) p. 31.

"The expenditure of the British Cotton Industry Research Association, which is the largest in existence, may be expressed in terms of 1/200th of a penny on every pound of cotton imports: the British Cutlery Research Association, which is one of the smallest, has succeeded in raising from the industry, by the painful process of voluntary contributions, an annual fund of £1,000 for co-operative investigation of new processes which we are assured by prominent men in the industry are needed to save it from virtual extinction: the annual funds raised by industry for the support of the British Electrical and Allied Industries Research Association are at present equivalent to one penny on every 2000 units of electricity generated in this country. Our own opinion is that the system of voluntary contributions to co-operative research associations is inadequate, and we are watching with interest the efforts being made by some associations to introduce some kind of voluntary or compulsory levy on raw material, on manufacture, or on individual outputs."³³

A further opportunity for trade and professional associations may be noticed. They are in a favorable position to supply impartial and expert advice as to where and how a member can get his research needs most economically supplied. The Society of Automotive Engineers, for example, maintains a research department in New York, which functions in this way.

Concerning outside research work, then, we can say that an increasing number of new specialized and expert services are coming up for consideration by the entrepreneur of research for a given company. The ordinary commercial relations, regarding research, with customers or commercial laboratories present few features unfamiliar to business managers, but the truly co-operative forms—voluntary associations and industrial fellowships—exhibit numerous pros and cons, the force of which vary according to the type of research. Investigations on matters of highly competitive importance within an industry, especially when results are comprehensible to competitors, bring questions of property sharply to the front; these are specially suited to private and commercial organizations. There are other types, however, such as studies of materials, protection of metals, and promotion of standards, in which co-operation is easier to sustain.

ORGANIZATION: CO-ORDINATION OF RESEARCH ACTIVITIES

Our next problem relates to the internal organization by which these numerous types of research and quasi-research are managed for

³³*Ibid*, p. 42.

the benefit of the individual concern. This administrative function is truly "entrepreneurial", or managerial in the full sense. It is concerned, not merely with securing competent technicians, and stimulating them to do their best, but above all with financial considerations—finding out, as nearly as may be, what sorts of research and researchers have yielded most profit in the past, and deciding which show best prospects for the future. Practicable means of systematic improvement, for all phases of the business, must be sought continually. The recent history of certain automobile companies illustrates the danger of neglecting market analysis, for the product may become unsaleable through change in consumers' tastes, even though it remains mechanically efficient. In small enterprises, of course, the progress-functions must be combined with other managerial rôles; whereas in large concerns, in which the tendency is toward "a vice-president for every day in the week", there are several possibilities as to specialized direction.

Among the numerous matters which might be discussed under the head of organization are these prominent personnel-administration problems: How shall we find suitable research workers? How shall we pay, and otherwise stimulate them? Detailed consideration of these questions has not seemed quite worth the space it would require, for purposes of the present study. Some hints are indeed given in the following paragraphs on organization relationships as to types of people required; but many aspects of the vocational problem, like the capacities of women research workers, and suitable training and experience, are definitely left aside.

As to rewards, we may say briefly that the usual policy is to pay experimenters on the straight salary basis, in return for which they agree to assign to the employer, without special compensation, any patents to which they may become entitled through their work for him. In order that the inventive group, as a whole, may reach the maximum of productivity in the long run, it is necessary that much unspectacular foundation work be done, leading to no patents; and such valuable inventions as do emerge are thought to be much more truly the product of the group than of the individuals who have the fortune to give the final patentable touch to the research. Furthermore, there are many types of research—commercial, for example—

which can never lead to patents; and in any case the precise value of the individual researcher's product to his employer cannot be determined. It is true that a considerable number of experiments in the way of bonuses and royalties to salaried inventors have been reported, and of course, salaries must be readjusted as often as there is good reason to think the individual's value has changed. Some workers are clearly much more valuable than others. The services of researchers as a class are so important that employers will bid high for capable individuals if they are sufficiently scarce. We have some evidence, however, that research employees often think they are paid less than their product is worth, because frequently their work is so specialized that practically the employer has little competition for their services. In order to reduce this bad morale factor, it would seem that the management should occasionally discuss the matter with the research workers, so that neither side can fail to be aware of the other's arguments.³⁴

Of remaining aspects of research-organization, we select for examination the following: (a) What devices for co-ordination have been tried? (b) What are the prospects of further unification toward a single "higher command" of all engineering, development, and research? (c) What are the desirable relations between research and education? (d) How may both over- and under-centralization be avoided?

As to devices already current, we may notice three main types: (a) integration through a technical staff, under a high official; (b) committees (of executives) on research, development, and engineering problems; and (c) special *liaison* officers for assuring teamwork in producing and utilizing improved practices.³⁵

It is not uncommon to find the natural-science types of industrial research, as well as industrial engineering, in a technical division headed

³⁴Some other angles of this subject are presented in the writer's "Suggestions from Employees", *Michigan Business Studies*, I (No. 3, 1927). Some further references are there given. A recent German publication on the topic, with special reference to the chemical industry, is *Erfinderbeteiligung*, by Lothar Beckman; Verlag Chemie, G. m. b. H., (Berlin, 1927), 190 pp., including bibliography.

³⁵Compare, with the following discussion, *Organization of Industrial Scientific Research*, esp. Ch. 4.

by a chief engineer or vice-president of engineering. In addition to the examples given above, of this type of integration, we may mention the International Harvester Corporation and the Packard Motor Car Company. The Dennison Manufacturing Company has recently organized a major group called the Research Division, parts of which are the Research Planning Department, the Chemical Laboratory, the Rate Setting Department and Methods Sections. Many of the creative specialists are found in other branches of the company, however; in the Engineering division (developing, building, and maintaining plant), in the Economic and Sales Research sections, and in the Personnel division.

The National Research Council's list of industrial research laboratories does not give data as to the steps by which the directors receive authority and funds from the top, and apparently nowhere else has comprehensive information been published on the subject. In general it appears that all types of research units—laboratory, engineering, economic, personnel—usually have been added to existing business organizations in comparatively recent years. Hence they are likely to be administratively responsible to the officials who brought them into existence and who may be chief executives or executives in any level of the line or staff organization. We certainly find them under the wings of all manner of production managers, general managers, sales directors, and what not. We rarely find even all the technical progress-work of a company (engineering, scientific research, methods-improvement, etc.) under single direction; and almost never, a single co-ordinator of all engineering, both material and human.

Such co-ordination as is now accomplished is usually through committees, formal and informal. Informal committee action is exemplified by the sort of co-operation which always spontaneously springs from the mutual interests of the departments. The production manager imports a chemist, let us say, provides him a laboratory and a few assistants, and tells him to find his job. The chemist must thereupon become something of a salesman, whose customers are the executives of sales and advertising, as well as production, purchasing, and so on. Throughout every organization, alert people are continually

piercing the compartments which large-scale operations and specialization throw about them. In the realm of formal committees, also, the possibilities are almost endless as to form, but a few outstanding types may be cited for illustration. In the "Continental Machinery Corporation" (fictitious name), there is a New Work Committee, which brings together the chief research, engineering, production, and sales executives, for consideration of new products. Regular meetings are held fortnightly, with mimeographed exhibits, circulated to all members in advance. These exhibits include such material as letters from sales outposts, reports on experimental investigations, new propositions offered to the company for sale, and leading complaints.

Committee action notoriously has limitations, especially when it tries to get something for nothing; i.e., to get sustained contributions to a group from individuals who are already overloaded with their own specialist duties. Hence some of the larger corporations have established *liaison* officers whose chief job is co-ordination of progress-work. Such a person is often the full-time secretary of the type of committee we have just noticed. For example, in the "Continental Machinery Company", and also in the General Motors Corporation, there are secretaries to committees of production managers or engineers from the various works. These secretaries are to secure adoption, throughout the company, of improved methods discovered in any department or branch. In another large manufacturing company, a single co-ordinator has recently been assigned this type of job in connection with co-ordination of the suggestion systems of the various plants. In the "Continental Machinery Company", besides the device of the New Work Committee mentioned above, there is a man whose job it is to follow up the suggestions and complaints which the sales division receives to see that the research and production people understand these suggestions and take adequate action on them.

We have had a birds-eye view of some actual organizations. Now for some reason-why; some discussion of pros and cons. Searching analysis of several points is to be found in a pamphlet, *The*

Place of Sales Research in the Marketing Organization,³⁶ by Dr. C. F. Hansen, chief of research of the W. T. Grant Company (a chain of 25 cents-to-one-dollar stores). Dr. Hansen properly has a good deal to say about man-specifications as well as job-specifications; for example, as the research movement develops, all executives will acquire something of the research outlook and method in their own work; and research directors must know the business in which they are working, as well as scientific methods in general. "If a statistician comes from a University to become the sales research director of a butter and egg company, he should become a butter and egg man." The first essential in his training, however, is accounting and statistical skill. Hansen further argues that the sales research unit should be directly connected with the highest managing officers of the company, preferably the president or perhaps the comptroller.

"The putting of the research department under the President, as a staff department, leads to impartiality of viewpoint and a lack of pressure from company politics. It is most important, however, that the sales research work be under an officer who can give it intelligent support and who can use the results sufficiently to justify the payroll involved. If the Sales Manager meets those requirements best, by all means the sales research department should be under him."

One objection to normal sales managers, however, for this purpose, is that they "are so far removed from the bankers . . . that the sales research division can render a real service by carrying the sales program to the point where it shows the amount of profit involved in each step in sales work". That is, the salesmen are absorbed in increasing volume of sales, and need independent check-ups on the cost at which various sales are secured. A similar position has been taken on several occasions by Dr. Weld.

The remarks just quoted are directed primarily at marketing research. Do they apply in any degree to other types? Are there net advantages to be expected from more comprehensive directors of research within companies—from further centralization? The problem seems closely analogous to that of personnel administration. In

³⁶American Management Association, "Sales Executives" Series (No. 24, 1926, New York), p. 18. Compare R. B. Flershem of American Radiator Co. *Sales Research Within the Company* (No. 6).

the latter case, centralization as to general policies, records, and methods has proceeded rather steadily; but over-centralization is always recognized as a real danger. The personnel director, of course, should aspire to make increasingly more efficient personnel managers of all executives in his company; and if there is to be a general director of research, so should he try to make industrial scientists out of everyone in sight. But practically, the personnel director will hang on to complete control of the personnel research as long as he can; and the research director will fight for complete authority over all research personnel. Similarly with all other departments. Another obvious difficulty in the way of further centralization of research is the impossibility of any one researcher understanding fully the work of more than a few others. Thus, a time-study man has little enough in common with a dye chemist, and each knows and cares still less about the computations of the market analyst. These barriers appear insuperable to Dr. Mees, who has written us on this subject in the following terms:

"The . . . question [of unification of research-supervision] will depend, it seems to me, on two factors, (1) the size and nature of the business under consideration, and (2) the qualifications of the research director himself. If the company is a small one or even of medium size it is clear that the research director will have a much greater field to cover than in a very large company and that it will be easier for him to cover it, since he will not be so pressed with the problems arising in each section of the work. In a large company, on the other hand, the variety of interests and the importance of decisions tend to produce great specialization. There is, however, another factor which is the dominant one in this matter—all companies are short of first-rate men. Now the research director would probably rank intellectually among the best men in the company since he is selected for his ability and his training, and if he is to be a good director of research he knows the company's business on the technical side better than anybody else does. He not only knows the underlying theory of the business and its manufacturing processes but he ought to know all about the sales opportunities, the developments in the business throughout the world, and be particularly well-informed as to the possibilities for new products.

"Now, if he knows all this and is the kind of man who can become an executive in any field except that of pure research, there are few parts of the company in which his work will not be valuable and the question is not should he take up this or that piece of work but which piece is the most pressing and necessary. Unless the company's condition is such that it is in serious trouble with its employees, the order of importance in which a research director

will place matters will be somewhat as follows: (1) possible new developments to be worked out and placed on the market; (2) research activities leading to new developments in the future; (3) immediate works troubles; (4) research activities leading to improvement of works processes; (5) possible expansion of sales and markets, especially with a view to new introductions; (6) organization matters; (7) cost and budget problems not only in his own but in all departments; (8) personnel matters. In addition to this he is likely to take an active interest in the publicity of the company and quite possibly write some of the technical matter himself. I don't think that most research directors in large companies will have much time to look after personnel relations—it will take most of their time to deal with the first three or four items that I have outlined above.

"The analogy that you draw between a works manager directing a number of operations and a research director controlling a number of matters is not quite just. A research director must understand the whole of the scientific work that he is directing. He need not be as competent in organic chemistry, for instance, as his organic chemist, or in physics as his physicist, but he must understand and keep up with organic chemistry, physics, and physical chemistry, and all of the other branches of science and techniques with which he has to deal, so that he can be competent as a critic, and this will take a great deal of work. If he goes into other fields as I have suggested he will have to study economics and he will have to understand the works processes and it is quite easy to widen the field until he is merely a rubber stamp and no longer really understands what he is doing. When this happens he ceases to be a research director, and unless somebody else does the work, the business ceases to prosper."

Yet several forces are seen to be working in favor of centralized supervision of all types. Not many production managers or general managers can be personally skilled in all the operations in their charge, yet it is clearly necessary that the various supervisors should finally be co-ordinated by a single head or small board. At present the general manager is the final research co-ordinator; and the problem is merely whether he should have a single understudy for this field, in place of a number of part-time understudies on research. Another unifying factor is the library facilities, which are indispensable to advanced research of any type, and in which there is some economy from centralization. The most important centripetal force, however, is the common foundation of scientific method and logic which underlies all research. Dr. Hansen hit on this matter, in leading off his remarks on man-specifications: "The most important consideration, generally, in technical training, is that the man chosen should be accustomed to the logical and systematic method of tackling things-

that is known as 'the scientific method'. If this man has had training in engineering or in one of the sciences, like physics or chemistry, or in logic, he is likely to attack the problem in the right way when he enters the company." Engineering training, notice, is here held to be a good foundation for the development of sales research skill. Among all the real sciences, a common body of mathematical and statistical concepts, like probability, correlation, and measures and significance of variations from the "average", is becoming increasingly prominent. The many uses of training in the weighing of historical evidence is another tie that binds. And so the upshot is that there is more chance than appears superficially that research leaders may be developed with sufficient familiarity with economic-statistical practices, as well as with engineering and other natural-science fundamentals, so that they can supervise the economical purchase or conduct of all sorts of research.³⁷

Such a leader doubtless should not have charge of the activities which have become part of the routine of the business, such as maintenance "engineering" and control testing (overloading with routine duties is an outstanding and insidious danger to all research units); though he should be able to use some of the equipment and personnel in these lines—particularly in the testing and measuring divisions—in creative research, so as to save the cost of duplicate plants for the research division. A great many variations are practicable, in the degrees of advice and authority which a head supervisor may have, as is illustrated already by relations of chief engineers and distant works engineers. The latter must always, to a considerable extent, be responsible to the local works manager.

An argument against attempting to centralize the supervision over all research within a large company, communicated to us by Major L. Urwick, lately Organizing Secretary of Rowntree and Co., Limited, has special authority because of the author's rare combination

³⁷Only two actual organizations built along these lines have come to our attention; those of Armour and Company and The Borden Company. Compare H. B. Bergen, "Why Is an Office Manager?" *Management Review*, June, 1927; also W. J. Donald, "Management Research Methods and Qualifications," *Harvard Business Review*, V (January, 1927), 149-156.

of theoretical study and practical experience. In part, this argument runs as follows:

". . . . Directly you give a man the title of research director, he is apt to think that it is part of his duty as an energetic executive to acquire some degree of control over every activity which can be described as research. Now, as you have found in looking through our own chart, immediately you try to organize a business along modern lines, activities which are in some degree research activities grow up in almost every corner of the undertaking. The imposition of a research director into such an organization would result in a crop of demarcation disputes.

"My own view, and the view which we are trying to work up here, is that if Taylor's conception of the necessity for functionalizing the task of foremanship was sound, the same considerations apply with added force to the higher managerial control. That is to say, the main divisions of the business, though they may be expressed in two dimensions on a chart, are really not dimensional at all, but functional. The authority of the man who is responsible for statistics runs wherever statistics are taken out in the organization, for that subject—and that subject alone. The authority of the man who is responsible for relations with operative labour runs wherever labour is employed in the undertaking, for that purpose—and that purpose only. As Taylor himself pointed out, this completely upsets the old organization theory that no man can serve two masters. Perhaps—more important still—it destroys all the old physical boundaries, the limits of geography and of processes, which defined areas of responsibility in the older forms organization. * * *

"My own view, for what it is worth—and it is expressed in our organization—is that there is only one type of research which usually constitutes a separate activity, viz., the physical and chemical research arising out of the laboratory and engineering work of the organization. I believe this is best built up by a special co-ordinating unit operating under the general controller of both the engineering and chemical functions.

"The kind of research which is required for every function should naturally flow from the activities of the head of that function, financial control being secured by budgetary and similar procedures imposed by the appropriate function. The final question of whether it is or is not worthwhile to employ, for instance, an economic research section, must rest with the president or final executive authority of the business, whatever its form.

"Now as to the question of personnel. It may be argued that good research work requires a particular cast of mind which is not frequently found in men who are also good executive officers. I believe this is decreasingly true. As you obviously recognize, there is a constantly increasing tendency among business executives to be grounded in the common statistical material of scientific method. But assuming that the men with research 'bent' are comparatively rare, I believe it is all the more important that the executives should be compelled to resume responsibility for this aspect of their function, and that the line and staff forms of organization break down completely on this one issue.

The line executive is traditionally a very busy man. It is one of his primary duties as he grows in responsibility, to learn to be less busy, that is, to delegate and train others both to carry out his wishes and also to do much of his preparatory thinking for him. If he has not the research mind himself, the best way to secure that he makes good this deficiency is to force upon him responsibility for progressive work within his function so that he is compelled to call assistance from a subordinate who *has* the research mind.

"Secondly, a number of people are very interested with the staff idea—the conception being that research be done by a lot of people who are *advisory* to the line executives who take all responsibility. I wonder how line executives who take this view think they are going to continue recruiting first-class minds for research work under such conditions? As you yourself note, a man who is fit to be research director is likely to be one of the best men in the organization. Is he going to be content for two minutes to be merely advisory to a number of more important line executives? I don't think so. He will naturally demand more executive responsibility and friction will be set up in organization in consequence.

However, you organize on the functional basis, each of the functional men at the top and second line of the organization—has a perfectly definite function. His function is as essential to the well-being of the organization as the next man. He has an opportunity for large-scale specialization in his own line. He should be given the opportunity for progress, and should be able to make a case for the employment of research staff on his own terms. Research staff should be employed. With the higher man an occasional change of function is probably essential if the supply of future general executives is to be maintained."

What is stressed by Mr. Urwick is, not that central research is an impossible task, but that better results may be obtained by holding each main executive responsible for his share of the business. Each one, in other words, should have a definite rôle—to keep operations going according to plan, and at the same time to maintain whatever progress is possible on his efficiency and provide for progress. The danger is that, as people become available for research, they may easily be misled by the appear-

show more interest in, and make more use of the work of their own research units than in the activities of central research organs.

Still another argument pointing in the same direction is that no high-grade man in business should be exclusively a research worker. If he is, he becomes too theoretical. He should have some part-time operating responsibilities to keep him in touch with practical needs.

Some central services on research methods, nevertheless, are likely always to be useful. Co-ordination of the various progress-units is also clearly a long-run need. The office management movement has demonstrated that improvement methods developed by industrial engineers in manufacturing departments can be applied to advantage in offices; and we have many other proofs that "outsiders" who have made inventions in other fields, have some decided advantages in open-mindedness over "insiders" who are steeped in prevailing operating methods and full of prejudices in favor of the latter. This consideration suggests the need of investigative experience and of contacts between the different research units.

The *educational* relations also affect the progress of research. A number of the "institutes" set up for their industries, and at the same time connected with them in their respective arts. Sometimes these trade schools are connected up in connection with universities; the meat and dairy institutes are examples. An instructor of mechanical engineering at a Ford trade school worked with his pupils on designs for the factory. The groupings of individual companies are held together by trade schools for non-research executives. The connection of these two functions is not intimate.

with arrangements for utilizing men and facilities in both directions.³⁵ One point which has impressed the bakers and laundrymen is that the research institute can afford, better than individual companies, to maintain a "model" plant, kept up to date in all respects. Trainees working in such a plant may be expected to learn something of the best practices all around, as should young farmers in an agricultural college. Many of such "theoretical" ideas, of course, are not fully grasped by the student, or are really not commercially practicable. Hence the trainees must later unlearn these particular ideas in the school of hard knocks.

Some relation of research to technical training is perhaps of value toward avoiding over-centralization of research. Superficially, it seems impossible to over-do the principle of letting experts standardize the "one best way", especially where there is large quantity-production of identical units. The local man on the job has less special training and equipment than these experts, hence apparently there is little chance that he can improve on their designs. But such specialists sometimes need the assistance of fresher attacks on their problems. Their research must necessarily be somewhat sheltered from practical operating difficulties, and so occasionally they send out unworkable or uneconomical designs. They may be so remote geographically that submission of problems to them is discouraged or delayed. Finally, there is little doubt that many, if not all, workers outside the ranks of the experts are more interested and effective if they are encouraged to think about their jobs and try to improve the methods used. For all these reasons, it is desirable to promote something of the research spirit and capacity throughout the working organization. A number of schemes, formal and informal, using individual money rewards or employee representation, are now current, all of which seem to have decided possibilities for developing such co-operation. They try to assure all suggesters that their ideas will be given unprejudiced consideration, and that any money value

³⁵Dr. Mees has written us: "In our industry there is a large number of the more promising young men both in the plant and in the office who have come from the Research Laboratory—this and the Accounting Department are, in fact, the chief sources of supply in the company."

these ideas may have will be fairly divided with the suggesters, individually or as a group. Such methods are educational, especially if suggesters are carefully criticized and instructed; and they represent a step in co-ordination of research, since alleged improvements from all over the lot are judged by a committee composed of experts from the various major divisions.

We have now noticed the existing variety of research organizations, including committees and *liaison* people, as well as formal units; and seen some reasons for this variety. There is much to be said for allowing investigational units to sprout almost anywhere in an organization, in the service of executives who show themselves able to profit by such research, and it is most important that the highest executives should have research service on the major problems of the business. Some drift is apparent toward a vice-president or assistant to the president in charge of the whole of the company's research, technical and development work; but the decentralizing tendencies are also very strong. Educational and research organs usually can be of special service to each other.

DEVELOPING RESEARCH POLICY FOR AN INDIVIDUAL BUSINESS

What does all the foregoing material mean to the individual manager who wants to improve his own research-situation? Not much of an answer can be given unless we know his industry, the size of his business, what sort of people he already has, and the state of his company-politics. But we shall try to give him a few generalized hints, as to how he may make allowance for all these variables and apply to his concern the discussions given above.

The departmental heads of production, sales, etc., must be given large responsibility for systematic development of their arts. This means a considerable variety of provisions, because they will have differing ideas as to their individual research needs, and there is also a place for more general expert advice, toward finding where the best opportunities lie. How shall the general manager get this service? His industry, and the volume of his sales and profits, immediately give some direction to the search. If his business is manufacturing or industrial operations, clearly he must see that his engineering

design, industrial engineering, control of quality, and so on, are in line with the best economical practice. If he is a merchant, on the other hand, chemical research may have little appeal to him; it is the commercial type he mainly needs. Large-scale marketing, in turn, as by a manufacturer or jobber, calls for analysis of territorial quotas, types of distributors, etc., which is quite foreign to the problems of a single retail concern. The latter's research will more naturally concern markets, personnel problems, testing merchandise, developing merchandise standards, and the study of comparative figures of similar stores. Finally, if his business is chiefly financial, like banking and insurance, the first research needed will be mainly of an economic character, such as that directed at forecasting the course of prices or finding comparative costs of making various types of sales. The alert manager, however, will not content himself with the type of research which is most common in his line of business. He will remember that at any place where he has considerable repetition of motion of either people or dollars, there are probably chances of discovering unit-saving by research. Hence progressive stores and good-sized offices apply industrial engineering to their operations; and good practice in manufacturing demands research on market trends and personnel matters, as well as on technical production problems. In any industry the manager should consider whether, by research on problems of interest to his customers, he can profitably improve his relations with them.

Knowing, then, in a general way what sorts of research probably offer most chance for gain, he should look for one or more advisers to audit and improve his situation. How shall he get this service? Commercial consultants will be easy to find, such as testing laboratories, industrial and accounting engineers, or marketing, advertising, and business counselors. Some of these would be able to save him their fees many times over, perhaps in part by training some of his own men for continuing specialized service, as well as by installing systems of improved routine. Advisers are also available—and may well be used to check the opinions of others—outside the commercial field; in universities, professional and trade associations, or government departments, for example: In whatever direction

he looks, our manager must estimate the breadth of their information about commercial and industrial research, their familiarity with practical business conditions (not too narrowly specialized), and their ability to keep uppermost in mind *his* needs, rather than how much service they can sell him. In a general way here, as in legal and medical matters, there is some advantage in buying separately the expert advice and the commodities which the expert recommends, rather than in getting one "free" in connection with the purchase of the other.

Among the various trade associations to which the manager belongs, there may well be at least one secretary or education director who would be a valuable counselor on research. In any case the proprietor is fairly safe in stimulating his trade associations to promote research. The assistance they can secure from non-profit institutions like universities, professional bodies, and government departments, almost daily makes research more feasible and attractive to associations. Limited groups offer still further possibilities: for example, the small groups of non-competing department stores who regularly exchange all manner of confidential figures, and secure central and local research directors to help interpret the comparisons. It would seem that the co-operative business associations who use the same trade-marks and central advertising and testing, each in his own community (e.g. bakers, gasoline-stations, cleaners, druggists, grocery-store groups, confectioners, and shoe-dealers) have special opportunities for co-operative research at low cost to each member.³⁹

It is easier, no doubt, at present to find specialists on a comparatively narrow range of research, than to find broad-gauge experts who know how to fit together the specialties required for the combination most suitable to John Doe. Hence he will do well to play one specialist against several others, in the effort to balance his program, unless and until a new crop of specialists emerge, who really

³⁹A project of this kind, whereby twenty Pacific Coast confectioners are jointly to use the trade-name "Candy Associates" is just reported. Manufacturers and retailers of footwear in New England have organized a \$1,000,000 corporation "to bring chain-store advantages of skilled management, massed buying, scientific merchandising and store control, to the benefit of the independent shoe retailer".

are capable of dealing with industrial and commercial research as a whole. Yet this difficulty is easily exaggerated, for already many of the natural-science consultants are doing something on the marketing side, and a few advertising agencies utilize technical research in behalf of their clients. The industrial engineering and cost accounting consultants have long aspired to administer tonics to all branches of the businesses to which they gained access, from production through personnel to finance, accounting, and sales. They are quite right in emphasizing the interaction of improved methods in all these domains, and doubtless the methods they recommend are ordinarily better than they find when they enter the shops of their customers. A good deal of the best research, like that in cutting metals and selecting employees, has certainly grown out of the scientific management movement. Among present-day practitioners who "doctor sick businesses", however, are many who have little comprehension of really careful scientific research of any kind. Again it may be suggested that trade association research directors have strong incentives toward taking an all-around view of both technical and commercial research problems in their respective industries. The literature on trade association research shows that all types are being tackled; though it may be doubted if any one association is yet covering its ground thoroughly.

As we have suggested, the proper balance between internal and external research agencies is a highly variable affair. The outside services available—commercial, governmental, educational, and trade association—are multiplying rapidly, and they are being used effectively by the largest as well as the smallest concerns. How many and what sort of internal researchers a given concern needs depends considerably on how favorably it can buy such services ready-made as compared with its internal cost of production. And the latter, of course, depends a good deal on the volume it requires. If, because of small volume of trade or other disadvantages, a metal factory can buy castings more favorably than it can make them, it needs not begrudge the "profit" which its supplier makes on the transaction; and for similar reasons consultants' or other outsiders' research services are often advantageous to their clients. Sometimes, as we emphasized

in discussing co-operative research, the element of secrecy is important, and practically dictates the employment of a commercial consultant or of private investigators, instead of collaborating with a university, trade association, or government bureau. In other cases the amount of secrecy which is really essential can be arranged with the latter types of organization.

The manager's faith is often severely tried by the long time which usually elapses before a new research-project can show profitable results. He will be tempted to divert part of the research staff's time to work of more routine nature which needs to be done immediately. This diversion is advantageous for the time being, but it may cripple the goose which eventually would lay golden eggs.

APPENDIX

NOTES ON CHART OF ROWNTREE AND COMPANY, LIMITED¹

- A. *Economic and Business Research Department*, prepares monthly reports on business conditions, follows up competitors' results, follows statistics of prices of raw material and of purchasing power of areas. Co-operates with:
- Purchasing (raw material prices)
 - Marketing (sales estimates)
 - Finance Director and Board (business forecasting)
- Uses London and Cambridge Economic Service.
- B. Statistical basis of all production improvements. Assists:
Statistical Manager to suggest lines of investigation.
- C. Statistical basis of all improvements in selling methods. Publishes weekly bulletin of general selling figures and special studies of lines of special interest. Co-operates with:
- Statistical Manager, as above.
 - Sales Manager, and
 - Market Research.
- D. *Industrial Engineering*. A small section of three or four engineers kept separate from maintenance work and at the disposal of (F) Research Group Manager.
- E. *Chemical Laboratory*. Provides personnel at the disposal of the Research Group Manager (F), does basic research, and also has Analytical and Production Sections, the latter engaged in the control of extraction plants and similar chemical processes. Co-operates with:
- Purchasing, analyzing of materials.
 - Progress, keeping tests.
 - Research Groups, investigation of productive processes.

¹See pp. 8-9 above.

Uses Confectionery Trade Research Association and other Technical Associations.

- F. *Research Groups.* Operates in each Production department, and also for separate questions such as power. They usually consist of representatives of Engineering, Chemistry, and Production control, co-ordinated by the Research Group Manager.
- G. *Organizing Secretary* undertakes research into methods of organization and systems, sometimes carried out by means of special research students, and has one permanent assistant. Also handles control of executive personnel, involving job analysis, grading, and similar research work. One assistant. Uses Management Research Group No. 1.
- H. *Technical Library.* Co-operates with all departments in keeping published information on file, extracting journals, etc.
- K. *Staff Control.* Does some research work into figures of sickness, absences, salaries of clerical and minor technical staffs, etc.
- L. *Office Planning.* Maintains a small staff of investigators prepared to go into any department to investigate clerical methods. Also undertakes research work on forms, office machinery, etc.
- M. *Design Manager.* Assists Progress Manager in supply of boxes and decorations for regular and seasonal trade. Constantly watching for new designs. Co-operates with Purchasing in supply and novelty sections of department in bringing forward accepted lines to the stage of production.
- N. *Novelty Sections.* One such section in each department is constantly occupied in trying to produce new confections, or in working on ideas suggested by the Progress Manager or Marketing Manager.
- O. *Time Study.* Has representatives in all Production Departments engaged on analysis of operations and timing thereof. Co-operates with Wages Section (T), by supplying the material on which rates are fixed, and with Managers of all Production Departments.

- P. *Creative Advertising Section.* Co-operates with Design (M) to secure that new designs for boxes as produced accord with the Company's publicity policy. Has a staff of artists and craftsmen engaged in producing new ideas for window decoration and display. Also co-operates with Progress Manager on new lines.
- S. *Market Research.* Chiefly employed in producing sales estimates in co-operation with Sales Statistics (C). Marketing Manager has two assistants who sometimes undertake field researches.
- T. *Wages Section.* Assists the Labour Manager by examining the statistics supplied by the Wages Section. Investigations into wage methods used in other concerns, and general questions of wage adjustment.
- V. *Psychological Department.* Undertakes selection, motion study, and training. The training is undertaken by specially selected staff situated in the Production departments working in close co-operation with the Production Department Managers and Overlookers.
- W. *Medical Department.* Investigates working conditions in all Departments as well as maintenance of health of personnel.
- X. *Suggestion Scheme Committee.* Reports to Central Works Council.
- Y. *Psychological Committee.* Also reports to Central Works Council. This was set up to guide the Psychologist in the establishment of the Department.
- Z. *Special Committee on Chocolate Creams* was set up to investigate a particular difficulty in connection with the cost of the production of chocolate creams.