A STUDY OF A FOUR-YEAR PILOT
RUN OF AN OFF-THE-JOB TRAINING PROGRAM
FOR EMPLOYEES IN KEY PRODUCTION AND MAINTENANCE JOBS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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* * * * * *

The Ohio State University
1959

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CHAPTER I

INTRODUCTION

In recent years, rapid and accelerating technological progress has ushered in a critical and difficult personnel problem for industry. This problem is the deterioration in the job performance of older employees.

Technology has a way of racing ahead of the previously acquired skills of the men who press the buttons, pull the levers, and maintain the machinery. And now, as we move more and more toward automated lines, technology threatens to widen the gap even more between the worker and his job to the point where the senior employees could lose out altogether.

Some striking examples of this shift are provided in the steel industry where production units have been modernized through the installation of hydraulic and electronic equipment. Because hydraulic systems involved a great deal of piping, the job of maintaining these systems fell to pipefitters. Similarly, electric motor inspectors inherited the responsibility for looking after electronic equipment because it bore a general relationship to their field and involved electricity.

In both categories these employees were senior employees with many years of experience. They were first-class workmen performing key jobs. But so inadequate was their knowledge of the more advanced technical equipment that their job performance fell off sharply.
This erosion of the job performance of senior employees on key jobs was resulting from a shift in emphasis from physical or motor skills to mental or reasoning abilities. The comments of a steelworker who had recently been transferred from an outmoded bar mill to a brand new semi-automated mill illustrates this point: "The mill makes it easier physically. You don't have the heavy sledgering anymore, but automation makes you think."

In the past the job itself had provided the practical knowledge, experience and the necessary practice for motor skills. This was largely what the job required. The modern job, however, called for much more than motor skills. It required the exercise of judgment and thus made the acquisition of technical background and related knowledge essential for effective job performance.

These new, more stringent job requirements placed the greatest burden upon senior employees. A survey revealed that these older men had the least amount of schooling -- eight years on the average and had been away from school on the average for some thirty-odd years. Among all employees, these key men were least able, from an educational standpoint, to help themselves meet the severe demands of technological progress. Yet they had on the average over twenty-five years of job experience and a strong, unbending faith in the value of this experience. After all, most of them had become first-rate workmen largely through experience and experience alone.
It can be readily seen that this presented a unique personnel situation. Because of age, educational limitations, and attitude towards theory, these men were seemingly poor training risks. In addition, they exhibited very little motivation of the type typical of young men eager to make good. Thus, the prevailing attitude among management was, and in many instances still is: "Why bother with these older employees? They will retire soon anyway. They aren't interested in training. Besides you can't teach an old dog new tricks. Forget about them and concentrate on the younger employees who are ambitious and have a fairly good background of technical knowledge to start with." This attitude of futility was widespread and simply added to the obstacles that delayed and blocked effective solutions to the problem.

Nevertheless this unique personnel situation kept pressing for attention because the need for doing something about it kept growing in importance. Furthermore, this need was mutual, involving both the company and the employees.

From the company's standpoint the problem was acute because these senior employees were on key jobs and their job performance was therefore critical to the company's operations. As their job performance declined, the effects spread throughout an entire department. Yet these men, on the average, had approximately seventeen additional years on these key jobs if they continued until normal retirement age of sixty-five. The sheer longevity of the damage they could do demanded that something be done.
From the point of view of the senior employees themselves, their job success was being jeopardized in a way that seniority was unable to prevent. Their esteem in the eyes of fellow workers was being lost and they themselves were aware that they were losing their grip on their jobs. Their pride in achievement and confidence in their ability to handle their work were threatened. Their years of experience seemed of little avail, and even though they had security provided by the union through seniority provisions, they began to fear technological displacement.

One of the major companies faced with this problem was the nation's third largest steel producer, the Republic Steel Corporation, where the author has served since 1947 as Training Counselor.

After long and careful analysis of this problem, Republic's management decided that despite the obstacles that existed, the only solution, if there was a solution, was training. A check with other companies revealed that although many were conducting sound, practical training programs of one type or another, none were designed for this particular situation. Furthermore, a study of off-the-job training and educational activity of persons working at Republic's Cleveland steel plant revealed that a mere fraction of these employees were enrolling in such programs and that scarcely more than one-third were completing their courses. Even worse, nearly three-fourths were taking courses totally unrelated to their jobs.
Thus in 1955, Republic's management instructed the author to proceed with the development of a training program that he had conceived and recommended for hourly employees on key production and maintenance jobs. They further designated that the program be carried out initially on a pilot, or experimental basis.

The Human Engineering Institute*, a non-profit corporation headquarter in Cleveland, Ohio, and directed by the author, was selected to develop and carry out this program on a voluntary enrollment basis among the employees affected. It was assumed that if an effective program were developed to meet the needs of these senior employees, their interest would provide the necessary motivation to get them to attend on their own time. Attendance would be a major criterion of success, for the employees would enroll and complete the courses only if the training met their needs. The development of this special training program extended over a four-year period.

Purpose of the Study

The purpose of this study was to describe this four-year pilot run of an off-the-job training program for employees in key industrial production and maintenance jobs and to identify the personnel policy and educational factors that contributed significantly to the success of the training program.

*Note: Hereafter the Human Engineering Institute will be referred to as the Institute.
For this reason the title "A Study of a Four-Year Pilot Run of an Off-the-Job Training Program for Employees in Key Production and Maintenance Jobs" seems appropriate.

**Method of Procedure**

The primary source of data presented in this study was the actual four-year pilot run of the off-the-job training program. The unique nature of the training problem made this necessary.

Two separate searches of the literature in the field were made. The first was made previous to the organization of the pilot training program; the second was made recently, while this study was being developed. These searches were made in the Cleveland Public Library and The Ohio State University Library.

The first search was made in 1954. This revealed that the available data concerned itself with retraining engineers, training technologists and apprentices, and training employees on-the-job. Another large segment of material dealt with the training of management, supervisory and staff personnel. The specialized literature of adult education dealt primarily with citizenship training, cultural and hobby activities, community and government problems, and the problem of retirement.

In a negative sense, the literature revealed that relatively little was being done by industry to provide off-the-job training for senior employees on jobs requiring applied technology.
The second search was made in 1959. Special consideration was given to recent publications in the field. This showed that little change had taken place in the industrial training for production and maintenance employees in the intervening five years. Even the most recent and most authoritative survey of industrial training programs entitled *Classrooms In The Factories* revealed that in the majority of the companies surveyed the only real training for wage earners is on-the-job training as originated by the Training Within Industry Division of the War Manpower Commission during World War II. This training was designed primarily to instruct new employees in how to perform their new jobs.

In addition to these searches, a survey of the off-the-job training of wage earners by other companies was made. This survey revealed that a number of companies made some efforts in providing off-the-job training in applied technology, but only in a limited way. Only one company has sponsored such training for its employees in an organized continuous manner. The experience of this company was helpful in formulating the training program for this pilot run.

However, even the training program of this one company was not designed for, nor did it reach, the senior employees. Although it was off-the-job training, most of the employees enrolled were young men preparing for promotion, supervisors and staff personnel.

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1Harold F. Clark and Harold S. Sloan, *Classrooms in the Factories*. 
In fact, so few senior employees on production and maintenance jobs have participated that no provisions were made to remove a major obstacle to training these men -- the absence caused by the employee working rotating turns. In effect this meant that an employee working rotating turns would automatically have to be absent at least one-third of the time, thereby creating a "built-in" detriment to effective continuous training.

Therefore, considering the lack of information as revealed in the literature of the field and the lack of activity by other companies, this study was designed to deal with a study of the four-year pilot run of a program for employees in key production and maintenance jobs at Republic Steel Corporation, and to depend on this source for the major portion of its data.

The source of data in this study was the records of the Institute, the organization which developed and administered the pilot run program, and the experiences of the personnel involved in the program. Because this was a pilot run, excellent records were maintained. These have afforded sound factual data for use in this study.

Because of the success of the pilot run in supplying an effective answer to this universal training problem, it seems reasonable to hope the information presented will make a valuable contribution to the training field and to other organizations now facing a similar training situation.
The organization of the study is briefly discussed here. Chapter II traces the development of the pilot run. This includes a description of the major events in the development and improvement of the program. This chapter will present the preliminary planning involved, the basic requirements underlying the program, the methods of instruction used, the selection and training of instructors, and the organization of the training setup itself. In addition, it will trace the growth of the program through the four years in terms of the courses offered, the men attending, the instructors involved, the improvement of curriculum and study material, and the growth and expansion of the program to two other areas. An analysis of attendance figures is included since this was the most critical indicator of whether or not the training needs of the men in question were being met.

In Chapter III a review of the results to date is presented. This summarizes the development of the program and its effect on the Company and the employees, and presents the cost of the program.

Chapter IV is an analysis of the factors that contributed to the program in order to identify the significant personnel policies and educational factors contributing to its effectiveness. It was felt that the training program would fail if it did not take place within the framework of sound personnel policies. Conversely, even sound personnel policy cannot compensate for a program that is not educationally sound. This chapter identifies the major considerations in both areas.

Chapter V presents the conclusions and points out areas where further study is indicated.
CHAPTER II

THE PILOT TRAINING PROGRAM

Basic Requirements

The management of Republic Steel asked that these basic requirements be met in setting up the Pilot Program:

1. That the enrollment be voluntary - at no cost to the employees, and that employees attend classes on their own time.

2. That the programs be designed and developed to meet the needs of employees by major operating departments.

3. That the program be started initially in only a few of the departments, where the department heads were interested and wanted to undertake it.

All of these requirements were important for the success of the program.

Preliminary Steps

The first step in getting the pilot program under way was a meeting of the managers, heads of the industrial relations departments and training supervisors of the four Republic Steel plants in the Cleveland area, where the pilot study took place.
The Vice President in Charge of Manufacturing opened the meeting with this statement:

The technology of modern steel making places a premium on theory, as well as practical knowledge and experience. Technological progress -- constantly accelerating -- is making greater and greater demands on the exercising of judgment and insight by our key operating and maintenance employees -- also supervisors -- in the successful operation of modern steel making equipment and processing.

Unfortunately our best employees, those with years of successful experience are affected most by these technological changes. They are the least familiar with modern technology. We must help them catch up and keep up with these changes.

These senior employees in key operating and maintenance positions must not only know what to do and how, but also why. To understand the why of their job they should have a minimum theoretical background of the work they are performing and at least a grasp of the basic fundamentals of the science, mathematics and technology involved in their jobs.

Training these senior employees presents a unique training situation. They have been out of school many years and applied technological knowledge will not be easy for them to master.

Furthermore, it is somewhat of a new training need and most companies have not come to grips with it, so there isn't much experience to go on. We will, therefore, have to develop a practical and effective training program.

We have decided to set up an experimental training program on a pilot basis in order that we may find a practical answer. If the program works out satisfactorily in Cleveland, we will extend it to our other plant areas.
He then presented proposed plans for the Pilot Training Program.
After a thorough discussion of the proposed plans, the problems
that would likely arise, and what should be done to solve these
problems, a fairly well formulated plan resulted and was developed.

The next step was also a meeting, but this time on the plant
level. Each plant manager met with his department heads and ex-
plained the suggested plans for the development of the training
program on a pilot basis.

Introducing Program to Department Heads

The chart on the next page was used by the managers to explain
the nature of the problem and the preliminary management thinking
involved in the formulation of the suggested Pilot Training Program.

The managers used it to illustrate the nature and degree of
change that has occurred during the past ten years in the job
requirements of the steel industry. They pointed out that less
than ten years ago the amount of technology involved in key jobs
of steel making was relatively small. The average employee did
not have to be concerned about it for it was taken care of by
staff people who were versed in applied technology. But today
applied technology is such a major item in the steel making
operation that the employees in key jobs can no longer rely on
staff help and their former practical experience to satisfactorily
perform their jobs.
PROPOSED PROGRAM

for KEY PRODUCTION & MAINTENANCE EMPLOYEES

TECHNOLOGICAL PROGRESS

APPLIED TECHNICAL KNOWLEDGE

PRACTICAL KNOWLEDGE AND EXPERIENCE

1950 1955 1960
The chart also helped the managers focus on the core of the training problem, namely, that technical know-how cannot be acquired through experience - it is something that has to be studied and learned.

Furthermore, they pointed out that the many years of experience the employees possess will make it easier for them to learn, for they will readily see the value, relationship and purpose of applied technology in their work.

After the presentation and discussion which followed, it was decided in what departments the program was to be started, who the instructors would be, how the program would be started and the procedure for selecting and recommending the employees who would be given the first opportunity to participate in the program.
First Year 1955-56

Six departments chose to cooperate in getting the program under way. They were: Coke Plant, Blast Furnace, Open Hearth, Strip Mill, Mechanical and Electrical Departments. These constitute key departments involved in steel making. Many different types of jobs are performed in these departments all of which have been radically changed in the last decade by rapid technological progress. A number of sections from "Steelmaking Illustrated" have been included in the Appendix, p.137 to 144, to provide the nature and scope of activities involved in steel making, also to provide a description of the functions of the departments and give meaning to the terms common to the steel industry, which are used in this study.

The following constituted the announcement made.

Republic will embark on a new training program designed to help key operating and maintenance wage roll employees keep pace with the progress in developing and installing new processes, new facilities and new equipment.

These training courses at the start will be given to personnel from a number of departments of the Cleveland District as well as to men working in several manufacturing divisions in or near Cleveland. As the program evolves, it will be extended to other departments and other districts.

1STEELWAYS. Steelmaking Illustrated, American Iron and Steel Institute, New York, 1953.
The program is designed to provide employees not only with a greater depth of knowledge concerning the technical aspects of their jobs but also a greater breadth of understanding regarding why they do the things required of them. It is felt that if they have an understanding of the why of their jobs, and how their functions fit into overall productive processes, they will be better equipped to exercise good judgment in handling the varying problems that arise day by day.

The program includes three courses for each department, developed in cooperation with department superintendents. The courses are conducted at the Human Engineering Institute, a non-profit organization created for the development of programs aimed at better and more effective use of manpower. Courses are ten weeks in length, 1-1/2 hours per session.

Senior employees in the top of the job progression who can absorb and benefit from the training are given the first opportunity to enroll. Enrollment is based on the recommendation of department heads and is purely voluntary on the part of the employees recommended. Attendance is on the employees' own time. There is no tuition; Republic is financing the entire cost.

Courses will be offered each year in each department. Successful completion of each course makes the employee eligible for recommendation to the succeeding course.

Interest in the program will undoubtedly be high. Only two-hundred employees will be enrolled in the course this year.

Announcement of the training struck a harmonious chord among the supervisors and union leaders. It was favorably received, in fact welcomed. The major complaint was that it should have been started at least ten years ago and that not enough employees are being given an opportunity to enroll.
This enthusiastic support on the part of the union leaders was backed by an unusually high and unexpected enrollment on their part in the first classes. Shortly after the program got under way, the supervisors expressed a desire to obtain similar training and were later given the opportunity.

The Institute which conducted the training was organized in 1954 by the author to continue the development of training and personnel testing programs for industry and business which were previously conducted at the Personnel Development Center at Fenn College, but dropped in 1947.

Republic Steel Corporation underwrote the initial cost of starting the Institute and has since financed the major development projects which are now in process of development, including the Pilot Training Program.

The author, because of his dual capacity as Director of The Human Engineering Institute and Training Counselor for Republic Steel Corporation, has been in the position to both direct the development of the programs and to supervise their installation and operation in the plants. At the present time a number of other companies are taking advantage of the development activities and experience of the Institute and are sharing in the cost of its operation.
In the initial meetings the purpose and activities of the Institute had to be explained because it was a relatively new organization. The information on the next two pages was reviewed and presented to the supervisors and union leaders for their own file as reference information on the Institute.

**Selection and Training of Instructors**

Each superintendent was asked to recommend two instructors and an alternate. In four of the departments the superintendents and their assistants decided they would like to become the instructors. Their decision, which proved to be highly beneficial to the program, was influenced by the fact that their senior employees in key jobs would constitute the first classes and because they wanted to assume personal responsibility for the successful conduct and development of the program in its beginning stages.

The Institute staff provided the instructors with three half days of training at the Institute. The training consisted of the following topics:

- Introduction to the Industrial Training Program.
- The Role of the Industrial Teacher.
- Basic Purposes of Each Meeting.
- "Keys" to Creative Learning.
- Approaches to Conducting Sessions.
- Techniques in the Creative Approach to Learning.
- Appraisal of our Teaching.
- Suggestions for Improvement.
- Summary.
THE IDEA BEHIND HUMAN ENGINEERING INSTITUTE PROGRAMS

The basic programs of H.E.I. vary in content and method, depending upon their purpose and function. Each of the programs, however, is based upon the following rather simple but very fundamental assumption.

Maximum job proficiency will result only when each employee is:

- **PROPERLY PLACED** — on a job for which he is best qualified-vocationally and consequently has the best chance for success, progress and personal satisfaction.

- **ADEQUATELY TRAINED** — so that he does his assigned job correctly, safely, steadily and conscientiously.

- **EFFECTIVELY SUPERVISED AND MANAGED** — so that he is provided with the quality of leadership and work conditions which will motivate him to do a top-flight job.

**Proper Placement**

**Adequate Training**

**Effective Supervision and Management**

Results in

**Quality Job Performance**

Great Masses of Men Work Constantly at Points Below Their Top Capacities. We Must Help Them Rise to Their Opportunities.

Henry Ford
H.E.I. is a non-profit organization dedicated to the development and application of the science of human engineering. As such, it assists employers to improve the quality of employee performance.

H.E.I. is unique in its —

- Philosophy and methods of developing programs which:
  - bring about better placement, training and supervision of employees
  - are practical, economical and effective
  - become an integral and dynamic part of the ongoing personnel activities of an organization.

- Success in improving and supplementing these programs so that they remain current and have in them a "built-in" factor necessary for continuous progress.

- Effectiveness in training and developing personnel within an organization to carry out the program activities, thus making the organization self-sufficient.

- Ability to "follow through" in the programs in order to insure their continued success.

- Professional leadership by reason of the quality, experience and creativeness of its staff.

H.E.I. services permit companies, regardless of size, to benefit from the most advanced personnel research and techniques. The majority of the basic programs offered were developed in some of the country's outstanding industries under H.E.I. staff leadership.

Industry's tremendous technological advances point up a serious lag in the improvement of employee performance. This lag exerts a strong braking force on industrial progress. Only by applying our present knowledge of the human factor and by furthering research in this vital area can we bring employee performance abreast of technical growth.
For a more complete description of the method used to train the instructors see Handbook for Industrial Teachers in the Appendix, pp. 151.

Selecting and Enrolling the Employees

Each department head conferred with his foreman to decide on the employees to be recommended as candidates. It was assumed that only about 50 percent of those recommended would enroll. To avoid the possibility of having classes with more than fifteen to eighteen people, only forty employees were placed on the recommended list from each department. If an insufficient number enrolled, names of additional candidates were to be submitted.

Two sections, A and B were formed. Section A was the starting class, and Section B was a trailer class that started a week later. Having two sections meeting a week apart made it possible for the employees enrolled to attend each session regardless of the shift they were on. In the steel industry the men work on one of the three eight-hour shifts (day, evening and night shift) and rotate shifts each week. If a trailer section was not available the men on the evening turn, 3:00 p.m. to 11:00 p.m., would miss their class session once every three weeks.

The employees who were recommended for the training were notified by letter which was sent to their homes.
A copy of the content of the letter sent to the applicants of the Electrical Department follows:

We are pleased to learn that you have been recommended by supervisors in your department for enrollment in Electrical I of the training program for this coming year. These classes, which are held here at the Institute, are taught by members of the Electrical Department. By attending class one evening a week you will study the what, the why and the how of your job, especially in relation to the new developments in the Electrical field.

The classes will be small and your instructors will make use of visual aids, chart pads, maps, models, etc. to make the work interesting and easy for you to understand. We believe you will enjoy this opportunity to learn more about the new developments in your department.

The classes are held from 7:00 to 8:30 p.m. on Monday and Wednesday evening of each week. The starting dates are as follows:

Section A - Wednesday, September 17th

Section B - Monday, September 22nd.

You choose the section that fits your work schedule, but be sure to come to the first class on one of these dates for the beginning session. Your supervisor will talk with you about your section assignment. You should tell him which opening session you can attend. We will look forward to seeing you. The parking lot is at the rear of the building located on the west side of East 36th Street between Carnegie and Prospect Avenues.

The nature of the training program was explained by means of a folder, which was included in the letter. It contained the following information.
The Production and Maintenance Training Programs are designed to help key operating and maintenance employees keep pace with the progress in developing and installing new processes, new facilities, and new equipment.

An employee of Republic recently made the statement: "It's no fun trying to do our job if we don't understand what we are doing or why."

Rapid technological advancement, new equipment, more complicated processes, have changed the nature of our jobs greatly in the last fifteen years and even greater changes will occur in the years ahead.

Republic Steel Corporation has asked the staff of the Institute to develop a training program which will help you catch up with the changes, especially technological, that have affected your job.

Courses will be taught by selected men who have broad knowledge and years of experience in steel making. Classes will purposely be kept small enough to encourage questions and shop talk between instructor and classmates.

You'll find the instructors to be practical steel men who talk your job language. They will use diagrams, charts, pictures, cut-a-way drawings, models, mock-ups, films and photographic slides to explain the course topics. The topics themselves will be made interesting, easy to understand, and closely related to your job. The same is true of the specially prepared written material which you will use in the course and keep for future reference. Class discussion in which you share your ideas and experiences with the instructor and classmates will be the basic method of teaching used in these courses.

Senior employees in the top of the job progression who can absorb and benefit from the training are being given the first opportunity to enroll.
Enrollment is based on the recommendation of department heads and is purely voluntary on the part of the employees recommended. Attendance is on the employee's own time. There is no tuition - Republic is financing the entire cost.

Courses will be offered each year in each department. Successful completion of each course makes the employee eligible for recommendation to the succeeding course.

The following is a list of the initial courses to be offered this fall in the Production and Maintenance Training Program.

**Departments**
- Coke Plant Practices
- Open Hearth Practices
- Blast Furnace Practices
- Cold Strip Practices
- Mechanical I
- Electrical I

Classes will be conducted at the Human Engineering Institute located at 2074 East 36th Street, Cleveland 15, Ohio. Parking is available. Each class meets once a week for one and one half hours starting at 7:00 p.m. A and B sections for each class permit you to attend regularly regardless of the turn you work.

Thirty class sessions make up the school year which is divided into three ten-week periods. Classes begin in mid-September and end early in May. Enrollment is strictly on a voluntary basis.

It is interesting to note that over 90 percent enrolled, although only 50 percent were expected to enroll. Two sections of each class were formed. Each section consisted of fifteen to eighteen employees.
A second letter was then sent to each employee informing him of the section assignment and starting date of the training program.

**The Classroom**

On the opening night these students found themselves in classrooms that were equipped with comfortable semi-upholstered chairs, arranged so that four or five could sit around a table. Scratch pads, flannel boards and other types of visual aid equipment was available. Ash trays to permit smoking added to the general informality of the classroom.

Classes started at 7:00 p.m. and lasted for one and one half hours. The school year which started in September consisted of three ten week quarters.* Two hundred and five employees enrolled in the first year.

In nearly every instance the men knew each other and the instructor. Likewise, the instructor knew most of the men in the class. After an exchange of greetings, and some kidding remarks about "going back to school", each class got under way in a friendly yet serious way.

The job titles of the class members were as follows: Motor Inspectors, Millwrights, Pip Fitters, Mechanics, Carpenters, Heaters, Stove Tenders, Larry Car Operators, First Helpers Rollers and Gaugers. Eighty-eight employees were in the maintenance departments and 117 were in the production departments.

*Note: The fourth quarter was the summer quarter and classes were not held during this quarter because of vacations.
Development of Text Material and Visual Aids

The superintendents of each of the six departments sat down with the members of the Institute staff responsible for the development and supervision of the program, discussed and outlined the major topical areas to be studied in a logical sequence. Each major topic was then broken down into units and into class session outlines. This was done by a development team of three Institute staff members who worked with each instructor. The three-man development team consisted of (1) a person who had training in technology and experience of steel making, (2) an individual who knew teaching methods and (3) a visual aids specialist. They worked regularly with the instructor in helping him prepare the text material, decide on the best methods of teaching it, and to design and prepare the visual aids that would make his instruction effective. They planned four weeks in advance and added to his text material each week. They also coached the instructors, helped them write and illustrate their text material, and prepared visual aids for them.

Starting with the initial class session the problem for the instructors has been to direct the discussion and equalize the degree of participation of the members during the class period, and shut off the discussion at the end of the class. Rarely did the members of the class leave the classroom at the designated time. The discussion often lasted a half hour or more. Classes ended and then the discussion would start over again in the parking lot that evening or in the department the next day.
By discussing operational problems, analyzing the cause of the difficulties, and searching for the reasons, it was surprising to the novice instructors how much applied technology and related fundamentals of science and mathematics he was able to weave successfully into his instructions.

The attendance throughout the year was excellent even though the obstacles were more numerous and more difficult than is generally encountered in training programs. For example, colds and other physical ailments were much more common in this group than is true of a group of college students, according to the Company dispensary records.

Eighty percent completed the first quarter successfully and were eligible to continue into the second quarter. Ninety-one percent of those who completed the first quarter also completed the second quarter.

Eighty-two percent completed the third quarter and received certificates at the end of the thirty weeks. Over two-thirds of the employees who enrolled at the beginning of the year completed all three quarters and were eligible to continue into the second year's program.

Table 1 supplies complete information on the enrollment, drop-outs and completion of the classes by quarters.
Some idea of the relatively high completions and low drop-outs by quarters is gained from the percentage of completion figures. Sixty percent completion, the lowest of any quarter during the entire year in any department occurred in the third quarter of the Blast Furnace class. The educational background of both the enrollees and of the instructors was the poorest in this department. More will be said about this when the results of the succeeding charts are explained.

In two instances one hundred percent of those starting the quarter completed it satisfactorily. Republic Steel management was surprised and pleased with the fine attendance the first year and in succeeding years.

The figures in Table 2 indicate the number of the original enrollees that completed all three quarters satisfactorily. Two out of every three employees originally enrolled received their graduation certificate. The highest percentage of completion (83.3 percent) occurred surprisingly in the Strip Mill where for years the most tense management-employee relations were supposed to have existed. In this class the morale was very high. The department head, who was transferred from another district, was the instructor. The class experience gave him an opportunity to get better acquainted with the key men and their activities in the department and as a result to more quickly develop his working relationships with them.
The second highest completion percentage (81.8 percent) was attained by the Coke Plant class. This was somewhat of a surprise. The class members were Negroes and although they successfully performed key jobs in the coke plant the general attitude prevailed, namely that the Negro generally was not ambitious, dependable, or willing to advance himself.

If additional proof was needed that this attitude toward the Negro was wrong, the attendance, interest, and participation of the members of the Coke Plant class supplied it abundantly.

Figure 1 - Completion by Departments for the School Year 1955-1956 points out that the departments with the poorest record as far as completion were the Blast Furnace and the Electrical I Steel Plant. In both cases the desired type of instructor was not available. The most capable instructor in the Electrical Class underwent a serious operation soon after the program began and the substitute was not able to maintain the interest of the class.

Five out of eight departments reached or exceeded the 66.3 percent completion average for the first year. The two departments at the low end of the chart were so much below the average that it can be said that the Institute very likely failed to act quickly or adequately enough to find a successful solution.
It would seem that with the close working relationship existing such poor results should not have occurred. Appropriate graduation exercises were held at the end of the year in which the plant manager of the steel plant acknowledged the participation and the progress of the employees and encouraged them to continue their training. The certificates were handed to the men by their department heads and a social hour followed. This "commencement" was looked upon by many of the men as an important event in their lives.
TABLE 1

PRODUCTION AND MAINTENANCE TRAINING PROGRAM
For the Year 1955 - 1956

BREAKDOWN OF ENROLLMENT, DROP-OUTS, AND PERCENTAGE OF COMPLETION
BY INDIVIDUAL DEPARTMENTS

<table>
<thead>
<tr>
<th>Department</th>
<th>1st Quarter</th>
<th>2nd Quarter</th>
<th>3rd Quarter</th>
<th>1st Quarter</th>
<th>2nd Quarter</th>
<th>3rd Quarter</th>
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<th>1st Quarter</th>
<th>2nd Quarter</th>
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<th>1st Quarter</th>
<th>2nd Quarter</th>
<th>3rd Quarter</th>
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<td>Completed 97</td>
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<th>1st Quarter</th>
<th>2nd Quarter</th>
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<td>Percent</td>
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<td>166</td>
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<td>82</td>
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<td>Enrollment</td>
<td>Drop-Outs</td>
<td>Completed</td>
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<td>------------</td>
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<td>BLAST FURNACE</td>
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<td>COKE PLANT</td>
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<td>9</td>
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<tr>
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<td>OPEN HEARTH</td>
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<tr>
<td>TOTAL</td>
<td>205</td>
<td>69</td>
<td>136</td>
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FIGURE 1

Completion by Department for the School Year 1955-1956
Second Year 1956 - 1957

In preparation for the second year the Vice President of Operations, who initiated the program originally the previous year, invited the plant managers, department heads involved, the instructors, and the Institute staff to a luncheon meeting. At this meeting he asked members of the group to (1) explain the progress made in the development of the programs in each department, (2) describe their teaching experience, and (3) report on the value and success of the program to date.

The report was unusually favorable and the interest extremely high. The group was then asked to give him their recommendation for any changes and additions to the program for the second year. The following requests and recommendations were made:

The Mechanical Department asked that the beginning course in Blueprint Reading be continued for another group of employees, and that a second course be added, called Mechanical II, for those who had satisfactorily completed Mechanical I. They also asked the Institute to develop a new course in hydraulics for pipefitters and other key maintenance employees, who had become involved in the rapid change-over to the use of hydraulic equipment in the plant.
The Electrical Department requested that the beginning electrical course in the fundamentals of electricity and direct current machinery be continued for another group of employees. They further asked that a more advanced course in alternating current machines be made available as a second year course for those who satisfactorily completed the first year.

The Strip Mill asked that the Hot Strip Training Program be continued and that the Institute develop a new program for the Cold Strip employees.

The Open Hearth Department asked that the floor program for first helpers be continued for another year, and that a new program for the men employed in the pits be developed.

Three other departments, Blooming Mill, Bar Mill, and Coal Chemical requested similar training programs for their employees. These requests for enlarging and extending the program were approved.
Accordingly, the programs and enrollment for the fall of 1956 were as follows:

<table>
<thead>
<tr>
<th>Department</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Mill</td>
<td>37</td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>18</td>
</tr>
<tr>
<td>Blooming Mill</td>
<td>30</td>
</tr>
<tr>
<td>Coke Ovens</td>
<td>36</td>
</tr>
<tr>
<td>Cold Strip</td>
<td>35</td>
</tr>
<tr>
<td>Electrical I</td>
<td>51</td>
</tr>
<tr>
<td>Electrical II</td>
<td>35</td>
</tr>
<tr>
<td>Hot Strip</td>
<td>33</td>
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<tr>
<td>Hydraulics</td>
<td>21</td>
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<tr>
<td>Mechanical I (Steel)</td>
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</tr>
<tr>
<td>Mechanical I (Mfg.)</td>
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<tr>
<td>Mechanical II</td>
<td>21</td>
</tr>
<tr>
<td>Open Hearth Floor</td>
<td>30</td>
</tr>
<tr>
<td>Open Hearth Pits</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>461</strong></td>
</tr>
</tbody>
</table>

These men represented one hundred twenty-one job titles, again largely made up of men at the top of their job progression. Two hundred seventeen enrollees came from the Maintenance Programs, Electrical, Mechanical and Hydraulics, 244 from the Production Department, Blast Furnace, Blooming Mill, Bar Mill, Coke Plant, Cold Strip, Hot Strip, Open Hearth Pits and Floors.

In addition to the fourteen instructors who taught in the first year, twenty-five additional instructors were selected to handle the training programs for the second year. The thirty-nine instructors were brought together in a series of training sessions. The following are some of the areas covered in this improved orientation and training program for the instructors:

An over-view of the needs for training in industry. Remarks and observations by the Vice President.
An overview of the first year's production and maintenance programs. Last year's courses, students enrolled, job classification, attendance, etc.

Programs planned for this coming year with courses, students, job classifications, etc.

Industrial teaching and the problems involved.

Challenges presented by individual training needs of students. The discussion led to suggested methods of meeting these problems and challenges.

Teaching techniques - An approach to "Creative Teaching".

- Key points in developing effective instructor-student guides and lesson plans.

- Presentation of typical class session.

- Review of manual entitled "Handbook for Industrial Teachers".

- How to use visual aids such as chart pads, blackboard, visual cast cells.

Improvement in Reading Material

During the first year much experience was gained in learning how to work with the men in the departments in developing the reading and study material that was used by the students.

At the beginning of the third quarter of this school year, the Superintendents of the Coke and Coal Chemical Departments asked that a special training program be designed and developed for all
supervisors in their department. This resulted in the development of both a Coke Oven and a Coal Chemical program for supervisors, in which fifty-two additional students were enrolled during the spring quarter. These programs were, therefore, launched in the third quarter and continued through all three quarters of the next school year, 1957 - 1958.

As stated earlier, one of the major tests of the success of the program was to be the interest of the men as reflected by their attendance. Table 3 and 4 and Figure 2 on the following pages show the enrollment and completion data for the school year 1956-1957. Table 3 traces enrollment and drop-outs by quarters. In no case is there any particular overall pattern for drop-outs. For example, 19 men dropped out of Mechanical I in the first quarter and seven dropped out in the third quarter. None dropped out of the Open Hearth Floor program in the first quarter, but ten dropped out in the third quarter. Table 4 gives the overall picture for the school year. Figure 2 summarized the attendance in descending order. It is interesting to note that two of the three departments with the lowest percentage of attendance, namely the Blooming Mill and Bar Mill, were not in the Pilot Run Program in the first year of its operation. If a study of this situation had been undertaken, it might have provided some valuable data.
In general, however, the percent of completion was encouragingly high. Combined results show that 85 percent completed the first quarter; 80 percent completed the second quarter; and 84 percent completed the third quarter.
### TABLE 3

**PRODUCTION AND MAINTENANCE TRAINING PROGRAM**

*For the Year 1956-1957*

**BREAKDOWN OF ENROLLMENT, DROP-OUTS AND PERCENTAGE OF COMPLETION**

<table>
<thead>
<tr>
<th>Department</th>
<th>Quarterly Enroll.</th>
<th>Percent Dropped</th>
<th>Percent Completed</th>
<th>Department</th>
<th>Quarterly Enroll.</th>
<th>Percent Dropped</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace</td>
<td></td>
<td></td>
<td></td>
<td>Mechanical I (M)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>18</td>
<td>2</td>
<td>89</td>
<td>1st Quarter</td>
<td>29</td>
<td>6</td>
<td>80</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>16</td>
<td>4</td>
<td>75</td>
<td>2nd Quarter</td>
<td>23</td>
<td>4</td>
<td>83</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>12</td>
<td>6</td>
<td>50</td>
<td>3rd Quarter</td>
<td>19</td>
<td>4</td>
<td>79</td>
</tr>
<tr>
<td>Coke Plant</td>
<td></td>
<td></td>
<td></td>
<td>Hot Strip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>36</td>
<td>3</td>
<td>86</td>
<td>1st Quarter</td>
<td>33</td>
<td>2</td>
<td>94</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>31</td>
<td>6</td>
<td>81</td>
<td>2nd Quarter</td>
<td>31</td>
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<td>90</td>
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<td>3rd Quarter</td>
<td>25</td>
<td>6</td>
<td>76</td>
<td>3rd Quarter</td>
<td>28</td>
<td>8</td>
<td>72</td>
</tr>
<tr>
<td>Electrical I</td>
<td></td>
<td></td>
<td></td>
<td>Cold Strip</td>
<td></td>
<td></td>
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<tr>
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<td>51</td>
<td>13</td>
<td>75</td>
<td>1st Quarter</td>
<td>35</td>
<td>2</td>
<td>94</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>38</td>
<td>7</td>
<td>82</td>
<td>2nd Quarter</td>
<td>33</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>31</td>
<td>7</td>
<td>77</td>
<td>3rd Quarter</td>
<td>33</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Electrical II</td>
<td></td>
<td></td>
<td></td>
<td>Open Hearth Fins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>35</td>
<td>2</td>
<td>94</td>
<td>1st Quarter</td>
<td>25</td>
<td>6</td>
<td>76</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>34</td>
<td>6</td>
<td>82</td>
<td>2nd Quarter</td>
<td>19</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>28</td>
<td>5</td>
<td>82</td>
<td>3rd Quarter</td>
<td>17</td>
<td>4</td>
<td>76</td>
</tr>
<tr>
<td>Mechanical I (S)</td>
<td></td>
<td></td>
<td></td>
<td>Open Hearth Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>60</td>
<td>19</td>
<td>61</td>
<td>1st Quarter</td>
<td>30</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>41</td>
<td>6</td>
<td>85</td>
<td>2nd Quarter</td>
<td>30</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>35</td>
<td>7</td>
<td>80</td>
<td>3rd Quarter</td>
<td>24</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Mechanical II</td>
<td></td>
<td></td>
<td></td>
<td>Blooming Mill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>21</td>
<td>5</td>
<td>76</td>
<td>1st Quarter</td>
<td>30</td>
<td>1</td>
<td>97</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>16</td>
<td>1</td>
<td>94</td>
<td>2nd Quarter</td>
<td>29</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>15</td>
<td>0</td>
<td>100</td>
<td>3rd Quarter</td>
<td>20</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>Hydraulics</td>
<td></td>
<td></td>
<td></td>
<td>Bar Mill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>21</td>
<td>2</td>
<td>90</td>
<td>1st Quarter</td>
<td>37</td>
<td>7</td>
<td>81</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>19</td>
<td>0</td>
<td>100</td>
<td>2nd Quarter</td>
<td>30</td>
<td>14</td>
<td>53</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>19</td>
<td>0</td>
<td>100</td>
<td>3rd Quarter</td>
<td>52</td>
<td>2</td>
<td>96</td>
</tr>
</tbody>
</table>

**TOTALS**

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>461</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>Second</td>
<td>391</td>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>Third</td>
<td>364</td>
<td>59</td>
<td>84</td>
</tr>
</tbody>
</table>
**TABLE 4**

*Enrollment and Completion Data for School Year 1956-1957*

<table>
<thead>
<tr>
<th>Program</th>
<th>Enrollment</th>
<th>Drop-Outs</th>
<th>Completed</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLAST FURNACE</td>
<td>18</td>
<td>12</td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>COKE PLANT</td>
<td>36</td>
<td>17</td>
<td>19</td>
<td>52.8</td>
</tr>
<tr>
<td>ELECTRIC I</td>
<td>51</td>
<td>27</td>
<td>24</td>
<td>47.1</td>
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<td>ELECTRIC II</td>
<td>35</td>
<td>13</td>
<td>22</td>
<td>61.4</td>
</tr>
<tr>
<td>MECHANICAL I</td>
<td>60</td>
<td>32</td>
<td>28</td>
<td>46.7</td>
</tr>
<tr>
<td>MECHANICAL II</td>
<td>21</td>
<td>6</td>
<td>15</td>
<td>71.4</td>
</tr>
<tr>
<td>HYDRAULICS</td>
<td>21</td>
<td>2</td>
<td>19</td>
<td>90.5</td>
</tr>
<tr>
<td>MECHANICAL I (M)</td>
<td>29</td>
<td>14</td>
<td>15</td>
<td>51.7</td>
</tr>
<tr>
<td>HOT STRIP</td>
<td>33</td>
<td>13</td>
<td>20</td>
<td>60.6</td>
</tr>
<tr>
<td>COLD STRIP</td>
<td>35</td>
<td>2</td>
<td>33</td>
<td>94.3</td>
</tr>
<tr>
<td>OPEN HEARTH PITS</td>
<td>25</td>
<td>12</td>
<td>13</td>
<td>52.0</td>
</tr>
<tr>
<td>OPEN HEARTH FLOOR</td>
<td>30</td>
<td>16</td>
<td>14</td>
<td>46.7</td>
</tr>
<tr>
<td>BLOOMING MILL</td>
<td>30</td>
<td>21</td>
<td>9</td>
<td>30.0</td>
</tr>
<tr>
<td>BAR MILL</td>
<td>37</td>
<td>21</td>
<td>16</td>
<td>43.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>461</strong></td>
<td><strong>208</strong></td>
<td><strong>253</strong></td>
<td><strong>54.9</strong></td>
</tr>
</tbody>
</table>
Completion by Department for the School Year 1956 - 1957
Third Year 1957-1958

At the review meeting of the second year's operation the executives of the Corporation expressed their satisfaction with the training programs and decided not only to continue the training program in the Cleveland District but to extend it to another area in which Republic plants were located. The area selected was Warren-Niles.

Up to this time all of these training programs have been conducted specifically for the wage-earner groups, namely those who were members of the bargaining unit.

An interesting and very important development followed. The second year of the pilot program many of the foremen and supervisors found themselves, at times, having difficulty answering the why type of question coming from their men enrolled in these programs. This led to requests for similar programs for Supervisors in the fall of 1957. It will be noticed in the following tabulation that four of these programs were offered specifically to supervisors.

The following programs were continued and offered for the wage-earner group:

<table>
<thead>
<tr>
<th>Program</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical I</td>
<td>26</td>
</tr>
<tr>
<td>Electrical II</td>
<td>24</td>
</tr>
<tr>
<td>Electrical III</td>
<td>19</td>
</tr>
<tr>
<td>Hydraulics (Steel)</td>
<td>42</td>
</tr>
<tr>
<td>Hydraulics (Mfg.)</td>
<td>15</td>
</tr>
<tr>
<td>Mechanical I</td>
<td>33</td>
</tr>
<tr>
<td>Mechanical II</td>
<td>18</td>
</tr>
<tr>
<td>Open Hearth Floors</td>
<td>44</td>
</tr>
<tr>
<td>Open Hearth Pits</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>389</strong></td>
</tr>
</tbody>
</table>
It will be noted here that three new programs were developed during this year, namely Coal Chemical, Electrical III, and Resistance Welding. Enrollment of three hundred eighty-nine in the Cleveland district when combined with 161 in the Warren-Niles district made a total of 550 enrolled during this school year. The percentage of students completing the programs for the year was as follows:

<table>
<thead>
<tr>
<th>District</th>
<th>Quarter</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warren-Niles</td>
<td>First Quarter</td>
<td>86 percent</td>
</tr>
<tr>
<td></td>
<td>Second Quarter</td>
<td>87 percent</td>
</tr>
<tr>
<td></td>
<td>Third Quarter</td>
<td>100 percent</td>
</tr>
<tr>
<td>Cleveland</td>
<td>First Quarter</td>
<td>89 percent</td>
</tr>
<tr>
<td></td>
<td>Second Quarter</td>
<td>82 percent</td>
</tr>
<tr>
<td></td>
<td>Third Quarter</td>
<td>91 percent</td>
</tr>
</tbody>
</table>

On the following pages, Tables 5 and 6 and Figure 3 show the enrollment and completion data for the school year 1957 - 1958. Again there seems to be no distinct problem in drop-outs. Overall attendance was good. The Open Hearth attendance was lowest (31.6 percent). This can be traced to a reduction in operations which caused cutbacks and layoffs. At first the cutbacks caused considerable shift changes, making it impossible for some of these men to attend. After that, some of the men enrolled were laid off temporarily. Of these, some continued to attend; others dropped out, some because they had secured temporary employment that prevented their attendance.
## TABLE 5

**PRODUCTION AND MAINTENANCE TRAINING PROGRAM**  
For the Year 1957 - 1958

**BREAKDOWN OF ENROLLMENT, DROP-OUTS AND PERCENTAGE OF COMPLETION BY INDIVIDUAL DEPARTMENTS**

<table>
<thead>
<tr>
<th>Department</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Completed</th>
<th>Department</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace</td>
<td>36</td>
<td>3</td>
<td>92</td>
<td>1st Quarter</td>
<td>42</td>
<td>2</td>
<td>95</td>
</tr>
<tr>
<td>1st Quarter</td>
<td>33</td>
<td>5</td>
<td>83</td>
<td>2nd Quarter</td>
<td>46</td>
<td>2</td>
<td>96</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>28</td>
<td>2</td>
<td>93</td>
<td>3rd Quarter</td>
<td>44</td>
<td>2</td>
<td>95</td>
</tr>
<tr>
<td>Coal Chem. &amp; Coke Ovens</td>
<td>46</td>
<td>2</td>
<td>96</td>
<td>1st Quarter</td>
<td>23</td>
<td>1</td>
<td>96</td>
</tr>
<tr>
<td>1st Quarter</td>
<td>49</td>
<td>3</td>
<td>94</td>
<td>2nd Quarter</td>
<td>22</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>46</td>
<td>6</td>
<td>87</td>
<td>3rd Quarter</td>
<td>17</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>Cold Strip</td>
<td>44</td>
<td>0</td>
<td>100</td>
<td>1st Quarter</td>
<td>33</td>
<td>7</td>
<td>80</td>
</tr>
<tr>
<td>1st Quarter</td>
<td>46</td>
<td>4</td>
<td>91</td>
<td>2nd Quarter</td>
<td>26</td>
<td>7</td>
<td>73</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>42</td>
<td>1</td>
<td>98</td>
<td>3rd Quarter</td>
<td>19</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Elec. I</td>
<td>26</td>
<td>6</td>
<td>80</td>
<td>1st Quarter</td>
<td>18</td>
<td>0</td>
<td>100</td>
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<tr>
<td>1st Quarter</td>
<td>20</td>
<td>7</td>
<td>60</td>
<td>2nd Quarter</td>
<td>18</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>13</td>
<td>2</td>
<td>90</td>
<td>3rd Quarter</td>
<td>9</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Elec. II</td>
<td>24</td>
<td>1</td>
<td>96</td>
<td>1st Quarter</td>
<td>44</td>
<td>5</td>
<td>89</td>
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<tr>
<td>1st Quarter</td>
<td>23</td>
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<td>70</td>
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<td>16</td>
<td>0</td>
<td>100</td>
<td>3rd Quarter</td>
<td>36</td>
<td>2</td>
<td>94</td>
</tr>
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<td>Elec. III</td>
<td>19</td>
<td>3</td>
<td>84</td>
<td>1st Quarter</td>
<td>19</td>
<td>5</td>
<td>73</td>
</tr>
<tr>
<td>1st Quarter</td>
<td>16</td>
<td>6</td>
<td>62</td>
<td>2nd Quarter</td>
<td>14</td>
<td>5</td>
<td>64</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>10</td>
<td>1</td>
<td>90</td>
<td>3rd Quarter</td>
<td>9</td>
<td>3</td>
<td>67</td>
</tr>
<tr>
<td>Hyd. (Mfg.)</td>
<td>15</td>
<td>6</td>
<td>60</td>
<td>2nd Quarter</td>
<td>17</td>
<td>4</td>
<td>77</td>
</tr>
<tr>
<td>(Combined with Steel in 2nd &amp; 3rd Quarter)</td>
<td></td>
<td></td>
<td></td>
<td>3rd Quarter</td>
<td>13</td>
<td>3</td>
<td>77</td>
</tr>
</tbody>
</table>

**TOTALS**

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>189</td>
<td>44</td>
<td>89</td>
</tr>
<tr>
<td>Second</td>
<td>369</td>
<td>67</td>
<td>82</td>
</tr>
<tr>
<td>Third</td>
<td>402</td>
<td>28</td>
<td>91</td>
</tr>
</tbody>
</table>
TABLE 6

Enrollment and Completion Data for School Year 1957-1958

<table>
<thead>
<tr>
<th></th>
<th>Enrollment</th>
<th>Drop-Outs</th>
<th>Completed</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLAST FURNACE</td>
<td>36</td>
<td>10</td>
<td>26</td>
<td>72.2</td>
</tr>
<tr>
<td>COAL CHEMICAL AND COKE OVENS</td>
<td>46</td>
<td>11</td>
<td>40</td>
<td>86.5</td>
</tr>
<tr>
<td>COLD STRIP</td>
<td>44</td>
<td>5</td>
<td>41</td>
<td>93.2</td>
</tr>
<tr>
<td>ELECTRIC I</td>
<td>26</td>
<td>15</td>
<td>11</td>
<td>42.3</td>
</tr>
<tr>
<td>ELECTRIC II</td>
<td>24</td>
<td>8</td>
<td>16</td>
<td>66.7</td>
</tr>
<tr>
<td>ELECTRIC III</td>
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<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>HYDRAULICS (STEEL)</td>
<td>42</td>
<td>6</td>
<td>42</td>
<td>73.7</td>
</tr>
<tr>
<td>HYDRAULICS (FOREMEN)</td>
<td>23</td>
<td>11</td>
<td>12</td>
<td>52.2</td>
</tr>
<tr>
<td>MECHANICAL I</td>
<td>33</td>
<td>14</td>
<td>19</td>
<td>57.6</td>
</tr>
<tr>
<td>MECHANICAL II</td>
<td>18</td>
<td>9</td>
<td>9</td>
<td>50.0</td>
</tr>
<tr>
<td>OPEN HEARTH</td>
<td>44</td>
<td>10</td>
<td>34</td>
<td>77.3</td>
</tr>
<tr>
<td>OPEN HEARTH (2nd Helpers)</td>
<td>19</td>
<td>13</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>389</td>
<td>129</td>
<td>260</td>
<td>67.0</td>
</tr>
</tbody>
</table>
FIGURE 3

Completion by Department for the School Year 1957-1958
Fourth Year 1958-1959

Toward the end of the third year a business recession took on serious proportions. The Cleveland district had the benefit of three years of these training programs and other plants were asking for the same training opportunity for their employees. Accordingly, top management asked the Institute to reduce, for one year, the operations in Cleveland and extend the training program to a third area - the Canton-Massillon area.

The following programs were approved for the school year 1958-1959. Again as in the preceding summers, many of these programs were revised and refined, growing out of the experience received during the preceding three years. The enrollment by programs and districts for the school year 1958-1959 is as follows:

Cleveland -

<table>
<thead>
<tr>
<th>Program</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical I (Steel)</td>
<td>35</td>
</tr>
<tr>
<td>Mechanical I (Mfg.)</td>
<td>12</td>
</tr>
<tr>
<td>Mechanical II</td>
<td>17</td>
</tr>
<tr>
<td>Hydraulics</td>
<td>35</td>
</tr>
<tr>
<td>Electrical I</td>
<td>27</td>
</tr>
<tr>
<td>Electrical II</td>
<td>15</td>
</tr>
<tr>
<td>Electrical III</td>
<td>21</td>
</tr>
<tr>
<td>Combustion</td>
<td>15</td>
</tr>
<tr>
<td>Resistance Welding</td>
<td>14</td>
</tr>
<tr>
<td>Open Hearth Supervisors</td>
<td>45</td>
</tr>
<tr>
<td>Open Hearth First Helpers</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>254</strong></td>
</tr>
</tbody>
</table>
Warren-Niles -

- Electrical I Wage Earners 36
- Electrical I Supervisors 16
- Mechanical I 18
- Hydraulics 14
- Mechanical II 16
- Electrical II 25
- Preventive Maintenance 17
- General Foremen 35

197

Canton-Massillon -

- Electrical Maintenance 37
- Mechanical Maintenance 35
- Hydraulics 36
- Electric Furnace Operation 42
- Enduro Stainless Steel Processing 30
- Metallurgy of Steel Making 41

211

The attendance record during the fourth year is of particular significance. The percentage of those completing the program was the highest of any of the four years despite the fact that some of the men enrolled were on reduced work or laid off because of reduced business activities. On the following pages, tables 7 and 8 and Figure 4 illustrate the attendance data. In even the department with the lowest rate of attendance one-half of all men who originally enrolled completed the program. Also, the one new course developed in the Cleveland area, Combustion, had the highest attendance (93.3 percent). Referring back to Tables 3 and 4 and Figure 2, it was noted that the reverse had happened in the Blooming Mill and Bar Mill courses when they first started. This indicates more clearly the need for a study of the drop-out problem.
It is to be noted that in each of the four years interest in
the training program brought in other departments and a need for
development of new programs.

During the fourth year five new programs were developed,
namely

- Electric Furnace
- Enduro Practices (Stainless Steel)
- Metallurgy
- Preventive Maintenance
- Combustion.
### Table 7

**Production and Maintenance Training Program**

*For the Year 1958 - 1959*

**Breakdown of Enrollment, Drop-outs and Percentage of Completion by Individual Departments**

<table>
<thead>
<tr>
<th>Department</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Percent Completed</th>
<th>Department</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mech. I (Steel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>33</td>
<td>4</td>
<td>89</td>
<td>1st Quarter</td>
<td>21</td>
<td>1</td>
<td>95</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>31</td>
<td>7</td>
<td>80</td>
<td>2nd Quarter</td>
<td>20</td>
<td>6</td>
<td>70</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>24</td>
<td>6</td>
<td>75</td>
<td>3rd Quarter</td>
<td>16</td>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>Mech. I (Mfg.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>12</td>
<td>1</td>
<td>90</td>
<td>1st Quarter</td>
<td>35</td>
<td>3</td>
<td>94</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>11</td>
<td>5</td>
<td>85</td>
<td>2nd Quarter</td>
<td>33</td>
<td>6</td>
<td>81</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>6</td>
<td>0</td>
<td>100</td>
<td>3rd Quarter</td>
<td>27</td>
<td>2</td>
<td>93</td>
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<tr>
<td>Mech. II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>17</td>
<td>3</td>
<td>70</td>
<td>1st Quarter</td>
<td>15</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>12</td>
<td>1</td>
<td>92</td>
<td>2nd Quarter</td>
<td>15</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>11</td>
<td>0</td>
<td>100</td>
<td>3rd Quarter</td>
<td>14</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Elect. I (Open)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>27</td>
<td>6</td>
<td>80</td>
<td>1st Quarter</td>
<td>45</td>
<td>3</td>
<td>93</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>26</td>
<td>5</td>
<td>81</td>
<td>2nd Quarter</td>
<td>43</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>21</td>
<td>3</td>
<td>80</td>
<td>3rd Quarter</td>
<td>37</td>
<td>6</td>
<td>84</td>
</tr>
<tr>
<td>Elect. II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Quarter</td>
<td>15</td>
<td>1</td>
<td>93</td>
<td>1st Quarter</td>
<td>14</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>2nd Quarter</td>
<td>14</td>
<td>2</td>
<td>86</td>
<td>2nd Quarter</td>
<td>13</td>
<td>1</td>
<td>93</td>
</tr>
<tr>
<td>3rd Quarter</td>
<td>14</td>
<td>3</td>
<td>80</td>
<td>3rd Quarter</td>
<td>12</td>
<td>4</td>
<td>67</td>
</tr>
</tbody>
</table>

**Totals**

<table>
<thead>
<tr>
<th>Quarters</th>
<th>Enrollment</th>
<th>Dropped</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>254</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Second</td>
<td>218</td>
<td>39</td>
<td>82</td>
</tr>
<tr>
<td>Third</td>
<td>182</td>
<td>29</td>
<td>84</td>
</tr>
<tr>
<td>Year</td>
<td>254</td>
<td>98</td>
<td>72</td>
</tr>
<tr>
<td>Course</td>
<td>Enrollment</td>
<td>Drop-Outs</td>
<td>Completed</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>MECHANICAL I (STEEL)</td>
<td>35</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>MECHANICAL I (MFG.)</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>MECHANICAL II</td>
<td>17</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>ELECTRIC I</td>
<td>27</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>ELECTRIC II</td>
<td>15</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>ELECTRIC III</td>
<td>21</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>HYDRAULICS</td>
<td>35</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td>COMBUSTION</td>
<td>15</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>OPEN HEARTH (Supervisors)</td>
<td>45</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>WELDING</td>
<td>14</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>236</strong></td>
<td><strong>93</strong></td>
<td><strong>153</strong></td>
</tr>
</tbody>
</table>
Completion by Department for the School Year 1958 - 1959
CHAPTER III

AN OVERVIEW OF THE FOUR YEARS

Growth and Expansion of Enrollment

In this voluntary training program attended by employees on their own time, the increase in enrollment over the four year period consistently increased. This is significant since there was no compulsion, real or implied, and there was no relationship of the course to monetary returns. At the outset the Company supplied the Human Engineering Institute with the list of the senior employees, (those with the greatest amount of service) in six departments. If an insufficient number of that group responded to an invitation to enroll the plan called for the company to submit another list of employees who were next in line in point of service. It was estimated that not over 50 percent of the first list would be interested enough to enroll. Instead, almost 90 percent enrolled for the first year.

Interest in enrollment was high and the attendance except for a few classes each year was consistently regular. Figure 5 shows graphically the percentage of completion for each of the four years as well as the variation for the Cleveland area.

It is interesting to note that the lowest percentage of completion was 54.9 in the year 1956-57 and the highest, 67 percent the following year. However, the difference was only 12.1 percent.
FIGURE 5

Percentage of Completion for the Four-Year Pilot Run
There were at least two apparent reasons for the drop in the percentage of completions of the training program in 1956-1967. The first was the change in class hours. Two groups were scheduled each evening. One came at 6:00 p.m. and the other at 8:00 p.m. Attendance at the 6:00 p.m. classes was poorer than at the former starting time of 7:00 p.m. However, as the year progressed the 6:00 p.m. classes became well attended again. The second reason for the drop in attendance and probably the more important one was the large influx of new instructors. It was difficult for the Institute staff to give them the necessary supervision and coaching.

In the Cleveland area Table 9 shows that 1291 employees enrolled and 802 successfully completed the year's training for a percentage of 62.1. However, it is believed that many more will complete the training they started. It is interesting to note that each year more drop-outs pick up their training programs at the point they left it in previous years. Others have completed the available training in their own departments and have enrolled in other classes where the training is related and helpful.

A 62.1 percent completion no doubt is highly significant. It is surprising and gratifying to Republic Steel management. How significant it actually is further study will have to reveal. At present the only comparison that can be made is with the data presented in Table 10.
TABLE 9

Enrollment and Completion Data for the
Four-Year Pilot Run

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
<th>Drop-Outs</th>
<th>Completed</th>
<th>Percent Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955-56</td>
<td>205</td>
<td>69</td>
<td>136</td>
<td>66.3</td>
</tr>
<tr>
<td>1956-57</td>
<td>461</td>
<td>208</td>
<td>253</td>
<td>54.9</td>
</tr>
<tr>
<td>1957-58</td>
<td>389</td>
<td>127</td>
<td>260</td>
<td>67.0</td>
</tr>
<tr>
<td>1958-59</td>
<td>236</td>
<td>93</td>
<td>153</td>
<td>60.2</td>
</tr>
<tr>
<td>TOTALS</td>
<td>1291</td>
<td>499</td>
<td>802</td>
<td>62.1</td>
</tr>
</tbody>
</table>
TABLE 10

Enrollment and Completion Data for 1954-1955
Prior to Pilot Run Program

<table>
<thead>
<tr>
<th></th>
<th>Enrollment</th>
<th>Completed</th>
<th>Percentage of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Institutes</td>
<td>54</td>
<td>22</td>
<td>40.7</td>
</tr>
<tr>
<td>Adult High Schools</td>
<td>24</td>
<td>10</td>
<td>41.6</td>
</tr>
<tr>
<td>Correspondence Schools</td>
<td>82</td>
<td>25</td>
<td>30.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>160</strong></td>
<td><strong>57</strong></td>
<td><strong>35.7</strong></td>
</tr>
</tbody>
</table>
In the summer of 1955 a study was made of all the employees in the Cleveland steel plant which had enrolled in available training programs in the fall of 1954.

The study revealed that 365 employees enrolled in various training programs; 205 were supervisors and staff employees and 160 from wage-earner groups similar to those participating in the Pilot Training Programs.

A breakdown of this group of 160 wage earners is made in Table 10. Fifty-four enrolled in the local technical institutes, twenty-four in the two high schools available to adults and 82 took correspondence courses. Practically all of these employees were young men eager to improve their chances for better paying jobs. Most of them found it difficult to complete the training they started; in fact only 35.7 percent successfully completed their training. It should be noted that over fifty percent were taking correspondence school courses in which completion is normally low.

It is interesting to note that the percentage of completion of the enrollees in the Pilot Training Program was 27 percent higher and that only in a few cases was the percentage of completion lower than 35.7 percent. However the two sets of data did not represent comparable situations.

All of the enrollees in the Pilot Training Program were pursuing training that helped them improve their performance on their present job. This wasn’t true of the 160 enrollees in the programs listed in Table 10.
Seventy-one percent of these enrollees registered for educational courses that would prepare them for work unrelated to their present job. In other words, they wanted to move into other types of work.

In the four years twenty-one training programs have been developed, fourteen in production, and seven in maintenance. These programs were as follows:

**Maintenance Programs**
- Electrical I
- Electrical II
- Electrical III
- Mechanical I
- Mechanical II
- Hydraulics
- Preventive Maintenance

**Production Programs**
- Coke Ovens
- Coal Chemical
- Blast Furnace
- Open Hearth Floor
- Open Hearth Mill
- Bar Mill
- Hot Strip
- Cold Strip
- Electric Furnace
- Enduro (Stainless Steel)
- Combustion
- Metallurgy
- Welding

The thirst for knowledge of these men was a thrilling experience to observe. The program seemed to fulfill this need since

- the enrollment of eligible employees was very high.
- the attendance was regular.
- the drop-outs were relatively few.
- the demand for similar training came from other departments culminating at the end of four years in 36 courses in 12 departments.
The enrollment for each year and the total enrollment for the four year period was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td>205</td>
<td>Cleveland district</td>
</tr>
<tr>
<td>Second Year</td>
<td>513</td>
<td>Cleveland district</td>
</tr>
<tr>
<td>Third Year</td>
<td>550</td>
<td>Cleveland and Warren-Miles districts</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>662</td>
<td>Cleveland, Warren-Miles and Canton-Massillon districts</td>
</tr>
</tbody>
</table>

Total 1930

One of the most objective evidences of the felt need of the program to the men occurred during the latter part of the third year and the beginning of the fourth year. This was a period of temporary economic recession in which those enrollees who had less seniority on their jobs were laid off. Both the Institute and the Company assumed that the course should be discontinued for these people since they were not employed. When the Company made the announcement the employees who were laid off protested, saying that they desired the training even more, since they would have more time to devote to it. The company approved their continuation in the program and agreed to pay for the training even though they were not on the payroll.

Another evidence of the impact that the training was having within the Company came about the end of the second year. The key employees were not only enthusiastic for their training but they were developing a far greater background of technological knowledge than their supervisors had and the supervisors, therefore, requested similar training. Separate, but parallel courses were organized for supervisors as the result of this request.
In the initial stages the plans called for limiting the pilot training program to the Cleveland area of the Company. However, requests for its extension and the need for it were so obvious that a similar training program was started in three other districts long before the Four-Year Pilot Program was completed - Warren-Niles, Ohio; Canton-Massillon, Ohio and in Gadsden, Alabama.

Development of Course Content, Texts and Visual Aids

When the Pilot Program was first started one of the most discouraging aspects of it was the scarcity of text material, visual aids and educational aids. The volumes of text materials, the wide variety and large amount of visual aids that now exist are evidence of the accomplishments of four years of steady, consistent and diligent program development. These are up-to-date, practical and functional teaching aids, since they were developed "in action" at the scene of the operation by people trained and experienced in the technology of steel making. By carefully planned teamwork, their technical knowledge of the operation was transformed into educational materials with the help of the industrial training specialists. The department management people therefore were in a sense the authors of the texts. The Institute then trained them in the techniques of teaching so that in reality a member of the department management team not only prepared the teaching materials but instructed the key employees in his department.
Improvement in Job Performance Effectiveness of Employees

It was realized at the outset that precise statistical data demonstrating the improvement in employee job performance attributable to this pilot training was practically impossible to obtain. The reason was that many factors influence operating results. Some of these—wide swings in a plant's operating rate, for example—cause such major fluctuations in a department's operating efficiency that the contribution of improved employee knowledge and application of that knowledge is obscured.

Thus, as mentioned before, employee regularity of attendance was set up by Republic's management as the most significant yardstick for measuring the effectiveness of the training. After all, the best test of voluntarism is participation, and participation in this case was the clearest, most definitive indicator of what the training meant to the men themselves.

It must be remembered that one of the basic reasons for this training was a deterioration in the morale and job satisfaction of senior employees. Thus the exceptional regularity of attendance and the repeated request by trainees that additional training be offered which is not generally typical of older employees furnished powerful evidence that the training was making decided headway toward satisfying a morale need.
Attendance, however, was not the only criterion. The judgment, opinions and evaluations of instructors merited, in this case, consideration and acceptance as valid evidence of the success of the training program. The instructors, by virtue of their position as plant foremen and superintendents, have acquired experience in appraising employee performance as a part of their jobs. They were in a position to recognize whether or not trainees were demonstrating improved knowledge and greater understanding of their fields of work. And they were able to observe this not just in the classroom but on the job as well.

Thus the judgment of instructors that the training was decidedly helpful and that the progress of many trainees warranted more advanced work was another indicator that the program attained its objectives.

The following is the information supplied by the instructors and other members of management in a position to observe the changes in the performance of the employees enrolled in the training program.

Strip Mill Department

In the four years since this program was first offered in the Strip Mill, the department has shown marked improvement, during normal periods of operation, in each of the following areas:

- total tonnage produced.
- number and length of down-time periods.
- quality.
- meeting scheduled shipment date.
The department head, who also was the instructor, gives much of the credit to the training program. The relationship between the supervisors and the employees in this department has also improved according to his observations.

**Coke Plant Department**

The quality of coke used is an important factor in the operation of the Blast Furnace. Because of a better understanding of how coke is made in the ovens and the conditions which need to be maintained to produce high quality coke, heaters and heater helpers, together with their supervisors have been able to improve significantly the quality of the coke they produce according to the instructors. Likewise in the coal chemical or by-product department of the Coke Plant, the employees and the supervisors came to understand better the chemical processes which made their work easier and their products more acceptable with regard to quality and also cost-wise.

**Maintenance of Hydraulic Equipment**

Nowhere in the entire program has improvement been as noticeable as in the maintenance of hydraulic equipment. When hydraulic equipment was introduced into the steel industry, the pipefitters inherited the job of installing and maintaining this equipment. Few, if any of them understood either the theory or the practice of hydraulic equipment. When this training program was announced so many requests were made that enrollment had to be limited. As a result of the training which these men received, necessary repairs
have been made more quickly, faster diagnosis of the causes of break-down have been achieved and down time has been substantially reduced - in some cases as much as a third.

**Improvement in Employee Status**

At the end of each school year the men who have satisfactorily completed the work required receive certificates of recognition. On these occasions the personal pride and satisfaction that come from knowing more about their job is demonstrated in many ways. Remarks such as these were common. "This is the first Certificate of Achievement I have ever received, and it means a lot to me." My work is more fun now that I understand why I am doing what I do." "This was a very enjoyable and profitable experience for me." "I didn't realize that modern education is so interesting and effective." "I wish we had started five or ten years ago." "I was afraid of the technical material and I didn't have to be. The instructor, who is my boss at work, really made it simple." Nearly all of the employees expressed appreciation to management for making this opportunity possible. Many of them wanted more training. Supervisors of these men have noticed considerable evidence of an increased sense of job satisfaction together with a greater feeling of self-respect and job security of the employees who have participated in the program. It is interesting to note, too, that a number of these employees have been advanced to first-line supervisors, and are now enrolled in the supervisory training programs at the Institute. Since these men
attend classes voluntarily and on their own free time, it was evident that the ability to meet the requirements of their changed jobs and to understand the changes was of major significance to them as well as to the Company.

**Improvement in Management - Employee Relations**

Almost without exception department heads who participated in these programs report an improvement in the relationship between supervision and the men on the production and maintenance jobs. When the supervisor-instructor meets his class for the first time he explains to them he has "taken off his supervisor's hat" to put on his "teacher's hat". He explains that the purpose of the program is to study together the why of the job and how the operation of their department can be improved by the improvement of their job performance. By working on a common objective the men gain a better understanding of the "instructor" and the supervisor gets a better understanding of his "students". More cooperation and team-work naturally resulted.

**Breakdown of the Development and Instruction Costs**

The first year of the operation of the program cost $91.26 for each enrollee. The enrollees were provided with forty-five hours of instruction. Therefore, the cost per hour of instruction for the first year, according to Table 11, was $2.02. This cost per
### TABLE 11

**COST PER ENROLLEE AND PER HOUR OF INSTRUCTION FOR EACH OF THE FOUR YEARS**

<table>
<thead>
<tr>
<th></th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enrollment</strong></td>
<td>205</td>
<td>461</td>
<td>389</td>
<td>254</td>
</tr>
<tr>
<td><strong>Number of Classes</strong></td>
<td>14</td>
<td>26</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td><strong>Average Enrollment Per Class</strong></td>
<td>16+</td>
<td>17+</td>
<td>16+</td>
<td>16-</td>
</tr>
<tr>
<td><strong>Cost Per Enrollee</strong></td>
<td>$91.26</td>
<td>$63.37</td>
<td>$52.25</td>
<td>$52.65</td>
</tr>
<tr>
<td><strong>Cost Per Hour of Instruction</strong></td>
<td>$2.02</td>
<td>$1.41</td>
<td>$1.16</td>
<td>$1.17</td>
</tr>
</tbody>
</table>
hour of instruction dropped to $1.41 the second year and then to $1.16 the third year. The reason for the decrease will be explained later. Table 11 which supplies this cost information shows that the cost remained practically the same the fourth year.

The average class enrollment was maintained at around the seventeen figure as originally planned. The number of classes varied from fourteen to a maximum of twenty-six in the Cleveland district. The cost per enrollee dropped from $91.26 to $52.65 for the school year.

Table 12 provides a detailed breakdown of the cost of instruction for each of the four years. The cost is broken down into six parts. The first is the cost of the development of the curriculum and the text material for each course. This was determined by pro-rating the actual development cost over a ten year period and seven districts. It was assumed that the technical material included in the courses would need only minor changes each year, but would probably have to undergo major changes at the end of ten years.

There are seven geographical areas in which the Company has major steel plants. In arriving at the average cost of the course development it was assumed that each of the seven districts would have a minimum of two classes of seventeen enrollees in each course.
### TABLE 12

**A BREAKDOWN OF THE COST OF INSTRUCTION PER ENROLLEE FOR EACH OF THE FOUR YEARS**

<table>
<thead>
<tr>
<th></th>
<th>1st Year 1955-56</th>
<th>2nd Year 1956-57</th>
<th>3rd Year 1957-58</th>
<th>4th Year 1958-59</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of Courses</td>
<td>$2.27</td>
<td>$2.27</td>
<td>$2.27</td>
<td>$2.27</td>
</tr>
<tr>
<td>Text material and Visual Aids</td>
<td>6.74</td>
<td>6.74</td>
<td>6.74</td>
<td>6.74</td>
</tr>
<tr>
<td>Visual Aid Equipment</td>
<td>6.08</td>
<td>3.04</td>
<td>1.52</td>
<td>1.52</td>
</tr>
<tr>
<td>Administration and Supervision</td>
<td>24.40</td>
<td>12.20</td>
<td>8.90</td>
<td>9.30</td>
</tr>
<tr>
<td>Facilities and Utilities</td>
<td>25.30</td>
<td>12.65</td>
<td>6.35</td>
<td>6.35</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$91.26</strong></td>
<td><strong>$63.37</strong></td>
<td><strong>$52.25</strong></td>
<td><strong>$52.65</strong></td>
</tr>
</tbody>
</table>
Six courses were developed the first year and each succeeding year. Therefore, average cost per student remained constant, $2.27.

The second part of the cost breakdown is the cost of instruction. This was determined by multiplying the number of hours of instruction by the cost per hour and dividing by the average number of students per class. The cost figure was $26.47 and remained constant.

The third part in the cost picture was the cost of the processing of the text material and notebook binders provided the students, and the cost of the visual aids used in each class. It also remained relatively constant because the budget was set for each class and expenditures were determined by the budget. The cost per enrollee was $6.74.

The visual aid equipment consisting of the overhead transparency projector, the opaque projector, the slide film projector and the 16 mm. motion picture projector and essential accessories with which each class was equipped cost $6.08 per enrollee the first year. The cost of the visual aid equipment is the fourth part of the cost breakdown. This figure was determined by dividing the total expenditure for visual aid equipment by five, the estimated life of the equipment.

After the first year two classes were held each class night, one at 6:30 p.m. and the other at 8:00 p.m. For that reason the cost dropped from $6.08 to $3.04. In the second and third year
three other training programs were conducted at the Institute, which utilized the same classrooms and equipment on the off evenings. This expansion of programs reduced the cost per month to $1.52.

The fifth item in the cost breakdown is the cost of administration and supervision. It includes the cost of administering and supervising the training and development activities, of training and coaching the instructors, reporting and discussing the progress of the programs to management, enrolling the students, commencement expenditures and other staff personnel costs. This cost amounted to $24.40 the first year and dropped to $8.90 the third year and because of a reduction in the enrollment was $9.30 for the fourth year. The reasons for the drop from $24.40 to $8.90 are the same as those which caused the drop in the cost per enrollee of visual aid equipment; more classes per night and more nights per week without any change in the overall administration and supervision cost.

The same conditions affected the average cost per enrollee of the facilities which included the rental of the classrooms, laboratories, offices and parking, and the utilities, namely the telephone service and the gas and electricity used in lighting, heating and air-conditioning. This was the fifth item of the cost breakdown; it dropped from $25.30 the first year to $6.35 the fourth year, as is indicated in Table 12.

The cost of the facilities, equipment and instruction in the fourth year amounted to $34.34 which is approximately two-thirds of the total cost. Not much can be done to reduce this cost, unless
the size of the classes is increased, which isn't desirable, and greater utilization is made of the facilities.

An analysis of the cost figures points up three important conclusions:

1. The expenditures for the educational and visual aids paid unusually good educational dividends.

The cost of the visual aids plus a prorated portion of the cost of administration and of the facilities is less than ten percent of the total cost. When this relatively small cost is compared with the improvement of instruction the maximum use of visual aids made possible, it can be readily seen that the expenditure was justified.

2. The maximum expenditure of money for the development of the courses was a wise expenditure.

The original cost of the development of the curriculum and text material appears large because it is expanded during the first year of the training program. However, it is a relatively small item of cost when it is spread over the total life and use of the course material. In the Pilot Program the cost amounted to $2.27 which is less than five percent of the total cost per enrollee. It should be kept in mind that this cost includes the three staff members who constituted the development team that had all their time charged to development of courses. They worked with the department heads and instructors
in developing the curriculum and text material. The quality of instruction was directly attributed to the fine job done in the development of the courses.

3. The employees' investment in terms of cost of his time spent in the classroom is approximately three times that of the Company.

During the last two years of the program the cost per hour of instruction per enrollee stabilized at approximately $1.17. The average hourly wage of the employees enrolled was approximately $3.50 per hour. If this training took place on the job, the cost to the Company would have been increased almost four hundred percent. This alone could make the training program economically unsound from the Company's point of view.

It is possible that in the future because of the experience obtained in the Pilot run that the $52.25 cost obtained in the third year figure per enrollee could be stabilized around $50.00.

Everyone involved in the Pilot Program was impressed with the fine results obtained and the reasonable cost. In the next chapter the underlying reasons for the success of the program are identified and explained.
CHAPTER IV

FACTORS THAT HAVE CONTRIBUTED SIGNIFICANTLY TO THE

SUCCESS OF THE PROGRAM

The factors which contributed significantly to the results of the Pilot Program are many. However, analysis reveals that they may be classified into two major categories - Personnel Policy Factors and Educational Factors.

Personnel Policy Factors

Training - Where? When? and By Whom?

From the initial planning stages of the Pilot Program to its conclusion consideration was given to its organization and structure so that it would not only satisfy the needs of management but also care was taken to assure that it complied with both the spirit and the letter of the labor agreement. However, mere compliance was not enough. It was recognized that the program must be such that it would be viewed favorably by the employees for whom it was established. Top management made it very clear that it wanted the program to contribute in a positive way to employee attitudes. It was recognized that it was necessary for the key Union members not only to passively accept the program, but their endorsement was desired as indicated by their active participation. Evidence of this acceptance lies in the fact that over two-thirds of the key
Union leaders from the departments represented enrolled in the first classes and over 95 percent of those men completed the first year's program. Over 50 percent continued their enrollment after the first year to register for the advanced courses.

These objectives would be difficult to achieve if the program, in effect, became entirely a company project. In view of all these factors the Company endorsed the proposed Pilot Training Program for production and maintenance employees with the provision that it be conducted (a) off the job, (b) off the company premises, and (c) by a third party, preferably one that would develop and refine the program as it progressed.

Arrangements were made for the training to be conducted at the Institute, a non-profit corporation with facilities to develop and conduct industrial training programs.

By this arrangement the Institute assumed the responsibility for the pilot project, not only for scheduling and conducting the training sessions, but for developing the teaching aids, and employing instructors. Although the instructors were employees of the Company, their participation in the Institute program after their working hours was an employment arrangement completely separate and apart from Company employment — thereby separating completely this training activity from that conducted by the Company.
In effect the Company's participation was limited to its underwriting the cost of the program and giving it unqualified support. (This is an over-simplification of the Company's role, but it is basically correct.)

Although this was a very satisfactory arrangement in relation to clearly defining the working arrangements of the Company employees who served on their own time as instructors, there were other very significant values. By delegating the responsibility for the training to a training organization, the Company was assured that the emphasis would consistently be on planned, organised training, not just steel making; on a carefully planned and executed development program, not meetings which may tend to drift into trouble-shooting sessions that provide stop-gap solutions to pressing operating problems. By disassociating the training from the job and making it an Institute course, a worker's success or failure, but particularly failure, would have no real or implied relationship to his job. If the program were conducted on Company time, failure may be interpreted as a part of his work performance having security implications in eligibility for job progression. Under third party sponsorship, failure to succeed, failure to attend, or even failure to enroll would not adversely change his job status.
With respect, therefore, to both the location of the training site, and who would do the training, the Company policy was very clearly established prior to the beginning of the Four-Year Pilot project. The training program should be off-the-job, off the Company premises, and conducted by a third party, preferably by the same institution that developed the program.

**Enrollment**

Another company policy adopted in establishing ground rules for the pilot project was that enrollment and continued attendance should be voluntary and on the employee's own time.

This policy removes the program from any connection with wage payment on job improvement training and places its acceptance or its failure on its own merits. This is a sound policy from other considerations. The factor of motivation and desire for learning is a very important one, particularly in relation to this group of employees. Only those employees sincerely interested in self-improvement will enroll and be regular in attendance. Furthermore they are the desirable ones to have in the program.
This policy provided the Human Engineering Institute staff with a real challenge, since they were faced with the very realistic fact that enrollment would be maintained and classes continued only if the enrollees were satisfied that the training was giving them the type of instructions they needed and wanted.

Although certificates were awarded at the conclusion of training, the typical rewards given in the usual more formal types of instruction were purposely omitted - grades, credits and degrees. There was no semblance of compulsion except that inherent in the value of the course. That the percentage of enrollment, of completions and of continuations into advanced classes all increased is evidence of the program's effectiveness.

Although the Company paid the tuition (training costs) the men were by no means getting something for nothing. Classes met in the evenings from 6:00 to 7:30 or from 8:00 to 9:30 once each week. It has been roughly estimated that the value of the employee's time (computed at his hourly rate) exceeded the amount the Company paid per man for the program.

Selection of Enrollees

The company adopted the policy that priority in enrollment should be given to the senior employees. This is consistent, in that seniority is used in establishing preferential treatment in all important areas of employee concern and welfare.
Union support of a training program is always essential, but it was particularly needed in this program which had many new and untried elements, and because of this fact, it could have been viewed with suspicion by the Union. Fortunately, however, this policy not only incorporated principles of seniority consistent with Union philosophy, thereby assuring Union support, but the policy of selecting the senior workers proved to be a wise one for a number of other reasons.

It bolstered job security. Fear of actual displacement by younger employees, who have more ability and more technical training may exist to some degree; yet these older employees are generally at or near the top of the job progression line, and in reality, unless grossly incompetent, they will not be displaced. Although their lack of knowledge of many of the technical aspects of the job may not cost them the loss of their job, they are aware of the fact and vitally concerned that they are not in command of the job. In discussing this fact in relation to the training program, a company executive said, "These fellows will admit rather readily and without a sense of shame the ignorance which they may have in such areas as politics, current events or certain areas of formal education, but ignorance and incompetence and lack of knowledge relating to their job is a matter that strikes at the very heart of their pride." Since technological advancement during
their work life has so rapidly outstripped the pace with which they have kept abreast of the advancement, employees in key production and maintenance jobs in the steel industry generally are deficient in job knowledge. This gives them concern, and a feeling of inadequacy. In effect, this feeling of unpreparedness and uncertainty in coping with the daily problems makes for insecurity and loss of job prestige.

It was felt by the company, therefore, that the greatest immediate need for training exists with those men who hold the key jobs in production and maintenance. This decision came about only after a great deal of consideration and even debate among those whose job it was to lay the ground rules for the program. Although the final decision was held at the outset by the majority of management, there were those who raised the questions, "Why put forth this energy and expense on those fellows who are, as a group, the oldest employees?" "These workers are the ones who will leave us by retirement within a comparatively few years, why not concentrate the training on the younger men, thereby giving the company more years of employee time for its training investment dollar?"

In planning a pilot training program it was agreed that it should be geared to meet the most pressing need of the moment.
That need is to provide training to men who hold the key jobs in production and maintenance in order to halt the current progressive widening of the gap between increased technology in the jobs and the know-how of the employees to cope with these technological advancements.

During the management consideration of this matter an illustration was given in which a first helper (the key job) in the open hearth department was observed giving instructions to a third helper. The instructions were so completely incorrect that, if followed, serious damage could have occurred to the furnace. This incident in itself was sufficient to persuade that person of the wisdom of the policy.

Class Organization

A policy decision was made rather early in the planning stages of the pilot training program that the classes would be organized and class groups would be established on the basis of major operating departments. This policy had a very significant influence on the nature of the program, since it was the major determinant in the personnel make-up of the classes as well as the curriculum and the methodology of instruction.

For purposes of this study, this policy is classified under the category of "Personnel" rather than "Educational". This is a somewhat arbitrary classification, since the policy embodies elements of both. Under the policy the integrating factor is
the departmental operation. Class groups are homogeneous in terms of their departmental assignment; however, they are heterogeneous in relation to general formal education, academic ability and knowledge, special training, and their technological knowledge.

The implications of this policy makes for some of the project's uniqueness, particularly in regard to the educational heterogeneity of each class. In relation to this factor it is not uncommon for the educational background of class members to vary from a very limited elementary education to a college degree in engineering. However, in spite of this wide divergence in formal training, there was a sort of stabilizing factor or balancing influence, in view of the fact that the focus of the instruction was on the operation. This was true both in the teaching methods and in the teaching aids. Since the training program centers around the operation, two elements for student success in the training are of vital importance - (1) job experience in the operation, and (2) technical and related subject matter knowledge. The stabilizing or balancing factor which was evident as the classes were observed over a period of four years was the fact that in general the men who had the more advanced formal education were those with more limited job experience in the operation, while those with the limited formal education were the so-called old timers with a wealth of experience.
One instructor expressed this idea very tersely and succinctly with the statement, "These old timers are long on the know-how and short on know-why, and the young fellows who work beside them are long on the know-why and short on the know-how, but none of them know well enough both the how and the why."

The younger men, with college background, had more knowledge of mathematics and the sciences, but this background did not make them stand out in the classes in such a superior way as one may assume in view of the fact that the focus was on the total operation rather than on the elements of the operation. Stated in another way, the instruction may be described as applied technology rather than theoretical and abstract science; with emphasis on the wholeness of the operation rather than on the component sciences in the operation. This approach has many educational implications, which will be developed in the following section. However, from the point of view of the personnel selection for class enrollment and for class organization, with the operation as the central theme, the fact that there is a wide range of educational backgrounds in each class seemed to work to the advantage rather than the disadvantage of the students. Those at each extreme of training and experience offer much to the other. If, however, the training sessions were organized around subject matter areas (combustion, metallurgy, chemistry, electricity, mathematics) the entire program would need to be organized on an
entirely different basis, both in terms of personnel as well as the educational approach.

**Educational Factors**

Since the Four-Year Pilot Training Program for key production and maintenance employees was an educational project, many of the practices and procedures were similar to those which are found in most typical classroom industrial training programs. It is not the purpose here to contrast the Pilot Program's policies, practices and procedures with those in other training programs or educational institutions, but rather to relate the major educational factors which seemed to contribute to the outcome of the Pilot Program.

**The Classroom**

The classes were scheduled from 6:00 - 7:30 p.m. or 7:30 - 8:30 p.m. The men came to class dressed informally where they met with their fellow department members. Casual observers have remarked on numerous occasions about the wholesome, relaxed climate in the classroom and the friendliness evidenced between the class members. This is unlike the inter-personal relations that one observes in a typical adult evening class in which there is a wide variation in vocational interests and background, and many of the students were strangers prior to the first class. The enrollees in each class were men all of whom
work in the same department, and depending upon their shift assignment, work together on the job.

During the Four-Year Pilot Program various kinds of physical facilities and teaching supplies, equipment and materials were used in attempting to provide classrooms which would contribute comfort to the informality described above and to the most desirable learning environment for the needs of these particular students. The following are some of the major items which seem to be consistently the most desirable features in the classroom. The sketch on the following page illustrates a typical classroom lay-out showing size, seating arrangement and equipment used.

**Size** - Small square rooms of approximately 20' x 20' in size accommodate 15 to 20 persons very adequately. This size room is ideal for making maximum use of the various types of visual aid equipment. The rooms are well lighted, air conditioned and well ventilated. Ventilation was particularly important since the man smoked during the class period.

**Seating Arrangement** - A definite effort was made to avoid simulating the traditional classroom with the use of arm chairs or unit desks. A 20' x 20' classroom would contain four tables accommodating five people at each table. In some rooms the tables were long enough to seat six persons. Arm chairs with padded seats and semi-padded backs and arms were provided for comfort.
TYPICAL CLASSROOM LAYOUT

Flannel Slap Board
Flannel Slap Board

SCREEN

SLIDING PANEL

Chart Pad

Chart Pad

SLIDING PANEL

20'

TRAVERSAL SLIDING DRAPER

VU-GRAPH PROJECTOR

MOVIE PROJECTOR

Folding Partition
Equipment - Conspicuous by its absence is the traditional chalkboard. In place of the chalkboard in each room is a flannel board and a hanging chart pad (approximately 2 1/2' x 3', fifty sheets of paper per pad). Various colored grease pencils are in the tray below the pad replacing the traditional chalk. The flannel board and chart pad space are a part of a built-in unit on the wall. Under a valance built across the top of the unit is a projection screen, on a window shade type roller, which is readily available at any time but quickly rolled out of sight at the top of the unit when not in use.

As the project enrollment expanded during the four-year period, new classrooms were equipped. The chart pad-flannel board-projection screen unit was improved. Added to the unit was a hard, glossy surface board on which a water soluble mark is made similar to that of a grease pencil, but erasable with a damp sponge. These various items are on a multiple track, and any combination of them is conveniently available for use.

As the Four-Year Pilot run of the program began to prove itself, the opportunity to purchase a building to house this training program presented itself. On the following page is a lay-out of this building. Actual construction started in March, 1959.
A BUILDING DESIGNED FOR THE P AND M TRAINING PROGRAM

1. Meeting Room
   20' x 20'

2. Meeting Room
   20' x 20'

3. Meeting Room
   20' x 20'

4. Meeting Room
   20' x 20'

5. Meeting Room
   20' x 20'

6. Meeting Room
   20' x 20'

7. Meeting Room
   20' x 20'

Utility Room
   Heater, Air Conditioner, Water Heater

Storage

Folding Partitions

Storage Cabinets (Sliding Doors)

Lav.

Drinking Fountain

Visual Aid Boards

Coats

Office

Lobby

Glass

Meeting Room

Meeting Room

Meeting Room

Meeting Room

Meeting Room

Office
Visual Aids and Educational Aids

Most of the enrollees of this program have been out of school for many years. Abstract ideas, expressed abstractly by the spoken word or by the printed page will not produce the desired learning. These people are not generally "word minded". As indicated later, the instructional methods of the program de-emphasize reading, lecturing and telling. Visual aids as well as the other instructional aids were indispensable tools in accomplishing the kind of creative teaching and the establishment of a learning climate which was essential for the program's success.

Some of the visual aids used during the first quarter of the Hydraulics course are described briefly on the following several pages in order to illustrate the nature and scope of these educational aids. Three schematic wall charts (not illustrated here) approximately 2' x 3' in size were prepared by the visual aids department of the Institute.

Wall chart #1 is a schematic drawing of the Complete Hydraulic System for Roll Steel Placement in Cold Mill. Over the basic drawing is a transparent acetate sheet for overlay drawings or markings with a grease pencil. The markings may be erased.
Wall chart #2 is a schematic drawing showing sequence valves. By use of the transparent overlay, the flow and directions are plotted during the class periods by using various color grease pencils.

Wall chart #3 illustrates the two-way and four-way hydraulic valve. Sliding panels show flow in various positions.

Page 93 is a reprint from the August, 1957 issue of Applied Hydraulics which describes the Hydraulics Equipment Board. For each valve in operation on the board there is a separate duplicate cut-away valve used by the instructor to demonstrate fluid power applications. The Hydraulics Equipment Board is a permanent part of the hydraulics classroom.

Pages 94, 95 and 96 identify and explain briefly the motion pictures and slide films presented. The Hydraulics course, probably more than any other in the pilot project, is a subject for which motion pictures and slides are available from sources outside the Institute, although many visual aids were also prepared locally for the course.

Each man in the class was presented with a three ring notebook at the beginning of the course in which at the end of each session he inserted the text material for that particular session. On page 97 is a list of the manufacturers' bulletins which were issued to the class members during the first quarter.
of the hydraulics course. The bulletins were punched to fit into the three ring notebook. By the end of the course, the notebook became a valuable reference book which was specifically related to the men's daily job.

The simplified blueprint illustrated on page 98 was one of a number of such prints used in the course. They too became a part of the students' notebooks. For class discussion purposes they were projected on a screen by means of an opaque projector.

A sample visual cast is inserted in an envelope on page 145 of the appendix. Hundreds of visual casts of which this is an example, are made and processed in the Institute's visual aids department. The visual cast, it should be noted, is in color; it is transparent; various overlays may be placed over the basic transparency, thereby building up or constructing a figure while the visual cast is in the projection machine. This has proved to be one of the project's most valuable and versatile visual aids.
With the rapidly increasing use of hydraulics in industry, it is essential to give maintenance personnel sound training in trouble shooting the new equipment. Here's how one company does it.

HYDRAULICS TRAINING

By R. D. Reeve

Instead of proceeding by trial and error, Republic Steel Corporation sponsors a course in hydraulics as part of their training program. In the first quarter, maintenance men design test hydraulic systems and then apply them to plant problems. During the second quarter they make a detailed study of simple valves and circuits. In the last quarter they analyze hydraulic elements and problems involved in trouble-shooting.

• Realism: Attendance is voluntary and after working hours. The learning situation must be effective and interesting. During each session the men discuss principles that can be applied to their jobs the very next day. Since a primary objective of the course is to help the employer keep abreast of new developments in hydraulics, the use of new manuals and work on new types of equipment are an integral part of the program.

• Hydraulic model: One of the devices used in the training program is a hydraulics equipment unit. This consists of a steel pipe for mounting equipment. The men are tested periodically, depending on the type of equipment. A hydraulic pump converts the water into a stream of water. Flow from one valve to another is visible on the board. Power is supplied by a single horsepower motor mounted on an oil reservoir containing baffles plates and a filter. Also mounted on the reservoir are...
HYDRAULIC BOARD permits demonstration of numerous fluid power applications. An accumulator, cylinder, various valves, and hose and tubing are mounted on a steel plate.

DIAGRAM shows how the components are placed on the board to facilitate setting up various hydraulic applications. System can operate from 100 to 1000 psi.

HYDRAULIC POWER is supplied by a single horsepower motor mounted on the oil reservoir, along with a fluid motor and pressure control valve.

is a hydraulic motor with a pressure control valve to operate the system from 100 to 1000 psi.

- Demonstrations: With the training board and visual presentations as possible, for example, while the group discusses the accumulator, they see it in actual operation, understand its characteristics and learn the safety precautions necessary in maintaining this piece of equipment.

A class has been set up as illustrated, to facilitate understanding. When the men are studying a manually operated pilot valve, they see a valve in actual operation as well as a cutaway model of an identical valve.

Both manual and pilot operated systems are studied in detail on the hydraulics board. If the students have discussed the overall function of manual or pilot control in a system, to understand the component parts of each system. By applying the knowledge gained, the group members become more adept at repairing breakdowns that occur on their jobs.

- Troubleshooting: Because many breakdowns that occur on the job can be simulated, the hydraulics board is a realistic troubleshooting aid. Sometimes pressure settings cause hydraulic failures in the shop. This same situation can be duplicated on the board. Thus, the maintenance men learn how to make correct pressure settings.
VISUAL AND EDUCATIONAL AIDS

USED IN THE FIRST QUARTER OF THE HYDRAULICS COURSE

Hydraulic Movies and Slide Films

Hydraulics. 13 min., 16 mm., sound. British Information Services, 30 Rockefeller Plaza, New York, N.Y. Shows applications of principles of hydraulics; that liquids are inelastic and cannot be compressed.

Hydraulics. 11 min., 16 mm., sound. Rent: Ideal Pictures Corp., Chicago; Kunz Motion Picture Service, Philadelphia; University of Ill., Visual Aid Service, 713 1/2 S. Wright St., Champaign, Ill. Explains principle of hydraulic pressure and method by which liquids are used to transmit power.

Harnessing Liquids. 12 min., 16 mm., sound. Loan: Shell Oil Company, New York, N.Y. Rent: Syracuse University, Ed. Film Library, 123 College Pl., Syracuse, N.Y. Demonstrates principles of hydraulics and many applications, shows liquids cannot be compressed, why great power is exerted by confined liquids, shows many industrial applications of hydraulic power.


Characteristics of Hydraulic Fluids. 10 min., 16 mm., sound. Loan: Civil Aero. Adm., Aviation Ed. Div., Commerce Bldg., Washington 25, D. C. Explains and illustrates essential qualities of hydraulic fluids, points out that they must be able to lubricate moving parts, reduce friction and prevent wear, must be free of water, rust and other impurities, must be of proper viscosity for the job.


Basic Principles of Hydraulics. 16 mm., sound. Sale: The Jam Handy Organization, Detroit 11, Michigan. Presents basic principles of hydraulic pressure, how liquids are used to transmit power, working models and laboratory experiments show fundamentals of hydraulic pressure, utilization of hydraulic pressure.

Hydraulic Components. Slide films, color. Loan: Denisor Engineering Company, Columbus, Ohio. Designed to broaden understanding of operation of hydraulic components. Slides cover pumps, motors and valves.
Hydraulic Movies and Slide Films
(Continued)

Fluid Flow in Hydraulic Systems. 8 min., 16 mm., sound, color.

### Title and Source

- **Hydraulic Two and Four-Way Valves** *(Operation and Maintenance Information)*  
  - Vickers, Inc.

- **Hydraulic Fluids for Industrial Machinery**  
  - Vickers, Inc.

- **Balanced Piston Type Relief Valves**  
  - Vickers, Inc.

- **Republic - Bulletin No. 757 - Types of Valves**  
  - Republic Mfg. Co.

- **Hydropneumatic Accumulators**  
  - Green Hydraulics, Inc.

- **Operation and Care of Hydraulic Machinery**  
  - The Texas Company

- **Component Application Sheets for Fluid Powered Equipment**  
  - Applied Hydraulics Magazine *(The Industrial Publishing Groups)*

- **JIC Circuit Guide** *(Industrial Hydraulic Symbols)*  
  - Denison Engineering Division
CLAMP AND RECIPROCATION SIMPLIFIED CIRCUIT
A full time commercial artist, who is trained and experienced in educational visual aids is a member of the Institute's staff. He has complete facilities available to him to prepare and process diagrams, charts, transparencies, overlays, models and graphs. This continuous service was not only invaluable during the pilot project in the preparation of text material, which was a continuous process during the four years, but the service was also available on short notice to develop material of immediate need in the classroom, or for the program in general, as emergencies or special needs arose. The integration of this highly specialized service with the total program was a vital factor in the program's accomplishments. It would be difficult to envision more than mediocre success for the program without this creative service as a part of the staff facilities of the organization conducting the program. If only the artistic skills and the equipment were required, such service could conceivably be purchased commercially. However, the creative skills of the artist alone are not sufficient. By his complete involvement in the program as a staff member, he not only can give it his undivided attention, but he also gains certain necessary knowledge of the technology as well as its educational implications which he is charged with translating into visual, concrete illustrations and diagrams. The head of the visual aids section has become such an integral part of the
Institute's overall program and has acquired such a comprehensive knowledge of the total operation that he has the administrative title of Assistant Director.

**Projection Equipment**

The numerous and varied visual materials which were prepared for the program warranted the effort to provide the most adequate facilities and equipment for their maximum utilization. Although models, wall charts and other display items were an essential part of the program, most of the visual aids were the type which lent themselves to use in the various pieces of projection equipment.

The overhead transparency projector was one of the most frequently used of all of the projection equipment; in fact it seemed to be in almost constant use. It was found to be easy to set up by the instructors, and it can be operated effectively in a lighted room. While using it the instructor can face the class, use a pointer directly on the material projected, which in turn is seen on the screen. Likewise he can write or erase on the transparency while it is being projected. By the use of overlays on a transparency (one of its most useful features) a concept can be developed in steps, projecting each step with an overlay, or a series of a variety of combinations can be projected.
A simple concept development is illustrated in the References, page 145, showing how this technique was utilized in a beginning Hydraulics course.

The opaque projector is the counterpart of the overhead transparency projector and one that is equally essential to the program, although used somewhat less frequently than the latter. The instructors made continuous use of this piece of equipment to project a page from their text or printed pages from other books. Blueprints and diagrams were very frequently projected.

Whereas motion picture projectors constitute the major visual aid in many training programs, they were used very infrequently in this program. This would appear to be one way in which this pilot program differs from that of other training programs. A later description of the empirical development of text material, and the functional nature of the instruction relating directly to the specific operation and specific equipment which the men use daily will indicate that standardized and more generalized motion picture films are not sufficiently applicable to the specifics of a given department. On the other hand, the visual aids developed as referred to above are current, pertinent, and specifically applicable to the particular situation the men face daily in their department. They are tailor-made to fit the program.
Other Teaching Aids

In addition to the contributions of the commercial art (visual aids) department, the instructors were very ingenious in preparing materials or being instrumental in obtaining models, testing equipment, three-dimensional build-ups, cut-aways, wall displays, and demonstration experimental equipment. Although this was the responsibility primarily of the Institute, there seemed to be a continuous searching on the part of the teachers to locate teaching aids which would contribute to the simplification of the subjects under discussion.

Curriculum

The development of the curriculum of the pilot training program, the program content, and instructional procedure should reflect the purposes of the program and should serve to correct those educational deficiencies which were major factors in creating the need for the program. Modern technology places a premium on practical knowledge and experience, but new and more complicated technological changes are constantly being made at such an accelerated pace that the technical know-how job demands on key production and maintenance workers are rapidly becoming so great that they cannot depend upon their wealth of experience and knowledge to maintain their job competency. These key employees have a rich background of knowledge of the what and the how of the job.
But the jobs have rapidly become so technical in nature that a knowledge of the why has become no longer just desirable, but essential.

To understand the why each key production and maintenance employee needs to have a minimum theoretical background of the work he is performing and an understanding and working knowledge of the basic fundamentals of the science and mathematics involved in his job. In a relatively short period of time, in fact within the work life of most of the key production and maintenance employees, their job requirements have changed to such an extent that the job has demanded that they become technologists - a demand that cannot be fulfilled simply by a background preparation of practical knowledge obtained from experience.

Realistically, however, these changes have occurred at the time of life of these experienced employees when many were not adequately prepared and willing to "go back to school" to take mathematics and science courses. What kind of training program would minimize their deficiencies and maximize their strengths and yet accomplish the desired results? This was the challenge which prompted the development of the Four-Year Pilot Training Program.
In the initial stages of the planning it was thought that a one year terminal program of general review of the mathematics and the sciences related to the various operations would be sufficient. Before the end of the first year, however, it became evident that one year would not be adequate time in any of the various courses to do the necessary comprehensive training required to prepare the key production and maintenance workers to handle the technological aspects of their job. Subsequent experience proved that it was a wise decision to make the first year’s training a cursory overview and that it was not a loss of time to cover the entire subject matter area for purposes of orientation. Experience has demonstrated that the first year should constitute a preview of the total area to be covered in the program, with the following two years showing progressively greater concentration in the technical aspects of the job.

Diagrammatically, this concept may be illustrated as follows:

```
  Second Year ▲         Third Year ▲
     ▼                  ▼
      |  ▼                |  ▲
    ▲           ▲       ▲           ▲
  First Year
```
The first year may be characterized as a broad general treatment of the entire course content in which the individual deficiencies in general mathematics are discovered and remedial assistance given. Likewise, a general overview touching lightly on the chemistry and the physics of the operation provides opportunity to teach the fundamental and basic concepts in the sciences. Thus a common base of knowledge is laid the first year.

In the two succeeding years the content is considered in greater depth. Having covered during the first year basic arithmetic and elementary science, the program is ready to gradually become more specific in the second and third years and include the necessary algebraic concepts and the pertinent scientific knowledge related to metallurgy, combustion, refractorys, and electricity, depending upon the department.

The Coke Plant Department text is a good example of the procedure followed in the development of the text and the method of instruction. The Table of Contents (on the following page) of the Coke Plant Practices course indicates how the text material is organized and covered in the three-year program. It includes eight major units which in turn are broken down into four to eight sections. During the first year the instructor covers all the units and sections and he weaves into the instruction the fundamentals of mathematics, chemistry and physics that are pertinent and needed.
### Table of Contents

**Unit I - Introduction**
- SECTION I: Purpose
- SECTION II: Definition
- SECTION III: Early History of Coke Making
- SECTION IV: The Modern Coke Industry
- SECTION V: Materials, Equipment and Process (Overview)
- SECTION VI: Questions and Problems

**Unit II - Coal Handling**
- SECTION I: Introduction
- SECTION II: Definition
- SECTION III: Chemical Nature of Coal
- SECTION IV: Recognizing Coal by Characteristics
- SECTION V: Blending of Two or More Coals
- SECTION VI: Names of Coals
- SECTION VII: Coking Coal Deposits in the United States
- SECTION VIII: Questions and Problems

**Unit III - Preparation of Coal for Coking**
- SECTION I: Introduction
- SECTION II: Unloading
- SECTION III: Breaking Up Coal
- SECTION IV: Coal Mixing
- SECTION V: Communication System
- SECTION VI: Oven Storage Bins (Coal Bunkers)
- SECTION VII: Questions and Problems

**Unit IV - Coke Oven Construction**
- SECTION I: Introduction
- SECTION II: Coking Chamber
- SECTION III: Heating System
- SECTION IV: Fuel Gas System
- SECTION V: Gas Collecting System
- SECTION VI: Questions and Problems

**Unit V - Coke Oven Accessory Equipment**
- SECTION I: Introduction
- SECTION II: Oven Top Equipment
- SECTION III: Oven Side Equipment
- SECTION IV: Questions and Problems

**Unit VI - The Coking Process**
- SECTION I: Introduction
- SECTION II: Oven Charging
- SECTION III: Pushing Coke From the Ovens
- SECTION IV: Coal Coking
- SECTION V: Questions and Problems

**Unit VII - Quenching, Screening and Handling Coke**
- SECTION I: Quenching
- SECTION II: Coke Screening and Crushing
- SECTION III: Storage and Shipping
- SECTION IV: Questions and Problems

**Unit VIII - General Maintenance**
- SECTION I: Introduction
- SECTION II: Repairing, Replacing and Patching Bad Brickwork
- SECTION III: Maintenance and Repairing Heating Flues and Gas Nozzles
- SECTION IV: Lubrication
- SECTION V: Questions and Problems
This provides the class with an overview of the activities of the entire department.

In the second year the instructor will come back to the first four units, I - Introduction, II Coal Handling, III Preparation of Coal for Coking and IV Coke Oven Construction, but this time he will expand on each section and weave in as much applied technology as he can. In the third year he will start with Unit V - Coke Oven Accessory Equipment, cover in detail all the sections and the remaining units - VI The Coking Process, VII Quenching, Screening and Handling Coke and Unit VIII General Maintenance.

In this way the text material is covered both in depth and breadth and effectively interspersed at proper points with the basic fundamentals of mathematics, science and applied technology.

The following may help to illustrate this point.

<table>
<thead>
<tr>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
</tr>
</thead>
</table>
| Instruction related to applied Technology | Instruction related to practical knowledge and experience | }
Developing Course Content and Text Material

Since the Pilot Training Program had as its focus the development of technical knowledge about the operations in the department in which the class members worked, course content and text material literally had to originate in the departments. It should be constantly kept in mind that the focus of the training program was on the operation. Continuously emerging from a consideration of a modern production and maintenance operation was the necessity to know the why. A knowledge of the why required certain knowledge of the related mathematics and sciences. This necessitated an entirely different approach to training than a program that sets out to train in the specific sciences and the specific subjects of mathematics. Subject-matter courses of study are well organized in colleges, technical institutes, and other training organizations.

In a subject-matter-centered training approach, the various sciences and mathematics related in a general way to the operations are often taught as a general, broad, fundamental, foundation-laying training program. In the operation-centered approach characterized by this Pilot Training Program, the operation is the center of interest. Those mathematical and scientific principles and concepts are introduced which are essential to the production and maintenance workers' necessary level of understanding of the why of the operation.
The former is essential in the training of scientists and mathematicians who become specialists; for example, combustion engineers in the coke plant. For the production and maintenance workers in the coke plant the latter method was chosen by the company because it seemed to be a practical, simple, functional way of raising the why knowledge to a level approaching the what and how gained from years of experience.

Logically, there seemed to be only one major source for the text material and course content; that source was the departments themselves. There existed logically also only one group of people in each department who had the necessary intimate knowledge to say in what area of competence the key employees were weak and what technology they needed to know. In fact, there was only one group of people who had sufficient technical and practical knowledge of the specific operations in each department in order to teach it. In both cases that small group in each department was the top department management people - department head, assistant department head, general foremen and key staff people.

Although these department management individuals were vitally necessary in determining course material and in organizing it for instructional purposes, it was recognized that these men already have jobs of high responsibility with many demands upon them. The time-consuming task of course construction text writing obviously could not be done by them.
A team of three specialists from the Institute assumed responsibility for obtaining from the Company's department management the resource material, suggestions, ideas and technical information. The team then worked up the material into text form, checking and rechecking periodically with the department staff, and finally following through by helping the instructor in techniques of teaching.

The course development sequence described here was the typical process followed for each of the departments in the training program. It should be stated here that the classroom teachers are selected from the department administrative personnel - department heads, assistant department heads, and general foremen.

The three people from the Institute who had the major assignments for the production and maintenance programs are -

(1) A man who has a rich background knowledge in the operations of the steel industry. He has a knowledge of steel technology and the steel business in general. His primary contribution in developing the training courses of study and texts was his ability to understand and interpret the technical contributions and ideas made by the department staff and translate that information into course material. He also did research and selected text material to supplement and enrich that contributed by the company department.
(2) A man trained and experienced in techniques of teaching. He may be called an expert in education. He analyzed and organized the material on the basis of its instructional value. He also coached, observed, and followed up on the instructor to assure the best possible classroom procedure.

(3) A man who is a commercial artist and a visual aids specialist, who was involved not only in the organization and content of the course from the point of view of his specialty, but he is the instructor's valuable aid in supplying the best visual aids available which are pertinent to the specific details of the operation.

The typical sequence steps of creating and developing the courses of study and text material is related below. There was very little deviation from this sequence throughout the four years, except as continuous experience contributed to refinement and more distinct identification of the roles of the development team members, both those from the Company and from the Institute. As may be expected, the initial efforts on the part of the dual team in this creative project necessitated a getting-acquainted period of time for each team member with the other, not only personally, but more important, learning to integrate and inter-relate ways of thinking, methods of expressing ideas, understanding relative personal and technical strengths and weaknesses. Someone described the beginning stages of the content
development of this project with that which would exist in writing and producing a stage play, in which a group of writers, producers, stage hands, and prop men assembled to write, and produce, and direct a dramatic performance. It would not be difficult to imagine the personal and professional orientation necessary to create the play, produce it, and get it on the road.

Considering the apparent difficulties, this project got under way in a relatively short period of time. The parallel relationship between this and the theatre breaks down when we consider that a dramatic production must be a finished product before opening night, whereas the pilot project course and text content required only the total program in skeleton outline in advance so that there was a general understanding and agreement regarding the scope and content of the program. From that point on the classes began immediately after the month's text and teaching materials were developed, and continued uninterrupted as the creative team kept approximately one month ahead of the classes in the development of the course content, text materials and teaching techniques and procedures.

In the following steps reference is made to the development of the Coke Plant text and course of study as an example. The table of contents of that text appears on page 104.

Step 1. This is the step in developing each department's course of study and text material which determined the scope of the course. The Institute team of three people, with the
technologist being the key person, met with the superintendent (department head). This person was not expected to give much of his on-the-job time to the course development, but this first meeting was very important in setting the stage, and in giving overall direction and making decisions regarding the selection of the specifics of the job for which the department head's technological knowledge of the operations qualifies him in a unique way. In an indirect way this first step provides an opportunity to obtain this key management man's stamp of approval of the over-all course content. Because he, more than any other person, has a better overview of the entire department and a better knowledge of the skills necessary to man the key jobs, and because his participation at this stage gives assurance of top management's knowledge and approval of what is being taught, the department head specifies the key areas to be covered.

These areas become unit headings in the course of study. The Coke Plant table of contents, for example, contains seven units in addition to the introductory unit. The superintendent of that department was of the opinion that there are seven major areas of knowledge that a key production and maintenance employee of the Coke Plant should have: 1. Coal Handling, 2. Preparation of Coal for Coking, 3. Coke Oven Construction, 4. Coke Oven Accessory Equipment, 5. The Coking Process, 6. Quenching, Screening and Handling Coke, and 7. General Maintenance.
Step 2. Usually prior to Step 1, the instructor for the course is designated - he is either the superintendent, assistant superintendent, or general foreman. In those steps succeeding Step 1 in which the company personnel is involved, the instructor is a major participant. In Step 2, the Institute team of three persons met with the instructor and such other person(s) as the assistant superintendent and general foreman may designate, and a breakdown into sections is made of each unit. At the end of Step 2, the team has the course content established. At this point, again using the example of the coke plant, the team would have developed the course content essentially as shown in the table of contents (See Coke Plant Table of Contents page 104).

Step 3. This step was in continuous process throughout the course. The Institute team met with the instructor to make a breakdown of each section in detail. As stated before, an effort was made to keep at least four weeks ahead in:

- preparing and processing text content material.

- processing visual aids for inclusion in the texts and for demonstration purposes and class instruction.

- observing the instructor, conducting coaching sessions with him in the best methods, techniques and procedures of teaching.
More specifically, describing the typical established process which became a pattern during the four-year program, in terms of the Institute staff roles, the technologist member of the staff returned to the Institute from his conference(s) with the instructor at the plant after having a pre-planning conference on the advance development of a four-week block of instruction. He would bring back with him the general and specific ideas of the instructor which he then developed into a segment of the text. He supplemented this with allied supplementary material and incorporated it all in a rough copy text form and submitted it to the instructor for his approval.

The instructor and the visual aids member of the Institute team then went over the rough copy and analyzed the content to mutually determine how the printed copy could be supplemented by illustrations, drawings, charts, graphs and animated illustrations of the text.

The specialist in teaching methods from the Institute analyzed the rough text in relation to its level of vocabulary, logical sequence of ideas, and other educational factors. He also assisted the instructor in the final decisions regarding the specific material he would cover in each of the four training sessions. This determined the breakdown of the four-week unit in relation to the material distributed at each class session.
With this background of preparation the four week unit of text material was typed and processed at the Institute on an offset duplicating machine on punched paper. Each enrollee was given the material covering the one period at each session; approximately one-fourth of the four week text material.

Step 4. This was an end-of-the-year evaluation step. It should be kept in mind that throughout the thirty-week period the program was developed in action. Continuously working on developing succeeding segments of the text material gave little opportunity to give serious attention to structure relating to continuity, logical sequence, transitional statements, and the like, particularly between the four week sections. There was greater concern regarding errors in form than in content since the highly qualified instructor in the technical aspect of the program could be relied upon to avoid content errors.

Although the end-of-the-instruction-year evaluations revealed points needing refinement and organization it was encouraging that the texts generally had good continuity and there was relatively few significant revision changes necessary. Step 4, however, was an essential one in the development process.

The evaluation members consisted principally of the three Institute representatives and the instructor.

Each of the Institute participants in this program had years of experience in training. However, it proved to be a new and
challenging experience to each of them to be able to create not only courses of study and texts but also, in the same sense, create teachers by training persons in the art of teaching, public speaking, and in the more formal types of personal communication. It was a heartening experience to observe the development of self confidence among the instructors many of whom at the outset expressed some doubt about their ability to conduct sessions in a classroom setting.

The Instructors and Their Preparation for Teaching

Reference has been made previously to those who were the classroom teachers in the Four-Year Pilot Training Program. Some description of these people, their background and their training has already been given since they contribute in such a vital way to much of the preceding consideration of the program.

The focus of all of the production and maintenance training in this pilot program was the operation - not the operation in just any steel plant, but the operation in the plant in which the enrollees worked. Although many or most of the concepts relating to a steel company's strip mill, for example, are approximately the same as those in other companies, yet each company has its own particular strip mill problems which are unique to that plant. Each has different types and different combinations of types of equipment and material. Therefore, because of the nature
and purpose of the program, it was imperative that the instructors come from the departments themselves. Only they had the special technical knowledge and could relate it to the specifics of the department.

The department superintendents are men who are well advanced in the salary brackets, often have many demands on their time outside of the scheduled work hours, and generally would not be expected to spend the time and energy required as teachers in this program. Nevertheless, when the program was launched many of the superintendents were so enthused about the program and so desirous of having the program started successfully that they offered their services to the Institute the first year. After that year fewer superintendents continued as instructors. However, the assistant superintendents were well represented on the teaching staff throughout the program.

Every effort was made by the Institute staff to train and coach the instructors in order that good and acceptable methods of education would be used in the classroom. In the description of the various steps of developing a program of studies mention was made of the help given to the teachers by the Institute specialist in educational methods and teaching techniques. This help was in many ways like that of a coach instructing a player. Help was given in organizing specific class assignments; classes were observed periodically and follow-up suggestions were made based on those observations.
In addition to this individual assistance, as the four year program progressed, each instructor, prior to his teaching was required to attend five one-half day intensive training sessions for instruction. These sessions were conducted on company time. A very comprehensive teacher training instructor's guide was developed for use in the workshop and to be retained by the instructor for future reference.¹

The objectives of the training sessions as listed in the instructor's guide are as follows:

I. To give the instructors insight into and some practice in the skills of industrial teaching - with emphasis on an effective approach where students learn through participation.

II. To help them clearly understand the purpose of industrial training courses, the important role of the instructor, and the need for thorough preparation before every class.

III. To make sure they understand their relationship as instructors to the Institute and its staff.

The outline of the teacher training program is as follows:

**Introduction to Teacher Training**

Purpose of the Instructor Training.
Purpose of the Production and Maintenance Programs.
Human Engineering Institute's Place in the Program.
Principles of Effective Teaching.
  a) Good Teacher-Group Relationships.
  b) Allowing for Individual Differences.
  c) Personal Identification -- belonging.
  d) Developing Active Participation.
  e) J.I.T. Motto - "If the Worker Hasn't Learned, the Instructor Hasn't Taught."

¹See Appendix for the *Handbook for Industrial Teachers*. 
Modern Approach to Industrial Teaching

Basic Types of Meetings and Leader's Objectives In Each.
The Four Steps to Student-Centered Teaching.
Teaching Techniques
   Using the Five Senses.
   Using the Questioning Technique
   Using Student Reports.
Sample Demonstration -- Acknowledging Responses from the Group.
Hand out Teacher's Handbook and Practice Material
   (Discussion Leader Problems) Assignments..

First Practice Session
Discussion of Reading Assignment (Teacher's Handbook)
Practice Sessions - In small groups - 6 to 8 participants in each group. On material assigned (Discussion Leader Problems). 15 - 20 Minutes Practice; 5 - 10 minutes Critique. Questions on Effective Teaching Principles Used.

Second Practice Session
Demonstration and Practice with Visual Aids.
   Chart Pad
   Overhead Projector
   Slap Cards
   Opaque Projection.
Practice Sessions (continued)
   In small groups as outlined in session above.
Hand out Discussion Leader Problem Material Covered in Practical Sessions.
Assignments.
   Read Handout Material.
   Continue Practice Sessions.

Third Practice Session
Discussion of Reading Assignments
Practice Sessions (continued)
   In small groups as above.

Fourth Practice Session
Practice Sessions (continued)
Hand out subject matter material for Introductory Session Practice.
Assignments.
First Introductory Session Practice
Discussion of Reading Assignments.
Introductory Session Practice.
   In small groups - subject matter assigned.
   Twenty minutes practice; 10 minutes critique.
   Questions primarily on how well introduction was handled.

Second Introductory Session Practice
Introductory Session Practice (continued)

Third Introductory Session Practice
Introductory Session Practice (continued)

Fourth Introductory Session Practice
Introductory Session Practice.
Evaluation of Workshop.

A typical schedule for training the instructors is as follows:

Schedule

First Day
1:30 - 3:00 p.m. - Introduction to the Workshop.
   Purpose of Instructor Training.
   Purpose of Production and Maintenance Courses.
   Principles of Effective Teaching.

3:15 - 4:45 p.m. - Modern Approach to Industrial Teaching.
   Teaching Techniques.
   Practice With Visual Aids.
   Assignments.

Second Day
1:30 - 3:00 p.m. - Discussion of Assignments.
   Instructor Practice Sessions.

3:15 - 4:45 p.m. - Instructor Practice Sessions.
   Assignments.

Third Day
1:30 - 3:00 p.m. - Discussion of Assignments.
   Instructor Practice Sessions.

3:15 - 4:45 p.m. - Instructor Practice Sessions.
   Evaluation of Workshop.
One of the firm convictions expressed at the outset of the program and emphasized continuously by the Company and particularly the Institute staff was the fact that much of the success of the program depended upon the effectiveness of the instructors. This conviction was evidenced in the extent to which the Institute carefully chose the instructors and worked with them throughout the four-year training program both as individuals and in groups.

Two expressions were rather commonly heard from the department representatives chosen as the instructors when the Institute staff started to work on the development of course content and the preparation of the teacher for their classroom duties. In respect to the course content, the approach to the instructor would not usually be, "What should be included in the course of study or text", but rather, "What technological information do the key employees need to know to do their job effectively?" Or, "What is the technical phase of this particular operation that the men must know to do it well?" The common expression in response would be that he (the instructor) could relate in a very short period of time what the men need to know. However, as the Institute staff conferred with the instructor to work out the details of the answer to the above questions, he and they both discovered that it would take hours rather than minutes for the instructor to relate the necessary details for inclusion as content material in the course of study. This participation
of the instructor from the ground work up through the final stages of the text preparation was an invaluable asset to the instructor. In effect, he wrote the text. He not only knew its contents thoroughly, but it was essentially the product of his own creation. The Institute staff served as a catalyst to transmit his ideas and knowledge into functional instructional material.

The initial reaction to the invitation to serve as an instructor often produced the second expression, to which reference is made above; a statement would be made such as the following: "Why I can tell those fellows what they need to know in this department in much less than ninety weeks." One of the most common practices which had to be changed in the early stages of instruction was the teacher's desire to tell the students; to lecture to them, and to do most of the talking.

The teacher training stressed creative teaching, with emphasis placed upon student participation. The teachers were encouraged to create a classroom climate that was conducive to the students sharing of experience and interchange of ideas. In the preparation of teachers the goal which was kept uppermost was learning, not teaching. Inquiring - analyzing - reasoning - searching for the why were held to be the kind of approach to the topic which produced the desired learning.

Since the department's operation comprised the course content, the teachers were reminded of their enviable position of using
familiar everyday problems to challenge the thinking of the class.
In addition the teachers were given help on ways to use the department as a laboratory for the course. An assignment, for example, to one individual or group may be to investigate a situation relating to a particular problem regarding an operation; another person or group in the class may assume the responsibility to confer with the metallurgist, the chemist, the combustion engineer, or other staff specialists on problems. Another assignment may be for a segment of the class to try out various alternatives to a problem in their daily department operation.

An actual example may be given of an assignment which followed a class discussion of the construction of the various types of coke ovens in the department. The men sitting at two of the tables were to investigate the base of the number one battery of coke ovens. Those at the other two tables were to examine the construction of the oven base in battery number two. How do these two differ? What are the advantages of one over the other? Get information from the supervisors, staff engineers, consult the construction blueprints if desired. (The superintendents or assistant superintendents would make these available.)

The curiosity and eagerness to delve into these problems (ovens they have worked on for years without a knowledge of the existing problems) and report back to the class was very interesting to observe. The sharing in the following class session
and expression of ideas based on facts they had obtained was a real pleasure to observe. Truly learning took place in those sessions in a climate which would please the most critical educator.

Upon returning to class at the Institute the following week the different groups and/or individuals were expected to report their findings in relation to the subject(s) under consideration. In the interval between classes the instructor was not miles removed from the class and seen only during class hours. He was also in the "laboratory" and as much an integral part of the operation as the class members themselves.

The teachers were instructed to make maximum use of this unique "laboratory" resource and to structure the classroom situation so that it motivates intellectual curiosity and contributes to a desire on the part of each individual to find solutions by using his own resources. In reference to job-related training, Clark and Sloan expressed this point very effectively.²

This is vital education indeed, a blending of learning, applying, reporting and relearning that plumbs the depths of reality on the one hand and, on the other, reaches out for the new and improved as revealed by experiment and research. No artificial motivation is necessary; the daily work life supplies it. And no distant use of knowledge gained need be encouraged; it will probably be needed that very afternoon.

²HAROLD F. CLARK and HAROLD SLOAN., Classrooms In the Factories, p. 60.
The experience of the Institute in this project has convinced the staff that the kind of teaching described above does not occur except by conscious and continuous effort on the part of the institution in which the training takes place. Probably the word that best describes the role of the training institution in regard to teacher training is the word coaching. This word involves first, training in the fundamentals; second, giving experience under close supervision in try-out sessions; third, standing by as an observer, and as the teacher becomes more proficient, assisting him to refine his performance and helping him avoid gradually falling into bad habits. Good coaching keeps the teaching edge sharp, and prevents the intrusion of short-cuts, "easy ways" and numerous other pitfalls which gradually, but surely, dull the edge.

The Institute attempted to instill in its instructors an appreciation of the fact that teaching is a creative art. In a Training Within Industry (T.W.I.)* program there was an expression that became a training slogan which challenged the effectiveness of those trainers, who taught millions of wartime industrial workers. The slogan: "If the student hasn't learned, the instructor hasn't taught." Just as the quality of his handiwork is the measure of the workman's true success, so the extent to which the students are

*Note: Training Within Industry was organized in 1940 as a part of the War Manpower Commission to provide a clearing house service in industrial training techniques and to make training consultation available to war production plants. A number of successful training programs were developed by T.W.I. and widely used during World War II.
able to make functional their assimilation of facts is a measure of the teacher's success. Although the instructors were without a background of formal courses in teaching, with careful coaching and with continuous emphasis on the necessity of good teaching the staff of instructors with a very few exceptions, did a very commendable job.
Conclusions

Although this Four-Year Pilot program involved many instructors and hundreds of students, the fundamental concept of the program was simple.

Republic Steel Corporation had many senior employees on key jobs who had years of practical experience but lacked the technical knowledge necessary for effective judgment. The Corporation also had management personnel who had a wealth of practical experience and the technical knowledge necessary for effective judgment. In the past the two had never come together.

The Pilot Program provided the management personnel (the instructors) with the necessary help to organize and plan their instruction and to present it effectively to the senior employees (the students) under pleasant conditions and within a favorable educational environment. This, in essence, was the training key to this unique personnel situation.

In recognition of the problems involved in measuring the effectiveness of training it was assumed at the outset that the attendance would be one of the major criteria of success.
Gratifying to both Republic Steel and the Institute was the
fact that enrollment, attendance and percent of completions were
far higher than their most optimistic hopes. Interest on the part
of employees and management was high. Employee interest was
reflected in regular attendance, enthusiastic participation and demands
for further courses. Management interest manifested itself in the
rapid spread of the program through the Cleveland district and the
expansion of the program to the Warren-Niles, Ohio, Canton-Massillon,
Ohio, and Gadsden, Alabama districts, where Republic Steel Corporation
has other major steel producing plants.

In view of the small classes, extensive use of visual aids and
the necessity for developing the program on a going basis while
training was in progress, the cost of this training proved reasonable.
It averaged $65.00 per year per student, or a total of $195.00 for a
student completing a three-year course. Taking the case of the average
trainee, the cost of a three-year course represented an annual
investment of $11.50 for each of the seventeen remaining years of
anticipated service. Compared to the average income of $8400 a year
earned by the trainees, an annual investment of $11.50 for improved
performance must be regarded as relatively insignificant.

Specific data on the improvement of operating and maintenance
efficiency are difficult to obtain in this type of training situation
for there are so many other factors that enter into the picture.
However, the results have been readily apparent to the management of the operating and maintenance departments in terms of both performance and morale.

**Significant Personnel Factors**

The personnel aspects of this program appear to be as basic to success as the educational factors. The decision to conduct the training outside the company premises, and with voluntary enrollment on the employee's time has worked out well. The broadening of the program under the acid test conditions of continual and sustained attendance on the part of trainees has challenged the caliber of the program and furnished a continuous yardstick as to its effectiveness. In addition, these features of the program -- particularly attendance on the employee's own time -- made the project economically feasible for the company. Otherwise the cost of training would have been prohibitive.

Having the program developed and conducted by a third party appears also to have been sound, especially in view of the fact that both the instructors and the students were from the same organization. This approach tended to insure that the training was conducted on a planned, organized basis utilizing sound educational principles that were made readily available to the instructors.

Organizing the instruction by departments and using departmental management personnel as instructors also contributed significantly.
The class grouping was homogenous in terms of the educational focus of the class and plant operations performed. The instructors had the same practical experiences as the students, therefore, they were able to relate and integrate the theory with practices the employees understood.

The decision to develop the program "in action" and on an experimental basis rather than trying to master mind it beforehand appears to have been helpful. It enabled the instructor and development center to meet the needs of each class situation by adjusting the type of material, amount of material covered, methods of instruction, and the reading and study material to each course and class as they progressed.

It should be noted also that the personnel policy decisions involved could not have been made in a vacuum. Their importance had to be carefully weighed in relation to the effect they would have on the educational aspects of the problem. For example, although it is difficult to prove, the program development staff agree that the decision to train the employees by departments was of tremendous importance educationally. Furthermore, it became very evident as the program progressed, that the personnel policies regarding voluntary enrollment and class attendance on the employee's own time were key factors in the effectiveness of the training program involved.
Educational Factors

One of the significant factors in this program was the fact that it brought together in an effective way some well-known educational principles and techniques.

Some of these appear to be of particular significance. The organization of the classroom itself was unusual. Small classes in a small room, men grouped in comfortable chairs by fours around a table, smoking, a relaxed and easy air of informality - all proved to be features contributing to a most suitable classroom environment.

The curriculum was designed on the principle of relating technical theory to practical experience, thereby giving a broad view of the total operations of the department. In the second and third years more and more emphasis was placed on the theoretical and less on the practical, but continued attention was given to weaving the theory into the employee's practical experience. During these years, the curriculum expanded in both breadth and depth, introducing one logical phase of the total operation at a time and developing a thorough understanding of the technology involved. In developing the curriculum, both the development staff and the instructors made unique contributions.

The teaching methods employed are well known. In training the instructors, it was referred to as creative teaching.
Their goal was to help students learn rather than merely to cover a certain specified body of knowledge within a certain time. In this connection the text was used to supplement teaching; it was a general guide to what should be taught.

The generous use of educational and visual aids proved helpful in presenting some of the technical concepts, particularly in relating these concepts to the experience of the man.

Because of certain limitations inherent in the nature of the Pilot Program itself, it cannot be proven that this necessarily presented the best way the problem could have been handled. However, the extraordinary attendance record of trainees coupled with their enthusiasm and request for more advanced training provides convincing evidence that this program fulfilled specific training needs to a degree far beyond anything developed up to that time.

Recommendations

Although this program has proved satisfactory to both management and employees, the experience of the Four-Year Pilot Run has indicated a need for further study in some areas.

A major question that needs to be answered in the near future is: Will younger employees with less experience be as interested in, and benefit as much from, the present program as the older employees?
As this training continues, younger, less experienced men working on lower level jobs will become eligible for this program. Will the program as now constituted meet their needs? Will only minor modifications be necessary? Or will a completely new approach have to be devised?

Other important questions need further study. It was found that many supervisors benefited from this training. This raises the question as to whether they should receive this training before their men receive it. Moreover, is it desirable for both supervisors and key employees to be trained together?

There is the question of the feasibility of using staff specialists, such as metallurgists and combustion engineers as instructors. Another practical point - can day and night sessions be scheduled successfully to make more effective use of the educational facilities?

Perhaps the most perplexing question is: Will the present training of senior employees prove to be sufficient to help them keep abreast of technological changes that will occur in the future, or will it be necessary to provide them with periodic training?

As the program is extended to other districts more consideration needs to be given to setting up the training program in a manner which would produce better measure of results.
Even though difficulties will be encountered, more data can be obtained on how much applied technology has been learned by the employees attending the classes and how effectively it is being put to work.

The Pilot Program described and analyzed in this study is just one of many indicators that American industry is moving into new realms of employee training. Scientific and technological progress is forcing industry to raise its sights and attach new dimensions to the education of employees long after they have completed their pre-employment academic studies.

It is to industry's enlightened self-interest that this be done. But, as is so often the case with progressive steps made in pursuit of specific economic objectives, the sociological benefits may reach well beyond the limited goals originally sought. Messrs. Clark and Sloan put it this way:  

It is possible that we are now witnessing in the educational activities of American industry the birth of a third great educational force of far reaching consequences. For, just as the first has perpetuated learning, and the second has provided the bulwarks for democracy, and for a free economy, so this third innovation is adapting civilization to a new technological era, the ultimate consequences of which stagger the imagination. Nor is this merely an adjustment to mechanical workers. It is an integration of new technical skills with revitalized human relationship, envisioning a world augmented not only in material comforts, but, far more important, in spiritual values.

1HAROLD F. CLARK and HAROLD S. SLOAN, Classrooms In The Factories, pp. 134-135.
BIBLIOGRAPHY


From Coal to Coke
How fuel is baked for the blast furnace

Eighty-six byproduct coke plants in the U.S. are engaged in what at first might seem like a pointless
operation. They bake solid, substantial bituminous
coal until it is half air by volume.

But this porous fuel they make is just the ticket for
a blast furnace. Coke, unlike coal, burns inside as well
as outside. It doesn't lose into a sticky mass, and it
breaks up under the charge of iron and limestone fed
into the furnace.

Third in a series of charts on steelmaking

The coke oven is delicate though it doesn't look
like it. Made of vitrified brick, it must be warmed up
slowly over a month or more to avoid cracks.

Averaging in size in depth and 15 to 18 feet in
height, it is unit 14 to 15 inches wide. In a battery
of such ovens gas burns on flame on the walls
heating the coal to about 2,000 degrees. The heated
heat drives off gas and the carbon. Remaining hor
are reduced to products of his fuel when
then the coal is heated through top of oven from
hearth up to the level of its top, a process
aided by a large, electrically driven fan inserted through a
small opening in top of the oven door. As taking
place, the side of oven is removed and molten iron
slowly made into a plastic mass that does not break

Most spectacular sight in a coke plant is the
quenching operation. As water hits hot coke, a
huge steam cloud rises.

Most outstanding product of the coke oven is
blast furnace fuel, but there are equally
touched. From the hot gas stream carbon, sulfur
of oxides, metal, and other impurities are
and it makes raw-oil products like planters' fertilizers
...
Inside the Blast Furnace

How Iron Ore Is Converted to Iron

Hot air, far from desirable in an after-dinner speech, is indispensable in a blast furnace. As much as four and one-half tons of it may be needed to make one ton of pig iron. It pours in at the bottom of the furnace and roars up through the charge of iron ore, coke, and limestone that has been dumped in from the top.

Fanned by the air, the coke burns. Its gases reduce the ore to metallic iron by removing oxygen from it while the limestone causes the earthy matter of the ore to flow. Freed, the heavy metal settles to the bottom. From there, 100 to 300 tons of pig iron are drawn off every four or five hours.

The blast furnace, when nearly 100 feet high, is a huge steel shell lined with heat-resisting brick. Three in operation, it is run continuously until the furnace has to be removed or demand falls off. The alternate layers of coke and limestone led in at the top work their way downward, growing hotter and hotter as they continue. While they are in the top half of the furnace, gas from coke takes oxygen from the ore. Above a certain zone, the limestone begins to combine and react with the impurities in the ore and coke to form a molten slag. Further down, the coke gives up its carbon, while the iron steel slowly separates itself from the slag and carbon from the coke. An efficacious chemical plant, the blast furnace ensures practically nothing is wasted. The air blast and the hot flame ensure that waste products like cold coke and smoke are avoided.

In iron works, 3 percent of the pig iron output is dumped in molten pools in thousands of tons. Where it is made into a variety of castings. Solid pigs are also used by steel mills that do not have blast furnaces but are necessary for making their own supply of iron.

When the blast furnace is tapped for its store of iron, the molten metal is channelled into a vat called a gigantic drum lined with refractory bricks. Hot metal cars carry about 200 tons of liquid iron.

A half full of molten iron into lime kiln wrap steel alloying materials in an open hearth to form a special kind of steel meeting rigid specifications.
The Birth of an Ingot
How Steel is Brewed in the Open Hearth

The open hearth furnace comes about as close as anything to disproving the adage about not having your cake and eating it too. Because of the furnace's efficient way with scrap, steel never grows old. Yesterday's pork heap turns into tomorrow's limousine; the sorry harvest of an attic cleanup campaign may become armor on a heavy cruiser.

Even the burning fuel oil, tar or gas that melts the charge of pig iron, scrap and limestone does double duty. As flames surge over the charge, first from one end of the furnace, then from the other, much of the heat to their exhaust is stored in bricks that are used to preheat the incoming air (and the fuel if gas is used). Because of the open hearth's efficiency, it is used to make 90 per cent of the steel made today.
Steel's Electric Caldron
How Steel is Made in the Electric Furnace

Steels poured from an electric furnace are the thoroughbreds of the industry. No trainer could ever be sure of the antecedents of a racehorse, but a melter is of the exact make-up of the molten metal he cooks with crackling white electric arcs.

Because the heat of his furnace is intense, rigidly controlled and independent of any need for oxygen for combustion, the melter is able to make steels that cannot be produced readily by any other way. Electric furnace production in 1950—6 per cent of the national total—made up the bulk of blemishes like the stainless and heat resistant steels and alloys for bearings, tools, magnets and jet engine parts. See article page 12.
Fundamentals of Building

How Plates and Steel Shapes Are Rolled

The cross sections of the various structural steel shapes make up an alphabetical curiosity that looks as if it might fill an empty blank in a difficult crossword puzzle. Looked at endwise, these shapes, which form the steel skeleton for such things as bridges, skyscrapers and ships, resemble T's, U's, I's, Z's, S's and H's, plus some other letters not found in any language. They are carefully designed to get the most strength out of the smallest amount of steel for each of their particular uses.

Plates, which are flat, are among the most widely used of steel products. They may make up the watertight hull of a ship or the floor of a bridge; they may hold live steam as part of a locomotive boiler, or a city's water supply as a water tank.

Both plates and shapes are rolled — plates on smooth rolls, and shapes on grooved rolls. The rolling of both calls for artistry; the look of impersonal dependability about the skeleton of a skyscraper is the result of the highly personal, experience-tempered judgment of the steelman.
Through The Billet Mill
How One of Steel's Basic Shapes Is Rolled

Over the years some of the steel industry's language has come to vary from one place to another, so nobody can define exactly what a billet is. All anyone can say is that most billets in cross section are roughly square and often range from two to five by five inches. One thing for sure, though, is that all products rolled in a billet mill are called billets—all that is, except round billets which are called tube rounds.

Though the billet has remained undefined it is still important. In billets, as in slabs and blooms, steel is in a semifinished form, intermediate between the ingot and the finishing mill. Whether a billet is two by two or five by five or some other dimension altogether, it is in just the right shape to go through one of the steel industry's final production processes with a minimum of heat-loss and work.

A billet gets an identifying number which tells what heat of steel it came from. Number may also tell whether the billet came from the top or bottom of an ingot.

The cross-country mill brought production line principles to the rolling of billets. In the three high mills all of the grooves that are contributing nothing to the final shaping of the billets are removed. In the cross-country mill the piece moves on leaving the previous grooves for work that must stand but to be cleared before the next piece arrives. The details concerning this and by transfer time from one stand to the next keep production losses in a cross-country mill down to the continuous billet mill.

The billet as it comes below will go to a reheating furnace where it will be heated under controlled conditions at the correct temperature. The heated billet will then be made into various wire products.
EXPLORING THE INGOT
How Steel Shapes Up in Solid Form

Most molten steel is cast into ingots so it will be a convenient shape for rolling or forging. Ingots, like people, come in a variety of shapes and sizes. They are formed in cast iron molds that may be square, rectangular, round, oval or even geometrically complex in cross section. The most common sizes are a foot and a half to a yard wide and about six feet high.

In the mold they cool from the outside in. This gives them a skin. And some of their constituents, remaining liquid at lower temperatures than the iron base, tend to segregate as crusts do in moose. The cross section of an ingot has, as a consequence, slightly varying characteristics.

For these reasons and others, steelmen have controlled the cooling of ingots so they could control the ingots' anatomy. Originally ingots were simply buried in the ground to keep them from cooling too rapidly. Today, they are kept in soaking pits heated by oil or gas until they are of uniform temperature throughout. From there they go to the blooming mill where they are rolled into shapes called blooms, billets and slabs.
Steel's Quick Stretch
How Strip and Sheet Steel Are Rolled

In three minutes the continuous hot strip mill pictured in the first half of the diagram below can turn a fat, six-foot slab of steel into a thin strip or sheet a quarter of a mile long. In another five minutes the cold reducing mill shown in the latter half of the diagram can flatten the steel still further into a ribbon a mile and a third long. The speed of this slenderizing process is important because a lot of strip and sheet steel is needed every year to take care of our insatiable demand for automobiles, washing machines, razor blades, medicine cabinets and thousands of other products. In fact about one third of all the finished steel processed in the United States is made into either hot rolled or cold rolled strip and sheet steel.

* Thirteenth in a series of charts on steelmaking
COLD STRIP
PRACTICES

LUBRICATION AND ROLLING OIL

SECTION I
INTRODUCTION

SECTION II
HISTORICAL BACKGROUND OF GREASE AND OILS

SECTION III
DEFINITION AND MEASUREMENTS OF GREASE

SECTION IV
MEASUREMENT YARDSTICKS FOR MINERAL LUBRICATING OILS

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SECTION VII
CLEANER AND OIL USED IN COLD ROLLING

SECTION VIII
MECHANICAL DEPARTMENT'S RESPONSIBILITY FOR THE OPERATION, MAINTENANCE AND REPAIR OF THE VARIOUS LUBRICATING SYSTEMS

SECTION IX
QUESTIONS AND PROBLEMS

HUMAN ENGINEERING INSTITUTE

12-20-57
I. INTRODUCTION

A. Heavy reductions at high speed on any of the various types of mills generate considerable heat and not only raise the temperature of the product but also that of the rolls.

B. The resultant steel temperature generally runs between 150° and 250° F. On high speed tandem mills rolling 0.010 inch thick tin plate stock, at delivery speeds up to 5,000 feet per minute, the temperature of steel may be as high as 400°F.

C. The heat generated must be dissipated by a system of flood lubrication in which a water-soluble oil or mixture of oils is directed in small streams or jets against the roll bodies and the surface of the steel.

D. This unit will briefly explain some of the history, fundamentals, measurements, and application of lubricants in regard to cold rolling.

II. HISTORICAL BACKGROUND OF GREASES AND OILS

A. Historical references tell us that a grease was used as far back as 1400 B.C. to lubricate the axles of Egyptian chariots.
1. It is also recorded that this early grease was made by combining fat and lime.

2. These are exactly the same materials used today to make a certain type of grease.

B. Up until one hundred years ago, little progress was made in lubricants largely because lubrication requirements were nonexistent and all needs could be met with animal fat or vegetable oil.

1. The first oil well was drilled in 1859 by Colonel Francis Drake in Pennsylvania and for the first time an oil was combined with a soap to form grease.

2. At this time the formulas for making different greases were jealously guarded and passed on from father to son.

C. With the advent of the chemist, manufacturing methods were improved and the older products which were developed by trial and error have since been replaced.

D. The present day products which are the results of scientific study have resulted in one of industry's most scientific products.
1. The laboratory largely directs the processes or steps in making of oils and greases, but it still has not been taken entirely out of the hands of the grease maker.

a. There still remains a certain degree of art in the manufacture of greases which the grease maker uses to result in the properties desired.

(1) The knowing of when to add the oil to the soaps may spell the difference between a satisfactory batch of grease and one that is not satisfactory.

b. The combination of the chemist and the grease maker are responsible for many arrays of greases and oils designed to meet all the conditions of lubrication.

III. DEFINITION AND MEASUREMENTS OF GREASE

A. There are several definitions of grease as follows:

1. Grease is nothing more than a soap thickened oil.

2. Grease is a soap thickened lubricating mineral oil, either semi-solid or solid, with or without fillers.

3. For our purpose we can simplify the definition by comparing grease to an ordinary sponge filled with water.
a. A sponge has an extremely porous structure and when wet with water, holds onto the water by the forces of attraction, called adhesion.

b. Thus, grease which consists essentially of soaps and oil does the same thing as the sponge.

c. The soap, which is a jelly-like substance, is a carrying agent for the oil, and the forces which hold the oil and soap together are so strong that when squeezed, the oil cannot be separated from the soaps.

B. Measurement yardsticks for grease.

1. The yardstick for some of the measurements of grease are penetration, dropping point, and percentage of oil and soap. Each is defined as follows:

a. **Penetration** is the consistency or hardness of a grease determined by an instrument which measures the number of
millimeters that a cone-shaped plunger will penetrate a sample of grease at a certain temperature in a certain period of time.

(1) The results are written in numerical order with the harder greases having the lower penetration numbers.

(2) Greases vary from a fluid product at room temperature to a brick grease which is so hard that it has to be cut with a wire or a knife.

(3) Typical penetration results:

<table>
<thead>
<tr>
<th>NLGL</th>
<th>GRADE</th>
<th>ASTM PENETRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>355-385</td>
</tr>
<tr>
<td>1</td>
<td>(Soft cup grease)</td>
<td>310-340</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>265-295</td>
</tr>
<tr>
<td>3</td>
<td>(Medium cup grease)</td>
<td>220-250</td>
</tr>
<tr>
<td>4</td>
<td>(Heavy cup grease)</td>
<td>175-205</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>130-160</td>
</tr>
<tr>
<td>6</td>
<td>(Hard cup grease)</td>
<td>85-115</td>
</tr>
</tbody>
</table>

b. The dropping point or melting point of a grease is the temperature at which the first drop of oil disengages from the original material or soaps.
(1) The apparatus used in conducting this test consists of a specially designed glass test tube, a chromium plated brass cup to hold the grease, a special thermometer, and an oil bath.

(a) The cup is placed in a special test tube which is then placed in an oil bath.
(b) One thermometer is placed in the grease and the other is placed in the oil bath.
(c) The oil bath is heated and the grease in the cup, in the test tube, is observed.
(d) When the first drop of oil leaves the grease, this is the dropping or melting point of the grease.
c. The oil content of a grease means the percent of oil in the grease in comparison to the amount of soap in the grease.

(1) The oil content of a grease is found by putting a 10 gram weighed sample into a wire cone, suspending it from a wire into a closed beaker, and heating the grease to 212°F. in an electric oven for a specified time.

\[
\text{Weight percent of separated oil} = \frac{\text{weight of oil separated}}{\text{weight of sample}} \times 100
\]

(a) At the end of the specified time the assembly or beaker is taken out of the oven and left to cool at room temperature.

(b) When the assembly reaches room temperature the soap remaining in the wire cone is weighed.

(c) From this, the percent of separated oil can be calculated and by knowing the percent of oil in the grease, the percent of soaps in the grease can also be determined.
2. A grease, to be satisfactory, must have excellent cohesive qualities and good adhesive qualities.

   a. Good adhesive qualities are important in a grease so that the oil will remain with the soap instead of separating.

(1) When the oil is separated from the soap all that remains to do the job of lubricating is soap.

IV. MEASUREMENT YARDSTICKS FOR MINERAL LUBRICATING OILS

A. The yardstick for some of the measurements of mineral lubricating oils are as follows: Viscosity, Flash and Fire Point, Color, Pour Point, Specific Gravity, Carbon Residue and Neutralization Number.

1. **Viscosity** is normally expressed in seconds of time required for 60 milliliters of liquid to flow through a standard orifice of an instrument called a Saybolt Universal Viscosimeter.
a. This test is run at a predetermined temperature with the sample being tested immersed in an oil bath.

2. **Flash and Fire Point**.
   a. The flash point of an oil is the temperature at which sufficient vapors are given off to ignite.
   b. The fire point is the lowest temperature at which the vapors, when ignited, will continue to burn.
3. **Color** is expressed as a number.
   
a. It is determined by matching the light transmitted through a predetermined depth of oil with that same light transmitted through numbered or standardized glasses or discs.
4. The **pour point** of an oil is the lowest temperature at which an oil will pour or flow when chilled without disturbance under definite prescribed conditions.

   a. The oil is chilled in a test jar. At temperature intervals of 5° F., the test jar is removed and tilted just enough to ascertain whether or not the oil is still fluid.

   b. The recorded, or quoted, pour point is 5° above the temperature at which the oil will show no movement when held horizontally for exactly five seconds.
5. The specific gravity or density of a liquid is a numerical value which enables the determination of the weight of a known volume of the product.

   a. The specific gravity of water, which is 1.0, is used as the standard.

   b. Then the product, depending upon its gravity, is either lighter or heavier than water.

   ![Diagram of light oil, water, and heavy oil]

   \[
   \begin{align*}
   \text{Light Oil} & : 0.94 \\
   \text{Water} & : 1.0 \\
   \text{Heavy Oil} & : 1.2
   \end{align*}
   \]

6. Carbon residue is a means of determining the amount of carbon which remains after an oil has been evaporated under certain conditions of high temperature and under exclusion of air.

   ![Diagram of carbon residue test]

   ![Carbon residue deposits]
a. This test indicates the weight of carbonaceous residue left in the crucible, expressed in percentages of the original weight.

7. **Neutralization** number is the weight in milligrams of the amount of potassium hydroxide required to neutralize the acid constituents in one gram of oil.

a. All oils contain some percentage of acid and this test is a big help in deciding when to dispose of hydraulic oils that have been in use for long periods of time.

![Diagram of a titration setup](image)
B. Oil, when separating two surfaces going in opposite directions, has good adhesive qualities and low cohesive qualities.

V. THE NEED FOR GREASES AND OILS

A. All fluids or non-fluids are said to be lubricating when holding two solid surfaces apart by a film, regardless of their cohesive and adhesive qualities.

B. These products, called lubricants, are used to either reduce or eliminate friction.

C. Correct lubrication, in order to be maintained, must rigidly adhere to the following rules:

1. An unbroken film must be maintained between the two solid surfaces with either an oil or a grease.
2. The lubricant must prevent excessive heat.
3. The lubricant must carry away the heat normally developed, or the grease or oil will break down and metal-to-metal contact will be present.
4. The lubricant also acts as a sealing agent.
VI. **Friction** -- is resistance to motion due to the contact of surfaces.

A. There are three kinds of friction: sliding, rolling, and fluid.

1. **Sliding friction** results when the surface of another solid body such as when a sled runner is drawn over the bare ground. Other examples of sliding friction are:
   a. A piston sliding in a cylinder.
   b. A shaft revolving in a sleeve bearing.
   c. The carriage of a lathe sliding over the bed.

2. **Rolling friction** is the friction developed when a cylindrical or spherical body is rolled over a plain surface.
   a. For example: roller bearings and ball bearings produce rolling friction.
b. Less force is required to overcome rolling friction than sliding friction.

(1) It is easier to roll a heavy stone or log than to drag or slide it.

(2) For this reason, heavy objects are generally moved on rollers instead of skids.

3. Fluid friction -- when a fluid is injected between two solid bodies, and one or both of these bodies are set in motion. For example:

a. A boat floating on a river represents one body, the water represents the fluid, and the bed of the river represents the other body, and if the boat is moved through the water, or the water moved under the boat (due to current) there will be fluid friction.

b. It is easier to pull a heavy log along the surface of a body of water than to either drag or roll it along the ground.

c. No fluid friction exists unless the fluid is set into motion by the movement of at least one of the two solid bodies with which the fluid is in contact.
d. The fluid body called the lubricating film is split into layers.

(1) The resistance of the fluid to this splitting action and the tendency of the layers of the lubricating film to stick together, is called cohesion.

B. There are two degrees of friction; friction at rest and friction in motion.

1. Less force is required to overcome friction of motion than friction of rest. For example:

a. When starting a boat from rest, the power which moves it must begin at once to overcome friction.

C. Friction always produces heat.

1. The amount of friction or heat produced varies greatly depending on the type of friction; sliding, rolling or fluid.

a. Sliding friction produces the most heat.

b. Rolling friction produces less heat.

c. Fluid friction produces the least amount of heat.
D. Friction produced is governed by two conditions:
1. Roughness of the surfaces.
2. The pressure or load.

E. The cause and amount of friction in any solid or fluid is largely governed by two properties which exist in all known elements. These two properties are cohesion and adhesion.

1. Definition:
   a. **Cohesion** is the force that holds any substance together.
   b. **Adhesion** is the force that causes fluids to stick to solids.

2. Solid bodies versus fluid bodies:
   a. Solid bodies have a high degree of cohesive power, but a relatively low degree of adhesive power.
   b. Fluid bodies usually have a high degree of adhesive power but a relatively low degree of cohesive power.
VII. CLEANSER AND OIL USED IN COLD ROLLING

A. A cleanser is used on the first and last stand of the tandem mill. This cleanser can be a mixture of one part cleanser to from 20 to 40 parts water.

B. At the present time, we are using either Palm Oil or Palm Oil substitute.
   1. These oils are referred to by the general classification of "roll oil".
   2. At each unit in the mill, the "roll oil" may be called by a name which describes its function.

C. Roll oil, when used as a lubricant at the pickler, is called slushing oil or pre-coat.
   1. This oil should be of such a nature as to absorb moisture, neutralize any acid carry-over, and prevent rust. It also helps eliminate digs, gouges, and scratches while being recoiled and transferred to the mill floor.
   2. It should be of suitable nature to eliminate scratches while being uncoiled at the mill.
D. The type of oil used for cold rolling strip (called roll oil) is very important.

1. For example, hardness tests have shown progressively greater reductions may be taken with fluid lubricants in the following order: dry, water, kerosene, compounded mineral, oil and palm oil.
   a. The surface finish of steel, however, is affected in the reverse order of the hardness tests.

2. We try to get an oil with lubricating ability, yet one that will not mix easily with water and be washed away before the rolling process really happens.

3. The supplement oil that we use on the middle stands of the tandem mill is mixed one part roll oil and 3 parts coating oil.

4. A lubrication film must exist between the strip and the rolls under pressure of 5 to 6 million pounds.
   a. Correct lubrication does help to produce a smooth, flat, clean, smut-free, low cost strip with low mill loads.
b. The absence of lubrication results in mill wrecks, torn strip, off gauge, poor surface, roll wear, dirty strip and buckles.

c. Some of the lubricant penetrates the pores of the steel during preceding passes and becomes active in a hydraulic sense under the rolling pressure.

d. The lubricant must have high absorption properties with low surface tension to adhere or wet the steel evenly in the presence of water.

5. The lubrication effect could be extended to a point where it will interfere with the "bite" which will cause slippage and produce corrugated strip or wreck the mill.

6. Conventional lubrication theories adapted for sliding surfaces or bearings are not applicable under the conditions of high pressures in cold rolling.

a. In bearing lubrication, the viscosity of the oil is a prime factor, and the heavier the body, the greater the film strength of its resistance to adhere between the sliding surfaces.

b. Under high pressure the viscosity of oils increases, as demonstrated by research work performed by several laboratories.
(1) Mineral oil is ten times greater in viscosity at 100°F., 15,000 p.s.i., than at the same temperature at atmospheric pressure.

(2) Mineral and vegetable oils also increase in viscosity, but only one-fourth in cold rolling.

7. We must also use an oil that will burn free in the annealing without causing carbon.

8. The requirements of lubrication and cooling are localised in the same place, at the area of contact between the strip and the rolls.

a. For rolling, we should use an oil having good film strength that will prevent excessive heat and dissipate heat. This is best done with water, as water dissipates heat 88 times quicker than oil.

b. Two principal methods of application are direct or recirculating (oil and water mixture).

(1) Both systems have adherents among cold mill operators.
(2) Examples of each are as follows:

(a) The direct application is where the roll oil is dripped onto the back-up roll which carries the oil to the work roll and steel.
(b) The recirculating application of a tandem mill is where the mixture of oil and water is directed in small streams or jets against the roll bodies and the surface of the steel.

(c) The function of the coolant constituent or water is obviously to remove the heat generated in a controlled manner and also to regulate the contour of the rolls under thermal expansion, and thus assure equal distribution of rolling pressure which then enables the roller to make a flat, clean, even, gauge strip.
9. However, and again I will repeat, roll oil has a direct 
effect on power consumption, preventing pick-up, 
permitting higher rolling speeds, and making a clean, 
flat, smut-free strip with less roll wear.
10. The roll oil, when annealed, must burn off clean without 
smut.
11. However, even with ideal conditions and the best of above, 
it is impossible to acquire this feat with a lousy hot 
band full of rolled-in scale, off gauge, cambered, 
buckled sheet or a strip from the pickler that is 
under-pickled or over-pickled.

VIII. MECHANICAL DEPARTMENT'S RESPONSIBILITY FOR THE OPERATION, MAINTENANCE, AND REPAIR OF THE VARIOUS LUBRICATING SYSTEMS

A. There are ten large circulating oil systems and about 40 
smaller systems throughout the rolling mill.
1. Circulating oil systems keep the mills alive.
   a. Oil lines of the mills can be compared to blood 
vessels of the body.
2. Clean oil, of the proper viscosity and the proper 
temperature and pressure is being pumped continuously 
to the large back-up bearings and the drives of the 
rolling mills.
a. Each bearing must get the right amount of oil as a specific temperature and pressure depending upon the speed of the mill.

b. A high speed stand requires a lighter oil than a slow speed stand.

c. A high speed stand also requires more oil than a slow speed stand.

3. A typical large circulating oil system of a tandem mill morgoil system. (See following page.)
1. Recirculating Tank
2. Heating Coil
3. Orifices
4. Pump
5. Filter
6. Pump Protection Valve
7. Pressure Tank
8. Cooler
9. Line Pressure Regulator
10. Pressure Reducing Valves
11. Bearings
4. To accomplish the variations in viscosity for the different stands, the oil is heated or cooled.

a. For instance, the 54" tandem morgoil system uses a 2400 sec. oil at 100°F.

(1) The oil is heated to about 115°F. in the 12,000 gallon tank in the basement.

(2) The oil pumped to No. 3 and No. 4 stands will drop to 105°F. at the mill.

(3) The oil pumped to No. 1 and No. 2 stands passes through a cooler so that the temperature is 95°F.

(a) At 95°F. a 2400 sec. oil is about 2700 sec.

(b) A higher viscosity oil is required for slower speed mills.

b. Rate of flow of oil is accomplished by the use of pressure regulators at each stand and orifices of a definite size at each bearing.

(1) The slow speed mills have small orifices and lower working pressures.

(2) The fast speed mills have larger orifices and higher working pressures.
5. Alarm systems warn of trouble.
   a. One alarm warns that the initial pressure or pump pressure is low.
   b. A second alarm indicates that the filter is getting clogged and the self-cleaning operation is not functioning.
   c. A third alarm warns the oil system operators that the pressure is low at a particular stand.
   d. Mill operators, as well as oil system operators, should observe these alarms.

   (1) When an alarm sounds, it is best to stop the mills, when possible, in order to prevent serious damage and long shutdowns.

6. Another kind of protection in a mill is that of interlocking the mill motors with the oil systems.
   a. If oil pressure drops to a critical point, the mill motors are cut out, thereby stopping the mills.
   b. The interlocking feature is not used to any extent on large mills.
   c. The only mill that we have interlocked is the No. 4 stand of the 54" tandem mill.
7. There are several different types of bearings used in the rolling mills.

   a. Plain bearings.

   b. Anti-friction bearings.
c. Mergoil oil bearings.

1. Mergoil bearings on the back-up rollers of the rolling mill incorporate the principle of hydrodynamics.

   (a) A film of oil of the proper viscosity, between the outer surface of the sleeve and the inner surface of the bushing, floats the whole roll assembly.
(b) On the first mills, the 54" and 72", a roller bearing is included in the design to take care of the thrust load.

B. There are five large grease systems and a number of smaller manual systems.

1. Large grease systems supply the work roll bearings, breaker blocks and the mill housings with a specific amount of grease at regular intervals of time.
   a. The systems are automatic and are operated by an electric timer.
   b. The amount of grease supplied to each bearing is regulated by a valve for that bearing.

2. Smaller systems at the shear lines are operated manually.
   a. Much of the greasing is done with a power gun or hand grease guns.

3. It will be noted on the tandem mills, where a large amount of water is used, that the grease supplied seems excessive because a certain amount of grease will find its way out of the ends of the chucks.
a. This is done because as the grease is forced out it forms a seal which prevents water from getting into the bearing.

(1) If water gets into the bearings it can cause the grease to wash out, thereby causing bearing failure.

(2) When a bearing fails, the bearing housing the roll neck can be badly damaged.

(3) Grease at 5 or 10 cents a pound is much cheaper than a $2,000 roller bearing or a $5,000 chuck assembly, or a $6,000 roll.
Experience shows that Industrial Training requires teachers who have a rich background of practical experience in addition to their formal training.

That's why key Production and Maintenance men from the Company are used as teachers at the Human Engineering Institute.

But teaching, especially "creative teaching" is both an art and a science.

This Handbook is designed to help you gain insight into and acquire skills in the basic techniques of effective teaching.
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2074 East 36th Street, Cleveland 15, Ohio
STUDY AND READING MATERIAL

INDUSTRIAL TEACHER PRACTICES

INTRODUCTION TO THE
INDUSTRIAL TRAINING PROGRAM

SECTIONS

SECTION I THE SETTING
SECTION II THE PROBLEM
SECTION III THE ANSWER
SECTION IV THE IMPORTANCE OF TRAINING
SECTION V USE OF THIS MANUAL

HUMAN ENGINEERING INSTITUTE
2074 East 36th Street, Cleveland 15, Ohio
I. THE SETTING

Modern industry is a complicated process involving:

- **MATERIALS** with varying specifications.
- **MACHINES** designed to perform the many operations.
- **MEN**, each skilled in his particular and often highly specialized job.

Even if nothing changed, the proper coordination of these three -- Materials, Machines and Men -- presents a challenge to supervisory people.

But, changes do come in each of the three areas -- often rapidly:

- Technological advances bring changes in methods, in machines and even in materials.
- Enlightened personnel practices bring us new insights into methods of handling men.
- The demand for new and improved products faces us.
In fact, "change" is about the only thing about which we can be sure. It's normal for our day. What we knew yesterday may not be good enough today -- and today's methods may not be adequate tomorrow. Men tend to get left behind when changes occur.

II. THE PROBLEM

The task we face is that of helping men gain the necessary insight and understanding, as well as the higher level of competence, which modern industry requires of them.

"Better and more effective utilization of manpower" has become a critical need.

III. THE ANSWER

Possible alternatives:

A. More and stricter supervision.
B. Replace those who fall behind.
C. Train them to become more competent and responsible.

"A" is obviously expensive and ineffective.

"B" is neither practicable nor possible.
"C" — Training — education — helping men keep up with the change — helping them to understand the "why" as well as the "what" and "how" of their jobs — is the only basic solution.

The training will need to include, among other things:

A. Knowledge
   General
   Technical

B. Skills
   Administrative
   Operational

C. Attitudes
   Handling Men
   Team Spirit
   Willingness to Learn
   Willingness to Change

D. Ability to Solve and Handle Problems
   Operational
   Maintenance

One phase of this training — study and reading materials, and course outlines and training aids — is developed.

This manual is intended to assist you in developing additional skills and techniques in teaching and to give you practice in using them.
IV. **THE IMPORTANCE OF TRAINING**

**A. To the Company**

A high percentage of the proceeds of modern industry goes into operational and maintenance costs. One mistake - one accident - one oversight - or one failure to do a task properly and at the right time may cost the company thousands of dollars of unnecessary expense. This is so important that the company just cannot afford not to keep its men trained to the necessary level of competence.

**B. To the Men Themselves**

When the knowledge and skills which were once adequate to do a job are undermined by changes and by technological advances, men may begin to feel inadequate and, hence, insecure. Only a few men have the enterprise to keep up. Many men resist changes, cover up, pretend, even experiment and perhaps blame others; they may feel a sense of frustration, or inadequacy and, hence, of insecurity.

However, when they realize that these programs will help them, they will be in favor of the programs.
C. To Those Who Teach

To you who teach will come the greatest benefit of all.

Your job will be made easier — for as your men become more competent, you will have fewer headaches. Your relationships with your men will be even better.

You will get the thrill of helping your men succeed. Leaders will emerge ready for promotion when openings occur.

Time and effort spent in training men under you will "pay off." And, best of all, you will enjoy your work even more.

V. USE OF THIS MANUAL

The materials in this notebook are an outline of the program:

Unit One -- Introduction to the Industrial Teaching Program.
Unit Two -- The Role of the Industrial Teacher.
Unit Three -- Basic Purposes of Each Meeting.
Unit Four -- Keys to Creative Learning.
Unit Five -- Approaches to Conducting Sessions.
Unit Six -- Techniques in the Creative Approach to Learning.
Unit Seven -- Appraisal of Our Teaching — Suggestions for Improvement — Summary.
They will give you some idea of the problems involved in creative learning and will suggest some techniques and methods to use, as well as ways of evaluating the work.

They represent an outline, only, for the real training must come from experience.
INDUSTRIAL TEACHER PRACTICES

THE ROLE OF THE INDUSTRIAL TEACHER

SECTION I  THE TYPE OF TEACHER NEEDED
SECTION II PURPOSES
SECTION III THE APPROACH - THE METHOD IS THE KEY
SECTION IV LEARN BY DOING

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INDUSTRIAL TEACHER PRACTICES

UNIT: II

I. THE TYPE OF TEACHER NEEDED

Men are selected to become industrial teachers who not only know the WHAT, the HOW, and the WHY, of their own jobs, as well as the jobs of the men under them, but also who have already displayed leadership in handling men.

II. PURPOSES

The purpose of the teaching you will do, is to bring your men to the new and higher level of understanding that the modern industry requires of them.

III. THE APPROACH - THE METHOD IS THE KEY

Through research and practical experience with industry - the Human Engineering Institute finds that the creative approach to learning where the teacher becomes the leader and the director of the learning experience is best.

And, what do we mean by the creative approach to learning? Basically, we mean an approach to learning where:

A. The teacher encourages students to participate by drawing upon their work experience.
INDUSTRIAL TEACHER PRACTICES

UNIT: II

B. The students are stimulated to explore and to understand the "why" of their jobs.

IV. LEARN BY DOING

First-hand experience under guidance is the best way to learn how a group works, and how to get results with them. In the teacher training program a part of each meeting will be given over to "practice" in which everyone has an opportunity to test and evaluate his skills.
INDUSTRIAL TEACHER PRACTICES

BASIC PURPOSES OF EACH MEETING

UNIT III

SECTIONS

SECTION I SPECIFIC GOALS

SECTION II PROCEDURAL STEPS FOR INTRODUCTORY SESSION OF PRODUCTION AND MAINTENANCE COURSES

SECTION III SUGGESTED PROCEDURAL STEPS FOR EACH MEETING

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I. **SPECIFIC GOALS**

A. **Understand the Purpose**

Each member should understand the purposes of each meeting and feel that they are worthwhile and preferably have a part in formulating them. They become HIS problem, not yours. This aim should be clearly identified at the beginning of each meeting.

B. **Group and Individual Participation**

Each member should participate in each meeting, ask questions, make suggestions, help solve a problem, or make a report of a brief presentation. Doing something that involves him directly in the program makes him a part of the activity. His ideas may or may not be the best, but they are HIS and that's important. This helps to hold his interest.

C. **Direct Benefit to the Learner**

Each member should learn something at each meeting - something that becomes a part of him and something that he can use on his job. Help him recognize and solve a problem, a difficulty. It follows that he should leave each meeting looking forward to the next meeting, with a problem to explore in the meantime.
II. PROCEDURAL STEPS FOR INTRODUCTORY SESSION OF PRODUCTION AND MAINTENANCE COURSES

The introductory session in your class is very important. It will set the tone for the course. The information presented in this outline is important to the student and no section or part should be neglected.

A. Introduction of Self

The men may already know you but you are now assuming a new role with them. The introduction should include the following:

1. Name.
2. Years of service.
3. Departments in which you have served.
4. Family and children.
5. Hobbies.
6. Other information which you feel may be of interest to the men.

B. Introductions by the Students in the Class

Again, the men may know each other but this gives you and the others more information concerning the person in the class.

The following are two possible practices:
1. Have all persons fill out name cards.

7. On the back of the name cards get the following information:
   a. Age.
   b. Service.
   c. Experiences.
   d. Background -- family, etc.
   e. Hobbies.
   f. Any additional information you may feel is important.

3. If the men do not know each other have the man introduce himself.

4. If the men know each other, have cards passed and have the students introduce each other.

C. Define the Purpose of the Course

The following outline will give some points as to the reason for the men coming to class.

1. To help men keep up with the technical aspects of their jobs.
   a. Doctors must read and study new techniques to keep abreast in medicine.
   b. Lawyers must know new laws and court decisions to represent clients.
c. Steel producers must keep up with new scientific developments in steel making to serve new customers.
d. Maintenance people must know and understand new machines, etc. to keep production going.

2. To involve the class at this point, the students could be asked to name some of the new equipment and processes in their department in the last ten years.

3. Without technical knowledge a person cannot:
a. Understand the why of new equipment and ideas.
b. Understand the how of new equipment and ideas.

4. Again, ask the students to give you some other ideas that they have as to the reasons for training and why they are attending class. The following are possible answers:
a. To feel pride in knowledge of the job.
b. Help in advancement.
c. Understand more of the over-all picture of production.
d. A knowledge of theory (why?) will help you in your work.
D. Define the Challenge and the Responsibility of Being a Student in the Class

The following points are important:

1. Classes are small for the following reasons:
   a. To help you be able to discuss your problems.
   b. To give you every opportunity to participate.
   c. This means that you are one of the few chosen to attend. To fail to attend would mean that someone who wanted to attend has been deprived by someone who fails to take advantage of the opportunity.

2. Through this class and effort you are building yourself up as a person and a worker.

3. You have the following responsibilities as a student in this course:
   a. Working on class work so as to help yourself and others in the class.
   b. Attending class regularly. To miss one class is to miss important information for you.
   c. To practice what you have learned in your job.
INDUSTRIAL TEACHER PRACTICES

UNIT: III

E. What Will Be Covered in This Course?

Topical outlines of the courses in your field are listed at the end of Section II of this unit.

F. What is the Role of H.E.I. in This Class?

1. To furnish the materials, space, equipment and teachers to help you learn.
   a. The teacher may be a supervisor in the plant but here he is your teacher. I, as a teacher, am on the H.E.I. staff.

2. H.E.I. wants to help you learn the technical aspects of your job.

G. Check to See if You Have Fully Explained This Information to Your Class

1. Ask for questions at this point.

2. Reiterate any important parts which the teacher feels has not been understood.

H. Leading Into the Next Session

Prepare the students for the next class session.
1. Give a short history of the development of text material.
   a. Information from people of Republic Steel and other sources.
   b. Written by H.E.I.
   c. Approval by Republic Steel
   d. Develop illustrations and visuals to help in teaching.
   e. Printed for your use.

2. You will receive the text material by units as the material is to be covered.

3. Make assignments.
   a. Pick main points for study, etc.
   b. Try to stimulate the group.

I. Close the Session on a Note of Thanks, Congratulations, etc.

Make the members of the class feel that they have an important part in the success of the program.

Challenge to the teacher: At the end of the introductory session your students should feel the following:

1. Interest in the course.
2. Wanted in the class.
3. Understand why they are attending the class.

4. That they are taking away something.

III. SUGGESTED PROCEDURAL STEPS FOR EACH MEETING

While the rigid formal procedure is not to be desired, there are nevertheless certain specific techniques and methods that have proven effective.

A. Greeting

The greeting of the class is very important in the type of reaction one can expect from the class. The following are suggestions:

1. Be on time.

2. Be friendly and greet individually where possible.

B. Review or Play-Back

The leader highlights briefly what was done at the last meeting and records it on the chart pad in brief form.

The leader asks for questions, comments or suggestions growing out of last week's meeting or out of the ensuing week. He may also ask for additional problems which have come up. Again, it is well to note them on the chart pad.
C. Development of Key Points

The written material will include key points which are to be developed and emphasized during the session.

How key points will be developed:

Through student problems and work sheets.

With questions to students.

Through discussion or teacher presentation.

With training aids.

With models or demonstrations.

Development of the key points will help students see how and where this information will be useful to them in their work.

D. Summary

Recap what has been covered in the session. Try to feel out if the group has understood the main points.

1. Summarize the development of the key points.

2. Ask members of the group to select important problems to be worked on during the coming week.

3. Be specific and make a record of who is going to do what.
E. Priming for the Next Session

1. Explain the next assignment.

2. Set the stage for a place to pick up and begin at the next meeting.

F. Close the Session on a Good Note.
INDUSTRIAL TEACHER PRACTICES

"KEYS" TO CREATIVE LEARNING UNIT IV

SECTIONS

SECTION I GOOD TEACHER-GROUP RELATIONSHIP
SECTION II ALLOWING FOR INDIVIDUAL DIFFERENCES
SECTION III DEVELOPING A SENSE OF PERSONAL IDENTIFICATION
SECTION IV SECURING ACTIVE PARTICIPATION
SECTION V EFFECTIVE LEARNING YIELDS PERSONAL SATISFACTION
SECTION VI CONCLUSION

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I. GOOD TEACHER-GROUP RELATIONSHIP

As the leader, you will influence the group's behavior and attitude. You can inspire them and build up their confidence in themselves.

They will be interested and feel free to take part if they think of you as the group leader, and themselves as participating members.

Here are some personal characteristics that will be helpful:

1. Good personality and appearance.
2. Pleasant voice and manner of speech.
3. Enthusiastic about the job.
4. Cheerful.
5. Courteous.
7. Tactful.
8. Confident, but not "cocky."

There are many other factors favorable to creative learning, but there are two which are very important and should be remembered:

1. Be punctual in starting and stopping your classes.
2. Before class, become familiar with the reading material and training aids.
II. ALLOWING FOR INDIVIDUAL DIFFERENCES

As a teacher, the first thing you will learn is that no two of the members of your group are alike. In their family background, in their attitudes, in their education, in their willingness and ability to work with others, and in many other ways they will be different.

Your challenge will be to find some way of working effectively with each of these personalities.

1. Accept them as individuals - their questions, their problems, their suggestions, as worthy of consideration.

2. Try to clarify their own statement of their problems so they can be made a part of the training program.

Here are some ways of showing considerations towards students:

1. Be interested in every student (what they say and do.)

2. Do not belittle anyone.

3. Be a good listener.

4. Never give students the "brush-off."

5. Direct your teaching at the level where your students are - not where you think they should be.
Example: Maybe some of them need to learn how to multiply and divide before they can solve a problem involving simple mathematical operations. Help them where they need help.

III. DEVELOPING A SENSE OF PERSONAL IDENTIFICATION

Basically, each of us likes to feel that we are needed — that we are wanted — that we belong — that what we do is important. We want to be on the team.

So it is in a learning situation. It builds us up if we are a part of it — if we help solve a problem — help the other fellow — in short, if we contribute to, as well as receive, something from the meeting.

IV. SECURING ACTIVE PARTICIPATION

Mostly — we learn by doing.

Generally speaking, a meeting which provides opportunity for both group and individual participation creates a favorable learning situation.

The following help create active participation:

1. Informal and approachable personality.
2. Ask many questions and develop good discussion.
3. Skill and use of teaching techniques.
Always remember that it's better to help your men learn to solve their own problems than for you to give them the answers.

V. EFFECTIVE LEARNING YIELDS PERSONAL SATISFACTION

Most of us get a kick out of learning something new, especially if we have become curious about it.

We are born with a terrific curiosity -- a desire to learn. Children have it as revealed by questions as, "Where do babies come from?" "Why does the moon stay up in the sky instead of falling down?" Why? Why? Why?

Teaching methods in our schools all too often fail to use this curiosity as a basis for learning. What is even more tragic, they often stifle it. Unfortunately, we lose too much of that sense of curiosity as we grow older.

In industry, we tend to tell people what to do -- perhaps even how, but seldom do we find time for the "why".

If we can rekindle that curiosity -- that "why" attitude -- in our men, we will have established one of the most important of all conditions favorable to learning.

From there, it is an easy step to imagination -- to resourcefulness -- to the creative approach to solving problems. The satisfaction and glow that comes with it is terrific.
It's dynamic -- it motivates people -- it gives them incentive -- it makes new men of them.

VI. CONCLUSION

Experience shows that learning occurs when the forementioned conditions are maintained.

We need to remember at all times that if the men haven't learned -- we haven't taught.
STUDY AND READING MATERIAL

INDUSTRIAL TEACHER PRACTICES

APPROACHES TO CONDUCTING SESSIONS

UNIT V

SESSIONS

SECTION I DISCUSSION APPROACH
SECTION II INFORMATION APPROACH
SECTION III COMPARISONS

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I. **DISCUSSION APPROACH** is characterized by the participants sharing in the presentation. In such a session the leader's purpose usually is to get the group to gain insight and understanding through an exchange of ideas and knowledge. The group members have some background of experience. The leader, through a questioning process, gets the group to draw on their experience and contribute ideas and opinions about the problem. He further gets the group to evaluate these ideas and opinions and thereby gain insight and understanding as to the "why."

A. The Three Step Pattern

There is a process or pattern which has been found useful in the discussion approach. It consists of three steps which make it possible for the session to become a good learning experience. A brief description of the steps follows:

1. **Introduction Step:**

   The topic to be discussed is presented to the group usually in the form of a question.

   **EXAMPLE:** Why is a mixture of four kinds of coal used in coke ovens?
2. The Drawing Out Step:

During this step, ideas and opinions which have bearing upon the answer are brought out. These are usually recorded on the chart pad and discussed further.

3. The Agreement or Conclusion Step:

In this step, the group examines and evaluates the ideas and opinions expressed and reaches a conclusion or agreement.

B. In carrying out the "three steps" the discussion leader uses two basic tools: statements and questions. He makes introductory and lead-in statements and he makes summary statements. He asks discussion questions. He has a stock of auxiliary (clarifying) questions available as needed to guide and stimulate the discussion.

Before the teacher can get up and lead a discussion successfully, however, he needs to prepare himself so that he can make the necessary statements and ask the questions which will constitute his leadership of the session. He must plan the session and prepare a guide which will help him to follow the plan.
II. **INFORMATION APPROACH** often takes the form of a talk and is characterized by the leader doing all or most of the talking. In such a meeting the leader has an objective, which is to pass on certain information to the group. At the start, the leader has the information which the group lacks. The leader makes statements and perhaps uses visual or other aids to transfer this information from himself to the group. There is usually a place in the information approach for the participants to ask questions for clarification. However, the transfer of information is mostly one way, from leader to participants.

   A. A talk should be short enough to be interesting and to hold interest and attention, and long enough to cover the subject.

   B. If the material to be presented requires more than ten or fifteen minutes, it should be broken down into smaller units with ample opportunity for questions and comments.

   C. Reading an entire talk kills interest. However, there are occasions when short, pertinent quotations may be read in the interest of clarity and brevity.

   D. Straight forward, but informal presentation of the main points is preferred. You may want to outline the main points for clearer and easier presentation.
E. It will help if you can gather or recall interesting examples or experiences to relate during your talk.

F. To avoid possible confusion, it may be desirable to confine your presentation to one or two major ideas.

G. Many times, in place of giving a talk, the material can be assigned as a "between meeting" reading activity for the students.

III. COMPARISONS

In comparing these two types of approaches, we see that each has a leader and participants. However, in other aspects they are quite different. In the information method, for instance, the participants need have little background of experience related to the problem, while in the discussion method participants must possess experience from which they can draw ideas and opinions. In the information method, the leader does nearly all the talking, while in the discussion method the participants share in the talking. In any session, both approaches will probably be made.
A. The information approach is necessary when doing the following:

1. When a brief introduction is needed to focus on the problem.

2. When a presentation of the over-all plan is desirable.

3. When a quick review and recapitulation is desirable, either at the beginning or close of a session.

4. When an explanation of something the group could not know about is necessary.

B. It has been demonstrated that the discussion approach lends itself to most teaching situations and particularly industrial teaching. We need to remember that possessing knowledge is one thing, being possessed by knowledge is another matter. When the student does something as a result of knowledge, when he applies knowledge in some way, he learns. Merely collecting factual information is not learning.
Some of the distinctive values of the discussion approach are:
1. Helps the student gain a feeling of belonging.
2. He goes through a process of self-education.
3. He learns from the group as well as from the teacher.
4. He builds up confidence, builds up ability to communicate.
5. He is helped in modifying and improving his own ideas and attitudes.
6. The type of learning becomes a part of him and is more likely to be used by him.

Remember that no one approach will meet all situations.
The teacher must judge which approach will be best at a given time.
STUDY AND READING MATERIAL

INDUSTRIAL TEACHER PRACTICES

TECHNIQUES IN THE CREATIVE APPROACH TO LEARNING UNIT VI

SECTIONS

SECTION I FIVE SENSES -- THE TOOLS OF COMMUNICATION
SECTION II TRAINING AIDS
SECTION III QUESTIONING
SECTION IV STUDENT REPORTS -- EXPLANATIONS
SECTION V SUMMARY

HUMAN ENGINEERING INSTITUTE
2074 East 36th Street, Cleveland 15, Ohio
I. FIVE SENSES -- THE TOOLS OF COMMUNICATION

In teaching, the use of as many of the senses as possible will ensure better understanding of the immediate key points and the over-all objectives of the program.

A. In teaching and learning, we may employ one or all five of our senses:

- Seeing
- Hearing
- Smelling
- Feeling
- Tasting

B. People learn through action, through conversation, and through observation. All these methods can be used in a session; but learning through seeing is often the best single way. For example: You all know what it's like to have trouble understanding a rather complicated idea when it's being described to you, and then understanding it easily when you see a couple of charts or pictures explaining it.
II. TRAINING AIDS

A. What are some reasons for using training aids?

1. As an effective way of possibly making use of more than one of the five senses in a session.

2. Training aids can add new ways of putting points across, and so may keep the presentation from becoming dull and monotonous.

3. Training aids can present material in such a way that the student feels that the experience being discussed is real -- almost as if it were happening to him.

4. A presentation of central ideas through training aids can reinforce and clarify points. For example: Through a few well-chosen pictures, you can illustrate electromagnetic induction much more clearly than you can by talking about it for hours.
B. When to use training aids:

1. We should always remember that we are using training aids to help the group learn. They supplement and clarify the point we want to make. They should be thought of as helpers.

2. We should ask ourselves:
   a. What is the best way of presenting this point?
   b. Would a training aid help?
   c. What training aid should be used?

C. What are the major training aids?

1. Chart pad or blackboard: The chart pad or blackboard is a basic tool in teaching. They can be used for illustrating an idea, listing problems, presenting information, recording progress in a discussion and similar purposes. The chart pad can be used quickly in front of the group to reflect the ideas being discussed at the time. The pages may be taped to the wall and kept before the group throughout the discussion; since they can be saved, they will be available for any purpose. The blackboard has a larger working area, and the written material can
erased and revised. However, if material is to be saved, it would have to be copied.

2. The slap-on board: The slap-on board or flannel board is covered with black felt. The backs of the slap-on cards are also covered with felt, and stick to the board when placed against it. The front of the card contains a sentence, a phrase, a word, a symbol, or a picture. These cards are usually professionally made in advance, and have vivid colors and bold lettering or drawing. They may be used to show single ideas as they are presented to the group. You can arrange the cards on the board to show the relationships between these ideas, and can make a major point in the discussion or presentation by building a diagram on the slap-on board as you talk. You can show changes in the group's opinion during a discussion by moving the cards from one category to another on the board. You can use blank cards to modify or change the ideas set up on the prepared cards, when the groups' discussion makes this necessary. Their use needs to be planned in advance. Since slap-on cards are prepared in advance, they can be designed attractively. Being moveable, they can be used dramatically.
3. **The slide and filmtstrip projector**: Slides and filmtstripes contain transparent pictures to be projected onto a screen. Slides are individual pictures, and filmtstripes are a series of pictures arranged in a certain sequence. Projecting a picture on the screen creates a large, life-like image which the group can see easily. Charts, diagrams, and pictures can all be made into slides. Many excellent slides and filmtstripes are available from commercial sources.

4. **The visual cast machine**: The visual cast machine has the unique advantage of enabling the leader to face his audience in an undarkened room while operating the machine. It will project slides or writing as it is being written. However, only the leader can use this machine with ease. This machine is very versatile in that it allows for the use of color for clarity. In addition, the overlay approach makes possible understanding of the individual basic features and the building of concepts of the over-all picture. Cells are produced at the Human Engineering Institute both quickly and inexpensively. Since these cells can be produced at H.E.I. they can be made pertinent to both the
teaching session and the experiences with which the students are familiar. The instructor can help by making a rough sketch of the key points that he wants to have illustrated.

5. The opaque projector: This can project items in any form — e.g., pages of a book, a piece of paper, a photograph. The items, therefore, needn't be made into slides, and you can prepare them quickly merely by gathering them.

6. The sound projector: The sound projector is used to project motion picture films. The films often present experiences and ideas which are best shown through a combination of sound and sight. For example, a map or chart can be shown easily on a flip-chart or through a projector; but a presentation of the way iron becomes steel can be best understood through observing a film in which the steps are seen and heard.

7. Actual equipment: Equipment assembled as a unit or in parts, or as cut-a-ways will enable the students to better understand the equipment actually used on the job.
8. Models: Scale models, moving or still, may be used to give a three-dimensional picture of the article or item.

D. How to use training aids:

1. Choose and use the aid so that it will enrich the teaching process:
   - Use only a few aids in any one meeting.
   - Use them as "aids" to the process of teaching and learning.
   - Use aids only when you are sure they are the best way to present or clarify a topic.

2. Prepare in advance for using your aids:
   - Arrange the aid so it can be seen by each member of the group.
   - Plan how the aid will fit into your presentation.

**EXAMPLE:** If it is a movie, see it in advance, relate it to your presentation, and formulate questions that will highlight its key ideas.

3. Check the equipment in advance. Make sure it is in good condition and that you know how to use it.
III. QUESTIONING

A. The use of questions as a means of directing and encouraging learning is one of the most important tools you will have as a teacher.

1. Use it frequently and whenever needed. It is the way in which you can get the combined experience and thinking of the group to focus on the issues or problems.

2. Your job of leader is made less direct and more acceptable to the group if you make use of questions rather than direct statements.

B. The kind of results you get from questioning will vary, however, with the amount of skill used in handling them, as well as with your understanding of what you wish to achieve in using them.

1. The skillful use of "though-provoking" questions represents a most effective way of securing active participation.

2. We should not use questions that can be answered by yes or no. Rather, questions which use why, how, when, what, who, where, etc. are better -- they require thoughtful answers.
a. Precautions:

(1) We should not force a given individual to participate before he is ready, either by calling his name or by a direct question to him. This approach may well embarrass him.

(2) Rather, we should watch for evidence of interest -- and a desire to participate. He will volunteer when he sees that others do so, without embarrassment.

C. Important Factors in Using Questions

1. Phrase questions clearly and concisely.

2. Cover a single point directly related to the topic.

3. Give the individual or group plenty of time to answer.

   a. If no answer comes from the group, as a direct question.

   b. Lastly, suggest some possible solution and ask them to react to it.
4. Avoid questions that can be answered by a yes or no response.
   a. Such an answer tells you nothing. He may not understand the question. He may say "yes" even though he doesn't understand just because he is ashamed to admit that he doesn't know. The "why" or "how" question will show the insight of the student.

5. Use words that have meaning and interest to members of the group; words that when properly used will make them think.

6. Use words that are natural to your own vocabulary, words that will clearly express what you have in mind in asking the question.

7. Acknowledge all responses.

8. Don't put anyone on the spot. If a member is floundering for an answer, get him off the hook.

9. Avoid sarcastic, antagonistic and personal questions.

10. The **tone and manner** used in asking the question are just as important as words used. A leader can make a good question produce a poor reaction by failing in this respect. He must above all display a real
interest in the subject and in the response. He must convey the idea that he really wants to hear the views of the group. He asks the question, and in so doing, he obligates himself to listen carefully. If he displays indifference, sarcasm, or a know-it-all attitude, he will discourage the participants from expressing themselves fully.

IV. **STUDENT REPORTS -- EXPLANATIONS**

A. The concept "we learn by doing" is especially applicable to creative learning.

B. Actually, the only way to learn how to make a report or explanation is to do it.

1. Suppose each member has the opportunity of standing before the group for such purposes as:
   a. Presenting a report.
   b. Giving an explanation.
   c. Solving a problem.
   d. Explaining a procedure or operation.
   e. Manipulating training aids.
C. The student, through this technique, grows personally, becomes an active contributing member of the group, and becomes identified with the group. The group benefits from his presentation.

V. SUMMARY

The leader should regard these suggested techniques as tools to be used. They are good tools — but they still require a skilled man to use them. How to use them intelligently and effectively is still the responsibility of the leader.

THERE IS NO ONE WAY TO TEACH — NO ONE TECHNIQUE.
RATHER, THERE ARE MANY WAYS — MANY TECHNIQUES.
HELPING PEOPLE TO LEARN THROUGH PARTICIPATION

One of the best tools that any teacher may have at his disposal is that of getting group participation through discussion.

Group participation through discussion can only be gained by skillful use of questioning techniques.

PURPOSE OF QUESTIONING

Your primary purpose in asking questions is to help the group engage in a process of thinking on the subject. Experience has shown that active participation of the group in this thinking process not only maximizes understanding and acceptance but also materially increases retention.

In addition, the skillful use of meaningful questions provides a highly effective means of channeling the thinking of the group toward the desired objectives of the session. And in the process it can become your most effective "selling" tool because the group "sells" themselves.

IMPORTANT FACTORS IN USING QUESTIONS

The power of a question in the development of constructive thinking lies in its requirement of an answer so that the group
individually and collectively are stimulated to think and motivated to discuss. There are three important factors within the control of the teacher that affect the level of stimulation and motivation:

Framing the question.
Directing the question.
Choosing the right type of question.

1. Framing the question.

Some general rules for framing a good question are:

a. Be brief.
b. Cover a single point.
c. Be directly related to the topic
d. Develop thinking from a constructive point of view.
e. Use words that have meaning to the group.
f. Use words that are easy for you to use.
g. In most cases, be phrased to avoid yes or no answers.

2. Directing the question.

A prime factor in your success in starting and maintaining a discussion along constructive lines is knowing to whom (group or individual) you should address your question. The various kinds of directional questions are overhead, direct, reverse and relay. Directing questions is largely a matter of judgement. You can improve your judgement by studying your group to learn their capabilities, their attitudes and their feelings.
3. Choosing the right type of question.

The five types of questions most commonly used in helping people to learn are listed below with some general guidelines for their effective use.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>WHEN USED</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Question</td>
<td>To get information or opinions. Good for discussion starters.</td>
<td>What, where, why, when, who, how many, etc.</td>
</tr>
<tr>
<td>Leading Question</td>
<td>To broaden the discussion. To introduce additional facts. To suggest an answer and get group to analyze. (Since this type is often yes-no type, must be followed with additional factual or justifying questions.)</td>
<td>Does safety enter this picture? Is production the only factor? Can we sacrifice quality for quantity? Is cost the only factor or involved? What about the effects on morale?</td>
</tr>
<tr>
<td>Justifying Question</td>
<td>To deepen the discussion by having group analyze and justify their reasoning. To challenge old ideas and develop new ones. To avoid snap judgements. To find the real causes of problems. (Most effectively used to follow up responses to all other types of questions.)</td>
<td>Why do you think so? How will your suggestion help? In what way will that solve the problem? Why can't we do that?</td>
</tr>
</tbody>
</table>
**INDUSTRIAL TEACHER PRACTICES**

**SUPPLEMENT, UNIT: VI**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>WHEN USED</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothetical Question</td>
<td>To suggest or introduce teacher's ideas into discussion. To suggest what you feel may be an unpopular but correct opinion. (If they disagree, they are disagreeing not with you but with a hypothetical company or situation. Their response should always be followed with a justifying question.)</td>
<td>In another company they did this.... how would it work here? Suppose we did this.... what would happen?</td>
</tr>
<tr>
<td>Alternative Question</td>
<td>To make a decision between two or more possible courses of action. To comparatively evaluate suggested solutions. To bring discussion to a head. To reach agreement.</td>
<td>Which of these solutions is best? Can we all agree on this solution? (If necessary, justify decision: Why is A better than B?)</td>
</tr>
</tbody>
</table>

A final word on questioning. Above all, let your questions come as a natural part of the discussion. Ask questions because they are important to the development of the discussion; never take the position of a school master with a list of questions that you must ask or die trying.

**QUESTIONING TECHNIQUES**

The use of questions as a means of directing and encouraging group discussion is one of the most important tools you will have as a teacher. Use them frequently. The results you get will vary with the skill and understanding you have in using them.
Questions are designed with a specific purpose in mind. For example: **Overhead questions** are directed to the entire group to open a discussion, introduce a new phase of discussion or give everyone a chance to comment. **Example:** What are some of the ways we could lick this problem?

**Direct questions** are those in which you designate a specific person to answer. They are designed to have someone furnish information that he has to the group. **Example:** "John, what do you think about the use of a breaker switch in this case?"

**Reverse question** is a question that is directed back to the person who asked it to encourage him to think it out or bring out his own opinions. **Example:** "How do you feel this situation should be handled?" -- or, "How about giving the group your opinion first?"

**Relay questions** are questions that are referred from one person to another, or to the entire group to develop the subject by engaging more members in the discussion or to redirect a question back to the group that the leader feels he should not answer. **Example:** "George has asked, 'Will this solution work out?' -- How do the rest of you feel about it?"
A skillful teacher will use the following factors in his questioning technique. He will:

- Give the individual or the group plenty of time to answer.
- Acknowledge all responses.
- Avoid leading questions.
- Avoid questions that can be answered "yes" or "no."
- Avoid putting anyone on the spot.
- Avoid sarcastic, antagonistic and personal questions.
- Let all questions become a natural part of the discussion.
STUDY AND READING MATERIAL

INDUSTRIAL TEACHER PRACTICES

APPRAISAL OF OUR TEACHING--
SUGGESTIONS FOR IMPROVEMENT--
SUMMARY

SECTION I APPRAISAL OF OUR TEACHING
SECTION II SUGGESTIONS FOR IMPROVEMENT
SECTION III SUMMARY

HUMAN ENGINEERING INSTITUTE
2074 East 36th Street, Cleveland 15, Ohio
I. APPRAISAL OF OUR TEACHING

We need to evaluate our programs. We need to develop ways of securing evidence of progress and, if possible, to measure — to evaluate — the amount of progress.

We are training men to do better, more intelligent jobs. How to solve new and even unforeseen problems; how to stimulate their imagination, their curiosity to learn "why"; how to challenge them to do the best of which they are capable; to develop in them resourcefulness, loyalty, the ability to work more effectively with others, etc. — in short, our objective is to develop men.

Now, these qualities aren't so easy to identify and to measure — they are not quantitative — in fact, they often pertain more to how we feel about things, our attitudes toward the company, the men under us, our jobs, etc.

How can we detect and, if possible, measure these "changes" in men that we now think of as our real objectives? Would answers to such questions as these help us evaluate results:

✓ Were most of the men genuinely interested in the program?
✓ Was participation voluntary or forced?
✓ What was the attendance record?
How do the men themselves really feel about the course?

Did they come up with some good ideas?

Did their attitudes change? If so, how?

Are they more conscientious?

Did you notice any difference in their work? In what way?

Are they more willing and able to assume responsibility?

Did any of them become excited -- catch on fire, so to speak?

Are they more ready to help the men under them and less inclined to criticize or blame them?

You men in operation will think of other ways of getting evidence of the value of these programs. Make notes of them and bring them to the meetings.

In a short period of Pre-Training, we can touch only the key points of helping you develop and become skilled in the techniques of creative teaching.
As you begin to teach your groups, you may desire individual coaching around new problems that develop. Members of the Human Engineering Institute staff will assist you in developing the material into instructional units and in preparing your presentation for each meeting.

Your Human Engineering Institute staff leader is willing to "sit in" on your sessions as an observer and to make himself available to you for consultation.

II. SUGGESTION FOR IMPROVEMENT

Near the end of the program it is always helpful to ask your group for suggestions as to how the program can be improved.

These suggestions should be received, recorded, and used as a guide to improve future programs.

Here, again, the skillful use of questions may bring out suggestions that do not occur to your men at the moment.

This procedure further identifies them with the program, makes them feel that it is "their program." It also makes them feel good to think that their suggestions are useful.
III. SUMMARY

We have considered the purposes of these training programs, their importance to all of us, and the methods and techniques that seem most desirable. We have used these tools of teaching to improve instruction.

We have taken some of the first steps toward "better and more effective utilization of manpower."

It doesn't end here. Progress, which brings changes is here to stay. We have only to decide what we are going to do about it.
I, Joseph S. Kopas, was born in Flushing, Ohio, November 14, 1907.

I graduated from Flushing High School in 1926.

1926-1931. I attended Fenn College, studied under the cooperative plan - alternating three months in the Engineering School and three months working in industry. In 1931 I received the B. S. degree in Electrical Engineering.

1931-1936. I taught Electrical Engineering at Fenn College and placed students on cooperative jobs. I attended Columbia University and Western Reserve University during summer vacations receiving the M.A. degree with a major in education and a minor in vocational guidance.

1936-1947. I developed the vocational guidance program at Fenn College and directed the student counseling and personnel activities. I helped industry develop and install placement tests, select and train supervisors and direct the executive development program. During the war years I served as a consultant for the Training Within Industry Division of the War Manpower Commission.

I attended the Graduate School at Ohio State University during the summer periods and completed the course and language requirements for the Ph.D. degree.
1947-195-. I became the Training Counselor for Republic Steel Corporation on a part-time basis; developed, installed and supervised the employee testing and the training program.

I founded the Human Engineering Institute and utilize part of my time as its director.

It was during this period that I completed the remaining requirements for the Ph.D. degree.