THE EARLY SOCIOLOGY OF MANAGEMENT AND ORGANIZATIONS

EDITED BY KENNETH THOMPSON

Volume V

MANAGEMENT AND THE WORKER

F. J. Roethlisberger and William J. Dickson

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MANAGEMENT AND THE WORKER

An Account of a Research Program Conducted by the Western Electric Company, Hawthorne Works, Chicago

BY

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WESTERN ELECTRIC COMPANY, HAWTHORNE WORKS

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To the
EMPLOYEES, SUPERVISORS, AND OFFICERS
OF THE
WESTERN ELECTRIC COMPANY
WHOSE CO-OPERATION MADE POSSIBLE THIS BOOK

FOREWORD

THE WORK described in this volume grew out of our experience in other investigations which revealed a considerable deficiency in our knowledge of the intangible factors in the work situation that affect the morale and productive efficiency of shopworkers. These previous studies had indicated that the human reactions of people engaged in productive work have a much more important effect on their morale and efficiency than had previously been realized. The investigations reported in this book were undertaken in the hope that the light which they would throw on this little-understood subject would be of real value in improving our methods of dealing with employees.

The first organized effort to expand our understanding of the human reactions of employees, which began in 1927, was necessarily crude, but the work progressively took on a research character as it advanced from one development to another, each step pointing the way to the next. This process of evolution is still under way and, as the knowledge acquired is far from complete, the research is continuing very largely in directions which are self-determining.

Originally we were asking ourselves a few rather simple but fundamental questions, the answers to which required knowledge not then available—the natural beginning of a research effort. As the studies progressed, simple and specific answers to the questions we had in mind were not forthcoming, but rather the studies unfolded a much broader understanding of worker attitudes and reactions than had been anticipated. This knowledge resulted not only in a better understanding of the effect on employees of various types of action taken by management and by supervisors but also in a more adequate method of evaluating and dealing with the human problems arising in the business. It became clear that what really was most significant was not conclusive answers to specific questions, but a development in the understanding of human situations which would help to improve employee relations and aid in resolving the problems arising in them when and where they occur. This is the principal contribution of the research, and Messrs. Roethlisberger and Dickson are deserving of much credit for the fine work which they have done in analyzing the results of these studies and recording them in a clear and comprehensive manner.

One may well ask what success our management has had in applying these developments to the human problems of the business, since this is a phase of the work not directly discussed by the authors. Throughout the course of these studies, the points of view which were emerging were frequently lifted out for application to current situations. At the Hawthorne Works, where the studies were made, there was continuous use of the better understanding of human reactions which was developing, not only in dealing with specific situations but in training supervisors in more human and effective methods of dealing with their workers. Much experience has been had in trying out and testing the findings of this research in real work situations and it seems clear that the knowledge acquired has been increasingly helpful in our efforts to create a better relationship between supervisors and workers, the kind of relationship which contributes naturally to proficiency and a high state of morale.

The nature of these studies was such as to require the collaboration of many individuals, both within and without the Company. In such a comprehensive project, mention can be made of only a few of the many who have contributed to the progress of the work.

The advice and assistance given by Professor Elton Mayo of the Industrial Research Department of the Harvard Graduate School of Business Administration were of the highest character and deserve special commendation. He and his staff actively participated in these studies almost from their inception, and the results obtained are due in large part to their enthusiastic interest in the work and to their valuable contributions to it.

Professors F.J.Roethlisberger and W.Lloyd Warner made particularly helpful and enlightening contributions at many critical stages. Professor T.N.Whitehead made an exhaustive and valuable analysis of the records of the Relay Assembly Test Room, which he has summarized in his book *The Industrial Worker.* Professor Clair E.Turner of the Massachusetts Institute of Technology did much helpful work in connection with the relay assembly studies.

Within the Company much credit is due to those who were in active direction of this research: to Mr. G.A.Pennock, who was in general charge from its beginning; to Messrs. M.L.Putnam, H.A.Wright, and W.J.Dickson, who were associated with him in planning and supervising the work; and to Messrs. H.Hibarger and A.C. Moore, who made outstanding contributions in conducting particular experiments.

Perhaps the greatest credit should go to the many employees who

participated in this work. The members of the research staff were constantly inspired by the spirit of helpfulness of the many hundreds of employees who expressed themselves so fully to the interviewers and by the wholehearted co-operation and interest of the group of employees who through a considerable period participated in the various test room experiments. The willingness of employees to collaborate in the studies and the co-operation which they gave the people conducting this research contributed in a large measure to its success.

C.G.STOLL

Western Electric Company
New York, N.Y.
July 15, 1939

PREFACE

ABOUT TWELVE years ago the Western Electric Company, at its Hawthorne plant, began the series of inquiries into the human effect of work and working conditions described in this book. In the last six or seven of these years many papers, monographs, books, have been published describing the investigation or analyzing some aspect of it. My own Lowell Lectures in published form *(The Human Problems of an Industrial Civilization,* The Macmillan Company, 1933*)* gave three short chapters to "the Hawthorne experiment." North Whitehead's *The Industrial Worker* (Harvard University Press, 2 volumes, 1938) is a careful analysis, partly statistical, of the original "test room" records. A monograph by the authors of this book, Roethlisberger and Dickson, "Management and the Worker" (Harvard Business School, Division of Research, Business Research Studies, No. 9, 1934), attracted much interest in the United States and in Europe: it was even quoted in an industrial case in the Chancery Division in London. The general effect of these and many other publications has been to give industrial audiences an illusion of familiarity when the Hawthorne experiment is mentioned. But this is illusion: many of us have long been aware that there is no sufficiently general understanding in industry, or elsewhere, of the course that the inquiry ran, of the difficulties it encountered, and of the constant need to revise and renew the attack upon the diverse problems presented. This book offers for the first time a continuous history of the entire series of experiments; it also relates together the many different inquiries.

It is too often assumed that almost any young university graduate of sufficient intelligence can charge out of university and into industry and, armed with some rags and tatters of scientific method borrowed mainly from physics or chemistry, can proceed to make interesting findings. This belief ignores completely the mutual dependence and complexity of the facts of human association. If Mr. G.A.Pennock, who began and developed this series of experiments, had not been intimately acquainted with this human complexity, if he had not been thus inspired to critical inspection of the first apparent findings, then this history would not have been written. It would have been easy, for example, to shut down the "test room" at the conclusion of Pe-riod XI and to announce to the world another observation to the gen-eral effect that rest periods (of a certain length and periodicity) lead, of themselves, to improvement in production and morale. But Mr.

Pennock and his colleagues were not satisfied that the continuous improvement could be so directly related to rest periods, and the "return to original conditions" (see page 69) was instituted as Period XII. This critical change proved fruitful for the whole course of the inquiry; it led indeed to a clear realization of the need for other and supplementary investigations. From this point on, a constant shift to inquiries not anticipated in the original plan became characteristic.

The authors nevertheless succeed in demonstrating that, in spite of this constant shift, the relationship between the original and the supplementary inquiries was always maintained. In the end a considerable enlightenment was gained that applied to every item in the series. In using the phrase "considerable enlightenment" I must not be understood to claim that it was either very extensive or very profound; the authors of this book and those who participated in the work would alike repudiate such claim. The fact remains, however, that those who took part feel that they have learned something of the facts of human association in work, something about techniques of human investigation; they know also that what they have learned was, to them at least, novel and unexpected. But they regard this as a beginning rather than an end.

What there is of achievement must be credited in large measure to G.A.Pennock, to M.L.Putnam, who succeeded him in control of the experiments, and to the officers of the Western Electric Company generally. It took courage and determination to persist with inquiries that often seemed doomed to inconclusiveness. The recurring need to find a way around obstacles that seemed insuperable demanded insight and ingenuity. It is also to the credit of the Company itself that there were no prohibitions: every participant in the investigation was free to find what he could find, provided always that such observation would stand up against the immediate critical inspection of his colleagues and would reveal itself unshakeably as fact. For this reason the work has been extraordinarily interesting to all those who have shared it. They have been many, and for all of us, whether our participation has been continuous and intimate or episodic and remote, there are pleasant memories of occasions when our colleagues have said to a diffident suggestion, "Why—of course." I cannot name all who have thus participated, who can thus think with satisfaction of the experience: an attempt to name everyone would read, a colleague suggests, like a telephone book. But it can at least be claimed that in studying the need for more effective human collaboration in industry we ourselves have learned something of the art.

Of none of us is this more true than of the authors of this book. Both have been continuously and intimately associated with the work—Roethlisberger for Harvard University, Dickson for the Company; both are still so associated. Everyone concerned was content that they should assume the task of revision for report and publication, and we believe that they have done it well. The work that they report is the work of many hands—their own and others—but the selection, development, and presentation of topics are their own. Where intelligent elaboration has been needed, they have provided it. In this they have had the support and aid of the Company and of Harvard University.

And this last should be acknowledged also. Collaboration in work of this kind presumes not only an active relation between workers of the university and of the industry, it presumes also a relation between institutions. The aid given by Harvard University has been as admi-rable in its way as the freedom to inquire and the support given by the Company. Over a period of twelve years the investigation has benefited by the collaboration where required of the Fatigue Laboratory, the Graduate School of Business Administration, the Medical School, the Department of Anthropology in Harvard College. Dean Wallace B. Donham and Dr. Lawrence J.Henderson, both of the Committee on Industrial Physiology, must be considered to have been actively participant in the research from the beginning. Their role in the University group is comparable with that of Mr. C.G.Stoll and Mr. W.F.Hosford of the New York office and Mr. C.L.Rice of Hawthorne in support of Mr. G.A.Pennock, Mr. G.S.Rutherford, Mr. M.L.Putnam, and the

Company group. There can be no question that Dean Donham and Dr. Henderson have fulfilled an important function in the general development of the study.

The authors ask me to acknowledge the invaluable aid in preparation of this book for publication given by Mrs. Hilda Richardson Carter, secretary of the Industrial Research Department. Mrs. Carter has revised and edited the manuscript, has prepared the index, and read the proof sheets as they came off the presses. Miss Helen M. Mitchell prepared the figures.

One other comment must be made. Researches of this type are usually impossible because of a foolish convention that institutions en-gaging in industrial research are expected to "pay their way" or "earn their keep." This means, in effect, that any such institution, living from hand to mouth, is committed to the futility of endless repetition of some former discovery. The interesting *aperçu,* the long chance, may not be followed: both alike must be denied in order that the group may "land another job." This confusion of research with commercial huckstering can never prosper: the only effect is to disgust the intelligent youngster who is thus forced to abandon his quest for human enlightenment. But for an endowment from the Rockefeller Foundation, Harvard University would have been unable to permit so many men to participate in an inquiry that has developed, at a varying pace, over a period of twelve years.

Can anyone doubt the need for inquiries of this type? The spectacle of Europe, erstwhile mother of cultures, torn from end to end by strife that she can by no means resolve, should give pause to the most "practically-minded," should make such persons ask what type of research is likely to be most practically useful at the moment. The art of human collaboration seems to have disappeared during two centuries of quite remarkable material progress. The various nations seem to have lost all capacity for international co-operation in the necessary tasks of civilization. The internal condition of each nation is not greatly better: it seems that only a threat from without, an unmistakable emergency, can momentarily quiet the struggle of rival groups. In this general situation it would seem that inquiries such as those undertaken by officers of the Western Electric Company have an urgent practical importance that is second to no other human undertaking. How can humanity's capacity for spontaneous co-operation be restored? It is in this area that leadership is most required, a leadership that has nothing to do with political "isms" or eloquent speeehes. What is wanted is knowledge, a type of knowledge that has escaped us in two hundred years of prosperous development. How to substitute human responsibility for futile strife and hatreds—this is one of the most important researches of our time. It is our hope that the inquiries described in this book are the beginning of a small contribution to such knowledge.

ELTON MAYO
July 15, 1939

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THE SCOPE AND DURATION OF THE INQUIRY

THE experimental studies of human relations to be reported in this book were conducted at the Hawthorne Works of the Western Electric Company in Chicago. They were begun in the spring of 1927, when five employees were segregated from a regular operating department for special study. At the beginning of the inquiry the general interest was primarily in the relation between conditions of work and the incidence of fatigue and monotony among employees. It was anticipated that exact knowledge could be obtained about this relation by establishing an experimental situation in which the effect of variables like temperature, humidity, and hours of sleep could be measured separately from the effect of an experimentally imposed condition of work.

Little was it doubted that within a year, or perhaps less, definite answers to these questions could be obtained. But the inquiry developed in an unexpected fashion. In most cases the results obtained, instead of giving definite answers to the original questions, demanded a restatement of them. More adequate working hypotheses had to be formulated. Old methods had to be modified, and quite frequently new methods had to be introduced. As a result, the inquiry continued for five years, from 1927 to 1932, when for reasons unconnected with the experiment it was suspended. From the original observation of five workers, the investigation during one phase of its development had expanded until it included studies of about 20,000 individual employees.

PROBLEMS OF PRESENTATION AND SELECTION

In reporting an inquiry of such magnitude the authors were faced with many problems. There were problems of presentation: How was the material to be presented so as to give a clear account which would

involve the least possible distortion of the way in which things actually took place? How could the studies be presented without placing those people or groups of people with whom they dealt in an unfavorable or ambiguous position? There were problems of selection and emphasis: What weight was to be given to the theories which the investigators separately or collectively held? Where and when were the practical implications of the findings for industry to be discussed? To help them in solving these problems, the authors adopted certain guiding principles.

(1) In an experiment which ran over such a long period of time, and in which there was a considerable time interval between the conclusion of the experiment and the publication of the results, two alternative methods of presentation were possible. Either the authors could take the standpoint of the investigators at each stage of the inquiry, describing in chronological order the things they did, the discriminations they made, the leads they followed, and the conclusions they drew; or the authors could take the standpoint of the investigators at the end of the inquiry, presenting in a more systematic and logical order the results obtained and interpreting them in terms of the final conceptual scheme. Either approach had its advantages and disadvantages.

The authors finally decided to follow the chronological form of presentation for the following reasons. Although a narrative account of what was done step by step would bear the stamp of human imperfection, nevertheless it would describe what actually took place. It would picture the trials and tribulations of a research investigator at his work, and thus allow future investigators to see and to profit from the mistakes which were made. In turn, the authors would be spared the task of having to strengthen weak places and make their façades more imposing.

The authors realized that among the readers of the book there might be a substantial number of the Western Electric supervisory force and many of the workers themselves. They recognized their obligation to these people and to the company, which at all stages of the inquiry had done everything possible to protect these individuals or groups of individuals whose situations were being studied. It was important that no one employee or group of employees should feel that the company, of which they were justly proud, had not protected their interests in allowing certain material to be published. The authors felt that they could best fulfill their obligation to all parties concerned by maintaining a spirit of scientific objectivity, by being faithful to the data before them, and by presenting them, in so far as they were humanly capable of doing so, free from bias. In no other way could the authors represent better to the employees who might read the book the purpose of the inquiry and the attitude of management toward it, which can be described as a sincere desire on management's part to understand better the facts of human behavior, their own as well as that of their employees.

(2) In presenting the material, it was decided to keep separate the facts observed, as well as the uniformities among them, from the methods, working hypotheses, theories, or conceptual schemes employed by the investigators. The original facts of observation, as well as the final facts of verification, were to be granted primary importance. Theories were conceived of as only part of the working equipment of the investigators and never as ends in themselves. Therefore, it was decided to include for discussion only those theories or ways of looking at facts which assisted the research investigators to find more facts or to make more adequate discriminations in fact.

(3) During the inquiry many studies developed as offshoots from the main line of the experiment and ran their own course as more or less separate and independent phases. Although such studies have not been entirely omitted from this book, as in many cases they were of great interest, preference has been given to those studies which contributed more directly to the development of the inquiry and to the understanding of the investigators.

(4) The narrative form of presentation made it difficult at times to elaborate certain findings of the research with reference to industrial problems without, at the same time, losing the trend of the inquiry. Therefore, it was decided to leave such a discussion until the last part (Part V) of the book, where it would also be possible to discuss some of the practical problems of industry in terms of the final conceptual scheme which the investigators achieved.

(5) Chronologically, the inquiry divided itself naturally into four stages, each stage representing a major change in working hypothesis and method. The first four parts into which the book is divided correspond to these four stages of the inquiry. Part I is concerned with an experiment on working conditions and employee efficiency. During this phase of the inquiry the "test room method" was developed. Part II is concerned with an experiment in interviewing some 20,000 employees from all parts of the Hawthorne plant with a view to determining those aspects of their working environment which they either favored or disliked. In Part III the comments obtained in the interviews are analyzed and a general theory is presented to explain the nature of employee satisfaction and dissatisfaction. In Part IV a study of fourteen male operators is reported; in this study the interviewing method elaborated in the second phase was supplemented and reinforced by direct and simultaneous observation.

THE WESTERN ELECTRIC COMPANY ORGANIZATION

It may be helpful to describe briefly the setting of the Hawthorne plant, in which the tests were conducted. This description applies only to the company at the beginning of the inquiry. Many changes have occurred since then which, although not altering the general picture conveyed in this material, nevertheless would make the following description inaccurate at the present time in specific details.[1]

The Hawthorne Works of the Western Electric Company is situated partly in the city of Chicago at its western border and partly in the town of Cicero, Illinois. This plant is the largest unit of the Western Electric Company, which, in turn, is the supply organization for the telephone companies of the Bell System. Hawthorne covers many acres of floor space and gives employment to thousands of men and women engaged in the manufacture of telephones, central office equipment, loading coils, telephone wire, lead-covered cable, toll cable, and other forms of telephone apparatus. A wide range of type and grade of occupation is to be found, from iron worker to diamond cutter, from toolmaker to accountant, from apparatus assembler to engineer, from wire-drawer to textile dyer, from office boy to superintendent. By imagining the kind and amount of equipment necessary to serve millions of telephone subscribers, some impression of the exacting quality and tremendous quantity of small piece parts which are manufactured and assembled can be obtained.

In 1927, when the studies commenced, the company employed approximately 29,000 workers, representing some 60 nationalities. About 75 per cent of the employees were American born. The Poles and Czechoslovakians were by far the largest foreign groups; there was a fair sprinkling of Germans and Italians.

Eight Functional Organizations

The primary manufacturing activities of the plant were divided among eight functional organizations which the company called branches. These branches were Accounting, Operating, Production, Inspection, Technical, Specialty Products, Public Relations, and Industrial Relations. Except in the case of the Industrial Relations Branch, it will not be necessary to give detailed accounts of the functions of these respective branches. In passing, it can be said that the Technical Branch set piece rates, maintained the plant,

and serviced machinery. The Production Branch provided material, seheduled work, followed production, maintained stocks, and handled and stored materials. The Operating Branch made the products. The Specialty Products Branch planned the manufacture of and made special products and articles of small demand. The Inspection Branch controlled the quality of output. The Accounting Branch paid employees, figured costs, prepared local budgets, and issued financial reports. The Public Relations Branch maintained local publicity and civic contacts and promoted safety and health.

In as much as the company's terminology differed slightly from that in use in other industries, it is well to distinguish the functions of the Operating Branch from those of the Production Branch. It was the Operating and not the Production Branch which made the products. The Operating Branch was that part of the company which carried out the actual shop operations necessary to convert raw material into finished telephone equipment. The Production Branch, on the other hand, controlled all direct manufacturing work performed by the company: It gave the shop information concerning what, how much, and when to manufacture and assumed responsibility for meeting delivery dates. It was the duty of this branch to issue and trace all orders through the shop and to maintain stocks of raw material, piece parts, and apparatus sufficient to meet the manufacturing requirements. In terms of the number of people employed, the Operating Branch was by far the largest of the eight branches.

The Industrial Relations Branch

The Industrial Relations Branch was on a co-ordinate basis with the other branches and had as its function all those activities which have to do with employee relations. A prominent part of the Industrial Relations activities were discharged by a personnel organization working within each one of the eight branches. The major responsibility of these organizations was to supervise the carrying out of the company's employee relations policies[1] within the respective branches. To see that the employees were properly placed in work best suited to them, to arrange the transfer of employees for training, advancement, or vocational adjustment purposes, to keep adequate records of each employee's service, to advise with employees about personal problems, education, health, advancement, thrift, vocational opportunities, and individual welfare, to assist worker and supervisor alike in carrying on their daily work; these were some of the many duties of the branch personnel units. Meanwhile the tasks of running a restaurant that served some seven thousand meals a day, a fully equipped and modern hospital, an employment division to hire and place people, an organization to administer accident, sickness, and pension benefits, and an organization to conduct job training in various lines were assumed by a group of functionalized units within the Industrial Relations Branch.

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1 In presenting this material, the past tense has been frequently used, even though at times awkward, in order to remind the reader constantly of the fact that this description is of the years 1927 to 1929.

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1 In a statement issued by the company to employees responsible for directing the work of others, the company's Employee Relations Policies (referred to frequently as the "Ten Commandments") are stated as follows:

It is the policy—

I. *To pay all employees adequately for services rendered.* When the individual records of all employees are reviewed periodically, it is your duty to see that their rates of pay are adjusted fairly. Compensation should be based upon ability, responsibility, length of service and capacity for growth,

Agencies for Carrying out Employee Relations Policies

There were a number of agencies for carrying out the company's employee relations policies. It will suffice to mention some of them briefly:

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giving due consideration to cost of living, general business conditions and wages paid by other concerns in the same territory for comparable work.

II. *To maintain reasonable hours of work and safe working conditions.*

Special attention must be paid to conserving the well-being of employees in equipping and maintaining shops, warehouses, offices, restaurants and rest rooms and other facilities for comfort and convenience. Careful consideration must be given to hours of work, vacations, medical service and payment in case of absence.

III. *To provide continuous employment consistent with business conditions.*

In the management of the business a continuous effort must be made to provide steady work and permanent employment. When reduction in force is unavoidable, consideration should be given to retaining long-service employees. When additions are made to the force, preference should be given to former employees. Continuity of employees' service records should be guarded.

IV. *To place employees in the kind of work best suited to their abilities.*

Consideration must be given to placing each employee in the kind of work which offers opportunity for his maximum growth and usefulness. Great care should be used in assigning employees to work when they are first employed, and trial should be given on different types of work when necessary.

V. *To help each individual to progress in the Company's service.*

When vacancies occur, those already in the Company are entitled to first consideration. Every employee should understand the relation of his work to that of the Company as a whole, and there should be provision for training on the job, variety and progression of experience. Information and advice should be made available for those wishing to take advantage of outside educational opportunities.

VI. *To aid employees in times of need.*

It is necessary for you to understand fully the purpose and scope of the Employees' Benefit Fund for giving aid in times of disability due to sickness or accident, and for granting retiring allowances. You should keep informed regarding loan funds available for meeting other emergencies.

VII *To encourage thrift.*

. You are responsible for keeping your people informed and interested in the Stock Purchase Plan and other means available for encouraging thrift. Employees desiring information and counsel should be put in touch with those best qualified to advise on matters of home buying or building, use of banking facilities, insurance programs and other personal financial problems.

VII *To cooperate in social, athletic and other recreational activities.*

I. Encouragement may be given by supplying facilities, by sharing in the operating expenses of organized activities of this character, and by making better use of opportunities existing in the community.

IX. *To accord to each employee the right to discuss freely with executives any matters concerning his or her welfare or the Company's interest.*

It is your duty to establish the conviction among those whom you direct or with whom you come in contact that sympathetic and unprejudiced consideration will

(1) There were plans designed to encourage the practice of thrift. Among these was a stock participation plan which made it possible for the employees to subscribe to American Telephone & Telegraph Company stock.

(2) In order to help the worker protect his dependents, arrangements were made with one of the large and sound insurance companies by which the insurance company set up within the plant a local office and maintained a sufficient staff to act as insurance advisers and counselors to all employees who desired this assistance. Careful consideration was given to the individual requirements of each employee seeking this service, and all of the standard forms of insurance were made available to him and could be paid for through weekly deductions from his pay.

(3) There was a building and loan association operated by and for employees only, which was used by them for saving and investment as well as for home building.

(4) There was a ready money plan to assist employees in carrying out a systematic program of personal finance. Under this plan the company would withhold at the employee's bidding any stipulated amount from the employee's pay and deposit such amount periodically with well-selected savings banks at current interest rates.

(5) There were also benefit plans to provide relief for sickness, accident, and death of employees while working at the company.

(6) There was a pension plan on a noncontributory basis whereby employees became eligible for pension after a certain age and period of service.

(7) Another activity of the company was safety and health promotion. Health bulletins, pamphlets, and lectures were placed constantly before the employees; health classes were maintained; Red Cross first aid courses were given; and mechanical safeguards or devices were installed wherever practical. Furthermore, a modern hospital, completely staffed and equipped, was maintained for the emergency treatment of sickness or accidents, for the physical examination of applicants for employment and of employees returning from sick leave.

(8) Closely allied with this health program was a program of recreational, social, and athletic activities. All these activities were conducted by an employees' organization known as the Hawthorne Club. All employees belonged to this organization. They elected their own officers and promoted a wide variety of activities ranging from motion picture productions to track meets, and from target practice to checker tournaments. Gymnastics and athletic sports were conducted in a gymnasium and on an athletic field. Entertainments of all sorts—bands, orchestra, glee club, prominent speakers, dancing—were on the

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be given to any employee who wishes to discuss with you and with Company executives matters of his or her welfare or the Company's interest.

X. *To carry on the daily work in a spirit of friendliness.*

As the Company grows it must be more human—not less so. Discipline, standards and precedents become more necessary with size, but the spirit in which they are administered must be friendly as well as just. Courtesy is as important within the organization as in dealing with outsiders. Inefficiency and indifference cannot be tolerated, but the effort of supervisors must be increasingly directed at building up in every department a loyal and enthusiastic interest in the Company's work.

MAY, 1924.

calendar during the noon and evening programs. An evening school, with over 3,000 students in attendance, receiving instruction in 45 different subjects, was conducted by this club.

The Supervisory Organization

Generally speaking, the type of company organization was a combination of function and line. The units into which the organization was divided were functional, that is, each branch performed a group of logically related and interdependent activities. Within each functional unit, however, the general method by which authority was exercised and delegated was "line control."

According to the supervisory structure of the company, a superintendent was in charge of a branch; an assistant superintendent was in charge of a subbranch; a general foreman was in charge of a division; a foreman was in charge of a department; an assistant foreman assisted the foreman in the supervision of the department and sometimes was in charge of several sections of that department; a section chief was in charge of one section composed of several groups; and a group chief was in charge of one group of operators.

The name "supervisor" was often given in a general sense to all ranks of supervision above the worker. In most cases, however, any supervisor in a shop organization whose rank was above that of section chief was given his more specific title of foreman, general foreman, superintendent, and so on. The first-line supervisor, that is, the man who was in direct charge of and in contact with the workers, was in this organization a "group chief." In other industrial organizations this kind of supervisor is sometimes called a "gang boss" or a "straw boss." At the company the benchworker or employee of nonsupervisory status was referred to as an "operator." This word was used in preference to the term "operative," which is common in many other industries.

Some of the titles differed, depending upon whether one was referring to a member of a shop or of an office organization. In an office organization ranks comparable to those of assistant foreman and group chief in the shop were not common. Usually, there were only the department head, one or more section chiefs, and the individual employees. Therefore, in an office organization a section chief was the first-line supervisor. The head of a department in an office organization was called a "department chief"; the head of a division, a "division chief." Moreover, in an office organization the term "individual," rather than "operator," was given to an employee of nonsupervisory status. The word "employee" in its limited sense referred to persons who were not supervisors, but in a broader sense it was sometimes applied to both workers and supervisors. In this book the word "employee" will be used in its limited sense.

Figure I shows the major divisions into which a branch was divided and the corresponding rank of the supervisor in charge, depending on whether the organization was a shop or an office. According to the office and shop distinction, the functional units of the company were divided as follows: The activities of Industrial Relations, Public Relations, and Accounting, for example, were strictly office; the Operating unit was identified with the shop; in between were the Technical, Production, and Inspection organizations. Most of the supervisors in these latter units, however, regarded themselves as office rather than shop people and were usually given office space.

WAGE INCENTIVE SYSTEMS[1]

In no sense is this description of the wage incentive systems in operation at the company to be taken as a detailed and complete account. It will be merely a brief outline for purposes of general orientation. In general, the forms of incentive compensation could be divided into two

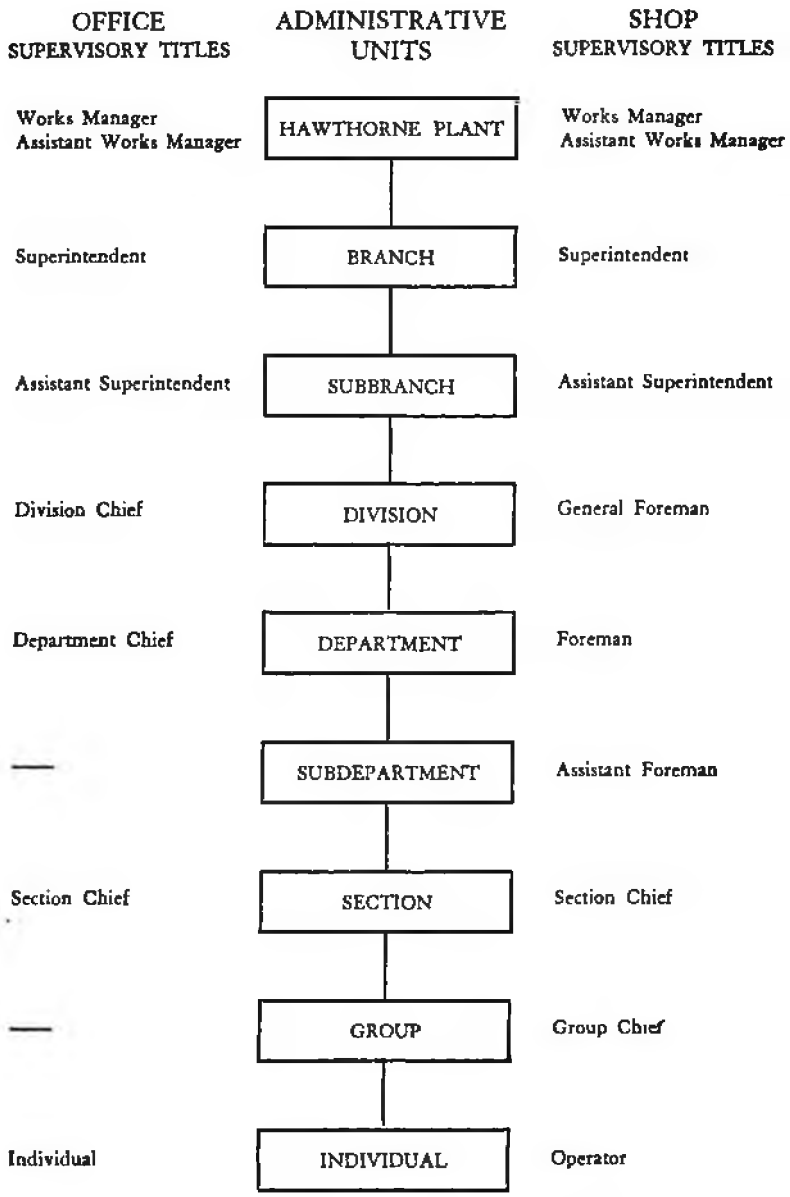

FIGURE I OFFICE AND SHOP SUPERVISORY ORGANIZATIONS HAWTHORNE PLANT

kinds: individual payment and group payment. In both cases, however, the company operated on the so-

1Two articles have been used freely in preparing this section: Holmes, Stanley S., "Extra Incentive Wage Plans Used by the Hawthorne Works of the Western Electric Company, Inc.," *The American Management Association,* Production Executives' Series, No. 17, 1925; and Hosford, William F., "Wage Incentive Applications in the Western Electric Company," *N.A. C.A.Bulletin,* Vol. XII, No. 21, 1931.

called "straight-line" principle of compensation, according to which the remuneration was directly proportional to individual or group output. Under both plans the day rate, or base wage, was guaranteed.

Basic Labor Grades and Hourly Rate Ranges within Each Labor Grade

The foundation upon which the wage incentive plans were laid was the labor grading system. This consisted of a series of labor grades covering all hourly rated operations performed in the plant. The lowest grade covered the simplest types of operations; the highest grade covered those operations involving the greatest amount of skill or responsibility; all other operations were placed in intermediate grades according to the skill or responsibility involved. Ranges of pay for these basic labor grades were so established that they would be comparable to the rates of pay prevailing throughout the Chicago district for similar classes of work. New employees were hired, and assigned an hourly rate, at the minimum rate of pay for the labor grade into which their work fell, and they were advanced within the rate range, or progressed to higher grade classifications, as they became more skilled and proficient. These labor grades supplied the base rates for the determination of incentive or piece rates.

Straight Piecework

The straight piecework system involved the establishment of a money rate per unit of output and was applied to operations completely performed by one employee, and to classes of work in which each employee's production was easily distinguished. The employee received the rate per unit multiplied by the number of units completed regardless of the time involved, except when the total piecework value was less than the total daywork value of his time, in which case he received his guaranteed day rate. The total daywork value for each employee was his hourly rate multiplied by the number of hours he worked.

Group Piecework

Under group piecework a money rate was assigned to a given amount of work or unit of production for those jobs which required the co-operative services of two or more employees. This system was confined largely to those departments where the multiplicity of the operations performed made it difficult to employ straight piecework. The earn ings of the group were determined by the number of good pieces it completed, multiplied by the rate per piece. The amount thus earned by the group each week constituted the fund out of which all wages were paid. The allocation of the weekly group earnings to the individuals in the group was based upon their hourly rates. The hourly rate of each employee multiplied by the number of hours he had worked during the week constituted the daywork value of the work he had done. At the end of each week, the total piecework earnings of all work produced by the group and the total daywork value of all time charged by the group were determined. The excess of total piecework earnings over total daywork value was expressed as a percentage of the total daywork value. Each employee's earnings were determined by multiplying his hourly rate by this percentage. The resulting hourly earnings figure multiplied by the number of hours he had worked during the week constituted a person's weekly earnings. Therefore, variation in individual earnings in a group depended entirely on differences in hourly rates. As under the straight piecework system, the operator's day rate was guaranteed.

The "Bogey" System

One feature of the group incentive system needs more explanation. Under straight piecework the maintenance of individual performance records was practically automatic, since comparative earnings were a direct measurement of relative performance of operators in the same labor class. The group payment system, however, did not provide a means of measuring the performance of individuals. In order to fill this need under group piecework, the company used what is called a "bogey" system of individual rating. The bogey, which was set up for each operation, represented a level of performance which could be sustained by a skilled and efficient operator. Records were kept of each individual's performance, and effciency was figured weekly, using the bogey as a basis for comparison. The supervisor used the bogey in this manner to keep records of individual progress and ability and to detect irregularities of performance.

EXPERIMENTS ON ILLUMINATION

In November, 1924, the Western Electric Company, in connection with the National Research Council of the National Academy of Sciences, planned to study the "relation of quality and quantity of illumination to efficiency in industry." These experiments lasted until April, 1927, a period of two and one-half years. Since the results from these experiments played an important part in the future research of the company on employee effectiveness, they will be briefly described. In the absence of any final formal report of this work it is impossible to give a complete, detailed statement, and therefore only a summary of the first tentative conclusions drawn by the Council's representative in charge of the work at Hawthorne will be reported.[1]

The First Illumination Experiment

The first experiment on illumination was conducted in three different departments carefully selected for the purposes of the test. In the first department the employees were inspecting small piece parts; in the second department the employees-were assembling relays; the third department employed coil winders.

The general test procedure for each department was the same. First, there was a preliminary period during which the operatives worked under the existing lighting installation supplemented by daylight. The average production rates obtained during this preliminary période furnished base lines for calculating any future production changes.

The level of artificial illumination intensity was then increased at stated intervals. Mr. Snow reports the results as follows:

The various levels of average illumination intensity [for the first department] were 3, 6, 14, and 23 foot-candles. The corresponding production efficiencies by no means followed the magnitude or trend of the lighting intensities. The output bobbed up and down without direct relation to the amount of illumination.

The illumination intensities [in the second department] were 5, 12, 25, and 44 foot-candles. The efficiency of this department increased more or less continuously during the test, but not as a sole function of illumination.

The various levels of average illumination intensity [in the third department] were 10, 16, 27, and 46 foot-candles. The production efficiencies corresponding to these periods of different lighting intensities were always higher than the starting level and did not always fall off with a decrease in illumination.

Mr. Snow concludes by saying:

The results of this first winter's test…brought out very forcibly the necessity of controlling or eliminating the various additional factors which affected production output in either the same or opposing directions to that which we can ascribe to illumination.

The Second Illumination Experiment

The second experiment was designed to eliminate some of the difficulties of the first. Only one of the above three departments was chosen for study. In this department the operators were engaged in winding small induction coils on wooden spools. It was decided to divide the workers into two groups, each group composed of an equal number of operators of about the same experience. These groups were so selected that at the beginning of the test each had about the same average output. One group, called the "test group," was to work under variable illumination intensities; the other group, called the "control group," was to work under an intensity of illumination as nearly constant as possible. The groups were located in different buildings in order to reduce the influence of any spirit of competition. The test group worked under three different intensities of light, 24, 46, and 70 foot-candles, while the control group worked under a more or less constant level of 16 to 28 foot-candles.[1] It was thought that by this method the differences in production eificiency could be related directly to differences in illumination intensity. Again, let us quote from Mr. Snow's report:

This test resulted in very appreciable production increases in both groups and of almost identical magnitude. The difference in efficiency of the two groups was so small as to be less than the probable error of the values. Consequently, we were again unable to determine what definite part of the improvement in performance should be ascribed to improved illumination.

The Third Illumination Experiment

Because it was thought that the combination of artificial with natural illumination during the previous test had resulted in a lack of definite control of the illumination intensities, a third test was conducted. In this third test only artificial lighting was used. The test group and the control group were used as outlined in the previous test. The control group was provided with a constant level of 10 foot-candles, while the test group was provided with intensity levels from 10 to 3 foot-candles in steps decreasing 1foot-candle at a time. Mr. Snow says of this experiment:

After the level of illumination in the test group enclosure changed to a lower value, the efficiencies of both the test and control groups increased

slowly but steadily. When the level of the illumination for the test group finally reached 3 foot-candles, the operatives protested, saying that they were hardly able to see what they were doing, and the production rate decreased. The operatives could and did maintain their efficiency to this point in spite of the discomfort and handicap of insufficient illumination.

1 Snow, C.E., "A Discussion of the Relation of Illumination Intensity to Productive Efficiency," *The Tech Engineering News,* November, 1927.

[1]The increase in daylight accompanying the advancing season was responsible for the amount of variation in illumination.

Further Informal Experimentation

Shortly after the completion of these three tests, the representative of the company who had collaborated with Mr. Snow in the research received permission to submit two operators to still further experimentation. Two capable and willing operators were selected. They were provided with working facilities in a locker room which could be made completely dark. The illumination at the bench in this room was cut down from the original amount of light to which the girls had been accustomed to 0.06 of a foot-candle, an amount of light approximately equal to that on an ordinary moonlight night. Even with this very low intensity of light, the girls maintained their efficiency. They said that they suffered no eyestrain and that they became less tired than when working under bright lights.

The experimenter was not yet completely satisfied that it had been clearly demonstrated that the effects of the illumination secured in the previous studies were more "psychological" than real. He therefore decided to try further tests on the girls in the coil winding group. First, the amount of light was increased regularly day by day, and the girls were asked each day how they liked the change. As the light was increased, the girls told the investigator that they liked the brighter lights. Then for a day or two the investigator allowed the girls to see the electrician come and change the light bulbs. In reality, the electrician merely took out bulbs of a given size and inserted bulbs of the same size, without in any way changing the amount of light. The girls, thinking that the light was still being "stepped up" day by day, commented favorably about the increase of light. After a few days of this, the experimenter started to decrease the intensity of light, keeping the girls informed of the change and soliciting their reaction. After a period of this day-by-day decrease in illumination, he again allowed the girls to see the electrician change the bulbs without really changing the intensity of illumination. Again the girls gave answers that were to be expected, in that they said the "lesser" light was not so pleasant to work under as the brighter light. Their production did not materially change at any stage of the experiment.

Conclusion

Although the results from these experiments on illumination fell short of the expectations of the company in the sense that they failed to answer the specific question of the relation between illumination and efficiency, nevertheless they provided a great stimulus for more research in the field of human relations. They contributed to the steadily growing realization that more knowledge concerning problems involving human factors was essential. As a result of the illumination experiments, the experiment to be described in the next chapter was started.

CHAPTER II
PLANNING THE RELAY ASSEMBLY TEST ROOM

THE TEST ROOM METHOD

FROM the illumination experiments those in charge of the work for the company drew two conclusions:[1]

(1) that light is only one, and apparently a minor, factor among many which affect employee output;

(2) that the attempt to measure the effect of one variable had not been successful because (a) the various factors affecting the performance of the operators had not been controlled, and hence the results could have been influenced by any one of several variables; (b) in studies conducted in regular shop departments or on fairly large groups of people there were so many factors affecting the reactions of the workers that it was hopeless to expect to evaluate the effect of any single one of them.

From the point of view of the company, then, the illumination experiments had not been unsuccessful, for the investigators felt that they had gained valuable experience in the technique of conducting tests involving human behavior. They were eager to make use of their new insight in a study of the various factors which contributed to employee effectiveness. As a result, they began the Relay Assembly Test Room, an experiment which, although planned for a much shorter period, continued for five years.

It was decided to isolate a small group of workers in a separate room somewhat removed from the regular working force, where their behavior could be studied carefully and systematically. Although there was no idea of a complete control of all the factors affecting work performance, it was thought that by selecting a small group of employees the number of variables which inevitably creep into a large group situation could be somewhat diminished. Such influences as the amount of work ahead of the operators, changes in type of work the introduction of inexperienced operators, the shifting of personnel because of fluctuation in work schedules could be largely eliminated. In a small group it would be possible to keep certain variables roughly

constant; experimental conditions could be imposed with less chance of having them disrupted by departmental routines. It would also be easier to observe and record the changes which took place both

without and within the individual. And lastly, in a small group there was the possibility of establishing a feeling of mutual confidence between investigators and operators, so that the reactions of the operators would not be distorted by general mistrust.

The Kind of Job Selected

The major considerations in the selection of the kind of job suitable for the test were as follows: First, because of the increasing tendency in industry toward mechanized and repetitive tasks and because of the growing interest in the effect of such processes upon those engaged in them, a task representative of this kind of situation should be chosen. Secondly, all the members of the group should be engaged in the same operation, as only in this way could accurate comparisons between individuals be made. Thirdly, since the output records would furnish the chief basis for statistical studies, a kind of work should be chosen in which a complete operation could be performed in a relatively short time, preferably in not more than one minute. Such a task would allow the building up of a larger statistical population than could be obtained in working with jobs requiring a longer interval for completion. Hence a more adequate analysis would be possible. Fourthly, that the job selected should be one on which employment would continue for a considerable length of time, and that it should not entail the costly movement of material or machines, were practical considerations that had to be taken into account. Lastly, because it was thought best to have the speed of the operation wholly controlled by the operator, machine work was excluded as a possibility.

The job finally chosen as best fulfilling these requirements was the assembly of telephone relays, an operation performed by women, which consisted of putting together approximately 35 small parts in an "assembly fixture" and securing them by four machine screws. The various parts entering into the assembly were placed in front of the operator in small bins. The selection of the parts was done by the operator, using both hands, and considerable skill was required in picking them up and placing them in the "pile-up" in front of her. The complete operation required about one minute; consequently, the task might be said to be highly repetitive, as each operator assembled approximately 500 relays each day. Figure 2 illustrates the number and comparative size of the parts and also the completed relay.

The one requirement which the relay assembly job did not wholly satisfy was the second mentioned above, namely, that of having the girls engaged in exactly the same operation. There were several hundred different types of relays which the company manufactured for telephone apparatus, some varying considerably in respect to the assembly operation, and others varying only slightly. No one type was manufactured in sufficient quantity to occupy fully the time of all the test room operators. However, it was possible in the experimental room to have the girls assemble only those types which were similar in all essential characteristics, their differences being mainly in the number of parts entering into the assembly. Even with this reduction in the number of types, however, there remained the problem of transposing the output data to some comparable basis.

The Operators Chosen for the Test Room

Certain problems arose in selecting the girls for the test. First, in order to avoid the influence of the element of "learning" upon the results, only operators who were thoroughly experienced in relay assembly work were selected. Secondly, it was desirable that the girls selected should be willing and co-operative, in order

[1]Pennock, G.A., "Industrial Research at Hawthorne," *The Personnel Journal,* Vol. VIII, 1930, p. 296.

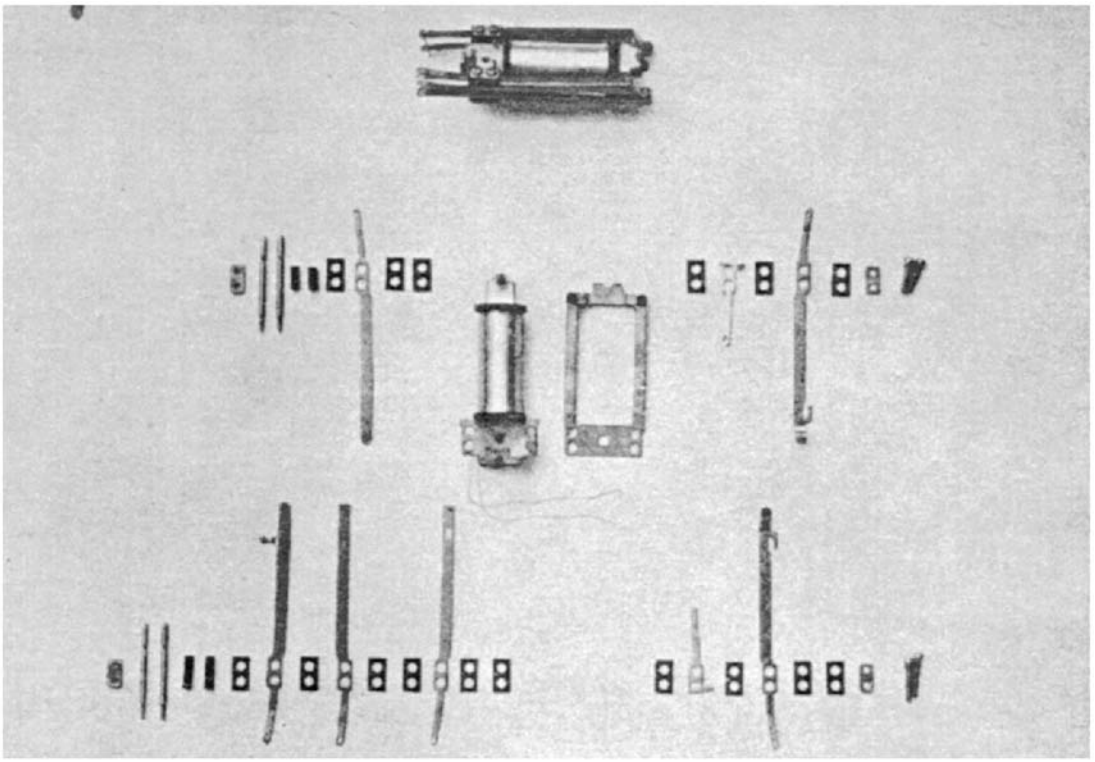

FIGURE 2 PHOTOGRAPH OF RELAY PIECE PARTS AND COMPLETED RELAY

that their reactions to the changing conditions of the test would be normal and genuine. The illumination experiments had demonstrated that an employee's response to an experimental change could not be ascribed solely to a simple physiological reaction. Some girls were on the defensive or suspicious and held back their output, while others, overly anxious to co-operate, increased their output by "spurting" when illumination was increased. In planning this test, the investigators wished to secure a kind of rèlationship with the participants which would insure their working at a natural pace and "as they felt."

The method adopted for selecting such a group was to invite two experienced operators who were known to be friendly with each other to participate in the test and ask them to choose the remaining members of the group. The group thus selected consisted of six girls: five to do the actual assembly operation, which has already been explained, and the sixth to act as layout operator. The latter's duties were of a minor supervisory character and consisted of assigning work and procuring parts for each assembler. This arrangement of having a layout operator serve the assemblers was identical with that in the regular relay assembly department, with the exception that quite frequently in the regular department one layout operator served six or seven girls instead of five as in the test room.

In order to facilitate reference and to protect the identity of the operators, each assembler was assigned a number from 1 to 5 corresponding to her particular position at the bench in the test room. This number will be used instead of a name in referring to a particular assembler. The term "layout operator" will be used in designating the sixth girl, whose duties are explained above.

Table I gives the age, nationality, education, and experience of each of the girls chosen.

The Test Room Observer

Besides the girls who composed the group under study, there was a person in the experimental room who was immediately in charge of the test. This position of test room observer was given to the man who more than anyone else had been responsible for initiating and planning these new experimental studies. Not only had he participated in the illumination experiments previously mentioned, but also he was thor-oughly familiar with shop practices and had had considerable experi-ence in setting piece rates. As test room observer, his function was twofold: (1) to keep accurate records of all that happened, and (2) to create and maintain. a friendly atmosphere in the test room.

The Location, Size, and Equipment of the Test Room

The test room occupied approximately 562 square feet of floor space in a corner of one of the regular shop rooms and was enclosed by a board partition which extended part way to the ceiling. It was located on the fifth, or top, floor, far enough removed from the regular relay assembly department so that the test operators did not come in constant and direct contact with the main group, yet close enough to permit easy trucking of parts and completed relays. This same room had been used for the illumination experiments previously mentioned and was already equipped with lighting fixtures which allowed for slightly more uniform distribution of light than in the regular department. These lighting fixtures and some electric fans, which had also been used previously, were retained in the experimental room. Daylight wąs admitted through skylights and large windows on one side of the room; this arrangement, however, was about the same as in the regular department.

The room was large enough to accommodate one regular-sized workbench, which was moved from the relay assembly department. So far as possible, the work equipment was not altered. Chairs, fixtures, and work layouts were identical with those in the regular department.

TABLE I COMPOSITION OF THE GROUP
RELAY ASSEMBLY TEST ROOM

			Birth places of parents				Work experience beflore April,1927	
Operator	Year of Birth	Birth place	Father	Mather	Education	Date of Employment	Other Companies	Western Electric Company
1A*	1908	Chicogo, III	Poland	Poland	Grade school	Sept, 1925	Clerk in mail order house, 2½ yrs	Relay Assembler 1 yr., 8 mos
2A*	1907	Chicogo, III	Poland	Poland	7th grade	July, 1923	None	Ewlay Assembler 3 yrs 10 mos.
3	1908	Pennsylvania	Poland	Poland	Grade School	June, 1925	None	Paper insulating machine operator 3 mos.

			Birth places of parents				Work experience beflore April,1927	
Operator	Year of Birth	Birth place	Father	Mather	Education	Date of Employment	Other Companies	Western Electric Company
								Relay assembler 1 yr., 8 mos.
4	1907	Cicero, III	Poland	Poland Norway	2 yrs. high school	Oct., 1923	Shop work, filing gaskets 10 mos.	Relay Assembler 3 yrs. Layout operator 6 mos
5	1898	Norway	Norway	Czechoslovakia	7th grade (Norway)	March, 1926	Sardine canner (Norway)	Relay Assembler 1 yrs., 1 mo.
Layput operator	1903	Chicogo, III.	Czechoslovakia		Grade School	Dec., 1920	None	Relay Assembler 2yrs., 5 mos Layout operator 3 yrs., 11 mos.

* These Operators were replaced by two others later in the test (see Chapter IV Table IA. p.61)

The only exception to this was a hole in the bench at the right of each girl's position through which the completed relays were dropped and which formed part of the production recording apparatus, to be described shortly. Besides the standard workbench, along which the five girls sat, there were other smaller benches for accommodating the recording apparatus, a desk for the test room observer, space for storing parts, and clothes lockers (see Figure 3).

The Measurement of Output

Considerable attention was given to the problem of determining the exact time taken by each girl to assemble each relay. This was accomplished by adapting an old-type printing telegraph which functioned by perforating holes in a moving paper tape. These holes were punched in five separate rows. Each row of holes represented one girl's production, and each hole signified a completed relay. The tape moved through the mechanism at a constant rate of one-quarter inch per minute; thus the space between perforations represented the time taken to assemble a relay. In order to eliminate the necessity of counting the holes, except when careful analysis was desired, a numerical register or counter was included in the circuit for each row on the tape, and by reading these counters at specified intervals it was possible to secure directly a record of the number of relays completed.

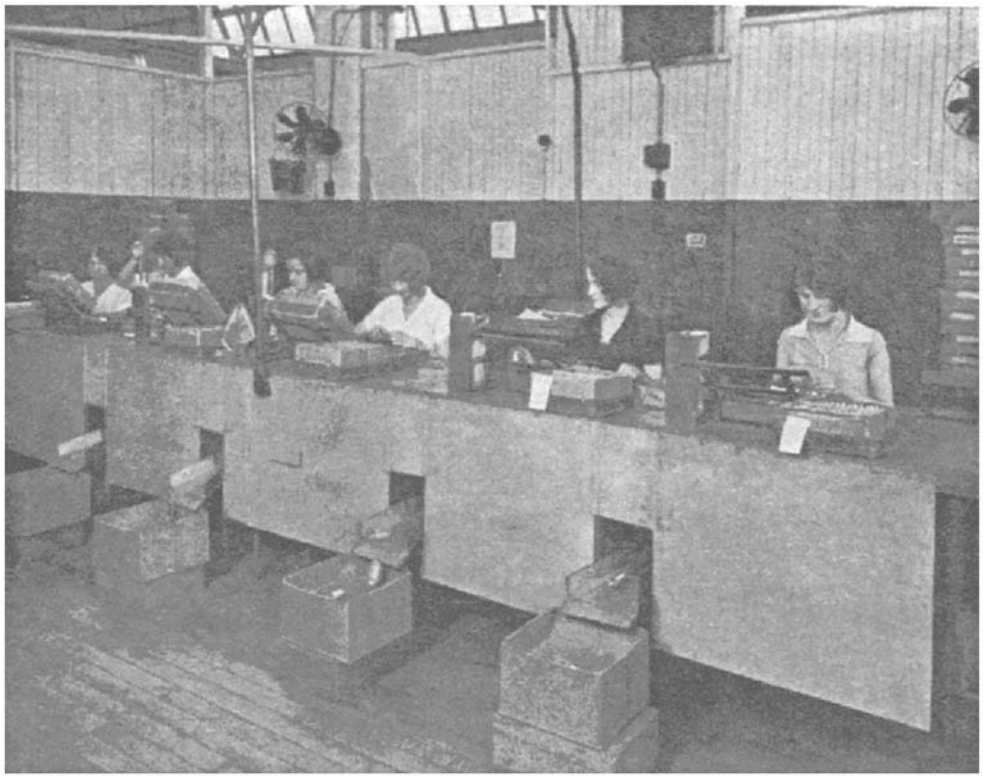

FIGURE 3 PHOTOGRAPH OF RELAY ASSEMBLY TEST ROOM

The other part of the recording device was attached to the workbench. The hole in the bench to the right of each girl's position, through which the completed relays were dropped, was the entrance to a chute in which there was a flapper gate actuated by the relay in its passage. The opening of the gate closed an electric circuit which sent an impulse to the corresponding arm of the perforating device and thus registered the completion of the relay in two ways: (I) by perforating a hole in the tape, and (2) by advancing the counter (see Figure 4)

The record of each day's output was thus recorded on a tape of approximately 120 inches in length. Since the mechanism was used continuously throughout the studies, the records thus accumulated are probably unique, both in their accuracy and, more particularly, in the length of time over which they extend.

Recording of Data: the Log Sheet

Most of the problems met in the beginning of the study were related to the general question of determining what data were to be collected and the manner in which they were to be recorded. One record, sup plementary to the automatic recording device, was developed by the observer for checking both the productive and nonproductive activities of each operator. This record, known as the log sheet, gave a daily chronological account of each operator's activities, and on it were entered the particular type of relay worked upon, the exact time work began on that type, the time at which changes from one type to another were made, and all intervals of nonproductive time such as time out for personal reasons, repairs, and so forth.

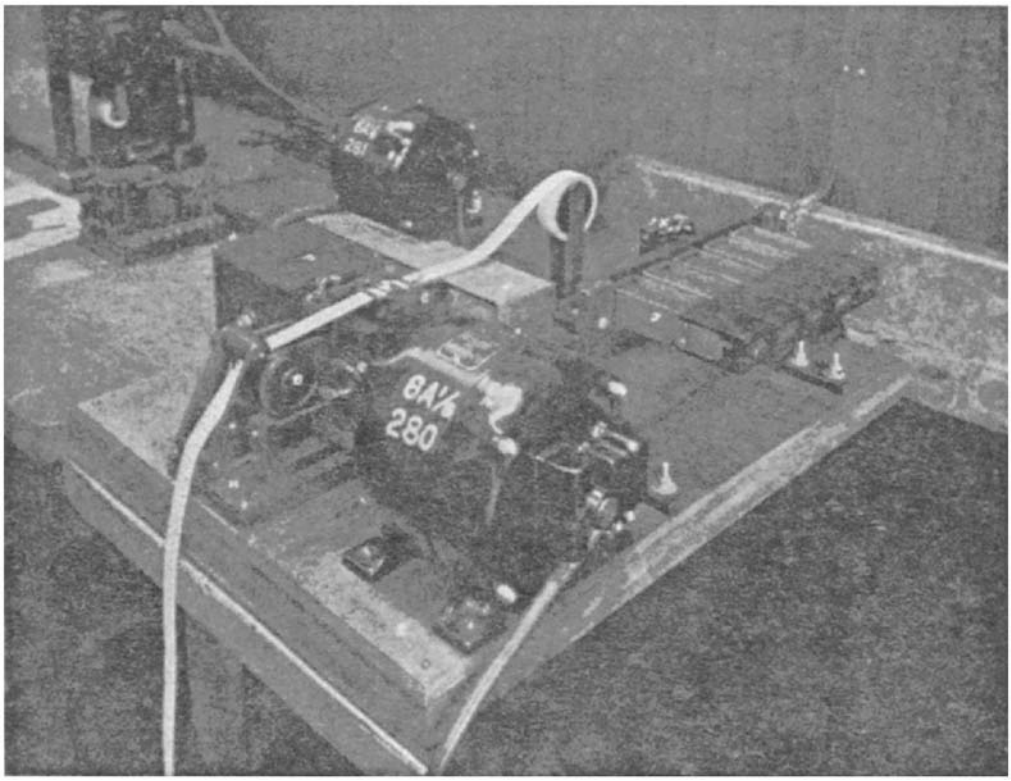

FIGURE 4 PHOTOGRAPH OF RECORDING DEVICE
RELAY ASSEMBLY TEST ROOM

Operators' Performance Record

The operators' performance record was a regular company departmental form which had to be filled out daily for purposes of pay roll routine. In the regular department this record was kept by the layout operator for each of the six or seven workers she normally served. It contained information as to the type of relay worked upon, the number of relays completed, and the time taken to complete units of 50 relays. Other items, such as breaks in the working day and repair time, were included. The layout operator in the test room kept these records for the departmental files. They were later returned to the test room, where they were filed for future use. These company records provided daily output data which were independent of those obtained from the recording device or the log sheet.

Half-Hourly Readings

As a part of the regular test room routine, readings were taken from the automatic recorder each half-hour during the day. It was thought that such data would be useful in studying and comparing variations in output rates. These half-hourly readings were totaled each day, and the figures thus obtained were checked against those recorded in the operators' performance record.

Quality of Output Records

Some method had to be devised to take account of variations in the quality of output. The errors or defects occurring in the assembly operation may be roughly divided into two classes: (1) those errors for which the operator was responsible, and (2) those errors which arose because of faulty parts which could not be detected by the assembly operator. In assembling relays, the operator was charged with the responsibility of selecting good parts. She had to be sure, for instance, that the contact springs had suitable contact points, and that the insulators were not broken and were of the proper thickness. This meant that the operator had to be constantly on the alert to select those parts which were suitable and to reject those which were not. The rejected parts she threw into a special bin or receptacle placed in front of her for that purpose. If she failed to detect a defect which she should have noticed and allowed the part to enter the assembly, the entire relay, of course, was found defective during inspection. There were, however, some defects occurring in parts which the operator could not detect. Chief among these were defects in the resistance of the coil winding, short circuits, and so forth. These errors were not charged to the operator. The quality of output, therefore, was reflected in two ways: (I) by the number of defective relays assembled, and (2) by the number of parts rejected by the operator. Suitable forms were designed to record these two measures of quality.

In planning the test room experiment, it was desired to have each operator's output inspected as soon as possible after completion so that the various errors could be related to the time at which they occurred. Each operator was responsible for repairing her defective relays and the matter of quality was, therefore, partly compensated for in the output records, as the more errors made, the greater the length of repair time, which was included as regular working time in computing her rate of output.

Converted Output

The difficulty which arose because the operators did not always assemble the same type of relay has already been mentioned. It was possible, however, to confine the number of different types assigned to the test room group to a relatively small number. Moreover, only those types were selected which were essentially similar, their differences being mainly variations in the number of piece parts. Exception to this rule was made only in the case of Operator 5, who continued to assemble a large number of types, making on some days as many as seven or eight changes.

In addition to controlling so far as possible the number of different types assigned to the test room, a method was worked out for reducing the original output data to a common denominator. This was accomplished by selecting a base type relay, technically known as type E901, and comparing the piecework rate of each relay type to the piecework rate of the base type relay. This yielded what was called a "conversion factor" for each relay type, by which any output figure for a particular relay type was multiplied. The results thus gave an output figure in terms of the E901, or base type, relay. For example, an operator as sembled three different types of relays during the day. Her output was tabulated as illustrated in Table II.

This method had certain limitations. In the first place, its accuracy depended upon the accuracy with which the piecework rates were established, that is, the degree of accuracy with which the piecework rates expressed the comparative difficulty of assembling each type. However, it should be noted that the piecework rates used in determining these conversion factors had been derived from rates in use prior to the beginning of the test room experiment and had been established by people responsible for computing piece rates throughout the plant.

TABLE II METHOD OF CONVERTING RELAY TYPES TO COMMON BASIS RELAY ASSEMBLY TEST ROOM

1 Relay Type	*2* Hours	*3* Output	*4* Conversion Factor	*5* E901 Equivalent *(3×4)*
B412	2:51	188	.798	150
B1	5:34	354	.77	273
B16	:10	9	.77	7
		551		430

This, at least, eliminated the possibility of any bias resulting from a desire for a favorable showing in the test room. The other limitation in the use of such conversion factors was the underlying assumption that the relative difficulties of assembling the different types of relays were the same for the different operators. This obviously might not be true.

Daily History Record

Another important account kept was the daily history record. This was designed to give a complete account of the daily happenings in the test room: what changes were introduced, the remarks made by the operators (both spontaneous and in reply to questions), the daily problems with which the investigators were concerned, and all other observations that might be of value in interpreting the output curves of each operator or of the group. This record was invaluable in reconstructing the history of the test room. It not only contained the dates of various events but it also indicated the kinds of questions the investigators were asking themselves at various stages of the experiment.

Temperature and Humidity Record

Early in the study, the investigators decided to record the temperature and the humidity in the test room. On May 24,1927, they began taking hourly readings of room temperature, as well as hourly readings of both a wet-bulb and dry-bulb thermometer to determine humidity. These readings were taken each day for several years and were posted on appropriate forms.

Physical Examinations

One important question which inevitably arises in studying a worker's efficiency is whether or not increases in output are obtained at the expense of the general health and well-being of the operator. In the test room experiment it was planned to take health into account as one of the important variables. Even though rest periods and other innovations might not result in increased output, they might be associated with marked gains in the health of the workers and, on that account, could be demonstrated to be of value. While it is true that no definite criteria exist by which the physiological condition of a person can be quantitatively stated, nevertheless frequent observations by a physician are likely to disclose any major changes in health, especially those changes which can be considered detrimental. A definite part of the test room procedure, therefore, included a periodic physical examination of each operator at intervals of about six weeks. Since company physicians and complete laboratory equipment were already available, the physical examinations were easily arranged.

Organization of the Test into Periods

At the beginning of the inquiry, the investigators had certain specific questions to which they hoped to find answers. All the factors which influence the reactions of the worker could not be studied at the same time; certain factors had to be studied before others. The original inquiry started with six questions, all of which were related, more or less, to the problem of fatigue:

1. *Do employees actually get tired out?*
2. *Are rest pauses desirable?*
3. *Is a shorter working day desirable?*
4. *What are the attitudes of employees toward their work and toward the company?*
5. *What is the effect of changing the type of working equipment?*
6. *Why does production fall off in the afternoon?*

These questions were originally chosen because they were typical of the questions being asked at the time. Rest pauses and fatigue were controversial topics in industrial circles. Furthermore, the illumination experiments had cast serious doubt on the method by means of which most conclusions on such topics had been reached.

The test was organized into periods, each period representing the number of weeks during which a specific condition of work was in force. The exact nature of the experimental conditions for all periods was not determined at the beginning of the experiment. It was thought best to plan only one step at a time and to let the results obtained in one period determine the conditions of the next period. The original questions with which the investigators started dictated the first set of experimental conditions imposed.

For convenience, the schedule of test conditions for the first thirteen periods is presented in Table III. The periods were numbered consecutively. Periods I–III constituted an introductory phase, the purpose of which was preparation for experimentation. During Period I the operators were still in the regular department. Period II, which covered the first few weeks the operators were in the test room, was planned to permit the girls to become familiar with their new surroundings. In Period III a change in wage payment was introduced, a necessary step before the experiment proper could begin. Periods IV–VII were concerned entirely with rest periods and constituted the second phase of the test. In Periods VIII–XIII the investigators experimented with a shorter working day and week.[1]

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1 It is well to keep in mind the fact that the Relay Assembly Test Room actually continued for five years (1927–1932), although only the first thirteen periods (1927– 1929) will be reported in this book. The reason for this partial treatment will become clear to the reader as the inquiry is more fully developed. The first tentative conclusions from the test room were reached in June, 1929, after the completion of thirteen test periods. These *findings* so completely altered the direction of the inquiry that although the test room continued for three years longer, the data accumulated during this period were never organized and systematically studied until 1932. Since then, Mr. T.N.Whitehead, Associate Professor, Harvard Graduate School of Business Administration, has made an exhaustive statistical analysis of the entire body of data collected during the five years, a study which has been published under the title *The Industrial Worker* (Harvard University Press, 1938).

Inasmuch as the first rough approximations reached in 1929 were the basis of the later, more detailed studies, the authors decided, in line with their policy of chronological exposition, to report the findings of the test room as they were obtained by the original investigators. From the point of view of methods in human research, these first thirteen periods, in the authors' opinion, are of sufficient importance to warrant separate treatment. Moreover, they constitute the first step in the development of the inquiry, leading directly to the interviewing program, to be reported in Part II. Following the same chain of reasoning, the authors also decided to omit from their

TABLE III SCHEDULE OF THE PERIODS
RELAY ASSEMBLY TEST ROOM

				Times of Rest Pauses	
Period Number	Special Feature	Dates ncluded	Duration in weeks	A.M.	P.M.
I	In regular department	4–25–27 to 5–10–27	Approx.2	None	
II	Introduction to the test room	5–10–27 to 6–11–27	5	None	
III	Special group rate	6–13–27 to 8–6–27	8	None	
IV	Two 5-min. rates	8–8–27 to 9–10–27	5	10:00	2:00
V	Two 10-min. rests	9–12–27 to 10–8–27	4	10:00	2:00
VI	Six 5-min,rest	10–10–27 to 11–5–27	4	8:45, 10:00, 11:20	2:00, 3:15, 4:30
VII	15-min, A.M. lunch and 10-min. P.M. rest	11–7–27 to 1–21–28	11	9:30	2:30
VIII	Same as VII but 4: 30 stop	1–23–28 to 3–10–28	7	9:30	2:30
IX	Same as VII but 4: 00 stop	3–1228 to 4–7–28	7	9:30	2:30
X	Same as VII	4–9–28 to 6–30–28	12	9:30	2:30
XI	Same as VII but Sat A.M. off	7–2–28 to 9–1–28	9	9:30	2:30
XII	Same as III (no lunch or rests)	9–3–28 to 11–24–28	12	None	
XIII	Same as VII but operators furnish own lunch, company furnishes beverage	11–26–28 to 6–29–29	31	9:30	2:30

PERIOD ACCOUNT OF TEST ROOM

In the remainder of this chapter and in the two chapters that follow, a detailed description of the major events that took place during the first thirteen periods of the test will be given. This method of presentation has been chosen in order to set forth a kind of evidence whiçh does not lend itself easily to summary treatment. For, at every stage of the inquiry, the attitudes of the investigators as well as those of the operators toward the test, and their interactions, were important determinants of the results obtained. In order to describe these attitudes as concretely as possible, it has been necessary at times to give rather lengthy accounts of certain happenings which may appear somewhat irrelevant to the test proper. Only in this way, however, is it possible to present certain data of which important use will be made later in the interpretation.

PERIOD I
(April 25, 1927–May 10, 1927)

During this two week interval the operators selected for the test remained in the main relay assembly department, having not yet been transferred to the test room. The purpose of this period was to obtain certain records which could be used as a base against which the effects of any subsequent changes could be checked. Two factors in particular were important for future comparisons: (1) the output of each girl before entering the test room, and (2) her physical condition.

How Output Was Measured in Period I

Because of the fact that whenever a new plan of recording employees' output is instituted there is very likely to be an immediate reaction on the part of the employees in the direction of either increasing or decreasing their output, it was necessary to obtain base période records while the operators were still in the regular department. The output records obtained for this period were taken, therefore, from the regular departmental records used for pay roll purposes (operators' performance record).

The First Physical Examinations

The first physical examinations were given during the second week of Period 1, just before the operators were transferred to the test room. These first examinations were more thorough than subsequent ones in order that any abnormalities or incipient conditions present prior to the beginning of the test might be disclosed. The findings of the first examinations were, for the most part, negative. Three of the girls, Operators 2A, 3, and 4, were reported as having slightly enlarged thyroid glands, and Operator 2A's blood count showed a slightly anaemic condition. Otherwise, the physician's reports indicated five normally functioning organisms.

Informing the Operators of Plans for the Studies

While the five girls were still in the regular department they were informed of the nature and purpose of the studies. A meeting was held at the office of the then superintendent of the Inspection Branch, who was at that time personally supervising the experiment. In this meeting great care was taken to convince the girls that the purpose of the test was not to "boost" production but rather to study different types of working conditions so that the most suitable environment for work could be found. They were urged not to hurry or "drive," but to work at a natural pace, as only in this way would the results have any significance. The following quotation is an excerpt from the superintendent's notes of this meeting:

First, we told them briefly about the illumination test, and how we had found employees generally hesitant about answering questions frankly. Although we could appreciate their reticence and timidity, nevertheless **we** felt that there ought to be some means whereby management and employees could discuss their problems frankly. Therefore, we decided to set up a small test group and see if after a reasonable période such a condition could not be established. We outlined briefly the questions that we had in mind but

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treatment of the first thirteen periods of the Relay Assembly Test Room all problems and questions which were either irrelevant to the major discriminations reached by the investigators in 1929 or which could be handled more effectively and systematically by considering the five years' data as a whole.

told the operators that we had no very clear notion of just what might come out of the test but were willing to get started and await developments.

We told them that we had in mind trying out several changes in working conditions, such as rest periods, lunches, the various lengths of working days and weeks, and that any changes of this sort would be discussed with the operators with the idea of getting their thoughts and comments before making the change. We assured them that we would tell them all we ourselves knew about the results as we went along—in other words, put all our cards on the table—and the employees were requested to be equally frank with us.

We told them that there might be changes made in working conditions which would be beneficial or desirable from the employees' point of view, and in such cases if they were practical there was no reason why the company should not be willing to make them, as it was our feeling that any change resulting in greater satisfaction of employees would benefit both the employees and the company, regardless of any change in production rate.

The group were assured that the test was not being set up to determine the maximum output, and they were asked to work along at a comfortable pace and particularly not to attempt to see how much they could possibly do. If increased output resulted from better or more satisfactory working conditions, both parties would be the gainers, but we assured them that no attempt would be made to force up production.

We told them that we had no idea how long the test might run—perhaps six months or longer—but the length of the test would be determined by the results. Finally, we assured each girl that it was not necessary for her to join the test group if she had any hesitation about it. Each girl was asked to express her feelings, and all of them decided to try it out.

PERIOD II
(May 10, 1927–June 11, 1927)

On the afternoon of May 10, 1927, the operators moved from the regular department to the test room, which had been previously pre-pared and equipped. In the test room the operators normally worked a 48-hour week consisting of five 8¾-hour days, from Monday to Friday inclusive, and one-half day on Saturday. The hours of work were from 7:30 to 12:00 and from 12:45 to 5:00. OnSaturdays they worked from 7:30 to 12: 00. They were paid time and a half for overtime in excess of eight hours; that is to say, on weekdays they received time and a half for the 45 minutes they worked in excess of eight hours.

Period II was designed to allow some time for the operators to become accustomed to the test room environment and also to give the investigators time to establish a routine for recording data and to make the final adjustments of the recording device. Care was taken not to make any changes in the method of work, and only one exception, the use of the chute mechanism into which the completed relays were dropped, was necessary. In the regular relay assembly department the operators had been required to place the completed relays in a small compartment or box in front of them, an operation demanding a little more care and time. From the beginning, the operators expressed a preference for the chute mechanism because it made the work slightly easier.

The Second Physical Examinations

One event occurred in these early weeks which is of interest because it illustrates the attitudes of the operators toward a certain feature of the test, as well as the way in which the situation was handled by the investigators. When it was time for the second physical examinations the girls, with Operator 1 as spokesman, expressed a dread of the examinations and objected to submitting to them so frequently. In order

to dispel some of their qualms, the investigators again explained the purpose of the examinations and made arrangements for the operators to go to the hospital together instead of separately, as before. After the examinations, the physician and other members of the hospital staff met with the girls for a friendly talk, the purpose of which was to break down the formality of the occasion. During this meeting it was suggested that ice cream be served on these occasions. This suggestion met with the immediate approval of the operators, who offered to furnish a cake. Plans were made for a "party" at the next meeting. This method of treating the situation seemed to satisfy the girls, for when the next examinations came around, they made no complaints.

PERIOD III
(June 13, 1927–August 6, 1927)

Change in Piece Rates

On June 13, 1927, the test room operators were formed into a separate group for the purpose of computing piecework earnings. Previously, in the regular department, the girls had been paid as members of a group of about one hundred operators. Now they were to be paid as members of a group of five. Since it was expected that this change might have a noticeable effect upon output, Period III was allowed to continue for about eight weeks so that the effect of the new pay incentive would work itself out before any additional changes were introduced.

This change in method of payment necessitated a change in piece rates, the purpose of which is best described in the test room progress report of February 25, 1928:

It was desirable that some method of payment should be introduced which would pay the operators in direct proportion to their efforts while on the test. It was felt that unless this was done the operators would not respond with the full co-operation essential to a test of this nature.

Also, it was necessary that the operators should feel assured that they would not suffer financially in any way as a result of their participation in the test. They were told, then, that a method of payment would be introduced after the test was well under way which would assure them of earnings equal to what they had been getting in the past, with the. possibility that these earnings would actually be increased should their output in the test room increase over what it had been in the regular department.

The chief consideration in setting the new piece rates was to determine a rate for each relay type which would pay the operators the same amount of money they had received in the regular department for an equivalent amount of work. The average hourly earnings of these five girls in the regular department were determined by the following procedure:

(a) The average earnings of the five test room assemblers were computed for the months of March, April, and May, 1927. It was found that during this period they had received an average of $.553 per hour.

(b) The average earnings of the layout operator were figured for the same three months. These earnings averaged $.659 per hour.

(c) The average earnings of the layout operator were 23.8% of the total earnings of the five girls:

$$\frac{.659}{5 \times .553} \times 100 = 23.8\%$$

(d) To cover the amount paid to the layout operator, who shared in the earnings but did not assemble relays, it was necessary to increase the average hourly earnings figure of $.553 by 23.8%, giving a figure of $.686.

This was the amount of money that each new piece rate had to return to the group per assembler for one hour's work, providing, of course, output re-mained the same as in the regular department.

The average hourly output for each relay type during Period I was next determined. Then, from the average hourly earnings, on one hand, and the average hourly output, on the other, the new piece rates could be figured as follows:

(e) The total output during Period I was expressed in terms of the number of piece parts handled. (It will be remembered that the distinguishing factor between types was a difference in the number of small piece parts entering into the assembly.)

(f) The average time for handling one piece part was determined by dividing the hours worked during Period I by the total number of piece parts handled.

(g) The time required to assemble one relay of any particular type was then figured by multiplying the number of piece parts in that type by the average time for handling each piece part.

(h) The rate per hour for assembling each type of relay was computed by dividing 60 by the number of minutes required to assemble each type.

(i) The new piece rate for each type was then determined by dividing $.686 (under (d)) by this rate per hour as computed above (under (h)).

Repairing Defective Relays

In Period III two minor changes in the method of work were introduced. The first of these was a change in the time at which each operator repaired the defective relays she had assembled. The usual procedure had been for the inspector to return defective relays to the operator some time during the afternoon. Repairs were made at once so that the completed relays could be shipped out of the test room without delay. This meant that each day there was a break in the output records which, although it amounted to only a few minutes, interfered with the continuity of the record. (Of course, repaired relays were not put down the chute of the recording mechanism.) To overcome this difficulty, it was decided that defective relays should be repaired only on Wednesday and Friday afternoons. On these two after-noons each operator repaired all the defective relays she had assembled since the last repair time. The time required varied from 3 to 25 min utes and averaged about 15 minutes.

Method Used to Check Irregularities in Working Procedure

The other change in the method of work was a temporary one, lasting for a period of five weeks, beginning July 11, 1927. It was introduced for the purpose of studying irregularities and interruptions in working procedure. The system adopted was for each operator to call out whenever she encountered a difficulty in the assembly operation, naming the kind of difficulty it was, e.g., defective clamp plate, bushing, screw, or coil. The test room observer then marked these interruptions on the perforated tape in accordance with a code. Such interruptions as taking time out for eating, drinking, combing hair, talking, and visiting were noted by observation and were also recorded on the tape by code.

Supervision in the Test Room

Several interesting observations relating to the general topic of supervision in the test room were recorded in the daily history record for these eight weeks. In planning the studies, no definite arrangements for supervision had been made. The girls had been previously under the direct supervision of a group chief,

who in turn reported to a section chief, whose superiors were the assistant foreman and foreman of the department. Inasmuch as the test room observer could assume responsibility for most of the day-to-day supervision, it was unnecessary to transfer the group chief to the test room. But some supervisory connection for the purposes of accounting, rate revision, promotion, etc., had to be maintained between the test group and the regular department, and in these matters the foreman exercised certain of his supervisory responsibilities. Consequently, the supervision of the test room came to be divided between the test room observer and the foreman.

The test room observer was chiefly concerned with creating a friendly relation with the operators which would ensure their co-operation. He was anxious to dispel any apprehensions they might have about the test and, in order to do this, he began to converse informally with them each day. Sometimes the topics he brought up pertained to their work, sometimes to personal matters, and occasionally they took the form of a general inquiry as to the attitude of the operators toward the test. The following excerpts from the daily history record, in which he entered information and observations, illustrate the way in which the supervisory functions were being performed:

Monday, June 13, 1927

Operator 1A: Said she was tired today.
Operator 2A: Tired also and said her head ached.
Operator 3: Was asked if she thought she did more, less, or about the same amount of work. Ans.: "More, I'm almost up to Operator 4 and I have a bigger relay."
Operator 4: "I feel fine today, not tired or anything."
Operator 5: "I'm tired today and sleepy."

Tuesday, June 21, 1927

The foreman informed the group of their low activity for the past week.

The weather was more favorable for work, cloudy and raining.

Operator 1A: "I feel fine today. Just right for work."
Operator 2A: "Today is fine for work."
Operator 3: "I went to bed at 9 o'clock last night and feel O.K. today."
Operator 4: "I feel great today."
Operator 5: "A day like this is much better for work than yesterday."

Tuesday, July 5, 1927

The operators were notified of their visit to the hospital tomorrow. They were told of the plans for a "party" following the examination. They were also shown how to figure earnings.

Operator 1A: "We like it better in here because some of the girls didn't get along with us so well."
Operator 2A: "We'll not have any ice cream or party at the hospital. I don't believe we'll have a party at all."
Operator 3: "I'll not believe we'll have a party until Mr. [the foreman] comes in and tells us."
Operator 4: "I like to work in here better than in the department because one don't have so many changes of layouts. It's nicer when we run along on one kind of relay."
Operator 5: Absent today.

Wednesday, July 6, 1927

The group visited the hospital for an examination today.

Dr. [the physician in charge] informed us that the general condition of the group had improved considerably and that two of the tendencies to enlarged thyroid glands were much improved.