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DISSERTATION

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

By
Paul Cochran Caley, B.S., M.A.

* * * * *

The Ohio State University
1969

Approved by

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Adviser
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PLEASE NOTE: Appendix pages are not original copy. Print is indistinct on many pages. Filmed in the best possible way.

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To Gail, my wife, for her patience and understanding.
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CHAPTER 1

INTRODUCTION AND STATEMENT OF THE PROBLEM

BACKGROUND OF THE PROBLEM

As the expansion of man's knowledge within our century has accelerated, pressures on the youth of our nation for learning have increased. In the not too distant past, the elementary and secondary schools seemingly had little difficulty with the task of selecting content from the body of man's knowledge for the purpose of devising curricula and organizing it into relatively distinct and numerically limited categories. We have commonly thought of these categories as being academic fields of study.

Since the turn of this century, in particular, there has been increased activity in educational circles not only in the realm of curriculum revision to absorb the discoveries of the 20th century, but also in the realm of teaching methods to facilitate learning. The reasons for revising curricula have been quite obvious, among them being the new discoveries in practically all walks of life, and the requirements of education to make adjustments in
teaching practices as the new knowledge was utilized and the old rejected, or modified. The growth of pedagogy in this country has come partially as a result of a new emphasis on education at all levels, but more than that, from a realization that a more efficient education was necessary if the schools were going to perform their function effectively in a technological society.

Pressures on the curriculum have increased as new courses have been organized to meet the demands of various segments of society. The traditional trivium and quadrivium subjects, or their equivalents, were failing to satisfy contemporary demands for learning. Such areas of study as home economics, business education, distributive education, driver education, and industrial arts, combined with the splintering of the traditional subjects into more and more specialized sub-categories, have caused educators to wonder how the length of a day could be stretched to accommodate all that was offered.

Various solutions have been recommended, but the ones which have seemed to give hope to all concerned have been those suggesting ways to make the process of learning more efficient by better subject-matter selection and by better teaching methods. This has necessitated, among other things, increasing the knowledge of how people learn. Theories of learning have arisen in rapid succession, many
of them growing out of psychological hypotheses and experiments. To a great extent, educational thinkers of this century have tended to revolt against rote learning and the verbalism which constituted much of teaching. Further, there has tended to be a turn toward a "child-centered" approach arising from the philosophies of Rousseau, Froebel, and later, Dewey. These trends led to the progressive education movement which emphasized the problem-solving and direct-experience approach to learning. In order to meet the objectives of education from this standpoint, a new emphasis was placed on laboratory work whereby the learner could autonomously engage in discovering concepts and principles through the use of "scientific methods."

With this era of education came a general de-emphasis on expository teaching whether in the form of lecturing, written materials, or other types, such as teacher-directed discussion.

Industrial arts, as a school subject field, never went through the stages just described (1) because it is a very young division of formal education, and (2) because it was originally conceived as being germane to the use of manual activity. For most of its existence as a school subject, it has not employed a well defined body of knowledge, and the necessary informational content has not neatly lends itself to organized verbal learning, distinct
from manual activity. Thus, industrial arts has blended easily with the progressive education doctrine and has flourished in this atmosphere. However, two events of relatively recent times have caused a dilemma in the field of industrial arts. First, educators have taken additional looks at the underlying theories of the progressive education movement. Thinkers such as Ausubel (1963) and Bruner (1967) have seriously questioned the theory that the "best" learning occurs in a learning environment as propounded by the progressivists. Examination of progressive educators' notions, from the standpoint of efficient use of available time, has revealed that the discovery methods of teaching-learning could not possibly endow the child with all the knowledge believed by many to be necessary to the citizen of our times. Even more important are recent practical formulations of learning theory employing structured verbal materials which have tended to repudiate the problem solving method as the most advantageous to all concerned in many learning situations.

The second event affecting industrial arts has been the efforts of educators in this field to re-define the subject area in terms more appropriate to contemporary education and in terms more defensible as a unique subject area. Several efforts have been made in this direction, but of particular interest here has been the work done at
The Ohio State University. Basically, this has consisted of identifying and structuring a unique body of knowledge of industrial technology which industrial arts should be primarily responsible for teaching. After this was accomplished, it was readily recognized that industrial arts did not need to depend primarily on laboratory activity to meet its objectives in education. The structure made clear a vast domain of informational content which previously had been employed in patchwork fashion in a laboratory setting, but now could be sequentially presented to students, employing any, or all of the verbal teaching methods in existence. Nevertheless, the laboratory, as a place for a viable learning climate, was not abandoned. Efforts at Ohio State have produced an industrial arts curriculum consisting of the study of the manufacturing and construction industries. The teaching methods used have arisen out of the study of contemporary research and thinking on effective teaching and learning, much of which revitalized the use of verbal teaching-learning methods in this field.

Out of the Industrial Arts Curriculum Project at The Ohio State University, hereafter identified as IACP, have come curriculum materials embodied in textbook readings, workbook problems, lecture and discussion, and laboratory activity. Basically, the underlying purpose of these materials is to present concepts structured in such a
manner that the knowledge which students gain can be generalized to all functions within the industrial realm of the economic institution. Basic to the construction of these materials has been the notion of reinforcement of learning. It has been supposed that the concepts presented in the textbook readings would be more completely learned in the workbook, lecture, and discussion, and further reinforced, or rewarded, by putting the concepts into practice in the laboratory activity.

It is at this point where inconsistency arises. The previous discussion cited the knowledge expansion, curricula proliferation, and the demands for educative efficiency. These clash with the requirements of an industrial arts program that employs verbal learning methods and generous amounts of laboratory work, and its resultant demands on a considerable portion of the school day. Even more important are possible underlying flaws in the rationale of the IACP. If, as Ausubel (1963, p. 153) suggests, verbal reception learning constitutes the most effective method of meaningfully assimilating the substantive content of a discipline in the post-elementary school years, it may well be that the laboratory segment of this curriculum is unnecessary to meeting objectives efficiently. This may be particularly so when the representations of the concepts to be reinforced are, of necessity, artificially
The problem traditionally has not existed in industrial arts because the basis for knowledge content flowed from the performance of practices in selected trades or crafts. The covert learning was assumed a result of the laboratory experiences which reflected these trades or crafts. With the Ohio State IACP program, the situation is reversed: One starts with the body of knowledge and then proceeds to the selection of experiences to reinforce that knowledge. The source of the content, therefore, arises largely, although not completely, from the trade in both cases, but the latter case does not necessarily recognize the existence of an organized trade or craft for each area of industrial knowledge.

It is at this point that this writer has made two crucial postulates based on his study of the IACP. The first is that the laboratory activity, or experience, provided in the IACP program does not, and cannot, provide practical direct experience in more than a minority of the concepts presented in the verbal written materials or the curriculum. Secondly, that the overt learning of the laboratory experience adds little to the objective of learning concepts in proportion to the time consumed by it.
There is a second direction to this problem as hinted earlier in this writing. The researchers with the IACP have devised curricula for teaching and learning the concepts of industrial manufacturing and construction by organizing a two-year course of study for youth at junior high school age. The first year is devoted to construction, and the second to manufacturing. Each course in this program is divided into conceptual units of instruction and specific teaching-learning components which, as mentioned earlier, rest upon the use of textbook readings, a workbook to be used in conjunction with the textbook, lecture-discussion, and laboratory experiences. In sum, the success of the curriculum materials developed at Ohio State has been assumed to rest on the inherent quality and worth of each of the teaching methods and the quality of their presentation to students toward meeting the objective of learning and reinforcing the concepts of industrial technology presented in the textbook.

Little evidence has appeared concerning the possibility that one or more of these teaching components may not be essential to learning the desired concepts. The doubt as to the value of the laboratory activity has already been noted, but in addition to this, it may well be that the lecture-discussion is an inefficient use of the time available to the student. It has been suggested by David
Ausubel (1963) that oral exposition takes considerably more time to cover a given quantity of material than does reading the printed page. A cursory test bears this hypothesis out as being valid. Because of the quantity of the informational content that has been organized in the IACP, it is inconceivable that the concepts contained therein could be learned in the time available without the employment of written textbook materials. Therefore, a text segment of the curriculum would appear essential to meeting the objectives of the program.

**STATEMENT OF THE PROBLEM**

Since the IACP is very recent and little direct research has been performed on the appropriateness, or value of each of the above-mentioned curriculum components, there is question concerning their value in concept learning and especially concerning their efficiency in achieving the desired student behavior changes in terms of concept understanding and application. Thus, the question is raised concerning the value of (1) the lecture-discussion and (2) the laboratory activity, as reinforcing agents to the textbook-workbook method in the time allotted to learning the concepts inherent in the body of knowledge termed industrial technology.
THE IMPORTANCE OF THE PROBLEM

Now, more than ever before, our schools are charged with the task of preparing students not only to be successful citizens in a democratic society, but also to be persons knowledgeable in the technological aspects of a constantly changing world of work. In the face of increased pressures resulting from this responsibility, the schools are endeavoring to meet the challenge by improving, revising, and enriching curricula to streamline the process of education in order that more and more may be learned in the time available. Among the results of this have been innovations in subject content, structure of knowledge, and teaching-learning methods. Although the latter has proliferated, as evidenced by the use of "new" teaching media and "new" criteria for building learning materials, the validation of these innovations has barely begun.

Of particular importance to this investigator is efficiency in learning technological concepts. Evidence in either support or rejection of the hypotheses stated in this chapter does not alter the recognition of other values gained from any of the teaching methods. However, if the objective of learning concepts is more efficiently reached through the use of particular kinds of teaching materials and methods, those materials which do not substantially add to the attainment of that objective should be re-examined.
OBJECTIVES OF THE STUDY

Specifically, this investigation was expected to provide the following:

1. Data that would aid in substantiating the value of written material for learning technological concepts.

2. Data that would aid in substantiating the value of unwritten verbal-learning materials in reinforcing the learning of technological concepts initially presented in written learning materials.

3. Data that would aid in substantiating the value of laboratory activity for learning technological concepts initially presented in written learning materials.

4. Aid to the investigator and curriculum developer in assigning values to the three types of industrial arts teaching methods for use in curriculum research and development.

5. Suggestions for further research and, ultimately, for possible revisions in instructional materials that will facilitate increased effectiveness in meeting industrial arts objectives.

ASSUMPTIONS RELATED TO THE PROBLEM AND TO THE HYPOTHESES

1. The statements made in the "Background of the Problem" and the "Statement of the Problem" are so generally accepted in the profession that further citation is not required.
2. The written materials are indispensable to the coverage of the concepts presented in any given IACP teaching unit in the span of time allowable for this coverage.

3. A sample can be selected from the Columbus Public Schools that is representative of eighth-grade students for which the IACP curriculum has been prepared.

4. This investigator can devise a measuring instrument which will test the students' understanding of selected technological concepts.

5. Minor adjustments can be made in the IACP units of study to make them amenable to single blocks of time without seriously altering their basic nature.

DEFINITION OF TERMS IN THE HYPOTHESES

1. Treatment A (Control): Instruction using selected IACP textbook-workbook materials.

2. Treatment B: Instruction using selected IACP textbook-workbook and lecture-discussion materials.

3. Treatment C: Instruction using selected IACP textbook-workbook and laboratory activity materials.

4. Treatment D: Instruction using selected textbook-workbook, lecture-discussion, and laboratory activity materials.
5. Textbook-workbook: Selected textbook readings which provide definitive meaning for the technological concepts selected and workbook problems which are designed to reinforce the student's understanding of the concepts.

6. Lecture-discussion: Straight narration devised to relate selected technological words to their appropriate application, and recitation questions devised to elicit student response evidencing an understanding of the technological concepts.

7. Laboratory activity: Activity devised to provide an opportunity for the student to discover the meaning of selected technological concepts. For convenience, the laboratory activity will also be referred to as discovery learning activity.

8. Achievement: Identifying word concepts as they relate to practices and knowledge inherent in the selected units of instruction, as measured on the criterion test devised by this investigator.

9. Criterion test: An achievement test devised by this investigator to provide the student with an opportunity to evidence his level of understanding of concepts germane to the selected units of instruction.

10. Technological concept: The definition of this term is highly related to the term "praxiological concept,"
which is concerned with concepts of the knowledge of mans' practices. (Towers, Lux, and Ray, 1966, p.16).
In this study, a "technological concept" is limited to a word, or group of words, which symbolize one, or a class, or practices, techniques, or actions within the body of knowledge termed "industrial technology" and therefore is in actuality an industrial technological concept.

**STATEMENTS OF THE HYPOTHESES**

The purpose of this study was to seek evidence to test the following hypotheses:

1. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to non-written verbal learning materials. (Ho: $A = B$, see Table 1).

2. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to discovery learning materials. (Ho: $A = C$, see Table 1).
3. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to non-written verbal and discovery learning materials. \((H_0: A = D, \text{ see Table 1})\).

Since another purpose of this investigation was to gain evidence concerning the relationship, or differential role of each of the teaching methods, three additional hypotheses were stated as follows:

4. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials and discovery learning materials, and students taught with written learning and non-written verbal learning materials. \((H_0: B = C, \text{ see Table 1})\).

5. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials and non-written verbal learning materials, and students taught with written learning materials, non-written verbal learning materials, and discovery learning materials. \((H_0: B = D, \text{ see Table 1})\).
6. In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials and discovery learning materials, and the achievement of students taught with written learning materials, non-written verbal learning materials, and discovery learning materials. (Ho: C = D, see Table 1).

TABLE 1

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<td>TREATMENT C TEXT-WORKBOOK X LAB. ACTIV. TEST</td>
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<td>TREATMENT D TEXT-WORKBOOK LEC.-DIS. LAB. ACTIV. TEST</td>
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LIMITATIONS

This study was limited to the 111 eighth-grade students described in Chapter Three who participated in it over a ten-week period in the Winter of 1969. Because of the small sample and the relatively short period of exposure, the conclusions are limited in their generalizability. Any generalizations should be made only after replication has been performed on students displaying
characteristics like those of the sample, in cities of population make-up comparable to that of Columbus, Ohio, and under learning conditions comparable to those described in this dissertation. The conclusions were based solely on the results of this one investigation. Only one aspect of learning was examined; namely concept formation. No claim is made as to the superiority of one teaching method over another, or about their relative values in the total scheme of learning. Limitations common to all educational research are also inherent in the experimental teaching and testing devices.

CHAPTER SUMMARY AND ORGANIZATION OF THE STUDY

Through the first two-thirds of this century, educators have strived to streamline the process of education. Industrial arts education, in particular, has taken the painful steps of self-examination, resulting in new curricula derived from examination of the realm of knowledge which it is responsible for conveying. Concurrent with this has been division in the notions of theorists concerning the most efficient and effective means for conveying knowledge. Two poles of this situation are seen in those who rely largely on "discovery" teaching methods and others who rely largely on verbal expository teaching methods. A question exists concerning the relative merits of each type of teaching method.
One kind of learning is that of concept formation. This study was designed to obtain evidence which would help educators determine what kind of teaching method most efficiently and effectively causes the student to learn technological concepts. The terms defined and the hypotheses stated were devised to help pave a road which leads to attaining that objective.

Chapter Two contains a review of the literature and includes a synopsis of the rationale and structure of IACP. Chapter Three consists of a description of the technological concepts selected, the experimental materials, the experimental methodology, and the identified variables. Chapter Four presents the results of the study and a discussion of these results. Chapter Five contains the summary, the conclusions, and the recommendations.
CHAPTER II
REVIEW OF THE LITERATURE

This review of the literature consists of two general sections which have bearing on this study directly, or tangentially. The first section will provide the reader with background information about the teaching materials employed; their origin, their content, their rationale, and the educational outcomes expected from them. Due to the newness of the IACP program, and the lack of literature relating to it, this section will be a synthesis of the Rationale and Structure for Industrial Arts Subject Matter (Towers, Lux, and Ray, 1966), the only comprehensive reference available on the subject. Description of the curriculum content, as gleaned from the actual teaching materials used in this study, will be provided in Chapter Three.

The second section of this chapter deals with relevant educational theories and studies in the area of concept learning. It should be noted that the literature on concept formation, discrimination learning, concept attainment, and reinforcement of learning is profuse. The problem was not one of finding such literature, but of selecting information which especially assisted this investigator as it related to the specific problem at hand.
During the years 1964-1966, the investigators on the IACP staff conceptualized and began the formation of a structure and rationale for industrial arts subject matter. They reviewed the status of industrial arts up to that time, and examined the terminology used in the field and the conceptual problems of classifying man's knowledge. From this task evolved a unique way of structuring industrial technological knowledge which industrial arts could logically be viewed as being responsible for teaching. A brief description of this structure will give the reader a better understanding of the conceptual framework from which the curriculum for industrial technology was created.

One of the first tasks of the IACP staff was to identify and order man's knowledge into four different domains. These four were termed (1) descriptive (e.g., the sciences), (2) prescriptive (e.g., fine arts and humanities), (3) formal (e.g., mathematics, logic, and linguistics), and (4) praxiological (Towers, et al., 1966, pp. 8-10). The derivation of industrial technology, based on praxiology, (the science of efficient action) laid the groundwork for continuing the research for, and structure of, curricula for industrial arts.

To identify the content of industrial technology, the IACP staff examined man's institutionalized activity
as it evolved with civilization. The basic institutions which encompass all institutionalized practices of society were viewed as being the familial, political, religious, educational, and the economic. The institution which encompasses the industrial dimension of praxiology was seen as the economic institution (Towers, et al., 1966, pp. 64-71).

It was believed by the IACP staff that all the practices within the economic institution still presented too broad a universe from which to draw knowledge and structure curricula for industrial arts. Therefore, the decision was made to center on the industrial material production function of the economic system. It was on this basis that the label "industrial technology" was derived from praxiology, since praxiology is a term which includes all the practices of man; industrial and otherwise. It was recognized, however, that the activities of the economic institution are interlaced to varying degrees (Towers, et al., 1966, p. 77).

At this point, the IACP staff was ready to structure industrial technology. For this purpose, the following criteria for classification were used (Towers, et al., 1966, p. 86). The classification must (1) include all industrial practices which affect people and things, (2) have mutually exclusive sub-categories, and (3) be operationally adequate for instructional purposes.
A new structure for the body of knowledge in industrial technology was conceptualized after each of the following was analyzed:

1. The historical development of industrial arts curriculum in terms of implicit or explicit structures for the body of knowledge.
2. Systems for classifying industrial practices designed by governmental agencies and private organizations.
3. The work of curriculum projects in other subject fields in terms of the structures developed for their bodies of knowledge. (Towers, et al., 1966, pp. 86-147).

Using a conceptual approach, the IACP staff began their taxonomy of technological knowledge within industry. The practices of industry were categorized as being of two types; those affecting people, and those affecting things. On examination, it was found that "practices" may be viewed as arising from two sources: management and production. Practices from both sources affect both humans and things. To reflect this categorization, the IACP staff selected the terms production technology, management technology, and personnel technology.

With these three aspects of industrial technology defined, a set of matrixes was constructed to identify the sub-elements in second, third, and fourth orders classifying the practices (concepts) which filled out the structure for the body of knowledge of industrial technology (Towers, et al., 1966, pp. 150-164).
As the staff proceeded with the structure, it became apparent that "three-dimensional" outlines, as shown in Figures 1, 2, and 3, would prove cumbersome. Therefore, they extracted the major structural elements for the purpose of analysis. These major elements are illustrated in Figure 4 with their interrelationships.

An instructional program could be built upon any one or a combination of these elements, or it could be based on any of the sub-elements (sub-concepts) contained in them. When the elements were analyzed, it was found that the generalized concepts of an element, industrial production technology, for instance, usually apply to both manufacturing and construction. The distinctions between manufacturing practices and construction practices become clear when the sub-elements are analyzed. For example, practices within each sub-element of production (pre-processing, processing, and post-processing) are different for manufacturing than for construction. As the higher-order details (concepts) of the structure were identified, they were compiled into lists, each representing a convenient segment of the total. The structured lists (see Chapter Three) were viewed as convenient divisions for the total structure of the body of knowledge of how to efficiently produce industrial goods.
Figure 1 illustrates the first breakdown of industrial technology into its component elements of management and production affecting humans and materials. Figure 2 illustrates the next order of the structure; it shows the sub-elements of management and production which affect materials. Note the distinction made for manufactured and constructed goods. Figure 3 illustrates the relationship of the sub-elements of management and personnel as they affect industrial material goods.

FIGURE 1
FIRST ORDER MATRIX OF INDUSTRIAL TECHNOLOGY

(Towers, Lux, and Ray, 1966, p. 158)
FIGURE 2
SECOND ORDER MATRIX OF INDUSTRIAL TECHNOLOGY AFFECTING MATERIALS

(Towers, Lux, and Ray, 1966, p. 159)
FIGURE 3

SECOND ORDER MATRIX OF INDUSTRIAL TECHNOLOGY AFFECTING HUMANS

(Towers, Lux, and Ray, 1966, p. 162)
FIGURE 4

MAJOR STRUCTURAL ELEMENTS
IN INDUSTRIAL TECHNOLOGY

(Towers, Lux, and Ray, 1966, p. 167)
Once the structured body of knowledge of industrial technology was tentatively complete, the staff proposed that teaching programs could be developed for all levels of education, although the first concern of the IACP staff was to develop a two-year articulated program for the junior high school years (Towers, et al., 1966, p. 223).

After considering the notions of several educationists in the field of curriculum development, the staff attempted to answer the question, "What are the factors, or elements, which should guide the selection and organization of learning activities and the development of course materials in industrial arts"? They settled on six general factors appropriate, necessary, and sufficient as guides to attain that end.

1. The structure of the body of knowledge
2. Desired behavior change or objectives of instruction.
3. The nature of the learner.
4. School facilities and materials.
5. Instructional procedures and materials.

Of particular importance to this study are number two, dealing with behavior change and number five dealing with instructional procedures and materials. A review of authoritative writing about teacher characteristics and instructional methodological theory produced a model of the instructional process (Towers, et al., 1966, p. 288). Figure 5 shows this model.
FIGURE 5

INSTRUCTIONAL MODEL FOR THE MANUFACTURING CURRICULUM

READ TEXT

RECITE WORKBOOK

IN CLASS RECEPTION-LECTURES, FILMS, ETC.

IN CLASS PROBLEM SOLVING

CONCLUDING

LABORATORY PRACTICE AND APPLICATION

LABORATORY PROBLEM SOLVING AND APPLICATION

CONCLUDING

MEASURING AND EVALUATION

(Towers, Lux, and Ray, 1966, p. 288)
The textbooks were planned to present ideas in a meaningful way. This was to be accomplished, in part, by writing an overview to introduce each group of related topics. Also, the textbooks were to be written so that the student could understand the material without teacher instruction.

To reinforce text readings, the staff proposed the use of carefully prepared study questions and problems. Since a workbook format was believed effective for directing the pupil's attention to ideas, it was decided that workbooks would be made an integral part of the total instructional package.

Class presentation of topics was planned to include lecture, discussion, and the visual media. All these methods were to focus on content which would attempt to pose and solve a problem within one class period. It was considered important that the materials provide adequate experience and stimulate positive learning attitudes. In discussion, there was to be provision for pupil feedback and teacher feedback to assure that the topics were being treated in meaningful ways.

Each laboratory activity was to be designed to exemplify concepts inherent in the program, thus providing reciprocal reinforcement with the text and class presentation. Such factors as the provision for problem solving
and pupil motivation toward learning were considered to be important in this area and the sequence, length, and level of difficulty of laboratory activities were to be controlled to assure pupil success. It was believed that the pupil should learn enough to practice what is learned, with little or no error, before leaving the laboratory (Towers, et al., 1966, pp. 295-298).

The daily sequence of textbook reading, workbook questions, class presentation, student activity, and review and evaluation was to provide a controlled "program" for the course. The staff considered this program similar, in some respects, to a teaching machine program, though not as rigid (Towers, et al., 1966, p. 299). Finally, the staff considered evaluation as a factor affecting the selection of learning activities. Three phases of the evaluative process were established. These are:

1. Measurement of behavior change or goal attainment.
2. Evaluation of the effectiveness of instructional procedures.

The first of these phases was viewed as necessary to the evaluation of meeting learned behavioral objectives. Evaluative data, once obtained, could be used by the learner to judge the appropriateness of his previous behavior, by the teacher to evaluate his own behavior, and by the IACP staff to make additional value judgements concerning
procedures. The second phase was necessary to making adjustments in activities, or methods, used by the teacher and for future recommendations in subsequent curriculum revisions. The third phase involves asking questions as to the degree of difficulty for the pupils, evaluating the soundness of the objectives in terms of relation to higher-level objectives, and determining suitability in terms of the subject matter, skill, or behavior. On the basis of these checks, decisions could be made to accept or reject an objective. (Towers, et al., 1966, pp.301-307).

In summary, the IACP staff undertook not only to devise a new curriculum for industrial arts, but also to re-structure the body of knowledge from which the content of this curriculum would be devised. In addition, they considered, and were guided by, the elements of curriculum design classified as objectives of instruction, the nature of the learner, school facilities and materials, and measurement and evaluation. At the completion of the Rationale and Structure for Industrial Arts Subject Matter, the staff had not developed a complete set of operational guidelines for each stage of the program. However, the rationale did indicate the method by which the staff would make decisions concerning the various factors of instructional design.
This investigator did not attempt to disassociate the present study from IACP to the extent that the latter became merely a source from which research materials could be obtained. On the contrary, he was vitally concerned with learning more about the validity of the IACP rationale and learning materials per se. Moreover, it was hoped that this investigation would provide some evidence, however small, either in support or rejection of IACP as a viable program. The primary emphasis was, however, placed on examining the relationship of the various kinds of IACP teaching methods to the learning of concepts. The methods and concepts described in Chapter Three could have been applied to virtually any subject area or subject matter. Furthermore, this investigator believed that valuable knowledge could be gained from the employment of reasonably realistic, or naturalistic, stimuli in the study of human behavior as it related to teaching-learning theory in industrial arts.

THEORIES AND STUDIES IN CONCEPT LEARNING

In dealing with concepts, it seems logical first to define the meaning of the term. Various definitions have been given. Woodruff (1967, p.102) has defined the term "concept" as follows: "It is [a person's] own subjective product of his way of making meaning of things he has seen or otherwise perceived in his experiences. At its
most concrete level, it is likely to be a mental image of some actual object or event the person has seen. At its most abstract and complex level, it is a synthesis of a number of conclusions he has drawn about his experience with a particular thing." The obvious shortcoming of Woodruff's definition is that it does not establish at a very concrete level, an objective basis on which a concept may be described.

Noble (1963, p. 82), has pointed out the difficulty of defining the exact meaning of words. He uses the word "Christmas" as an example of how many connotations for a term may be found. He has devised a formula for averaging the meaningfulness of words to persons by summing the responses, or associations to a given word or concept and dividing this by the number of respondents over a period of time. The result of this process is a mode score for the given concept.

Perhaps Noble's most useful idea for the present investigation is his examination of some of the salient features of meaningfulness and familiarity as concepts, with emphasis upon the rules they play in behavior. He points out:

1. One of the best established generalizations about verbal behavior is that speed of acquisition and performance level, other things constant, depend on the characteristics of the stimulus materials to be memorized.
2. It is well to be reminded of the broad territory covered by the term stimulus material. Recent interest in such topics as the term mediation and item selection in verbal learning serves to re-emphasize the importance of conducting thorough assessments of the nature of the materials which human subjects are required to learn (Noble, 1963, p. 90).

Noble provides little that helps pinpoint the relationship between words and the understandings associated with them. However, he does suggest one method by which word concepts may be identified. In the present investigation, many of the understandings revolve about words that have not been proven to be necessarily related to their respective groups of meanings. Whether or not the words are validly related to the meanings may be immaterial, since the learning materials might, conceivably, just as well have used nonsense syllables to identify the elements of the structured body of knowledge. The emphasis in this study is on the efficiency of grasping the relationship of a given word to its universe of related meanings, given the appropriate stimulus. Support for this notion is provided by Martin (1967, p. 59), who explains the attainment of a concept as "... being a state conferred upon an organism by an external observer who decides that a certain sequence of responses exhibited by the organism matches, according to some arbitrary rule invented by the observer, a certain sequence of stimulus events to which the organism is sensitive. A theory of concept attainment, therefore,
must be a set of statements that describe a process whereby the organism reaches this state of agreement with the observer (Martin, 1967, p. 59).

The identification of concepts based on the experimenter's criteria appears in writing by Slamecka (1967) who notes that the most typical procedure is to expose the subject to a variety of stimuli and give him some information about their class membership. As a result, the subject is expected to arrive at the criteria for their membership. If he is successful, he can correctly classify all future instances of such stimuli, and may also be able to visualize the basis for their inclusion. If this is done, he is then said to be using the correct concept. According to Slamecka (1967, pp. 443-444); "Concept attainment requires the attachment of the same response to a number of different stimuli ... what is essential is that the stimuli be paired with a common response by virtue of some general rule which permits their inclusion." This is a partial basis for the experiment performed by this researcher.

Martin (1967, p. 59) has defined a concept as "... a set of mutually induced response tendencies," and uses the following to clarify this definition: "When a person says that it is orange, in response to a query about a piece of fruit, one may assume that the subject
has a concept of color. If the subject says 'it is green' and means that it is not ripe, one may assume that the subject is not exercising this concept of color. Instead he must have a concept of maturity or readiness." Thus it can be seen, from Martin's example, that one must be careful that he is measuring the desired concept understanding if there is more than one possibility to a given response. The obvious solution to such a problem would appear to lie in the method of structuring the question posed to the subject.

A recent symposium of psychologists, reported by Kleinmuntz (1967, p. 247), revealed quite a diversity in the definitions of "concept" as used by the participants. Almost any inferred use of organized information would seem to qualify. Some members, however, were in accord with the definition arising from traditional research on concept identification and attainment; that is, a concept identifies objects as belonging to, or not belonging to, the class defined by the concept. In this regard, Bradley and Earp (1967, p. 190), have noted several points pertaining to the role of concept development in a reading readiness program. First, a child, to get meaning from reading, must recognize that the words he sees refer to something he knows in real life. Hence, the authors suggest that complementary experiences should be provided
so that the child will encounter problems dealing with the need for recalling details, comprehending the main idea, and following orderly sequences of thought. They suggest that concept development is ordered when the child strives to select and group ideas, answer problems, and follow written verbal directions.

Bradley and Earp also delineated a table which aided in conceptualizing an experimental mode for discussion and an evaluation procedure. This chart follows:

**TABLE 2**

<table>
<thead>
<tr>
<th>OVERT ACTIVITY</th>
<th>COVERT MENTAL OPERATION</th>
<th>ELICITING QUESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enumeration and Listing</td>
<td>Differentiation</td>
<td>What did you see?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hear? Note?</td>
</tr>
<tr>
<td>Grouping</td>
<td>Identifying common properties, abstracting</td>
<td>What belongs together: On what criterion?</td>
</tr>
<tr>
<td>Labeling</td>
<td>Determining the hierarchical order of items; suber and sub-ordination</td>
<td>How would you call these groups? What belongs under what?</td>
</tr>
</tbody>
</table>

(Bradley and Earp, 1967, p. 30)

However, Bradley and Earp are referring to young children who are going through the early stages of learning to read. Later in this chapter, evidence will be presented that such concrete, "real life" connections may not be necessary to concept attainment in the older child. Support and insight to the foregoing was provided by
Gagné whose work has distinct bearing at this point. He has stated that "... one way the individual can learn to respond to collections of things is by distinguishing among them. Another way, even more important as a human capability, is by putting things into a class and responding to the class as a whole. The first kind is a precondition of the latter which makes it possible for the individual to respond to things, or events, as a class. This is concept learning (Gagné, 1965, p. 126)."

A concept may be acquired by means of a trial-and-error procedure, but Gagné does not believe this to be the typical way. More commonly, the learner will establish an understanding of a concept through some rather definite set of operations; usually this will be through the exposure to certain situations that cause the learning of correct concepts. Gagné poses the question: "How many situations need to be used to establish precise discriminations of [a word] from other stimuli that are not [a word]"? His discussion does not provide an answer to this question, but does indicate that any discrimination learning activity should be conducted in a situation that represents the actual range of possible situations. Otherwise, the concept that emerges will be incomplete in one sense or another (Gagné, 1965, pp. 129-130).
Gagné describes two critical conditions of concept learning. First, it is necessary for the individual to identify several instances of a situation of like class. The second condition is that of reinforcement. He stresses the need for contiguity in the presentation of new stimuli and the recalling of concept names learned in prior experiences. The absence of contiguity is suggested as the factor responsible for the slowness of concept learning when it is done in a trial and error fashion. On the other hand, repetition is not believed to be necessary when learning conditions are optimal. He cites the lack of evidence for concept retention by means of additional instances (Gagné, 1965, pp. 134-135).

According to Gagné (1965, p. 137), "One cannot take the time to present to the student even a small fraction of all the specific situations in which he may encounter an 'edge' or a 'cell,' etc., but, if, with the use of a few examples, he can acquire these as concepts, one may expect that generalizing will occur to the whole of his experience." This appears to be contradictory to the previously noted belief held by Gagné and is not resolved in the particular references used here.

Contrary to Ausubel (1963, p. 128), Gagné believes that learning can become too verbal in that the concepts are highly inadequate in their references to actual
situations. He states, "The necessity of avoiding superfinality of words ... recognized in a number of educational doctrines such as 'learning by doing,' aid the recognition of the importance of the laboratory activity ... (Gagné, 1965, p. 138-139.)"

Ausubel (1963, p. 128) has tended to concur with Gagné on the means by which concepts are acquired by the learner. The fundamental difference is found in his emphasis on the verbal learning materials as opposed to the "concrete," particularly in the post infant years. Ausubel doesn't deny the need for concrete learning in the education of children, but he pushes for its reduction as rapidly as possible during the adolescent stages of growth. The following statement by Ausubel helps to clarify his position; "... as children increase in age and cognitive capacity, teaching methods can place increasingly less reliance on concrete-empirical props (Ausubel, 1963, p. 131)." Thus, in the elementary school years, concrete-empirical experiences are seen as necessary to concept development. However, in the secondary school the most significant development in cognitive functioning that occurs during the pre-adolescent and early adolescent years is the gradual transition from a predominantly concrete to a predominantly abstract mode of understanding. This developmental shift, in turn, holds importance for
teaching methods of a reading nature and curricular practices in the secondary school.

Ausubel (1963, p. 131) states that "... once the developing individual reaches the abstract stages of cognitive functioning, he becomes in large measure an abstract verbal learner. He now forms most new concepts and learns most new prepositions by directly apprehending verbally and symbolically stated relationships between previously learned abstractions." Therefore, following Ausubel's thinking, it would seem that in the junior high school years, teachers would no longer need to rely heavily on first hand, non-representational experience, nor actually perform any of the abstracted operations on the underlying empirical data.

With this background as a basis, we can now understand Ausubel's notion that the learner, on the secondary school level, is ready for verbal expository teaching that uses concrete empirical experience primarily for illustrative purposes such as to clarify or dramatize truly abstract meanings rather than to generate intuitive meanings. As a result of this thinking, Ausubel states "... that many features of the activity programs were based on the quite defensible premise that the elementary [school] child perceives the world in relatively specific and concrete terms, and requires considerable first-hand experience
with concrete instances of a given set of relationships before he can abstract genuinely meaningful concepts and relate them meaningfully to cognitive structure (Ausubel, 1963, pp. 131-132)."

Ausubel does not disagree with the notions held about the need for concrete activity in the elementary school years, as long as the activity devised is appropriate to the necessary expository teaching and that children's exercises are not artificially contrived to completely supplant expository teaching. But, more important to this investigator, is his position that in older children, once a sufficient number of basic concepts are consolidated, new concepts are learned primarily from verbal rather than from concrete experience. This has resulted in Ausubel's suggestion that it may be desirable to revise both the sequence and the relative balance between abstract concepts and supportive data (Ausubel, 1963, p. 132). This is not to suggest that Ausubel discards completely the need for concrete experience in the secondary school, for he doesn't. But, neither does he lay firm guides which help to answer questions pertaining to how much of each ingredient is needed for optimal learning efficiency.

To return briefly to the nature of concepts and concept attainment, a great deal of literature was located which dealt with this subject as it relates to memory, or
retention of learned concepts. A few of these references are included because they aided in the formulation of an instrument and a testing procedure which would measure concept understanding as well as identify the relationship between the concept term and the situation or group of things to which it pertains.

On the subject of memory, Metcalf (1966) discusses the factors that influence forgetting. She classifies these factors as follows:

1. Delay between the receiving of an original impression and the recalling of it.
2. Receptiveness of the person who remembers.
3. Environment

Each of these factors was significant for the present investigation. The last one was particularly cogent in terms of type of teaching method being employed. Metcalf (1966, p. 13) infers that teaching rules and methods greatly affect a person's organization of information before committing it to memory. She cites a 1954 study by Postman who trained several groups of students to categorize items of information according to different rules. In a subsequent memory task, both the number of items recalled and the quality of the errors were influenced by the rules for that group.
The interference theory of forgetting refers to the interference produced by new learning interpolated between the original learning and recall of that original learning. Slamecka (1967, p. 22-23) reports that in an experiment by Underwood and Postman, it was found that sources of interference in long-term forgetting (one-week) of a list of words may be due to two factors. First, that of letter sequence interference which is produced by well established association between letters in the learner's language and second, unit-sequence interference which reflects pre-experimental associations among the units of a list. This finding may have bearing on this study to the extent that the learning materials may influence some students differently than others due to prior learning and/or to some relationship between the content of the material and the language patterns of the subjects.

Psychology provides a wealth of information on such questions as retention of learning, concept formation, and stimulus-response learning. Regarding the latter, there are theorists who hold that a response to a stimulus is at zero strength until that trial on which it jumps to maximum strength. In short, the response is either fully learned or not learned at all. The incremental theorists hold that a response gradually gains increments of strength from each succeeding reinforced trial.
Compromise positions between these views have been suggested (Slamecka, 1967, pp. 157-165).

It has generally been found that the ordinary group learning curve would seem to provide evidence for the incremental view. However, the smooth ascents of such curves can be the result of the averaging process itself. When this is done, individual jumps from zero to some high level are obscured. According to Slamecka (1967, pp. 157-169), it has been found that superior performance of a control group to learning paired nonsense-syllables must be attributed to repetition of exposure to the learning materials.

Perhaps the answer to this question lies partially in the kind of material to be learned. For example, there is a considerable difference between nonsense syllables and such structured and orderly materials as those used in the present investigation.

Much of the discomfort felt by this investigator with the transference of findings from the often atypical learning situation commonly found in psychology to the more natural situations of applied research has been reflected by Ausubel and became evident as his writing was reviewed. For example, Ausubel (1963, p. 59) writes "... the law of disuse, as advanced by the functionalistic school of psychology as a factor in retention of learning,
had been rendered suspect by the demonstrations that unreinforced S-R connections are weakened by continued use, and that unpracticed memories sometimes become more available, days, and even weeks after original learning than they were at original testing." On the other hand, evidence favoring the interference theory of forgetting comes from studies of rote learning showing that the degree of forgetting is directly related to the amount and similarity of activities interpolated during the interval between the original learning and recall (Ausubel, 1963, p. 60). This notion gives reason to examine the long-term retention of learning as well as the short term.

In several studies on inductive concept formation reported by Elam (1962), normal subjects were compared on the effectiveness of manual and verbal response methods in learning to discriminate between pictures of human forms and others of geometric forms. It was hypothesized that the verbal treatment would be superior in learning correct responses than the manual treatments. The prediction was upheld. Elam concludes that in the development of a concept, the nature of the response is of equal importance as the arrangement of the stimulus materials. He further notes that in order to facilitate learning, the response required should be one which does not interfere with the
process by which the concept is obtained (Elam, 1962, pp. 16-17).

In a second study, Elam (1962, pp. 18-30) reports conflicting results on experimental treatments similar to those of the study noted previously. Subjects taken from the first, third, fifth, and seventh grades were compared on a similarity-difference problem in comparing pictures of humans. Half of the subjects responded manually while the other half responded verbally. The result indicated (1) that problem difficulty decreases with age, and (2) learning is facilitated by the verbal response method as compared to the manual response method with the exception of the seventh grade subjects where the results were reversed.

In general, Elam (1962, pp. 105-109) has concluded that for the normal subjects used in his studies, verbal responses are superior to manual ones in terms of number of responses correctly made when learning concepts.

It can be postulated that the learning of facts is highly related to the learning of concepts. On this assumption, this investigator examined several studies which attempted to evaluate the relative merits of learning through manual activity as contrasted to learning through verbal activity. It was recognized that the most obvious problem in placing fact learning and concept learning on
an equal basis is that facts do not necessarily fall into a structure, or logical order, whereas concepts can generally be categorized by having some relationship with one another. On the other hand, one could theorize that the mental processes which a human goes through are much the same whether he is acquiring facts or concepts.

Several studies have been reported from Columbia University (Briggs, et al., 1938) that have a bearing on the values gained from laboratory experiences. Of special interest are those dealing with the acquisition of facts as an outcome of laboratory techniques. Of the 79 studies dealing with pupil achievement in terms of facts learned, only seventeen which were objectively planned and executed gave statistically significant differences to the .05 level. Twenty one of the 79 studies did not show conclusive differences, with the remainder indicating objective differences, but not any that were statistically significant.

Several studies reported in the Columbia University publication favor traditional methods of instruction. One study (Briggs et al., 1938, p. 32) for example, indicates that the recitation method of instruction in general science results in more achievement than the unit method. In another study which examined the lecture, class demonstration, and individual laboratory methods of teaching chemistry, it was found that the lecture group excelled in
achievement. However, the differences were not great enough to be statistically significant. There was also a wide variation in achievement under the individual plan (Briggs, et al., 1938, p. 33).

Guthery (1967, p. 45) conducted an experiment comparing expository instruction versus a discovery method involving a problem of deciphering cryptograms using three instructional sequences: rule-example, example-rule, and example. A non-training control group was included. On the retention test, the rule-example group was superior to all groups, and the other groups did not differ. He concludes that the discovery method appears to facilitate transfer of learning, but not retention; expository instruction facilitates retention, but impedes transfer.

In contrast to this study, Tagatz (1966, pp. 25-26) investigated the effects of instruction, sex, and stimulus variables on groups of college-age students. He found that various modes of information presentation had no significant effect on concept attainment.

In a study by Swanson (1963, p. 637), several different devices were used as visual aids supplementing lectures to familiarize Air Force mechanics with complex sub-systems of the B-47 medium bomber. On comparing the use of live lectures and live lectures with visual aids, no significant differences were found among the mean final
test scores of the groups. Swanson concludes that, as a supplement to a well-prepared lecture for instruction of skilled technicians, complex and expensive training aids may be no more effective than less complex and less expensive aids.

A follow-up experiment was conducted by Swanson, Lunsdaine, and Aukes (1963, p. 637), using portions of the same training aids and tape recorded lectures on two groups and a control which received only the lecture. The conclusion was that the effectiveness of each training aid depends on specific instructional objectives.

Vernon (1963, p. 638) reports little difference in the performance of British grammar school students in charting statistical data when presented visual aids with or without printed text material. A later experiment by the same investigator failed to reveal any gain from the use of pictorial charts to accompany, precede, or follow the reading of text material.

Lunsdaine (1958, pp. 123-149), attempting to determine the value of pictures and words to learning, used four arrangements of pictures and words to present the paired items to be learned. The results showed rather conclusively, that the use of pictures to represent the first object of the pair is better than verbal presentation but that verbal presentation (printed words) is definitely
superior to pictorial presentation for the second "response" term of the pair. This held for grade school learners of wide ability range and for groups as well as individuals.

It is apparent that evidence favoring one teaching method over another in terms of performance is far from conclusive. It is interesting that none of the studies reported in Briggs' volume made mention of classification and its relationship to learning. Bruner (1967, p. 225), in more recent work, attaches great importance to categorization of what the person perceives to facility of his learning. This is evident in his statement "... we stimulate an organism with some appropriate input and he responds by referring the input to some class of things or events."

Bruner has experimented in the use of cues in inferring the categorical identity of a perceived object. He notes that inference from cue to identify in perception is in no sense different from other kinds of categorical inferences based on defining attributes. For example, he states "... that the feel and sight of an orange will reveal the correct perception of the fruit; further analysis such as taste, will provide conclusive evidence (Bruner, 1967, pp. 227-228)." He believes that this simple process does not differ from the more abstract task of learning the characteristics and use of numbers. He sees no reason to assume that the laws governing inferences of this kind
are discontinuous as one moves from perceptual to the more conceptual activities.

Ausubel is adamant on this point. He has devoted a considerable number of words to his belief in the superiority of verbal-type expository teaching over rote techniques and discovery methods of learning. In one reference reviewed (1963, p. 132), Ausubel is quite clear that he believes verbal expository teaching to be more economical in terms of time and cost, and that it also makes possible a qualitatively superior kind of abstract meaningful understanding.

Perhaps because of the difficulty of fixing the stages of cognitive child growth, the work of educators and psychologists appears to be confusing in terms of deriving precise "phases" which may be differentiated one from another, especially in terms of mental process stages.

Havighurst (1960) has identified a number of developmental stages, or readiness ages for doing certain tasks. He views the developmental stages as being relatively inflexible in that the child becomes more successful in performing succeeding tasks only after he has mastered the preceding ones. This notion is much like that held by Piaget who, perhaps, has devised one of the finest models for further research.
It is recognized that much of Piaget's work is disputed by some critics, yet it is certainly thought-provoking, and of value to the investigator attempting to identify the ages at which a child can and cannot be expected to perform certain types of tasks.

The five stages of child development identified by Piaget are: (Piaget, 1950, pp. 123-250).

1. The stage of sensori-motor intelligence, (birth to two years).
2. The stage of preconceptual thought, (two to four years).
3. The stage of intuitive thought, (four to seven years).
4. The stage of concrete operations, (eleven to fifteen years).

According to Travers (1965, p. 94), the child first realizes that objects exist even when removed from his field of vision. The second stage is where the child begins to use language. He can abstract and apply symbols to the results of the abstraction. At this stage, the child is beginning to categorize things, but his ability is quite limited. The child, as this stage of development, reasons from the particular to the particular rather than deductively from the general to the particular or inductively from the particular to the general (Bruner, 1967, pp. 316).

The third period is described as that when the child begins to depend more on his thought processes for accurate information rather than on his immediate conceptions about a phenomenon. The child at this stage is still dominated...
by his perceptions. He tends to focus on one facet of a situation and ignore all others (Bruner, 1967, p. 317).

At the age range of seven to eleven, the child is able to manipulate concrete data mentally to solve problems, although he is still not able to think abstractly about problems (Travers, p. 94). The reasoning processes of the period of concrete operations emerge when a certain basic stock of concepts has been acquired and organized into coherent systems. Piaget calls the concepts which figure in operational thought "operations" because they are internalized responses. This may be understood when one examines the three types of operations of importance (Bruner, 1967, p. 317).

The first operation is that of grouping together of objects recognized as similar. This classification process enables the formation of more inclusive classes and their systems with which large bodies of knowledge, for example, can be systematically studied. The second operation is the formation of relations. This enables the person to understand that some things, for example, are related to others in terms of size, or color, or as a result of something else. The third operation is concerned with the use of numbers. Facility in this operation is seen by Piaget as the combined result of classification and ordering. Working with numbers involves the grouping
together of objects to form a class of a certain quantity and that of placing the number of the quantity into a sequence of natural numbers (Bruner, 1967, p. 318).

The final stage of child development, termed the formal stage, is that where the child can apply operational thinking to concrete data to solve problems. His thinking capacity to judge, to solve problems to think creatively, and to think about combinations of possible solutions is what we consider to be adult thinking behavior (Travers, 1965, p. 94).

Piaget (1950) tends to view these stages as being relatively unchangeable; that all children go through them and that a child cannot enter an advanced stage until he has sufficiently developed through those prior to it. Each stage is enclosed on either end primarily by the maturity level, age-wise, of normal humans.

Ausubel (1963, pp. 133-135), on the other hand, believes it possible to accelerate children's progress at least through the stage of what he calls concrete logical operations. This roughly corresponds to Piaget's fourth stage. This acceleration can be accomplished by taking into account the child's characteristic limitations, and by providing suitably contrived experience geared to his cognitive capacity and mode of functioning. Ausubel recognizes that the transition from concrete to abstract
cognitive functioning enables the post-elementary school student to master a much greater volume of subject matter knowledge through expository teaching than has been thought possible by progressive education theorists. He has stated that "... the most significant development trends in conceptualization consist of a gradual shift from a pre-categorical to a categorical basis of classifying experience and from a concrete to an abstract basis of categorization (Ausubel, 1958, p. 559)."

In addition to the learner's higher level of abstract understanding through verbal methods, they make possible a more efficient means of organizing and integrating the materials that are presented. The final result is that high order concepts and relationships are more meaningfully formulated in truly abstract and general terms. They become clearer, more stable, more precise, and sufficiently inclusive to subsume a wider array of differentiated facts and sub-concepts. In view of this, Ausubel believes that the secondary school student is prepared to cope with a greater depth as well as a greater volume of subject matter (Ausubel, 1963, p. 13).

On the discovery method in transmitting subject matter content, Ausubel (1963, pp. 151-152) contends that "... it is impossible to consider the pedagogic feasibility of learning by discovery as a primary means of teaching
subject matter content without taking into account the inordinate time-cost involved." He further notes that the same factors apply to the "contrived" or "arranged" type of discovery. He places value on these methods when the student is in the concrete stages of cognitive development or in the abstract stage (Piaget's formal stage), and lacks manual sophistication in a particular subject-matter field when the learner is faced with a difficult learning task. In general, Ausubel does not defend discovery and subverbal techniques in the transmission of complex and abstract subject matter beyond the elementary school. He even has certain reservations for its use in the lower grades.

Using "discovery" in a slightly different context, Havighurst (1960, p. 55) notes that in children around the age of fourteen, the degree of skill in using and understanding abstract words and in discovering meaning from context varies from almost zero to the level of genius. He provides for individual differences in stating that "... concepts are formed or experienced by both the direct experiences of the senses and the vicarious experience of reading books and working mental experiments." People of low conceptual ability must remain very close to direct, concrete experiences in attaining concepts. Concepts of algebra, he believes, are beyond the reach of many adolescents and the complex concepts of modern economics, for
example, will always be beyond the reach of these same persons. On the other hand, Havighurst (1960, p. 54) states that grade placement of such subjects as history, geography, and arithmetic would be more sure if we knew more about the child's formation of concepts of time, space, and number.

Following Havighurst's belief that the human mind, by the age of fourteen years, has developed essentially to the adult mentality, the following experiments are reported which supply evidence of how individuals approach stimuli to form concepts. In nine experiments conducted at the University of Wisconsin, several investigators tested five hypotheses related to strategies and efficiency of concept attainment. Using concepts imbedded in four basic types of cards, but in various combinations, with college-age subjects, the results indicated that different learning strategies result in greatly different performances. In five of the experiments it was found that concept attainment strategies are positively correlated to three of the types of stimulus materials; those being figural in nature, semantic of low meaningfulness, and semantic of high meaningfulness. The fourth stimulus material was figural of low meaningfulness (Klausmeier, 1964, p. 106).

The strategies are described by the investigators as being the ways that subjects approach stimuli and in
turn infer concepts. The measurements were taken of the amount and method of learning concepts and the degree of forgetting which occurred. In general, it was concluded that the type of stimulus material to be learned has an effect on the strategy used by subjects in learning that material. The type of strategy, in turn, affects the efficiency of learning (Klausmeier, 1964, pp. 106-116).

Gagné (1965, p. 24) has stated that the features of the educational process should be determined by the requirements of getting students to learn efficiently. He points out that many of the problems of importance to education cannot be solved by applying a knowledge of the principles of learning. For example, there are many aspects of the personal interaction between a teacher and his students that do not pertain, in a strict sense, to the acquisition of skills and knowledge that typically form the content of a curriculum.

He notes that one important implication of the identification of learning conditions is that these conditions must be carefully planned before the learning situation is entered into by the student. The planning that proceeds effective design for learning is a matter of specifying with some care what may be called the learning structure of any subject to be acquired. In order to determine what comes before what, the subject must be
analyzed in terms of the types of learning involved in it (Gagné, 1965, pp. 24-25).

It is clear, in reading Gagné's work, that he holds that a variety of instructional methods are necessary to the creation of efficient learning, and that when the various instructional resources are identified, they must be placed in some particular arrangement called a mode of instruction. The various modes of instruction are employed for the purpose of getting the greatest instructional usefulness from media and their combinations. The treatments used in the present experiment are actually four different modes of instruction by this definition.

Gagné has identified eight different types of learning of which concept learning is one (Gagné, 1965, p. 58). He discards none of the types but emphasizes, to some degree, greater value and use of some over others, though hardly to the extent that Ausubel does. On the subject of concept learning, Gagné varies little from the statements by other writers with regard to its definition. He does, however, differentiate at least two kinds of phenomena commonly referred to as concept learning. One refers to the acquiring of a common response to a class of objects varying in appearance. This may best be called concept learning. The second refers to the combining of concepts into entities of ideas, facts, or rules. He refers to these as principles (Gagné, 1965, p. 180).
In regard to instructional media, Gagné makes the point that for a given function, certain means of interacting with the learner are quite ineffective. Accordingly, the characteristics of various media of instruction need to be considered carefully in making a choice from any of them (Gagné, 1965, p. 271).

Gagné concurs with previous writers in that instruction by means of printed matter is usually a very rapid and efficient process. Further, when pictures and diagrams are combined with printed text, the dangers of excessive verbalism can largely be overcome (Gagné, 1965, p. 277). He also notes advantages and disadvantages of lecture, discussion, and laboratory activity (Gagné, 1965, pp. 287-292). The most striking limitation to Gagné's writing on these subjects is that the evidence, either pro or con, is lacking which would help show the relative values of any of the modes of instruction to learning concepts. In one reference (1965, p. 193) however, Gagné does suggest that there is some evidence, though not much, that concepts and principles learned through discovery are better retained and transferred than if learned through reception learning.

Two re-appearing themes of the topic of conceptual development are those of structure, the grouping of related understandings into a class which can be identified by a word or group of words, and secondly with the structuring
of concepts into hierarchical categories with certain
categories with certain
concepts being subsumed by others. Bruner (1960, pp. 17-18),
in discussing the importance of structure in learning,
notes that "... transfer of learning is facilitated best
not through the learning of skill, but a general idea
which can then by used as a basis for recognizing sub­
sequent problems as special cases of the idea originally
mastered. The continuity of learning that is produced
by the transfer of principles is dependent upon a mastery
of the structure of the subject matter." In discussing
the relationship of "discovery" as an aid to teaching,
Bruner (1960, p. 21) points out one group of scientists,
scholars, and educators at the 1959 Woods Hole, Mass.
Conference called by the National Academy of Sciences who
stated that the method of discovery would be too time­
consuming for presenting all of what a student must cover
in mathematics. This point, however, should not lead the
reader to believe that Bruner leans away from "discovery"
learning. The literature generally indicates the contrary
inclination. Although the learning of mathematical concepts
and technological concepts is very different, it is apparent
that the proper balance between discovery and expository
teaching is far from clear.

Bruner further points out that there is a suprising
lack of research on how one most wisely devises adequate
learning episodes for children at different ages and in
different subject matters (Bruner, 1960, p. 49). With
respect to structure, he sets forth that there is a greater
push toward hierarchical connections in technical cultures
than in those that are less technical. Regarding the
value of lecture and discussion, Bruner states (1967, p. 324)
"... that as a society increases in technological complex­
ity, the knowledge and skill within the culture comes
increasingly to exceed the amount that any one individual
can know. This causes the development of new and moderately
effective techniques of instructing the young based on
telling out of context rather than showing in context."

Ausubel (1958, pp. 556-557) believes memory to
become more stable as a child establishes a more adequate
cognitive structure. As cognitive structure and language
growth progresses, children become capable of remembering
more difficult and larger quantities of material over
longer periods of time. He notes that when children
(or adults) only partially learn highly conceptualized
material, more is recalled after an interval of several
days than immediately afterwards. He suggests that this
phenomenon of reminiscence is probably attributable to
the initial shock of the new material and its interaction
with subsuming concepts and tends to improve for a time
thereafter as confusion gradually dissipates.
The final portion of this chapter is devoted to literature dealing with the need for applied research. Perhaps the most cogent piece located on this subject came from a periodical published at the University of Minnesota. In it, Moss (1968, p. 21) states:

> It is quite urgent that States begin to plan for the periodic collection of data which are necessary to evaluate existing programs. [This publication] has recommended that the data to be collected include measures of (a) student characteristics, (b) program characteristics and program costs, (c) intervening variables, and (d) program outcomes.

It is partially in the realm of (b) and (d) in which this experiment has been conducted. It is pointed out by Moss, "... that program characteristics cannot be used as evaluative criteria, for, by so doing, we assume, rather than prove, that those characteristics are good. Given the present state of knowledge, the major purpose of evaluation must be to determine which program characteristics actually produce the desired outcomes for a certain group of students." He goes on to state that "... almost none of our cherished 'principles' of vocational education practice [he is including industrial arts] have been empirically validated. Until they are proven, alleged evaluations based only upon the presence or absence of certain program characteristics are acts of faith. In fact, such evaluations merely serve to describe the program in terms of variables which we presently think are important (Moss, 1968, p. 6)."
Moss suggests that program characteristics may be thought of as the sub-systems of the total program. These sub-systems, such as the teacher, the content, the content organization, and the methods and techniques of instructional experiences can, together or separately, be the independent variables subject to evaluation in any given study. A careful description of program characteristics is prerequisite to evaluation. Many studies fail at this very basic level. Moss further states "... that because evaluation is a time-consuming activity, and each study can only provide data on a limited number of outcomes, it seems important that the attention of research evaluators be focused initially upon programs with basically different practical and theoretical sub-systems (Moss, 1968, p. 11)."

Carroll (1964, pp. 190-191) has leveled criticism at educational and experimental psychologists for their approach to the study of concept learning. He points out that most laboratory studies have used inductive procedures for studying conceptual behavior, whereas concepts are taught deductively in educational settings. He suggests that school concept learning is characterized by response learning and attribute learning, often called concept formation, while experimental studies generally seek to minimize such effects. He believes there are sound scientific reasons for attempting to isolate single
processes, but sooner or later these isolated processes must be studied in concert with each other. The present investigator does not agree that concepts are most commonly taught deductively in natural settings, but otherwise Carroll's criticism seems to hold merit.

O'Keefe (1968), in a study analyzing methodology for field studies, suggests that field studies are the appropriate form of investigation when one is trying to determine how conclusions of laboratory experiments or conclusions based upon different theories of education work in the classroom (O'Keefe, 1968, p. 158). O'Keefe was trying to construct a valid rationale for methodology in conducting and evaluating field studies. She points out that the experimental laboratory setting itself can provide a certain bias to the data, and can provide measures inappropriate to an evaluation of a situation in which the environment is not controlled (O'Keefe, 1968, p. 15). Unfortunately, the nature of the present study has required that certain variables be controlled in the learning environment. The conclusions obtained should, therefore, be cautiously used when transferring generalizations to other groups in more natural learning environments.

Proven guides which might help in placing values of learning efficiency of one kind or another on the various modes of instruction are lacking. This is evidenced
from the foregoing. Perhaps McNeil epitomized this dilemma over the methods of arranging the elements of the learning environment in order to formulate essential skills and abstractions. He states that "... classroom organization in the elementary school is chiefly for the purpose of arranging a sufficient number of concrete activities from which a central idea will be abstracted (McNeil, 1965, p.89)." A certain unit of instruction might serve to formulate the economic concept "specialization" for example, but, if the teacher makes the instruction rich in detail, the child may never see that which is necessary for formulating the concept. It occurs to the present writer that if this is indeed true, it might also be possible that, in terms of formulating technological concepts, a unit of instruction can be made so complex and detailed, and have so many varieties of different activity, that the child may never grasp the desired concepts due to the multiple interaction of extraneous ideas.

In terms of making learning more efficient, McNeil (1965, p. 27) notes that school leaders have placed much emphasis upon ways for reducing the time required for the acquisition of learning. They have been interested in new teaching techniques and new instructional materials which will help pupils learn more effectively.
SUMMARY

In the first part of this chapter, the rationale underlying the technological concepts used in the present investigation was reviewed. In the second part, several studies, conclusions, and opinions of certain leading educational investigators were considered. Efficiency of learning was stressed by three of these authorities, and several writers pointed out the need for further research on the relationship of teaching mode to concept attainment. It was apparent that there is considerable disagreement regarding which instructional methods are most efficient. Most authorities agreed that the adolescent, by the age of thirteen years or so, is capable of internalizing verbal relationships. The definition of "concept" was discussed, and finally, several guides were suggested for the conduct of the present investigation.
CHAPTER III

THE METHODOLOGY OF THE INVESTIGATION

As noted in Chapter One, the purpose of this study is to obtain some of the basic knowledge that is needed for the development of superior methods for teaching technological concepts. In this chapter, the details of the experiment used in the investigation are set forth. The sample is described, and the reasons for using the selected technological concepts are given. The achievement test and the treatments are described, and the performance of each treatment is explained.

SELECTION OF TECHNOLOGICAL CONCEPTS

As described in Chapter Two, the structure of industrial technology, as posited by IACP, began first with a breakdown into two major groupings termed "Construction Technology" and "Manufacturing Technology." Each of these, in turn, was subdivided into the three groupings called "Management Technology," "Production Technology," and "Personnel Technology." To some extent, each of the three may be related to either construction or manufacturing; however, there are certain characteristics germane only to
one or the other. Therefore, it became necessary to choose either construction or manufacturing from which could be derived knowledge which exhibits inclusiveness for instructional and experimental purposes. This first breakdown is portrayed in Figure 6.

FIGURE 6
FIRST TWO ORDERS OF INDUSTRIAL TECHNOLOGY

(Towers, Lux, and Ray, 1966, p. 167)
The next breakdown in Manufacturing Technology is seen in the analysis of what constitutes management, personnel, and production. The IACP staff used three sub-elements, or concepts, which make up manufacturing management. They are planning, organizing, and controlling. Each of these, in turn, were analyzed to determine their constituent parts. This structure is shown in Figure 7.

FIGURE 7
ELEMENTS OF MANUFACTURING MANAGEMENT TECHNOLOGY

(Towers, Lux, and Ray, 1966, pp. 174-175)

The highest levels of specificity have been left out of Figure 7. It should be recognized that this abbreviated list depicting the relationships of the second, third, and fourth-order elements can be, and is, further expanded to specify fifth, sixth, and even seventh-order elements for more specialized study.
The structure for Manufacturing Personnel Technology was similarly identified by analyzing its sub-elements and then by identifying more specific practices under each sub-element. This structure is shown in Figure 8.

FIGURE 8
ELEMENTS OF MANUFACTURING PERSONNEL TECHNOLOGY

(Towers, Lux, and Ray, 1966, pp. 194-195)
At the fifth level of specificity the structure for industrial production technology took distinct paths: one for construction and one for manufacturing. The practices relating to the concepts shown in Figure 9 are, therefore, generally unique to manufacturing. As in Figures 7 and 8, the highest levels of specificity have been left out of Figure 9.

FIGURE 9

ELEMENTS OF MANUFACTURING PRODUCTION TECHNOLOGY

(Towers, Lux, and Ray, 1966, pp. 176-190)
NATURE OF THE TEACHING-LEARNING MATERIALS

The Textbook

The curriculum for manufacturing developed by IACP is patterned after the structures shown above. The concepts in the structures are woven into a chronological story depicting the life cycle of any manufactured product. Each unit of instruction is built around one or more of the concepts and "programmed" so as to present this conceptual order. The practical result of the work has been instructional media consisting of major study units that introduce the students to additional units composed of the sub-elements of the material covered in the introductory days. This organization enabled the selection, by this investigator, of four readings which introduce and explain the meaning of the high-level concepts, or words, used in the course. The first reading, (see Appendix A) titled "Manufacturing Technology," explains the meaning of Manufacturing Management Technology, Manufacturing Personnel Technology, and Manufacturing Production Technology, and gives a definition of manufacturing. In addition, it gives a cursory exposure to many of the sub-concepts beneath the above-mentioned three titles.

The second reading, titled "Manufacturing Management Technology," explains the concepts planning, organizing, and controlling, and their sub-concepts of formulating,
research, designing, and engineering (under planning),
structuring and supplying (under organizing), and directing,
monitoring, reporting, and correcting, (under controlling).

The third reading, titled "Manufacturing Personnel Technology," explains the concepts hiring, training,
working, advancing, and retiring. It also describes the
meaning of recruiting, selecting, and inducting---the
sub-elements of hiring. The fourth-order elements of
training, working, advancing, and retiring, are inadequately
treated in this reading and for this reason were not used
in the present investigation.

The fourth reading, titled "Manufacturing Production Technology," explains pre-processing, processing, and
post-processing, and provides a reasonably comprehensive
explanation of the sub-elements handling, storing, and
protecting (under pre-processing), separating, forming,
and combining (under processing), and installing, main­
taining, repairing, and altering (under post-processing).
The concepts receiving and unpacking are inadequately
handled in the reading and therefore were not included in
this study. A diagram showing the concepts identified
for use in this investigation is shown in Figure 10.
FIGURE 10

TECHNOLOGICAL CONCEPTS IDENTIFIED FOR USE IN THE EXPERIMENTAL INVESTIGATION
The information presented in the text materials which could help a person understand the words shown in Figure 10 was written so as to teach the meaning of the concepts as they relate to practices found in manufacturing. Although there are additional meanings which can be attached to the concept words, this investigator worked only with those understandings having industrial (manufacturing) connotations.

The workbook

The IACP manufacturing curriculum incorporates the workbook as a means of controlling the student's attention toward the subject at hand. The workbook questions and problems are designed to reinforce the concepts learned in the textbook by posing the work in such a way that the answers given will tend either to complete a thought or to give the student an opportunity to apply what is presented in the text reading. Another use of the workbook is to make the learner review the text materials to the extent that he must re-read the content dealing with information about which he is uncertain. Many of the existing workbook questions were accepted by this investigator as appropriate for reinforcing the selected concepts. However, since some workbook problems did not represent information relating to the concepts, some new questions were added. Care was taken to assure at least one workbook question or
problem dealing with each selected concept. The workbook section of this experiment is shown in Appendix B.

The Lecture and Discussion

The IACP program includes some lecture and discussion materials dealing with each unit of instruction. However, these were deemed totally inadequate for the purposes of this study. New lectures were written by this investigator which reinforce the understandings available in the textbook. Care was taken to include information on every concept used in this study. The lectures were tape-recorded so as to control teacher presentation. Representative discussion questions were also written which were designed to elicit responses indicating an understanding, on the learners' part, of the concepts and their hierarchical relationships in the lecture. Specific responses were written out where a specific response could be expected, and possible responses were written out where more than one correct response was possible. The discussion, lasting up to ten minutes, was continued until all discussion questions were adequately answered by the students. Teacher help was provided only when students were totally unable to continue the recitation. The scripts of the lectures and the discussion questions and responses are shown in Appendix C.
The Laboratory Activity

The laboratory activity was, in part, adapted from the IACP curriculum; the remainder was devised by this investigator. The first unit activity, The Big Manufacturer game, was taken directly from the IACP material. The game board is shown in Appendix D. It will be seen to introduce all the concepts used in this study plus additional ones which were not used. It will be seen also, that little information regarding the concepts is provided, but that it is possible for the learner to be heavily exposed to the words and their particular order of occurrence in hierarchical structure. Some related informational content is provided in the drawing cards used with the game. In playing the game, the students were divided into groups of three or four. Playing instructions were carefully given to the whole class and then the students were told to begin. As each student drew a card from the stack, he read it to the other players and replaced the card at the bottom of the stack. The teacher moved from one group to another as the activity commenced and individual assistance was given in questions regarding playing rules and score-keeping. All groups completed the game at least once during the 35 minute activity period and no problems of an extraneous nature were encountered.
The second activity, for Manufacturing Management Technology, was a role-playing script written by this investigator which incorporated all the concepts used in the second unit. Related information regarding each concept was embedded in the script and each concept was used in an appropriate setting. There were thirty parts to the script. The students were assigned parts in rotation around the class so that many students had two parts to read. No student was required to read aloud if he choose not to. All students were asked to read along silently with the person reading aloud. After the script reading, the students were asked to complete an organization chart which incorporated all the parts in the script. They were permitted to turn back through the script in search of answers. This activity was enthusiastically received. The script used in this activity is shown in Appendix D.

The third unit of activity incorporated the use of newspaper job advertisements pasted on a poster, and a work sheet posing questions so structured as to utilize the concepts of Manufacturing Personnel Technology. Working in pairs, the students were asked to answer the questions on the work sheet by referring to the advertisements. The advertisements were selected so as to insure reference to each concept being used. After a period of thirty minutes, each pair of students was asked to
report on the number of advertisements which mentioned the practices exemplified by the concept. This activity is shown in Appendix D.

The fourth laboratory activity, for Manufacturing Production Technology, was devised to permit the student to relate the production concepts to illustrated practices found in manufacturing. A filmstrip was adapted from the IACP material which shows manufacturing practices on every second frame. The in-between frames show the answers, or concept words, which are related to the practice shown. A work sheet was devised to enable the student to write down, as the picture was shown, whether it represented pre-processing, processing, or post-processing. In addition, the student was asked to note the practice (concept) under the appropriate heading. The students were allowed twenty seconds to perform this task while a short narration was read, and they were then shown the correct answers. They were told to check the correct answers. Working in groups of two to three, the students were allowed to discuss quietly among themselves the response that they would write down. Each group competed against the others for correct answers, which were totaled at the end on a point system. Honesty in the competition was encouraged, but dishonesty made no perceivable difference as far as the experiment was concerned. This
activity, minus filmstrip, shown in Appendix D, was also well received by the students.

**THE SELECTION OF THE SAMPLE**

It was predetermined that the sample should include 100 or more cases in order to give statistical significance to the study (Furguson, 1966, Chapter 4). If this sample were divided into four equal groups, then, there would be 25 in each. Hence, the original N was 152, and for each of groups A, B, C, and D, 45, 39, 34, and 34 respectively. This large a sample was chosen to allow for mortality of the Ss. It was further decided that the sample should be drawn from representative junior high schools at a grade level appropriate to IACP learning materials. Although any type of class in the school would have been logically suitable for this study, it was decided to employ industrial arts classes because of their relevance to the materials and to the environment for which they were designed. The schools were those located in urban areas of Columbus, Ohio which are best described as middle socio-economic level.

As is true in most metropolitan areas, the schools within the Columbus school system display extremes in all directions on any number of criteria. Since this investigator had been living in the Columbus area for some time and had taught in the Columbus Public Schools, he believed
that he had an adequate knowledge of the individual characteristics of many of the schools. On the basis of this knowledge, several junior high schools were selected which were reasonably representative of the fictitious "midpoint" of American society. With additional aid from administrative personnel in the Columbus Public Schools, three schools were selected from the total where facilities were adequate, time schedules were consonant with the guides of this study, and teachers were cooperative in allowing the use of their classes. Mechanical drawing classes were selected because the facilities in this type of classroom are suited to the kinds of work the students would be asked to perform.

The three schools selected were McGuffey, Medina, and Clinton Junior High Schools. Each of these schools was roughly equivalent in terms of student ability. The eighth grade enrollments of the classes used were: McGuffey, 60 (four classes), Medina, 53 (two classes), and Clinton, 39 (two classes). This provided a total of 152 students in eight classes. By dropping students who did not meet the criteria set for inclusion in the sample and by not counting students who were absent during any of the exposures and tests, the final population for each group was reduced to 29 in Group (treatment) A, 27 in Group B, 29 in Group C, and 26 in Group D. The total N was,
therefore, 111. Students for whom permanent record data were inadequate were not included, nor were students whose age fell more than plus or minus one and one half years from age fourteen.

Although it is difficult to generalize, each of the junior high schools tended to assign students to industrial arts on the basis of ability. Thus, in each school, one-half of the classes tended to be made up of students of lower than average ability and the other half of somewhat higher ability. Examination of achievement and intelligence scores, however, indicated considerable variation from this generalization. In order to obtain greater homogeneity among the groups, each lower ability group was arbitrarily paired with a higher ability group. The means obtained by this process proved to be satisfactory in attaining groups of equal ability as judged from achievement and intelligence test scores.

It is understood that ability is not composed of a very limited number of factors such as reading, mathematical ability, etc., but is a composite of many factors. Perhaps unfortunately, in our public school systems, we have relied quite heavily on the ability factors associated with the use of the English language and the use of mathematical symbols. The result has been a rather heavy emphasis on achievement tests in reading, verbal
comprehension, and knowledge and application of mathematics. The third commonly employed measure is that of intelligence which, as Horrocks (1965, pp. 121-122) points out, is central to all human behavior particularly as it is concerned with the ability to learn and profit from experience. While none of these tests is an ideal answer to assessing the ability and achievement potential of an individual, it must be admitted that they are the best measures available for assessment on a mass scale.

Since the available knowledge of ability for the sample consisted of reading and arithmetic achievement and intelligence test scores, it was decided to employ this information in eliminating individuals who might not be useful in validating the hypotheses. Of the three measures, reading achievement and intelligence scores are the most cogent. The former was used because the experimental reading materials were geared to the junior high school level. Therefore, all students below 7.0 grade level in reading achievement were eliminated from the sample. The intelligence measure was used because of the questions regarding general performance ability in relation to the various kinds of teaching and testing methods employed. All students below 80 I.Q. were eliminated from the sample.
The inclusion of the measure of arithmetical achievement gave pause to this investigator. However, after considering its import as a factor related to general intelligence, (Spearman, 1927), it was decided to include this as a criterion for sample selection, but only by setting lower limits than for the other two measures. Therefore, all students having arithmetic achievement scores below 6.0 grade level were eliminated from the sample.

Another measure which reflects general ability may be said to lie in prior school achievement in terms of grades received in courses. The use of this criterion was rejected on the grounds that the Columbus schools group students by ability and frequently the group to which a particular student belongs is not recorded. Even more important, it would likely be inadvisable to try to equate grades from among groups since the ability groupings commonly employed in the schools tend to obscure the meaningfulness of letter grades when compared across the groups.

For assessment purposes, the measures of individuals consisted of standardized scores on available tests within the schools. They are:

1. Average scores on the Stanford Achievement Test in Reading, Form X.
2. Average scores on the **Stanford Achievement Test in Arithmetic**, Form X.

3. Intelligence based on scores on the **California Test of Mental Maturity**, Form S.

Because the test scores were not necessarily recent, present achievement levels of the Ss were extrapolated from the most recent test administered. According to two studies mentioned by Pressey, et al. (1959), ability of children tends to remain stable through ages nine to eighteen. For example, when children were measured repeatedly in one longitudinal study, the students' intelligence measurements at ages nine, eleven, and fifteen correlated .80, .87, and .84 with the same measure at age eighteen on the Wechsler Test for Adults, (1939 edition) (Pressey, et al., 1959, p. 58). Evidence favoring a consistent rate of achievement is provided by Bloom (1963, p. 385) who found that repeated measures of achievement over periods of two to six years after grade five or six rarely correlated less than .80. He found the relation between previous and later achievement tends to remain high and even become higher during the secondary level. Even though individual variations from a steady increase in achievement do occur, it was believed valid, by this investigator, to assume that the averaging procedures of this group study would cause any variations
to have little effect on the experimental results. Nevertheless, since variations might tend to increase as the time span between testing and this experiment increased, no subjects were used if the scores were more than three years old. Most available measures were less than two years old.

The intelligence test was composed of two parts: a language and a non-language part. Because the individual scores were not always available, the composite intelligence score was the measure recorded for each student. Table 3 illustrates the mean and standard deviation of scores on each of the three measures, as well as the mean age per group. These means were analyzed for statistical differences and the results of the analyses are shown in Chapter Four. Individual measures are shown in Appendix F.
TABLE 3
MEANS AND STANDARD DEVIATIONS OF SCORES ON THE STANDARDIZED READING, ARITHMETIC, AND INTELLIGENCE TESTS AND MEAN AGE OF EACH GROUP

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>READING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>8.7</td>
<td>8.7</td>
<td>8.9</td>
<td>8.8</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.3</td>
<td>1.4</td>
<td>1.0</td>
<td>1.4</td>
</tr>
<tr>
<td>ARITHMETIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>8.5</td>
<td>8.5</td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.1</td>
<td>1.1</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>INTELLIGENCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>106.1</td>
<td>103.5</td>
<td>109.0</td>
<td>106.4</td>
</tr>
<tr>
<td>S.D.</td>
<td>12.8</td>
<td>12.8</td>
<td>10.7</td>
<td>12.7</td>
</tr>
<tr>
<td>MEAN AGE</td>
<td>13.8</td>
<td>14.1</td>
<td>13.7</td>
<td>14.0</td>
</tr>
</tbody>
</table>

The reading test is composed of four parts: word meaning, paragraph meaning, spelling, and language usage. In many cases the individual scores for these parts were unavailable, so the average scores were recorded for each student. The arithmetic test is composed of mathematical computation, application, and use of concepts. Since the part scores were often unavailable, again the average score was recorded.

INSTRUCTIONAL PROCEDURES

All instruction and testing was given by this investigator. The total number of exposures for each class was seven. The first exposure, of 15 minutes was given to introducing the purposes of the instruction.
On this day, the student enrollment was obtained, the class met the instructor, and the instructional materials were introduced. It was explained that new teaching materials were being tried with the group and that if the testing of the materials was to be valid, full cooperation from each student was required. All subjects consented, and agreed, that there would be no "horseplay" at any time during the period of instruction. An explanatory handout was given to each student; this may be seen in Appendix E.

The second through the fifth exposures for the classes consisted of the four treatments. Since only one group was exposed to the materials for the full 87 minutes for which the classes were in session, special arrangements had to be made to fill out the class period with activity not related to the experimental materials. All participating teachers were fully cooperative in taking over the classes after each treatment was completed. They all were prepared to keep the classes occupied in activity totally unrelated to the experiment and of a nature that did not particularly tax the students.

The sixth and seventh exposures for the classes were given to testing. Following Lunsdaine's recommendation (1963, p. 649), the test was administered five to six days after the fourth treatment and again three weeks after the first test.
In all schools in which the study was conducted, the eighth-grade classes met for double 42-minute class periods two days per week. This allowed 87 minutes per meeting, which includes the three minutes between periods. This amount of time was ample for the presentation of all units, including those presented to the group having Treatment D. The arrangement of class meetings during the week (Monday-Tuesday, Monday-Wednesday, Tuesday-Thursday, or Thursday-Friday) permitted the bulk of the study to be conducted during four consecutive weeks, the introductory day being the final class meeting of the first week and the first test being administered at the first class meeting of the fourth week. The classes at one school met on Monday and Tuesday, and on Thursday and Friday. Thus, the time span between the introduction and the first test for all groups was either 19 or 21 days, depending on the school. The re-test was administered exactly three weeks after the first test.

Each presentation was begun as soon as the students had assembled at their seats and were quiet. Pencils were offered to any students who needed them. The textbooks were passed out, and students were told where to begin each reading and where to stop. They were instructed not to read further than the end of each unit and to sit quietly until everyone had finished. After 10 minutes had passed,
each student was given the workbook sheet which corresponded to the day's reading. They were told during the introduction and before the textbooks were passed out that they could, and should, re-read portions of the textbook as a help in completing their workbook sheet. At the end of 30 minutes, the textbooks and workbook sheets were collected. This period of time was ample for virtually all students to complete the reading and the workbook. Attendance was taken by having the students write their name on the workbook sheets.

As soon as all textbooks and workbook materials were collected, the tape recorder was stationed on a desk in the center of the class. It was turned on as soon as the class (Treatments B and D) was completely quiet. The lectures ran from seven to nine minutes each. At the completion of the lecture, the tape recorder was removed and the class was presented discussion questions posed by the instructor. The students were asked to respond by holding up their hand. Several individuals were permitted to respond to each question until the answers sufficiently matched the predetermined responses or were sufficiently correct to render further discussion useless. The attempt was made to give as many different persons opportunity to respond as possible. Approximately two and one-half minutes were allowed for each question. If several incorrect
attempts to answer a question were made, the instructor provided clues until the correct response was made by the students.

With Treatment C, the laboratory activity was begun as soon as the text-workbook period was complete. With Treatment D, the laboratory activity was begun as soon as the lecture-discussion was complete. In both cases, the materials for each unit were passed out and the instructor explained what the class was to do. If the activity required that the class work in groups, the groups were formed around drawing tables. In all units except the fourth, the students were entirely on their own except for instructions given by the instructor. The instructor was, however, available for answering questions regarding word meanings and for misunderstandings regarding instructions. Aid was given only in cases where words needed definition or where questions concerning procedure needed clarification. No other kind of individual aid was given.

DEVELOPMENT OF THE ACHIEVEMENT TEST

An achievement test was devised by this investigator to measure the subjects' understanding of the concepts presented in the teaching materials. The first task in constructing the test was to search the textbook readings and compile all information which could provide an understanding of the selected concepts. This formed a basis
for devising the test items since the information which could be learned for each concept was now known. From this information, at least two test items were written having the stem incorporate an application of the concept. Multiple-choice items were employed in the test, so that they could be machine scored and so that consistency of form and format would be achieved. The distractors were so written that they frequently would appear to be sensible answers. The correct answer was the concept word correctly relating to the situation described in the stem. Many distractors were other concept words utilized in the treatment, though inappropriate to the stem situation. The items were generally constructed following the guidelines of The Psychological Corporation of New York City and the Educational Testing Service of Princeton, New Jersey.

Since only persons very familiar with the IACP rationale and structure knew the connotations of each word concept, only those persons could be used for validating the test item content. Even this was a problem since only a handful of the IACP staff was thoroughly familiar with this particular segment of the total structure and equally familiar with its use in the curriculum materials. Five persons who were believed to be adequately grounded with this knowledge were choosen to answer the first draft of 149 test items. Suggestions for improvement were also
solicited from these persons. The results of this trial test administration were used in eliminating items which were invalid and in modifying others for which improvement was indicated. In order to determine its length and to begin an examination of its validity, the resulting draft of 131 items was administered to thirty-two 14 to 16 year-old students in ninth grade classes who had no instruction with the experimental teaching materials.

This trial test administration indicated (1) that the test was too long and (2) that certain items were being correctly answered by an unusually large number of persons. On the whole, however, the scores indicated little better than random guesswork. Rather than subject this test to statistical treatment on the basis of such a small and relatively ill-defined sample, this investigator decided to eliminate, arbitrarily, all items which were correctly answered by eleven or more of the thirty-two persons who took the test. The reasoning used here was that random guess-work, all other factors being equal, would produce correct responses for each item eight times out of thirty-two attempts, since there were three distractors plus the correct response for each item.

The length of time for this second trial test administration ranged from forty-five minutes to one hour and ten minutes. After the above-noted questions were
removed, the third draft totaled 113 items on which the thirty-two ninth graders scored below that expected from random guessing. It was decided that rather than have a pilot study, complete with presentation of the experimental materials, this draft of the test would be administered for the first measure of the experimental groups. On consulting with authorities in testing, this investigator was informed that it would be legitimate, and valid, to run statistical treatment on this test and to use the results to eliminate those questions which proved unreliable. The remaining questions could then be used for the experimental comparison and in the construction of a shorter re-test. The administration of the third-draft, 113 item test took a total time of one hour, although many persons completed the test in considerably less time. The results of the analysis of the 113 item test are shown in Table 4. The re-made test, consisting of 72 items, was also analyzed and the results are shown in the parentheses in Table 4. The 72 item test was the one administered for the re-test and the same items were the ones analyzed for all Ss on the first administration.

\[1\] Dr. Robert W. Ullman, Director of The Ohio State University Center for Measurement and Evaluation, and his associates, provided invaluable assistance in this matter.
TABLE 4

ANALYSIS OF THE THIRD-DRAFT, 113-ITEM TEST AND FOURTH-DRAFT, 72-ITEM TEST (72-ITEM TEST VALUES ARE IN PARENTHESES)

A. Number of items on test: 113 (72)
   Number of Ss: 42 (111)

B. Raw Scores: See Appendix F


D. Mean Test Score: 34.19 (27.44)

E. Median: 31 (26)

F. Mode: 29 (19)

G. Standard Deviation: 11.51 (9.91)

H. Skewness: 0.62 (0.42)

I. Kurtosis: -0.31 (-0.47)

J. Group Statistics: Percent Ss

<table>
<thead>
<tr>
<th>Total</th>
<th>100 (100)</th>
<th>Mean Score</th>
<th>34.19 (27.44)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>50 (27)</td>
<td>44.10 (40.10)</td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>50 (27)</td>
<td>25.18 (16.16)</td>
<td></td>
</tr>
</tbody>
</table>

K. Reliability Estimates:

- Kuder-Richardson 20 = 0.836 (0.850)
- Kuder-Richardson 21 = 0.827 (0.839)

L. Item Analysis (item-difficulty distribution):

<table>
<thead>
<tr>
<th>Range</th>
<th>Number of Items</th>
<th>Percentage of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.81-.100</td>
<td>21 (5)</td>
<td>19 (7)</td>
</tr>
<tr>
<td>.62-.80</td>
<td>69 (37)</td>
<td>61 (51)</td>
</tr>
<tr>
<td>.41-.60</td>
<td>22 (26)</td>
<td>19 (36)</td>
</tr>
<tr>
<td>.21-.40</td>
<td>1 (4)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>.00-.20</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

M. Mean Item Difficulty = .697 (0.619)

N. Item-Discrimination Difficulty Distribution:

<table>
<thead>
<tr>
<th>Range</th>
<th>Number of Items</th>
<th>Percentage of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>.81-.100</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>.61-.80</td>
<td>0 (6)</td>
<td>0 (8)</td>
</tr>
<tr>
<td>.41-.60</td>
<td>9 (22)</td>
<td>8 (31)</td>
</tr>
<tr>
<td>.21-.40</td>
<td>41 (24)</td>
<td>36 (33)</td>
</tr>
<tr>
<td>.00-.20</td>
<td>46 (16)</td>
<td>41 (22)</td>
</tr>
<tr>
<td>Below .00</td>
<td>17 (4)</td>
<td>15 (6)</td>
</tr>
</tbody>
</table>

Mean Item Discrimination = .167 (.332)
The test score distribution (B) and Range (C) indicate a relatively wide range of test scores and this caused the platykurtic positively skewed curve indicated under I in Table 4. One cause of this phenomenon could have been the long length of the test. The mean test score (D) indicates that the relative difficulty of the test is quite high. This conclusion is reinforced by the distribution of scores under the item analysis (L). The standard deviation was of little significance for this analysis, but of importance were the skewness and kurtosis resulting from the 113-item test. Quite obviously, the obtained curve varies considerably from normal. The curve may be approximately represented as in Figure 11.

FIGURE 11
APPROXIMATE DISTRIBUTION OF SCORES ON THIRD-DRAFT TEST

The group statistics (J) are merely of passing interest at this stage, but will be discussed fully in Chapter Four. The reliability estimates (K) gave encouragement to this investigator. However, it is recognized that the length of the test had bearing on this statistic.
It was expected that this estimate could be pushed still higher after reconstruction of the test. Of special interest are the item analysis \((L)\), showing the difficulty distribution, and the discrimination distribution \((N)\). It may be noted that each of these is relatively low, although many test items discriminated quite well.

The results of the data in Table 4 were used to modify the test. All work in this direction was performed before any between-group analyses were made, so as not to create a source of bias.

Few constructive guidelines could be found regarding how the data shown in Table 4 might be used to improve test construction. Therefore, decisions had to be based to some extent on this investigator's knowledge of test construction and on "directional hunches." Nevertheless, the margin of movement was not entirely open since the data themselves provided boundaries within which to work.

In addition to determining the range, median, mode, skewness, and kurtosis, the following statistical treatments were run on each item: (1) relative item difficulty, (2) Phi coefficient, (3) point biserial correlation coefficient, (4) Kuder-Richardson 20 and 21 formulas, and (5) the discrimination index. Each of these is discussed below.

The measure of relative item difficulty is the percentage of students missing the items. As the percentage
increases, the item is more difficult. The Phi coefficient is an item-item relationship between the upper and lower groups. For this analysis the upper and lower groups were defined as the upper and lower fifty percent of the scores on the test. The point biserial correlation coefficient shows the relationship of the item to the total score on the test. It gives a measure of the validity of that item. It is therefore, a measure of the internal consistency of the test.

The Kuder-Richardson (KR) Formulas 20 and 21 are indexes of the internal consistency, or reliability, of the test and are functions of the number of items on the test, the variability of scores, and the proportion passing and failing each item. The KR Formula 21 differs from the KR 20 in that the mean score of each group is used instead of the percent passing and failing each item. The discrimination index reflects the degree to which the item discriminates between the upper and lower groups.

After examining the range and mean of the 113-item test, it was decided to analyze (1) the difficulty of each item, (2) the obtained point biserial correlation coefficient, and (3) the obtained discrimination index for making judgments concerning the value of each test item. This investigator wanted to construct the re-test so that superior questions were employed, numbering in the range
of 60 to 75 items. This shorter length was deemed desirable for maintaining student motivation.

The first statistic analyzed for each item was the obtained discrimination index, (see N on previous table). It can be seen that many of the test items did not discriminate adequately between those who performed well on the test and those who did not. Several of the items even had negative indexes. It was decided first to eliminate all items which failed to discriminate to the .15 percent level. This immediately eliminated more than 25 test items. Second, it was decided to maintain an item difficulty level in the range of .40 to .70, although this was kept flexible depending on the discrimination index for any particular item. All items above .80 difficulty were immediately dropped. Beyond this, value judgments played heavily in selecting or rejecting items for the re-test. For example, certain items were evaluated in terms of measuring the concepts involved in the experiment. The point biserial correlation coefficient was considered; an attempt was made to keep its level above .20. Typically, the latter statistic was related to the level of discrimination and difficulty.

The final draft of the test, used for the re-test, consisted of 72 items. It is shown in Appendix G. As can be seen from Table 4, (numbers in parentheses), the final (72 item) draft was an improvement over the 113 item test.
THE EXPERIMENTAL DESIGN

The experimental design used for this study has employed four major groups which were designated A, B, C, and D. Group A was the control treatment, exposed to textbook-workbook learning materials only. Group B was exposed to the textbook-workbook and the lecture-discussion. Group C was exposed to the textbook-workbook and laboratory activity, and Group D was exposed to the textbook-workbook, lecture-discussion, and laboratory activity. The experimental design is portrayed in Figure 12. There are eight basic aspects to the design:

1. The sample population of eight eighth grade classes is selected.
2. The sample is divided into four groups of two classes each by matching one high ability class to each low ability class on the basis of reading and arithmetic achievement and intelligence test scores.
3. Each group, (A, B, C, and D) is exposed to the same treatment, using a textbook and workbook, for a period of 30 minutes, to present each of four teaching units.
4. Groups B and D are exposed to lecture-discussion for a period of 15 minutes, for each of four units.
5. Groups C and D are exposed to laboratory activity for a period of 35 minutes, for each of four units.
FIGURE 12
THE EXPERIMENTAL DESIGN

INTRODUCTION
5-6 DAYS BEFORE FIRST TREATMENT

30 MINUTES

15 MINUTES

35 MINUTES

5-6 DAYS AFTER FINAL TREATMENT

3 WEEKS AFTER FIRST MEASURE

SAMPLE

GROUP A GROUP B GROUP C GROUP D

30 MINUTES TEXT WORKBOOK

15 MINUTES

35 MINUTES

5-6 DAYS AFTER FINAL TREATMENT

3 WEEKS AFTER FIRST MEASURE

ACHIEVEMENT TEST

TREATMENT OF DATA

COMPARISON: GROUPS A & B

COMPARISON: GROUPS A & C

COMPARISON: GROUPS A & D

COMPARISON: GROUPS B & C

COMPARISON: GROUPS B & D

COMPARISON: GROUPS C & D
6. All groups are tested on their attainment of concept understanding.

7. All groups are re-tested on their attainment of concept understanding.

8. The data are analyzed as follows:
   a. From the achievement of groups A and B
   b. From the achievement of groups A and C
   c. From the achievement of Groups A and D
   d. From the achievement of Groups B and C
   e. From the achievement of Groups B and D
   f. From the achievement of Groups C and D

Independent Variables

The independent variables are the methods of instruction described above. Each teaching component remained unchanged, regardless of its arrangement in the total instructional package. Each group received instruction using the textbook-workbook. In addition to this, Groups B, C, and D received instruction using lecture-discussion and/or laboratory activity in various combinations. The period of exposure to the teaching materials was as follows; Group A, 30 minutes; Group B, 45 minutes; Group C, 65 minutes; and Group D, 80 minutes.

Controlled Variables

To increase the internal validity of the study, five groupings of variables were controlled. They are (1) the
presentation of the teaching materials to each group, (2) the equipment and materials, (3) the exposure time, (4) the time between exposures and tests, and (5) selected attributes of the sample (reading achievement, arithmetic achievement, intelligence, and age).

**Dependent Variable**

The dependent variable was the Ss' performance on the criterion achievement test.

**Confounding or Extraneous Variables**

This investigator was aware of extraneous variables which are difficult, or for practical purposes, impossible to control. Precautions were taken to keep student motivation at a high level. Outside noise level was partially controlled by keeping classroom doors closed and by restricting entrance by outside persons. Percentages of under and over-achievers in each class were not controlled, though no noticeable differences were witnessed from one class to another. No unforeseen disturbances were encountered.

**SUMMARY**

In summary, Chapter Three provides a rationale for the selection of the concepts used in this study and describes the instructional instruments used during the experiment. The final draft of the achievement test was developed by eliminating the less valid and less reliable items through three administrations of the test. An item
analysis was conducted on the test and the resulting
difficulty levels, the point biserial correlation coeffic­
ients, and the discrimination indexes for each item were
obtained. The result of this analysis provided a guide
for eliminating many of the items. The final draft test
consisted of 72 items selected from the original 149. The
methodology of the study is portrayed graphically and a
description of the variables and the experimental procedure
is given. The sample was drawn from three junior high
schools. The final N was 111 eighth graders.
CHAPTER IV
PRESENTATION AND ANALYSIS OF THE DATA

In this chapter, the data obtained from the experiment are presented and analyzed. The statistical treatments performed are detailed and the results of the treatments are set forth as they relate to the six hypotheses stated in Chapter One. The findings are then examined for possible implications.

TREATMENT OF THE DATA AND THE RESULTS

In Chapter Three it was stated that eight classes of eighth-grade students were selected for the sample and that these were arbitrarily paired, high to low ability, to form the required four groups. The final N for each group was 29 in Group A, 26 in Group B, 29 in Group C, and 27 in Group D. Data were obtained on each S by examining school records for reading and arithmetic achievement and intelligence. The students' ages were obtained in years and months, from their own response. Only Ss with an age falling between plus and minus one and one half years from age fourteen were used in the sample.

The data used to analyze the results of the treatments are the reading and arithmetic achievement scores, the
intelligence quotients, and the scores on the first and second criterion testing instrument. The means and standard deviations of these measures for each group are shown in Tables 5 through 7. Each of the individual scores is shown in Appendix F.

As stated in Chapter One, the aim of this investigator was to attempt to determine the differential role that the different teaching components play in learning technological concepts initially learned in written learning materials. The first analysis made of the data to attain that end was to examine the extent of homogeneity among the groups. To determine if the groups were equal in ability and achievement in each of the selected ability factors, an analysis of variance was performed on the scores of the groups for each test. As shown by Tables 5, 6, 7, 8, and 9, the differences between mean scores of groups on the reading and arithmetic achievement tests, intelligence test, and Criterion Tests #1 (T1) and #2 (T2) are slight. The amount of statistical difference which was accepted as significant by this investigator was the .05 level. Therefore, the statistical treatments indicate that any differences which do exist can be attributed to sampling error and not to treatment effect (in the case of T1 and T2).
### TABLE 5
**ANOVA SUMMARY TABLE OF FOUR GROUPS OF READING ACHIEVEMENT SCORES**

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>29</td>
<td>26</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>Mean</td>
<td>8.7</td>
<td>8.7</td>
<td>8.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.3</td>
<td>1.4</td>
<td>1.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Between Groups</strong></td>
<td>46.303</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within Groups</strong></td>
<td>17,888.632</td>
<td>107</td>
<td>167.284</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17,934.935</td>
<td>110</td>
<td>167.184</td>
<td></td>
</tr>
</tbody>
</table>

* needed for significance with three and 107 DF is 2.70

### TABLE 6
**ANOVA SUMMARY TABLE OF FOUR GROUPS OF ARITHMETIC ACHIEVEMENT SCORES**

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.5</td>
<td>8.5</td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.1</td>
<td>1.1</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Between Groups</strong></td>
<td>18.424</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within Groups</strong></td>
<td>11,669.107</td>
<td>107</td>
<td>109.063</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11,687.531</td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 7
ANOV SUMMARY TABLE OF FOUR GROUPS
OF INTELLIGENCE TEST SCORES

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>106.1</td>
<td>103.5</td>
<td>109.0</td>
<td>106.4</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>12.1</td>
<td>12.8</td>
<td>10.7</td>
<td>12.7</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Square</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>415.903</td>
<td>3</td>
<td>138.635</td>
<td>0.954</td>
</tr>
<tr>
<td>(N.S.)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>15,553.393</td>
<td>107</td>
<td>145.359</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15,969.296</td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 8
ANOV SUMMARY TABLE OF FOUR GROUPS
OF ACHIEVEMENT TEST #1 SCORES

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>27.1</td>
<td>28.8</td>
<td>27.8</td>
<td>27.1</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>9.1</td>
<td>11.0</td>
<td>10.5</td>
<td>9.4</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Square</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>53.262</td>
<td>3</td>
<td>17.754</td>
<td>0.174</td>
</tr>
<tr>
<td>(N.S.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>10,921.511</td>
<td>107</td>
<td>102.070</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10,974.774</td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 9
ANOVA SUMMARY TABLE OF FOUR GROUPS OF ACHIEVEMENT TEST #2 SCORES

<table>
<thead>
<tr>
<th></th>
<th>GROUP A</th>
<th>GROUP B</th>
<th>GROUP C</th>
<th>GROUP D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>26.4</td>
<td>28.3</td>
<td>30.2</td>
<td>28.3</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>10.4</td>
<td>10.9</td>
<td>11.8</td>
<td>10.6</td>
</tr>
<tr>
<td>Sum of Squares</td>
<td>216.202</td>
<td>3</td>
<td>72.101</td>
<td>0.101</td>
</tr>
<tr>
<td>DF</td>
<td>3</td>
<td>107</td>
<td>119.907</td>
<td>(N.S.)</td>
</tr>
<tr>
<td>Mean Square</td>
<td>0.101</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The F ratio required for significance at the .05 level with three and 107 degrees of freedom is 2.70. It is clear that the groups showed a high degree of homogeneity in each of the measures. On the basis of these results, the first three hypotheses tentatively may be accepted.

However, since the ANOV on Criterion Tests #1 and #2 did not account for possible differences that may still exist when taking into account the combined effects of reading achievement, arithmetic achievement, and intelligence on the students' performance, an analysis of covariance was performed using these three factors as covariates in analyzing (1) the difference between the means of T2 minus T1 and (2) the difference between the means on T1 and on T2. Tables 10, 11, and 12 summarize these analyses.
### TABLE 10
ANOV OF T2 MINUS T1 WITH THE SCORES ADJUSTED FOR THE EFFECTS OF READING, ARITHMETIC, AND INTELLIGENCE DIFFERENCES

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>YY</th>
<th>SUM OF SQUARES (due)</th>
<th>SUM OF SQUARES (about the Mean)</th>
<th>DF</th>
<th>MEAN SQUARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (between)</td>
<td>3</td>
<td>86.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error (within)</td>
<td>107</td>
<td>7,554.8</td>
<td>111.7</td>
<td>7,443.1</td>
<td>104</td>
<td>71.6</td>
</tr>
<tr>
<td>Treatment plus error (total)</td>
<td>110</td>
<td>7,641.0</td>
<td>124.1</td>
<td>7,517.0</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Difference for Testing Adjusted Treatment Means</td>
<td></td>
<td>73.9</td>
<td>3</td>
<td>24.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F = 0.344 (with three and 104 degrees of freedom); N. S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 11
ANOV OF THE DIFFERENCE BETWEEN THE MEANS ON T1 WITH THE SCORES ADJUSTED FOR DIFFERENCES IN READING AND ARITHMETIC ACHIEVEMENT, AND INTELLIGENCE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>YY</th>
<th>SUM OF SQUARES (due)</th>
<th>SUM OF SQUARES (about the Mean)</th>
<th>DF</th>
<th>MEAN SQUARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (between)</td>
<td>3</td>
<td>53.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error (within)</td>
<td>107</td>
<td>10,921.5</td>
<td>3,758.5</td>
<td>7,163.0</td>
<td>104</td>
<td>68.9</td>
</tr>
<tr>
<td>Treatment plus error (total)</td>
<td>110</td>
<td>10,974.8</td>
<td>3,743.9</td>
<td>7,230.8</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Difference for Testing Adjusted Treatment Means</td>
<td></td>
<td>67.8</td>
<td>3</td>
<td>22.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F = 0.328 with three and 104 degrees of freedom; N. S.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 12

ANOV OF THE DIFFERENCE BETWEEN THE MEANS ON T2 WITH THE SCORES ADJUSTED FOR DIFFERENCES IN READING AND ARITHMETIC ACHIEVEMENT, AND INTELLIGENCE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>YY</th>
<th>SUM OF SQUARES</th>
<th>SUM OF SQUARES (about the mean)</th>
<th>DF</th>
<th>MEAN SQUARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (between)</td>
<td>3</td>
<td>216.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error (within)</td>
<td>107</td>
<td>12,830.0</td>
<td>3,014.5</td>
<td>9,815.5</td>
<td>104</td>
<td>94.4</td>
</tr>
<tr>
<td>Treatment plus error</td>
<td>110</td>
<td>13,046.3</td>
<td>3,081.8</td>
<td>9,964.6</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Difference for Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Treatment Means</td>
<td></td>
<td>149.1</td>
<td></td>
<td></td>
<td>3</td>
<td>49.7</td>
</tr>
</tbody>
</table>

F = 0.526 with three and 104 degrees of freedom; N.S.

On the basis of the data illustrated in Tables 10 through 12, it is apparent that to pursue this type of analysis further, in search of proof of significant differences as a result of the treatments, would be futile. On the basis of the ANOV and the analysis of covariance, it can be concluded that the variation of the means on T1 and T2 occurring with each group reasonably can be attributed to sampling error and that Treatments B, C, and D did not have a differential or additive effect on learning technological concepts.
Even though no significant differences were found among the means of each group on T1 and T2, it was felt that the different teaching methods might have an effect on the retention of concepts over a three-week period. An examination of the arrangement of the treatments revealed that the lecture-discussion and laboratory activity can be factored out of the total to examine groups either having, or not having, one or both of each treatment type.

With this plan in mind, it was possible to construct a two-by-two table as shown in Table 13. This table shows the difference between the means of Criterion Tests #1 and #2 across each of the treatments. These values were then analyzed for the variance of the means.

TABLE 13
TWO-BY-TWO TABLE ILLUSTRATING DIFFERENCE OF T2 MINUS T1

<table>
<thead>
<tr>
<th>NO LAB. ACTIVITY</th>
<th>LAB. ACTIVITY (Y)</th>
</tr>
</thead>
</table>
| NO LECTURE-
DISCUSSION      | -0.793            | 2.414 (Y) |
| LECTURE-
DISCUSSION (X) | -0.500 (X)       | 1.259 (XY) |

Total = -1.293  Total = 3.973
Avg. = -0.647   Avg. = 1.984
difference = 5.266
By summing the difference of the means of T2 minus T1 for those groups having or not having lecture-discussion and those having or not having laboratory activity, it was possible to analyze the difference between each of these values. This difference, also shown in Table 13 is .861 between those having and not having lecture and 5.266 between those having and not having laboratory activity. Although these differences were not statistically significant to the .05 level, there were some differences which may be seen readily in graph form. Figure 13 illustrates these differences.

It may be seen in Figure 13 that the laboratory activity component had the greatest effect on maintaining retention. Those students who did not receive either lecture-discussion or laboratory activity and those who were exposed only to lecture-discussion, lost an understanding of a portion of the concepts initially learned in the textbook. The average loss was .647 of a point on Criterion Test #2. The students who were not exposed to either lecture-discussion or laboratory activity showed the greatest decrease in retention. This decrease was .793 of a point.

Both groups of students exposed to laboratory activity showed increases in learning from T1 to T2. The average increase was 1.984 points from Criterion Test #1 to Criterion
FIGURE 13

EFFECT OF LECTURE-DISCUSSION AND LABORATORY ACTIVITY ON RETENTION OF CONCEPTS FROM T1 TO T2

Test #2. For a reason that cannot be explained by this investigator, the students exposed to laboratory activity, but not to lecture-discussion had the largest (but not significant) gain from T1 to T2. This gain averaged 2.414 points. A two-way ANOV performed on these differences resulted in the F values shown in Table 14.
TABLE 14

ANOV OF THE EFFECTS OF EACH TREATMENT TYPE ON RETENTION

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>SUM OF SQUARES</th>
<th>DF</th>
<th>MEAN SQUARE</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Cells</td>
<td>8493.5</td>
<td>107</td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>4.8</td>
<td>1</td>
<td>4.7</td>
<td>0.060 (N.S.)</td>
</tr>
<tr>
<td>Laboratory Activity</td>
<td>175.6</td>
<td>1</td>
<td>175.6</td>
<td>2.212 (N.S.)</td>
</tr>
<tr>
<td>Lecture and Laboratory Activity</td>
<td>14.5</td>
<td>1</td>
<td>14.5</td>
<td>0.183 (N.S.)</td>
</tr>
</tbody>
</table>

DISCUSSION OF THE RESULTS

Hypotheses Restated

As a result of this investigation, the following conclusions are drawn about each of the hypotheses stated in Chapter One:

Hypothesis One: In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to non-written verbal learning materials.

The results of this investigation did not reveal any statistically significant differences between the two groups of students described in Hypothesis One. The $H_0$ is, therefore, accepted.
Hypothesis Two: In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to discovery learning materials.

The results of this investigation did not reveal any statistically significant differences between the two groups of students described in Hypothesis Two. The $H_0$ is, therefore, accepted.

Hypothesis Three: In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught only with written learning materials and the achievement of students taught with an added exposure to non-written verbal and discovery learning materials.

The results of this investigation did not reveal any statistically significant differences between the two groups described in Hypothesis Three. The $H_0$ is, therefore, accepted.

Hypothesis Four: In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials and
discovery learning materials and the achievement of students taught with written learning and verbal learning materials.

The results of this investigation did not reveal any statistically significant differences between the two groups of students described in Hypothesis Four. The H₀ is, therefore, accepted.

**Hypothesis Five:** In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials, and non-written verbal learning materials and the achievement of students taught with written learning materials, non-written verbal learning materials, and discovery learning materials.

The results of this investigation did not reveal any statistically significant differences between the two groups of students described in Hypothesis Five. The H₀ is, therefore, accepted.

**Hypothesis Six:** In understanding selected technological concepts, there is no significant difference, as measured by a criterion test, between the achievement of students taught with written learning materials and discovery learning materials and the achievement of students taught with written learning materials, non-written learning materials, and discovery learning materials.
The results of this investigation did not reveal any statistically significant difference between the two groups described in Hypothesis Six. The $H_0$ is, therefore, accepted.

General Discussion

The statistical treatments of the data indicate that there is no significant increase in learning technological concepts when lecture-discussion and/or laboratory activity is provided for eighth grade students who have read textbook materials in controlled classroom learning under limitations such as those imposed on this investigation. In accepting the null hypotheses, this investigator has confirmed the notion that under the experimental teaching circumstances in which the study was conducted, the non-written verbal learning materials and the discovery learning materials have no significant effect on the amount of concept learning initially gained from written learning materials. On the basis of test scores on an achievement test designed to test students' ability to match a given situation to its appropriate concept word, no significant differences were evidenced among any of the treatment groups.

It was recognized that certain limitations were inherent in the learning materials that have made up each of the teaching components. For example, interaction is inherent in textbook and laboratory materials, the latter of which requires the student to do a certain amount of
reading. The same is true of lecture-discussion and laboratory activity where the latter requires two or more students to discuss certain aspects of the activity at hand. Obviously this is a difficult, if not insurmountable, problem to overcome. It is, therefore, recognized that a Type II error in accepting the null hypotheses is a distinct possibility, but it is one that cannot be resolved due to the type of research performed in this investigation.

Although this investigator failed to provide evidence supporting significant effect of the teaching components on concept learning, the laboratory activity component had a noticeable, but not statistically significant, effect on the retention of learning. A slight increase in learning from T1 to T2 was shown by the groups having the laboratory activity while a slight decrease was evidenced by the groups not having this component. Nevertheless, these differences may be attributed to sampling error.

Assuming reasonable validity in the definitions and limitations placed on each of the three teaching components employed, the findings indicate that written learning materials are as efficient, if not more efficient, than either of the other two methods used and that non-written verbal and discovery methods add little, if anything, to facilitating the task of concept learning. Considering the time factor required to utilize each of the teaching
methods, the findings further indicate that written learning materials are the most efficient means of conveying an understanding of technological concepts.
CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes the study and provides the reader with an overview of the procedures used in carrying out its objectives. The conclusions and recommendations, being the climax of the effort, will provide a perspective on the use of written, non-written verbal, and laboratory teaching methods. If properly implemented, the recommendations can provide the educator with a point of view from which thinking may be generated about teaching method. They can also provide the future investigator with bases for additional research.

SUMMARY

Little direct research has been performed on the appropriateness of textbook materials, non-written verbal learning materials, and laboratory activity toward the objective of learning concepts inherent in industrial technology. The major objective of this study was, therefore, to obtain evidence about the value of verbal non-written and laboratory teaching methods as reinforcing agents in learning technological concepts initially
presented in written learning materials. Hypotheses were formulated regarding the impact of the various combinations of the three teaching components on eighth grade students on learning technological concepts. Assumptions, definitions, and limitations were stated which provided bounds in which to conduct the experiment.

Review of the Literature

The review of the literature was an examination of publications pertinent to this study. The background of the IACP and the foundations of its curriculum were described. It was established that the IACP curriculum has been based on a conceptual framework by which industrial technological practices are identified by means of key concept words. Additional references were used to help define the relationship of words to concepts and to aid in constructing an instrument that would measure concept understanding. Several authorities holding contrasting points of view were cited to illustrate the existing dilemma in assigning values to various teaching-learning methods. Evidence was presented in this section that children, by the time they reach adolescence, are capable of learning through verbal means rather than having to rely largely upon concrete activity. A few references were included which established the need for the kind of research performed by this investigator.
Methodology

Chapter Three described the development of the experimental tools, the selection of technological concepts, the selection of the sample, and the conduct of the experiment. The technological concepts used in this investigation were derived from the conceptual structure on which the IACP based its curriculum. The total number of concept words employed was thirty eight, each relating to practices found in the manufacturing branch of the IACP curriculum. The experimental materials consisted of textbook readings, workbook problems, lecture-discussion questions, and laboratory activity. The textbook readings were taken directly from the manufacturing curriculum of IACP. The workbook questions and problems were largely those of the IACP curriculum, although new, additional questions were devised to assure reference to all concepts used.

The lecture and discussion were totally devised by this researcher; they assured reference to all concept words and to many related understandings. The laboratory activity was partially borrowed from the IACP curriculum and partially devised. Assurance was made that all concept words would be employed with as many of their respective applications to industrial practices as possible.

The achievement test was structured so that the student would have to select the correct concept word
from among four which related to a situation in industry. The achievement test was validated by experts and examined for reliability through repeated test administrations.

The sample was selected from three middle socio-economic junior high schools in Columbus, Ohio. It was limited to eighth grade students (1) with reading achievement scores on standardized tests above 6.9 grade level, (2) with arithmetic scores on standardized tests above 5.9 grade level, (3) with intelligence scores on standardized tests above 79, and (4) who were males within plus or minus one-and-one-half years of age 14. The final sample, after disqualification and mortality, totaled 111 Ss with 26 to 29 Ss per group.

Four groups were employed in this investigation. The first group, designated Treatment A (Control), was exposed to written learning materials only. The second group, designated Treatment B, was exposed to written learning materials and to lecture-discussion. The third group, designated Treatment C, was exposed to written learning materials and to laboratory activity. The fourth group, designated Treatment D, was exposed to all three teaching components.

The experiment was designed so that each group would be exposed to the textbook-workbook learning materials for 30 minutes. The second group (Treatment B) would be
additionally exposed to lecture-discussion for 15 minutes, a third group (Treatment C) to laboratory activity for 35 minutes, and a fourth group (Treatment D) to both lecture-discussion and laboratory for a total time of 80 minutes. All classes met for 87 minutes. The time not used in the treatments was spent in activity unrelated to the experiment. Four units were taught by this procedure. Each group was administered the achievement test to measure its understanding of concepts five to six days following the fourth unit and again three weeks after the first test.

Analysis of the Data and Findings

The major objective of this investigation was to examine the role that non-written verbal and laboratory teaching methods play in learning technological concepts initially presented in written learning materials. Hypotheses were stated, in the null form, which proposed that the addition of the verbal non-written and laboratory teaching components would have no effect on the achievement of learning concepts. The requirement for rejecting any, or all, or the hypotheses would be a statistically significant difference at the .05 level in one or more of the achievement test means of the four different treatment groups.

The data were analyzed by ANOV and analysis of covariance. The results of the statistical treatments revealed no significant differences between any of the
groups in learning technological concepts. The findings indicated (1) that the lecture-discussion and laboratory activity have no effect on learning technological concepts initially learned in textbook materials, and (2) that written materials are at least as efficient, if not more efficient, as other means by which technological concepts may be learned by eighth grade children. An analysis of covariance was performed on the difference of means of T1 and T2 to examine the effects of each type of component on retention of learning. Though the differences did not meet the level of significance set for this study, the effects noticed between the groups having or not having exposure to the lecture-discussion and laboratory activity provide fertile ground for further investigation.

CONCLUSIONS

On the basis of achievement test scores, all hypotheses can be accepted within the limitations set forth for this study. Specifically, the following conclusions were drawn based on the evidence obtained in this investigation.

1. Once a certain number of concepts are mastered from written learning materials, an additional exposure to learning modes of the lecture-discussion and laboratory activity type do not have a significant effect on the learning of additional technological concepts with adolescent-age children.
2. Because there are no significant differences between any of the teaching methods in learning technological concepts, there is no substantial evidence to support the contention of superiority of lecture-discussion over laboratory activity or vice versa, nor is there any advantage in adding either or both types of activities to a school program in hopes of facilitating technological concept formation in adolescent-age children.

3. In view of the time factor involved, it can be generalized that written learning materials are more efficient means of learning technological concepts than are lecture-discussion and laboratory activity, singly or in combination with adolescent-age children.

RECOMMENDATIONS

Several recommendations are presented in this section which particularly relate to the objectives stated in Chapter One. The first group of recommendations deal with the need to analyze further the type of problem dealt with in this investigation. They reflect certain of the limitations on this kind of research. The second group deal with curriculum planning and development. The third group of recommendations relate to the teaching-learning situation.
Recommendations to Educational Investigators

Owing to the nature of this problem and the methods used in performing this research, valuable insights were gained which can aid investigators in further validation, or rejection, or the conclusions drawn in this study. The following recommendations are stated on the basis of the experience gained from performing this investigation.

1. Because of the importance of concept formation in learning and the additional importance of learning efficiency, it is recommended that continued efforts be made toward determining the relative merits of different teaching modes in learning concepts by experimenting with variations of each teaching mode in different learning situations and under different learning conditions.

2. Additional research of this type should be performed using different concepts, technological and otherwise, to verify further or probe the findings of this investigator.

3. Research of a philosophical nature should be conducted to provide improved guidelines delimiting the content, nature, and bounds of each of the instructional modes employed in this study. Experimental precision concerning the teaching modes is in need of improvement when employed in a relatively naturalistic setting.
4. Although the present study did not examine the transfer and application of learned concepts, beyond the ability to recognize them on a test, the importance of transfer of learning is fully recognized. It is recommended that the effects of the differing teaching methods on the ability to apply and transfer concept learning to differing situations be tested.

5. Interest in learning and motivation for learning are recognized as highly important functions in the education of youth. Even though lecture-discussion and laboratory activity made little, or no difference in the amount of concept learning, it is possible that without these components, written learning materials would lose their efficiency over an extended period of use. It is therefore recommended that interest and motivational factors be studied as they relate to the different teaching modes.

6. Although highly significant differences were not obtained in the effects of lecture-discussion and laboratory activity, there is a fairly high probability that these components affected the level of retention of learned concepts. In view of this, it is recommended that further investigation be performed which would better establish a relationship, or lack of it, between these two factors on the retention of learned concepts.
7. This investigation was based on the assumption that the quantity of concepts and their meanings could not have been learned in the time permitted without the use of textbook materials. It might be fruitful to examine the efficiency of the lecture-discussion and laboratory activity in concept learning without the employment of the text materials, or in comparison with the text materials.

8. The conclusions of this investigation were based upon the analysis of the performance of groups of students. Since the three types of learning materials might have a differential effect on students displaying differing achievement, ability, and personality characteristics, it is recommended that further investigation be performed which might uncover effects of the methods on individuals.

Recommendations to the Curriculum Developer

The type of research performed in this investigation is vital to curriculum development and revision. Often, the research must be tailored to match the kind of curriculum development being performed. This was largely true in the present study. On the other hand, certain of the theories may be generalizable to all learning regardless of the subject matter employed. The following recommendations are primarily directed toward persons working in the area of curriculum development.
1. It is apparent that certain kinds of learning tasks readily lend themselves to several, or all, of the teaching methods employed. It is also apparent that certain other learning tasks are less suitable for certain of the teaching methods commonly employed. It would appear appropriate to remind the curriculum developer that it is far better to employ the most efficient method for teaching a given unit of study rather than be bound to policies which require certain, or several, teaching methods simply for the sake of continuity of program. It is therefore recommended that curriculum developers keep their programs flexible enough so that they are not bound to certain styles which must be maintained regardless of the content of a given unit of study.

2. The relatively high degree of efficiency of written materials in learning technological concepts would indicate that they are, for practical purposes, essential to an efficient program of learning. A major problem, evidenced from this researcher's empirical experience, is that much of the reading in school is highly voluntary on the part of the students and is done, at least in the IACP, outside of the classroom, whereas the other curriculum components require mandatory student participation.
The results of this investigation would indicate a misplaced emphasis in this respect. It is recommended, therefore, that thought be put into incorporating textbook reading directly into the students' obligations of classroom participation.

3. The previous recommendation focuses attention on another which deals with the students' ability and inclination toward learning from written materials. This point is certainly not unique to this study, nor is it restricted to industrial arts. Nevertheless, it is recommended that curriculum developers continue to pursue the search for any means that will facilitate the task of reading and/or comprehending meaning from written learning material.

Recommendations for the Teaching-Learning Situation

This group of recommendations is, perhaps, the most important. Since the ultimate value of educational research lies in improving what goes on in the teaching-learning situation, the following recommendations are directed toward teachers and administrators.

1. If the results of this study are valid, it would appear logical that an industrial arts program, even as envisioned by IACP, would not prove to be the most efficient use of the time in the
junior high school years. It is recommended, therefore, that teachers and administrators propose and conduct experimentation employing different units of time with different teaching methods on a longitudinal basis in order that more conclusive guidelines for programming and scheduling could be set up.

2. Since reading would appear to be essential to efficient concept learning, it is recommended that conditions conducive to making the task more pleasant be provided in industrial arts classrooms. This recommendations is, therefore, one which asks that a re-examination be made of industrial arts facilities in relation to curricula of the IACP type.

3. Should written learning materials be more widely and universally incorporated into industrial arts programs, it is recommended that industrial arts teachers be grounded more thoroughly in reading theory, in order that they will be more effective in using this teaching method with all levels of pupil ability.
APPENDIX A
Manufacturing Technology

The word "technology" comes from a Greek word which means expertness in the doing of any action, practice, method, or procedure; that is, expert or efficient doing. To be expert or efficient is to be skillful; so technology is concerned with the skills of any action. The word ending "-logy" means a science of. Science is any knowledge which is ordered or systematized. The word "technology" then means the science of expert doing or skillful action.

Man is a very active animal. Therefore he has many different kinds of technologies. These depend upon what he is doing. One major technology that you will study in this course is manufacturing technology, the science of the efficient action of the manufacturing of material goods. All of our material goods made in factories and plants across our country are the result, at least in large measure, of manufacturing technology.

Manufacturing technology has three major divisions: (1) manufacturing management technology, (2) manufacturing production technology, and (3) manufacturing personnel technology. In making goods, like making meals, there are stages. Before your mother prepares a meal, she must decide what she will cook. Then she must go to the store and buy the food which she will bring home for the meal. She will check often as she cooks the food to be sure it is properly done. The technology
There are three functions of manufacturing management technology: (1) planning, (2) organizing, and (3) controlling.

Many persons are involved in planning, organizing, and controlling. (Photograph: courtesy of International Tractor Company.)

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of doing this may be defined as the science of planning, organizing, and controlling. When this is done within the modern manufacturing establishment, it is known as the technology of manufacturing management.

Manufacturing Management Technology

In manufacturing, planning, organizing, and controlling are actions of management. The technology of manufacturing management is the science of planning, organizing, and controlling within the modern manufacturing establishment.

Management is often defined as getting work done through other people. To do this, decisions must be made. In this course, you will learn how persons do this. Although your mother decides what to cook, how to cook, and how to serve the food, she is not the only one who decides what to eat, and she is not the only one who does the work. It is important to remember that this is also true in manufacturing management. The actions of planning, organizing, and controlling are not done only by managers. Other persons help to carry out these actions or functions.

Manufacturing Production Technology

The making of manufactured goods is called production. Production of manufactured goods goes through stages which are known as (1) pre-processing, (2) processing, and (3) post-processing. The technology of manufacturing production may be defined as the science of pre-processing, processing, and post-processing within the modern manufacturing establishment.

Before material can be processed, it must be brought to the place where it is to be used, and then prepared for use. If you were to follow your mother from the time she first decided to serve corn-on-the-cob until the time you bite into a hot,
There are three functions of manufacturing production technology: (1) pre-processing, (2) processing, and (3) post-processing.
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Processing More commonly, these activities are called servicing. The knowledge needed for post-processing is the same that is needed for processing. The only difference is that the knowledge is used at a different time and in a different place.

Manufacturing Personnel Technology

In manufacturing, personnel technology is the name given to the (1) hiring, (2) training, (3) working, (4) advancing, and (5) retiring of employees. The technology of manufacturing personnel work may be defined as the science of hiring, training, working, advancing, and retiring. Your mother probably tries to find jobs you can do well and then tries to show you how to do them. In a similar way, personnel technologists try to discover what kinds of work are best for different people, what ways are best to teach them new jobs, and how to help each employee improve his performance. Every day more people are realizing that if each human being is to do his best work and be satisfied, those who manage him must have knowledge of what kind of person he is and how he feels. Personnel programs are designed to discover how this can best be done.

Summary

Manufacturing technology is the science of efficient action within the modern manufacturing establishment. The major divisions of manufacturing technology are: (1) manufacturing management technology, (2) manufacturing production technology, and (3) manufacturing personnel technology. This course in the World of Manufacturing is organized to help you understand what these stages are and what is done in each of them.
Reading 6

Manufacturing Management Technology

In the previous reading you have learned that manufacturing management technology is one of the important elements of manufacturing technology. The actions of management were described as planning, organizing, and controlling.

These actions, or functions as they are sometimes called, are common to all human work or play. Your parents manage family and home affairs. Your school principal and others manage school activities and events. Your city is managed by appointed or elected officials. Likewise, state and federal governments are managed. All economic activity in agriculture, business, and industry must be planned, organized, and controlled to assure success.

What, then, are the stages or steps in the management story that are unique to manufacturing? How do these stages in the management story relate to the management functions of planning, organizing, and controlling?

Manufacturing Management Stages

We might think of the management story in manufacturing as having six major steps or stages. These may be thought of as:

1) Identifying consumer demand.
2) Designing and engineering the product.
3) Planning production processes.
4) Tooling up for production.
5) Securing inputs to the system.
6) Establishing production, quality, and control.

Surveys are one method of identifying consumer demands. This may be asking the opinion of each of the members of a family and recording their preference. (Photograph courtesy of Eastman Kodak Company)
The inspection of this assembly line is one part of quality control. Similar inspections are performed throughout the process to assure that the quality of the manufactured product stays at a high level. (Photograph courtesy of Pontiac Motor Division of General Motors)

The Planning Function

Without planning there would be chaos in a manufacturing establishment. There are two basic types of planning: long-range and short-term planning. Long-range planning is done to give direction to company activity five, ten, or more years in advance. Long-range planning is very creative. Big-idea men in the top levels of management are needed in this role. Short-term or short-range planning, on the other hand, is done to provide direction for more immediate day-to-day, week-to-week, and month-to-month details. This type of planning is done by middle and lower level management.

Planning, as a function, involves: the establishment of company policies, goals, and objectives; the performance of research, and the design and engineering of products, processes, and plant. Planning, then, may be thought of as: (1) formulating, (2) research, (3) designing, and (4) engineering.

First of all, a company’s leaders must decide or formulate long-range and short-range goals and objectives. They must establish policies that will determine the future of the company and assure its continued growth. Should we build a new plant? Should we develop a new product line? Will we merge with another company? These and many other questions must be considered and answered by top level management.
Planning is done for the future as well as the present. Long-range planning gives the company direction and helps ensure that it and its products will not become obsolete.

Research is necessary to continuous company growth and product improvement. Most companies engage in research of varying types and to varying degrees. Even though research is generally expensive, its benefits more than offset its cost. (Photograph courtesy of Firestone Tire and Rubber Company)

Research is necessary to continuous company growth and product improvement. Some large companies have their own research staff and laboratories. Smaller companies may have research done for them by public or private research organizations. It is important to learn more about new materials, new processes, and new products. Researching provides answers to such questions as: What have others already discovered in the past? (retrieving) What is the present character of our surroundings? (describing) What will happen if I change some factors and keep others constant? (experimenting)

In manufacturing, many persons are involved in designing products and processes. Several solutions to each problem of design must be thought up. A product designer may create a new form (shape) or a new color combination for a product. A personnel man may design an employee suggestion system. An engineer may design a new device to handle heavy work pieces from one work station to another. The best solutions are selected, refined, and improved.

After products or processes are designed, they must be engineered. Designing and engineering, considered together, are sometimes called development. Engineers, technicians, and draftsmen work at engineering details. Production processes must be planned by engineers. The man-machine relationships must be planned. Costs are estimated. Work flow and materials are scheduled. The whole process is laid out as to what is done first, second, next and so on until the product comes off the end of the production line. Special tools and devices are developed to aid in the production of the product. Plans are made for the quality control system; that is, the standards of work that will be allowed to leave the plant as compared to those that must be rejected as poor quality. These are only examples of the engineering function of planning.

Today, most companies cannot exist or prosper without the benefits of knowledge gained through research. Some large companies have their own research staff and laboratories. Smaller companies may have research done for them by public or private research organizations. It is important to learn more about new materials, new processes, and new products. Researching provides answers to such questions as: What have others already discovered in the past? (retrieving) What is the present character of our surroundings? (describing) What will happen if I change some factors and keep others constant? (experimenting)

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The Organizing Function

The planning function provides the plan. In order for the plan to be successful, a manufacturing company must be organized so that the work will be carried out effectively and efficiently. There are two major sub-elements to the function of organizing. They are: (1) structuring, and (2) supplying.

Small companies with few employees often operate without a formal structure. Large companies have very complex organizational structures. A factory owner or manager must have people employed to do each and every job required by the plan. He must form or structure the company by identifying the work to be done and where it is to be done.

One way of showing plant organization is by using an organization chart. This is a very common procedure in most companies. It is most valuable for larger companies or corporations.

Once the organization is structured, it must be supplied with personnel and the necessary equipment and material. People must be employed for each management and production position in the company. All equipment and materials must be purchased. Sometimes certain parts of the work are subcontracted to other companies. After these parts are received from the subcontractor, they are then assembled into the final products. Organizing, as a function, is a constant process. Improvements are made when they will brighten the future of the company.

The Controlling Function

The performance of the work must be controlled. It is not enough just to carefully plan and organize the work. It must be controlled. The four major sub-elements of controlling are: (1) directing, (2) monitoring, (3) reporting, and (4) correcting.
MANUFACTURING MANAGEMENT Technology

Directing involves the supervision of all employees and the coordination of men, equipment, and materials. Directing helps get the work done. Supervision and coordination go on at all levels of the organization and in each department of the company.

Monitoring means to check on or to keep under observation. It is the responsibility of many persons in a manufacturing plant to check to see if the work is going according to plan. One major activity is checking the quality of the product as it moves through production. Inspectors are monitors. Even research activities are monitored to see if they are progressing smoothly. Inventories must be kept to see if enough stock is on hand for the work to be done. Keeping time of the work of employees is monitoring.

Reporting is a necessary activity. If an inspector, for example, finds that the work pieces are not the correct size, he must report this to a responsible person. If some material has a low inventory, this must be reported.

Correcting completes the controlling cycle. If the report indicates a need for correction of some difficulty, then action must be taken to bring the work back according to the original plan. Original plans often must be revised. This is a critical step in manufacturing. If corrective action is not taken, time, materials, and money will be lost to the company.

Summary

Many persons in manufacturing perform management activities or functions. Three major management functions in manufacturing, as in all human activity, are planning, organizing, and controlling. They go on at the same time in an operating company.

You can think of management as having a story, beginning with identifying consumer wants or demands and going to the point

![Diagram](image-url)

There are two elements of the organizing function in manufacturing management. They are: structuring and supplying.

![Diagram](image-url)

This chart represents a line and staff type of company organization. Note the different levels of management in an organization. There might be a number of plants in addition to the one represented here.
Foremen help monitor the work of the company. This man is observing the workers and giving advice when needed to assure that the work is being done according to plan. (Photograph courtesy of W. E. Foxboro Company)

Where all products are ready to be shipped to the consumer. Production activities in manufacturing directly change the forms of materials. Management activities make sure production proceeds smoothly.

Your next lesson begins the management story. Carefully study each assignment. As you read, you will discover how planning, organizing, and controlling are part of each step in the story.

There are four elements of the control function of manufacturing management: (1) Planning, (2) Monitoring, (3) Reporting, and (4) Correcting.
Manufacturing Personnel Technology

Everyone in our country is affected by industry. You don't have to walk long distances to school, because you can ride a manufactured object over a constructed highway. You don't have to worry about unusual heat or cold, because items of clothing protect you outside; and inside you are sheltered by the building and heating and cooling systems. You don't have to worry about food shortages, because seasonal food products and surpluses are processed so they can be kept until they are needed. The way people generally are affected by industry is studied in some way in most of your school subjects.

About 25 million people (one-third of the total labor force) are particularly affected by industry. They are the ones who work in the factories and on the construction sites. They are called industrial workers, employees, or personnel. They are affected by industry off the job much the same way as are other people. In addition, industrial workers are daily affected by personnel practices or technology on their jobs. Some of these practices are the same in manufacturing as they are in construction, but many of them are very different. However, all manufacturing employees and all construction employees are hired, trained, worked, advanced, and retired. Therefore, the practices used with employees can be studied under these major headings.

About 25 million Americans work in manufacturing. Fitting the people to the right job in the work of the personnel department. (Photograph courtesy of Northrop Corporation)
Some skills are learned best on the job. Older workers train newer ones. (Photograph courtesy of General Electric)

Personnel practices apply to all production workers and to all levels of management personnel. (Photograph courtesy of General Electric)

Manufacturing Personnel Technology

Importance of Personnel Technology

However well a manufactured product may be designed and engineered, little will become of it unless able employees can be hired to produce it. This makes the hiring practices important. If trained workers are not available, training must be provided to help employees gain the knowledge and skills which are required to do the work. Again, without this training, little will be accomplished.

Once the employees have been identified and can do the work, the working conditions that they find on the job will determine whether or not they want to continue working there. If they decide to stay, how long they stay, how satisfied they are, and how well they work all will be affected by their working conditions. Thus, it will do little good to recruit and employ good workers, if they will not be satisfied enough with their working conditions to want to work regularly and efficiently.

One of the important reasons for employees making a career with a particular employer is the kind of advancement and retirement practices that are used. If the employees feel they will be rewarded for good work and can look forward to an independent period of retirement, they will be more likely to stay with their employer.

What will be done with the people in the manufacturing system must be planned, organized, and controlled just as much as what is done with the tools, machines, and materials in the system. Because personnel are available for a lifetime, whereas most other resources are replaced much more regularly, personnel may be considered the most valuable resource.

Although personnel technology is usually thought to be something that relates only to production workers, all levels and types of management personnel are also affected by it. They too are hired and trained and worked and advanced and re-
Host management and many technical jobs require advanced training. College degrees are often needed. (Photograph courtesy of General Electric)

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tired. All manufacturing employees are affected by manufacturing personnel technology.

Hiring

All the personnel in manufacturing, except owners, have been employed or hired at least once. Hiring involves recruiting, selecting, and inducting. Recruitment practices are used to let people, who might be interested in a particular job, know that it is available. If there is more than one qualified applicant, techniques are used to select which would be the best worker. After the worker is selected, he needs to be inducted. That means he needs to be told what his work is, how he should do it, where he can get lunch or safety equipment, what to do if he gets hurt or needs to be relieved, and all the many things he needs to know to perform his required tasks and to satisfy his personal needs.

In order for hiring practices to be considered a part of technology, they have to work. This means that the techniques used to recruit, select, and induct must in fact bring to the attention of good candidates for jobs the information about job openings. Selection techniques must help to reject job applicants who will not do well and select those applicants who will do well. Induction techniques must help workers adjust to their new jobs and prevent them from making unnecessary mistakes. Effective personnel departments have studied hiring practices and do know which techniques work and which do not. That is to say, they use personnel technology.

Training

With manufacturing changing more rapidly every year, it follows that the employees must change also. They must pick up new knowledge and skills, if they
are not to become obsolete along with the machines with which they work. Most large manufacturing establishments have training programs which are planned, organized, and controlled to provide the training needed by all employees whether they be production workers or executives.

Training is provided in a number of ways. Some factories have complete schools which look much like the schools you are in. Others simply have training department workers who arrange for employees to be trained off the factory premises. They identify what training certain employees need and who offers it. They then make arrangements so the training can be given to the employees. This training may be by public or private schools or even by other factories. Other kinds of training are provided to workers on the job through brief lectures or demonstrations or closed-circuit television instruction. Sometimes workers receive coaching as they perform their regular tasks.

All employees must look forward to a continuing need for further education and training. Even individuals with advanced graduate training in a university must keep studying to keep up with the rapid changes in manufacturing. Industrial training departments help to provide employees with new knowledge and skills.

Working

The conditions under which employees work are set by rules. These rules affect them much as the rules and regulations in your school affect you. You are expected to arrive at school at a certain time, dress to a certain standard, behave in a certain way, and do many other things according to accepted rules for students. In much the same way, industrial workers act according to accepted rules for employees.

The working conditions in a factory state what wages and benefits employees will receive, what the physical surround-
MANUFACTURING PERSONNEL
TECHNOLOGY

ings will be, and with whom the worker will work. Most people know what wages are. Wages are the money one receives. Benefits are other things that may be provided, such as: free medical care, transportation, or housing. The concerns for the physical surroundings are mainly for the safety and comfort of the employees. The employers usually explain individual worker responsibilities and indicate the person to see for help or information.

All working conditions are important. For example, workers may work in an air-conditioned plant for less money. In effect, they are then trading some of their wages for the comfort they get from the air conditioning. Still other workers would prefer working in the heat, if they could get the higher wages. In the end, each worker studies the working conditions of a particular employer and his own preferences. He then decides where it is best for him to work. However, this does not mean everyone works in what he would describe as his ideal work situation. Most jobs involve some compromises, which means trading off one thing for another. It is equally true that most employees are compromises. That is, the employer often cannot find exactly the person he is seeking, so he makes do with what is available. Because of all of this, it is difficult to set working conditions that make everyone completely satisfied.

Advancing and Retiring

Advancement practices change the job assignments of individuals by moving them upward or promoting them. They also may be used in an opposite way by demoting individuals who do not meet their job requirements. A third kind of advancement may be lateral or along the present job level. Individuals may wish to work with other people or in other departments or areas and may consider it an advancement to move to a similar job in another location.
Manufacturing Personnel Technology

Retirement may be considered to be a special form of advancement. It is a kind of permanent advancement to a non-working position which continues to provide wages and benefits. Both advancement and retirement practices are important to employees. Therefore, they must be used well if employees are going to be favorably affected by them.

Summary

Industry affects everyone in many ways. In addition, industrial employees are affected by industrial personnel practices or technology. Employees may be considered to be an establishment's most important resource. This makes the practices which are used to hire, train, work, advance, and retire them very important. Personnel technology helps to obtain an efficient work force and to keep them working efficiently.

The productive capacity of machines may be predicted very accurately. They work according to their designer's plan. The productive capacity of employees cannot be predicted this well. It may be known what they can do; but they may not do it, if they are unwilling. People cannot be turned on and off the way machines can. With adequate personnel practices, employees will work nearer their capacity with greater personal satisfaction.
Reading 39

Manufacturing Production Technology

You have learned that before production can begin, products must be researched, designed, and engineered. In addition, production processes and plant layout must be determined. Production and quality control systems must be planned. Personnel, equipment, materials, and other inputs must be obtained. Throughout these basic management stages, various activities in planning, organizing, and controlling have been common. Management activity will continue throughout the next phase of manufacturing called "production."

Rather than study how one manufacturer produces a part of a single product or the whole product, we can study how all kinds of manufacturers, using different materials, produce any kind of product. You can do this, if you focus your attention on the production stages all materials go through and the practices used to change the form of the material within each stage.

Production Stages

In the production of any product, there is a general story or set of steps which are followed in order. First, raw materials must be refined and bulked. This we call preparing raw materials. Second, these materials are then converted and formed into standard industrial materials. This we call making industrial materials. Third, the
standardized materials are reshaped into components (single parts) or finished products made up of only one part. Fourth, several components are assembled or combined to form a more complete product. Fifth, in preparing for distribution, the product is packaged or prepared for shipment.

There are three important points to keep in mind about these stages. First, a material can become a product at any time. It becomes a producer's product, if used by another manufacturer, or a constructor. It is a personal product, if purchased and used by an individual, for example, in his home. The second point is that materials, processed by primary manufacturers (primary metals, textiles, petroleum, chemicals, energy, lumber, and others), produce by-products which become products for still other manufacturers. This cycle is nearly endless. Third, manufacturing production can be thought of as the continuous changing of material from the general to a particular. This means from rough to fine; from general sizes, shapes, weights and compositions to highly accurate sizes, shapes, weights and compositions; and from general skills to specialized skills. Chart 1 should help you identify the production stages of selected materials and what change has taken place in the material.

Production Practices

The practices of production may be classified into three major groups: (1) pre-processing, (2) processing, and (3) post-processing. Pre-processing, in a general way, may be thought of as getting the necessary inputs where they are needed and when they are needed. Processing may be thought of as the practices used to substantially change the form of the materials. Post-processing may be considered the ways we service or maintain the products during their lifetime.
### Chart I: Basic Production Stages

#### Raw Materials (Examples)

<table>
<thead>
<tr>
<th>Stages</th>
<th>Timber</th>
<th>Iron Ore</th>
<th>Cotton</th>
<th>Natural Rubber</th>
<th>Crude Oil</th>
<th>Milk</th>
<th>Sewage</th>
<th>Timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing Raw Materials</td>
<td>logs debarked</td>
<td>separated from impurities, cast into pig iron ingots</td>
<td>combed, washed</td>
<td>separated from impurities, coagulated, dried</td>
<td>washed, filtered</td>
<td>filtered</td>
<td>filtered, separate solids from liquids</td>
<td>logs debarked</td>
</tr>
<tr>
<td>Potting</td>
<td>rough sawed, kiln and air dried lumber</td>
<td>refined ore — made into steel sheets, bars</td>
<td>spun into yarn — woven into fabric, bleached</td>
<td>refined, dewatered into sheets, pellets, bails</td>
<td>distilled into raw gasoline, tar, kerosene, etc.</td>
<td>pasteurized</td>
<td>settled</td>
<td>ground, bleached, slurred, screened into pulp sheets</td>
</tr>
<tr>
<td>Making Components</td>
<td>shaped to dimensions: thickness, width, e.g., 2&quot; x 4&quot; x 8&quot;, 1/4&quot; x 36&quot;, dowel</td>
<td>sheet steel printed and stamped into bottle caps</td>
<td>dyed, cut into sleeves, collars, cuffs, bodies of shirts</td>
<td>sheets compounded, laminated and formed into belts</td>
<td>raw gasoline cracked into grades of gasoline</td>
<td>extraction of butterfat, whey</td>
<td>leached, aerated</td>
<td>reground, slurried, screened into logs of paper</td>
</tr>
<tr>
<td>Combining Components</td>
<td>combining of parts: points, feathers, paint, dowels</td>
<td>cork inserted into cap</td>
<td>fabric parts sewed together — buttons, labels added</td>
<td>fabrics and rubber belts vulcanised into tires</td>
<td>lead, color, lubricants, octanees added</td>
<td>water, vitamins, preservatives added</td>
<td>batching chemicals in correct amounts to purify</td>
<td>logs printed cut, folded into newspapers</td>
</tr>
<tr>
<td>Preparing for Distribution</td>
<td>packaged in lengths, types, quantities</td>
<td>packaged in quantities, brands</td>
<td>packaged by quality, color, style, size</td>
<td>wrapped and gathered into lots</td>
<td>collected into storage tanks or distributed by pipelines</td>
<td>bottled in containers by weight, grade, type</td>
<td>piped into reservoirs or storage tanks or into streams</td>
<td>bundled by quantity</td>
</tr>
<tr>
<td>Sample Products</td>
<td>Brand A 64-oz. target arrow 1 gross</td>
<td>Brand C 16-32 white French cuff dress shirt 1 doz.</td>
<td>Brand D 6.50-15, 4-ply snow tire 500</td>
<td>Brand E Blue std 100 octane automotive gasoline 1000 gal.</td>
<td>Brand F white, vitamin enriched, whole milk 100 qt.</td>
<td>Type G reclaimed fresh water</td>
<td>Brand H morning newspaper, 24 pages, 10 per bundle</td>
<td></td>
</tr>
</tbody>
</table>
THE WORLD OF MANUFACTURING

Pre-processing Materials

The main idea in pre-processing is to supply materials where they are needed, when they are needed, and in correct quantities. There are many ways to handle materials efficiently. The most efficient way depends upon the type of material, the kind of equipment used, and how well the material handling system has been combined with processing. Efficient handling may range from carrying it by hand to using automatic equipment to flowing materials through conduits. Whatever technique is used to handle materials, you can identify what is being done by one or a combination of the following practices: receiving, unpacking, handling, storing, and protecting. Keep in mind that none of these practices change the form of the materials.

Processing Materials

The ways in which materials are changed in form to increase their value can most simply be thought of as having one of three things happening to them. Materials can be: (1) separated, (2) formed, and/or (3) combined during processing. Separating, forming, and combining may be considered the elements of processing. They take place during all stages of production. Material handling, storing, and protecting may also take place before, during, and after any of the five stages of production.

With a deck of cards, you can cut the deck (separating), bend the deck (forming), and shuffle the deck (combining). These three practices apply to any material whether it is a solid, liquid, or gas. When you handle the cards to do these practices or pass the deck to another person, you are performing the handling function.

Let us take other examples. If you are sawing wood, you are separating. If you are bending wire, you are forming. If you are stapling two sheets of paper together, you are combining.
In manufacturing, there are many specialized techniques to separate, form, and combine. It is not necessary to know all of the techniques, but the following list of examples will help you identify which practices belong to each category. This list amounts to alternate ways to separate, form, and combine materials.

**Separating**

Classifying
- screening, floating, settling, filtering, clarifying, magnetizing, distilling, evaporating, absorbing, centrifuging, drying, crushing, milling, leaching, stripping

Material removing
- turning, shaping, planing, drilling, boring, milling, broaching, sawing, abrading, shearing, etching, burning

**Forming**

Working
- peening, rolling, drawing, pressing, forging, stamping, bending, extruding, molding, pounding, combining, winding

Thermal Conditioning
- curing, crystallizing, casting, heat treating, melting, freezing, chilling

**Combining**

Mixing
- beating, blending, kneading, impregnating, masticating

Coating
- spraying, brushing, rolling, dipping, dying, calendaring, oxidizing, printing, enameling, spreading

Assembling
- pinning, soldering, welding, gluing, interlocking, clamping, knitting, tying
MANUFACTURING PRODUCTION TECHNOLOGY

As you study the processes of production technology and try to observe products around you, record them and identify the practices which have been used to change the forms of materials in each stage of production. You will find that your understanding and appreciation for your manufactured world will take on added meaning.

Post-processing Materials

Post-processing practices with materials are those installing, maintaining, repairing, and altering activities which occur after the product reaches the consumer. These practices extend the life and value of manufactured products. Often these practices are referred to as servicing.

Many manufactured products are installed in buildings in cooperation with building contractors. This service, however, may be considered the responsibility of the manufacturer if so designated in the contract. Examples may be the installation of an air-conditioning system or a public address system in your school.

If your family automobile is not running properly, a tune-up is performed at a garage, service station, or at home. This is an example of maintaining the product. When you polish your shoes, you are maintaining them.

The practice of repairing is a common activity. New soles or heels might be fastened to your shoes to make them like new. If you should break the windshield of your family automobile, it could be repaired by placing a new one in the frame.

Altering might involve the cutting down of a pair of trousers that belonged to your older brother. Some day, you may mill down the head of your automobile’s engine to increase its power.
CHART II

RELATIONSHIPS AMONG MANUFACTURING TECHNOLOGIES

MANAGED-PRODUCTION SYSTEM

Identifying consumer demand
Designing and engineering the product
Planning production processes
Tooling up for production
Securing inputs to the system
Establishing production and quality controls

PRE-PROCESSING

Preparing raw materials
Making industrial materials
Making components
Combining components
Preparing for distribution

PROCESSING

Receiving
Unpacking
Handling
Storing
Protecting
Separating
Combining
Forming

POST-PROCESSING

Installing
Maintaining
Repairing
Altering

CONSUMER
THE WORLD OF MANUFACTURING

These are only examples of the many post-processing activities that are performed on manufactured products. It is important to remember that the knowledge used in post-processing is basically the same as that knowledge used in processing. It is merely done at a later time and at a different place.

Production Technology

All technology is directed toward how to efficiently do. To efficiently do includes the degree to which man has been able to plan, organize, and control his actions. The ways men have efficiently planned, organized, and controlled their management, personnel, and production practices gives us a managed-production system. The knowledge of efficient practices in manufacturing is known as manufacturing production technology.

You should be able to understand the relationships between the several technologies of manufacturing as shown on Chart II.

Summary

Manufacturing production technology refers to the knowledge used by man to change natural materials into manufactured products. It also takes personnel and management knowledge and skill to increase the values of materials bringing about changes in their form. There are five stages of production: preparing raw materials, making industrial materials, making components, combining components, and preparing for distribution. Throughout each stage, many practices of pre-processing and processing take place. The forms of materials are changed within each stage. Installing, maintaining, repairing, and altering of manufactured products are post-processing practices. These practices usually are called servicing.
APPENDIX B
MANUFACTURING TECHNOLOGY

Review 5
MANUFACTURING TECHNOLOGY

The following questions and problems will aid you in reviewing the reading assignment.

1. The word "technology" means the science of expert _d________ or skillful ac__________.

2. Manufacturing production may be defined as the science of pre-pro__________, proc__________, and post-pro__________.

3. The technology of manufacturing personnel work may be defined as the science of: hi__________, tra__________, wo__________, ad__________, and ret__________.

4. The technology of manufacturing management is the science of: pla__________, org__________, and con__________.

5. Manufacturing technology involves: man__________, pro__________, and per__________.

6. In the blank before each item, specify whether the item is a manufacturing management, production, or personnel technology.

   1. ___________ organizing
   2. ___________ processing
   3. ___________ training
   4. ___________ firing
   5. ___________ controlling
   6. ___________ planning
   7. ___________ pre-processing
   8. ___________ retiring
   9. ___________ retaining
1. The management function is common to all aspects of human work or play. T/F
2. Which of the following statements represent a stage of management technology?
   - a. Identify consumer demand
   - b. Planning production processes
   - c. Securing inputs to the system
   - d. Sales and distribution
3. The three functions of management are: ___, ___, and ___.
4. Once an organization is structured, it must be supplied with___, ___, and ___.
5. Directing, monitoring, reporting, and correcting are ___ functions.
6. In the blank before each item, write in whether this item is a function of either planning, organizing, or controlling.
   1. ______ planning
   2. ______ organizing
   3. ______ controlling
Review 34

MANUFACTURING PERSONNEL TECHNOLOGY

The following questions and problems will aid you in reviewing the reading assignment.

1. What will be done with the people in manufacturing must be pl__________, org__________, and con__________
   just as much as what is done with tools, machines, and materials in the system.

2. Hiring involves rec__________, sel__________,
   and ind__________.

3. Industrial training departments provide employees with new kno___________ and sk__________.

   change the job assignments b. Demoting the inefficient.
   of individuals by: (circle c. Retiring the old.
   the three best answers). d. Lateral movement.
   e. Paying higher wages.

5. The conditions under which employees work are set by rules which establish:
   a. What ws__________ and be__________ employees will receive.
   b. What the phs__________ surroundings will be.

6. Manufacturing personnel technology relates only to production workers. T/F

7. Closed circuit television may be used in the future for training workers, but it isn't being used now. T/F

8. Even though a worker knows his job well, he must still look forward to a continuing need for further education. T/F

9. The productive capacity of employees can be predicted as well as the productive capacity of machines. T/F
Review 39
MANUFACTURING PRODUCTION TECHNOLOGY

The following questions and problems will aid you in reviewing the reading assignment.

1. A material can become a __________________ product at any
time during the production cycle depending on the needs
of the consumer.

2. Materials are changed in form by having one of three things
happen to them: they can be ____________, for ___________,
and/or __________________ during processing.

3. There are five stages of
production. Select them
from this list of activities
and write them in the spaces
provided.

   a. Preparing raw materials
   b. Making industrial materials
   c. Hiring employees
   d. Making components
   e. Laying out a floor plan
   f. Combining components
   g. Preparing for distribution

4. You have just been hired as
a management trainee of a
large company that makes
electrical appliances. You
are handed a list of the
following production
activities and you are to
arrange them under the
categories of pre-processing,
processing, and post-
processing production
practices. The list contains:
   1) forming, 2) installing,
   3) handling, 4) storing,
   5) protecting, 6) combining,
   7) maintaining, 8) altering,
   9) separating, 10) unpacking,
   11) repairing, and 12) receiving.
The word "technology" is one used to describe a number of man's activities in many fields of work. Sometimes it is confused with the word "science." However, there is a difference. Technology has more to do with the ways that man applies what he has learned to doing things in his environment. A dentist, for example, practices technology when he works on your teeth. He is using scientific knowledge in this practice, but the knowledge is not technology. The technology is the things that the dentist is doing and the way he is efficiently using the tools in doing his job. Technology, therefore, is a term used in many kinds of jobs by many different people. In this short course, we are concerned with the technology of manufacturing; the practices that man uses to produce consumer goods in factories. For the time being, you do not have to at all concerned with the technology of medicine, of law, or journalism, or even of construction.

Manufacturing technology can be understood more easily if we study the elements, or concepts that make up the technology. This can be done by breaking manufacturing technology into its three major parts. These parts are called manufacturing management technology, manufacturing personnel technology, and manufacturing production technology. These are the headings under which one studies manufacturing
technology. Beneath each of these headings are the many practices of manufacturing. If you learn the terms which refer to these practices and the practices that go with the terms, you will have gained an understanding of manufacturing. Let's review the practices found under each of these headings.

Manufacturing management technology is the study of the practices of management. The practices are described as those of planning, organizing, and controlling. All work in manufacturing must be planned, organized, and controlled. After all the planning in a manufacturing business is complete, the concern must be organized so that the work can be carried out as it was planned. Managers organize, or create, the situation in which the work can be performed. Once the work is under way, it must be controlled. This requires such activities as assuring that the rate of production is correct, checking the work going on in production, and correcting any malfunctions.

The second sub-element of manufacturing technology, manufacturing personnel technology, deals with people. The technology of manufacturing is not complete without people to perform the practices. In studying personnel technology in manufacturing, we can study the concepts of hiring, training, working, advancing, and retiring. These five practices are the sub-elements which can help us learn
about the ways people are utilized, and provided for, in manufacturing. Each of these five practices can be further broken down into smaller elements for more specialized study.

The third division of manufacturing technology is that of manufacturing production technology. It is here that we find the actual practices used to increase the value of products by changing their form or by getting them from one place to another where they will be more valuable to people. For example, iron is more valuable at the plant where it is to be machined that it is at the refinery where it was made. In like manner, the iron is more valuable after it is machined than it was in the warehouse prior to machining.

Manufacturing production technology can be studied by learning about its sub-elements of pre-processing, processing, and post-processing. Pre-processing has to do with all of the practices used to get a material to the place where its form is to be changed. For example, we store materials in a warehouse for later use. We handle these materials in transporting them from one place to another. We protect them by keeping them in a dry place. These examples of pre-processing practices are all a part of manufacturing production technology.
The next stage of manufacturing production technology is that of processing the materials. Materials can be processed by separating, or taking away, some of the material as on a metal lathe, by forming as in the shaping of a plastic dinner plate in a mold without separating material, or materials can be combined to each other. Combining practices can be anything from gluing one piece to another to the application of paint.

The third stage of manufacturing production technology is that of post-processing. These practices are those which keep the product in working order after they leave the plant. The product must be installed, it must be maintained, it might need repairing, or it might need altering. These represent the sub-elements of post-processing.

You have read about manufacturing technology and the sub-elements of that technology which are manufacturing management technology, manufacturing personnel technology, and manufacturing production technology. Some of the practices found in each of the sub-elements have been noted as well. Try to remember the terms which label the practices of manufacturing and the sub-elements of manufacturing technology.
DISCUSSION QUESTIONS AND DESIRED RESPONSES FOR UNIT ONE

Question 1: Who can explain the meaning of the term manufacturing technology?

Response: Manufacturing technology is the study of the practices that man has invented and uses to efficiently increase the value of manufactured goods in a factory. Included in the technology are the practices used in securing, using, and providing for personnel and the practices used by managers in creating the environment where efficient production can take place.

Question 2: Who can explain the meaning of manufacturing management technology?

Response: Manufacturing management technology is the study of the practices that are used by managers in manufacturing to plan the work of others, organize the planned work so that it will be carried out efficiently, and control the performance of the work.

Question 3: Who can explain the meaning of manufacturing personnel technology?

Response: Manufacturing personnel technology is the study of the practices used to hire, train, work, advance, and retire people in manufacturing.

Question 4: Who can explain the meaning of manufacturing production technology?

Response: Manufacturing production technology is the study of manufacturing practices used to efficiently increase the value of materials through the stages of pre-processing, processing, and post-processing.
A major aspect of manufacturing technology is management. All the functions carried out in the production of products must be managed if maximum efficiency is to be assured. Even though "management," as a concept, is sometimes difficult to define, it is often easier to understand if we break it down into its sub-elements, or functions. In this lesson we have identified three sub-elements of manufacturing management. They are planning, organizing, and controlling.

The planning function is concerned with (1) laying out, or formulating, the steps and establishing the goals and objectives of the company, (2) the performance of research, (3) the design of products, processes, and plant, and (4) the engineering of products, processes, and plant. Establishing goals and objectives is termed "formulating." Management formulates objectives for short periods of time, as well as for the distant future. This helps assure the continued growth of the company by helping managers visualize where it is going.

The second function under planning is researching to learn more about the materials processes, and products. The knowledge gained through research is then used to improve the operations of the plant and the products produced in it.
The third and fourth functions, designing and engineering, insure that the company makes the best product that it is capable of making. Alternate designs, shapes, and sizes for the product must be thought up and reviewed. Determining the best solutions for production processes, material handling, and plant design, are also examples of how designing is employed in manufacturing. After products are designed, they must be engineered. Engineering will make possible all the steps performed in the production of the products as well as the power elements of the products. For example, a table lamp may be designed by the design department of a company for its shape, color, etc., but the engineering department will determine the components, or parts, which make the lamp operate. Sometimes, when we consider designing and engineering together, we are talking about development.

Organizing a system helps assure that the work will be carried out effectively and efficiently. Organizing may be thought of as having two parts. The first is called structuring and the other is called supplying. The creation of structure in an organization identifies the work to be done and tells who is responsible for the work. The supplying action will assure that all the people, equipment, and materials will be secured or purchased and be available when production begins.
The controlling function assures that the work of the organization will be accomplished as it was originally planned. We have identified four aspects which can help us understand controlling; they are directing, monitoring, reporting, and correcting. Directing may be thought of as having every person in the organization know his responsibilities. Every management employee and company employee is supervised so that the men, equipment, and materials are coordinated with each other.

Now, if something goes wrong, we must have some check so that corrections can be made. This involves monitoring and reporting. Management monitors, or checks by observation, to see that everything is going according to the way it was planned.

If something is amiss, the supervisor must report it to a responsible person so that it may be corrected. The efficiency of this cycle of directing, monitoring, reporting, and correcting will affect the economy of the company. The more efficient these aspects of controlling, the more efficient the production of goods will be.

The process of managing the production of goods may also be thought of as having six stages: They are (1) identifying the consumer demand for the product, (2) designing and engineering the product, (3) planning production processes that will manufacture the product, (4) tooling
up the equipment and plant for production, (5) securing inputs to the system so that the product can be made, and (6) establishing production quality and quality controls to be sure the product meets the standards set for it. Each of these stages must be planned, organized, and controlled. As we discuss each of the stages during the course, try to identify in your own mind what steps of planning, organizing, and controlling are necessary to be sure that each of the manufacturing stages is efficiently carried out.
DISCUSSION QUESTIONS AND DESIRED RESPONSES FOR UNIT TWO

Question 1: Who can state the sub-elements of planning?
Response: They are formulating, researching, designing, and engineering.

Question 1a: How do you utilize formulating in carrying out your school work and homework?
Possible Response: I formulate goals and objectives for doing my school work.

Question 1b: How do you utilize researching in carrying out your school work?
Possible Response: I look up information in reference books or ask experts.

Question 1c: How do you utilize designing in carrying out your school work and homework?
Possible Response: I work out the best format for my homework papers.

Question 1d: How do you utilize engineering in carrying out your school work and homework?
Possible Response: I determine the steps that I plan to follow to complete my assignments.

Question 2: Who can state the two sub-elements of organizing?
Response: They are structuring and supplying.

Question 2a: You are your own management system, but can you think of any other activity you do in structuring the homework you do?
Possible Response: I must decide when and where it is to be done.
Question 2b: How do you supply yourself with what you need for doing your homework?

Possible Response: I get all references, pencils, paper, etc. to my desk or work table.

Question 3: Who can list the four sub-elements of controlling?

Response: They are directing, monitoring, reporting, and correcting.

Question 3a: Who gives you directions in doing your school work and your homework?

Possible Response: My teachers and parents.

Question 3b: Who monitors your work to be sure you get it done correctly and on time?

Possible Response: Myself and my teachers check my work for errors.

Question 3c: Who performs the reporting function on your school work and homework?

Possible Response: My teachers report errors back to me.

Question 3d: Who makes the corrections when errors are found?

Possible Response: I make my own corrections.
It is difficult to draw a sharp line between management, production, and personnel. Most production workers are managers to some extent, and vice-versa. The machine operator on a production job measures and checks his work against the plan; he thereby is performing a control function listed under management. On the other hand, the product designer is physically producing a form as he develops a model for a new product. In reality, the distinction between production workers and managers is based upon the proportion, or amount of time each performs a particular function. Both are affected by personnel practices which effect the economic, physical, and social conditions related to their work environments.

All manufacturing employees are hired, trained, worked, advanced, and retired. These stages are the same as those used in other work fields. However, the practices used in each field might be quite different. For example, hiring practices in construction differ markedly from hiring practices in manufacturing. Hiring practices include recruiting, selecting, and inducting of all personnel; both managers and production workers. Personnel may be recruited through newspaper advertisements, by personal interviews and by trade journals. If there is more than
one applicant for a job, each must go through a process of selection. This may be performed through interviews with the personnel director and by various testing means. The employee is then inducted into the company by familiarizing him with his duties, the plant, and the other personnel.

Training practices consist of the various methods that are used to provide the manager or production worker with the knowledge and skills that are necessary in order for him to perform his job efficiently. This can be either on-the-job training or some other form of training. On-the-job training might be instruction for learning the skills and knowledge right in the plant at the station or place where the employee will do his work. Some companies also provide special instruction in a classroom or in a training laboratory. Training can also be given outside of the company. It might be provided in colleges, or through correspondence, or in another company that is set up to train people for certain kinds of work.

The working practices, or functions, of manufacturing personnel technology deal with the economic rewards, the physical, and the social environment that have a direct influence on the behavior of the employed person. The economic rewards are mainly the wages that a person receives for his services. Other benefits sometimes called fringe benefits, might be paid sick leave, insurance, or even
free food and rent-free housing. The physical surroundings of workers are also important to them and to the company. People work better in an environment that is pleasant, free of noxious odors, smoke, and dust. Sometimes cheerful colors, or music, for example, can greatly improve the work performance of employees. People are also happier if they get along well with their fellow workers. Some manufacturing companies provide recreational facilities for their employees as well as areas where the employees can get together for rest and just for conversation with other people.

Advancing practices change the job assignments of individuals by promoting, demoting, or discharging them from the job. Promoting a worker places him in a more responsible job which generally requires him to use more difficult skills and to be more answerable to the company for his actions and even the actions of others. As strange as it seems, demoting also falls under this term advancing. Demotions are far less frequent than promotions, but since another worker is often advanced when one person is demoted, the study of demoting is connected to that of advancing. Another kind of advancing that doesn't change the status of one's job is that if changing from one job to another of the same level. A worker might consider this an advancement if he happens to like the new job better than his old one.
Retiring practices are concerned with the permanent advancement of a worker into a payed, nonworking situation. This involves counseling for retirement, recognition of his service by the company, and the awarding of retirement benefits.
DISCUSSION QUESTIONS AND DESIRED RESPONSES FOR UNIT THREE

Question 1: What do hiring practices consist of?
Response: Basically, they consist of recruiting people by contacting available persons, or selecting the best qualified persons from among several possible applicants, and inducting them into the company by familiarizing them with their duties, with their co-workers, and with the facilities for employees.

Question 2: What are the ways that people are trained for manufacturing?
Response: People can be trained on the job by learning the skills and knowledge right in the plant. The company also might provide special instruction in a classroom or in a laboratory specially designed for training. The other method of training is in public and private schools, in other companies that offer training programs, and by correspondence courses.

Question 3: What sorts of provisions are made for employees working in manufacturing?
Response: Basically, manufacturing provides (1) economic rewards for its workers which include "fringe" benefits like insurance, pensions, etc., as well as wages, (2) a physical working environment which will render the surroundings in which the employee works at least bearable if not pleasant, and (3) a social environment in which the employee can feel comfortable among his fellow workers.

Question 4: What does advancing in manufacturing consist of?
Response: Advancing can mean the promotion of an employee to a higher level job which requires more responsibility and better returns for his effort, or it can also mean the demotion, or reduction of job status to a job of lesser responsibility. Another kind of advancement could be one in
which the employee changes from one job to another which does not have more or less responsibility or return for work performed, but is liked better by the employee, thus making him a happier worker.

Question 5: How does manufacturing provide for the retirement of its workers?

Response: The most common benefit in retirement is the provision for retirement benefits such as a monthly sum of money.
Perhaps you recall during the first lesson the reference to manufacturing production technology. Today's lesson expands on this a little bit and this lecture should help clarify the concepts in the reading you just finished. The three sub-elements of manufacturing production technology are pre-processing, processing, and post-processing. Pre-processing practices are those activities which occur prior to and during processing. Pre-processing can be studied by looking at its sub-elements of receiving, unpacking, handling, storing, and protecting.

Almost all materials and equipment must be received and unpacked before manufacturing can begin. All during the production phase, materials must be handled, or transferred from one place to another. This is done by using many methods. Materials can be trucked, piped, conveyed on belts, lifted by cranes, and so forth. All of these practices fall into the category of handling. Another pre-processing practice is that of storing. Materials generally must be stored if they are to be readily available for future use. They can be piled, stacked, or bottled, but whatever storing practice is used, it should be such that the materials can be handled easily and efficiently. All materials must also be protected from the elements.
The practices of protecting may include those of making sure that there will be no fire or water damage, or contamination. It also includes the practices used to safeguard equipment and materials from such occurrences as theft.

The second sub-element of manufacturing production technology is called processing. It is in this phase that changes are made to materials to increase their value. The practices which produce the changes can be grouped into three categories, or sub-elements of processing. They are separating, forming, and combining. The separating practices are those which remove material or take one material from another to increase the value of the wanted material. If moisture is separated from processed cloth through evaporation, the cloth has an increased value. If we separate pure iron from iron ore through smelting, we are increasing its value. The same is true of all material removal processes. When we sand a piece of wood we are separating material and making the wood smoother.

The practices of forming are those which change the shape of a material without removing any of it. Horseshoes can be formed by pounding the hot steel into the desired shape. Wire is formed by drawing the metal through small holes. Automobile bodies are formed into shape with large presses. All of these forming practices change the shape of the material without removing any of it.
Some products like washed gravel are complete after they are separated by size or others, like marbles, after they are formed. Most products, however, have to be combined. Materials can be combined by mixing them together, by coating one material on another, and by assembling them together using some mechanical means like screws or nails. If you have ever done any silver electroplating, you were doing a combining practice. Every time you add chocolate to a glass of milk you are performing a combining practice.

The third sub-element of manufacturing production technology is that of post-processing. It is in this stage that manufactured products are put into service and continued use. Manufacturing is concerned with the post-processing practices because of its responsibility to see that its products are properly installed, maintained, and repaired. If there is something wrong with the product, or if there is something to be done to improve it, it has to be altered. The practices of installing, maintaining, repairing, and altering are the sub-concepts under post-processing.
DISCUSSION QUESTIONS AND DESIRED RESPONSES FOR UNIT FOUR

Question 1: Who can list the five sub-elements of pre-processing?
Response: They are receiving, unpacking, handling, storing, and protecting of materials used in manufactured goods.

Question 2: Who can list the three sub-elements of processing?
Response: They are separating, forming, and combining.

Question 2a: Who can give three examples of separating practices?
Possible Responses: CLASSIFYING—materials can be screened (sand), filtered (chemicals), magnetized (scrap iron mixed with other materials), evaporated, (salt water), distilled (crude oil). MATERIAL REMOVING—turning (spindles), drilling (making holes), milling, (engine blocks), sawing (table tops), abrading (smoothing wood surfaces), burning (metal cutting with welding torch), shearing (making coins).

Question 2b: Who can give three examples of forming practices?
Possible Responses: Pressing (auto bodies), forging (piston rods), stamping (faces of coins), bending (notebook rings), casting (cast iron brake drums).

Question 2c: Who can give three examples of combining practices?
Possible Responses: Mixing (pastry ingredients), coating (spraying paint, printing), assembling (soldering jewelry, gluing paper, etc.), mechanical fastening (nails, screws, bolts, etc.).
Question 3: Who can list the four sub-elements of post-processing practices?

Response: They are installing, maintaining, repairing, and altering.

Question 3a: Suppose that the manufacturer was examining the post-processing practices of the shirts you have on. What would he be examining?

Possible Responses:

a. He might look at the selling practices which installed the shirts on your back.

b. He might look at how the shirts are maintained by washing or dry cleaning.

c. He would try to find out how well the shirts wear; that is, how soon do they need repairing.

d. He might examine the provision for the shirts to be altered by making them out of enough material so that they could be enlarged if necessary.
THE CREATION OF A CORPORATION

Speaker Script

No. 1 Proprietor (Later First Partner)

I, John Smith, am the owner of The American Baking Company. When I was a young man still in high school, I enrolled in a vocational course where I learned food preparation. There I gained an interest in the production of baked goods and got the idea that I would like to do this for a living. After high school graduation, I attended the community college where I took courses in business management. At the same time I worked in our local bakery. While I was working in the bakery and attending school, I got the idea that I could start my own business, baking bread and pastries for sale to other people. So, with the money I saved, I purchased the equipment needed to prepare and bake these goods, and I rented a small building where my business could be conducted. Last month an old friend, Mr. Jones, came into my store and told me........

No. 2 Second Partner

John, I have $10,000 I would like to invest in a company such as yours. I know that you have a successful enterprise, but if you combine your company with my money, together we could expand the manufacturing and sales of the baked products.

No. 1 Proprietor

I thought about Mr. Jones' offer and I decided to accept it. Even though I enjoy the personal satisfaction of sole proprietorship and the freedom to act as I want, I would like to expand my company which I can't do with the small amount of capital that I have.

No. 3 Narrator

So, Mr. Smith and Mr. Jones combined their capital and became "partners" in the New American Baking Company. With more money they were able to buy land and build their own manufacturing plant.
They also were able to open three retail outlets in their city where their products could be sold. Both Mr. Smith and Mr. Jones found that their combined judgment and managerial skills helped to make their enterprise more efficient. The management of the company was divided, by having Mr. Smith take care of the manufacturing and Mr. Jones handle the sales and distribution of the products. A number of employees have been hired to perform the many jobs that have now been created by the expansion of the company. A few years later we find the two partners discussing the company......

No. 2 Second Partner

Well, John we have been partners for five years now, and our company has been very successful. We know that we are manufacturing a good product because it sells well, but I think that if we had a larger marketing area, we could make a larger profit.

No. 1 First Partner

Yes, I agree, but to reach a larger market, we would need to expand our plant and we would have to build many more retail outlets where our baked products could be sold.

No. 2 Second Partner

We could sell our products in the supermarkets.

No. 1 First Partner

Yes, but I prefer our present method of selling in our own stores.

No. 2 Second Partner

All right, but to build and maintain our own retail outlets we will need a great deal of capital. Where can we find financing?

No. 1 First Partner

How about making our company a corporation?
No. 3 **Narrator**

So, Mr. Smith and Mr. Jones decided to incorporate their company. They obtained a corporation charter from their State, which resulted in their company being divided into 200,000 shares of common stock to be sold to private investors at ten dollars per share. Mr. Smith and Mr. Jones each received 51,000 shares, which gave them the controlling interest in the corporation.

No. 4 **First Investor**

I earn my living by investing money in profitable companies. I have studied the record of the American Baking Company, and it has been very good. I find that the company has had steady growth, and the management has been sound. I am going to buy 800 shares in this corporation.

No. 5 **Second Investor**

I don't have much money, but I would like to invest part of my savings in a growing company that will pay a reasonable dividend on my investment. I telephoned my stockbroker, and he suggested a number of available stocks that would meet my requirements. I have decided to buy ten shares in the American Baking Corporation.

No. 3 **Narrator**

Many people purchased stock in the American Baking Corporation. Each of the stockholders became an owner of the enterprise. This gave them the privilege of electing a board of directors to represent them in the affairs of the corporation.

No. 6 **Corporation Secretary**

As corporation secretary, I am reporting the results of the stockholders' meeting last week. Elected to the board of directors are Mr. Smith, Mr. Jones, Mr. Towers, Mr. Ray, Mr. Lux and Mr. Allen.
No. 7 Board Member

We board members have been elected by the stockholders who own the corporation. Each share of stock entitles its owner to one vote. The members of the board were selected on the basis of the valuable services and advice that they could contribute to the corporation. All of the board members are stockholders. We will plan the goals, establish the objectives, and policies of the company and will be responsible for seeing that they are carried out.

No. 8 Board Member

The stockholders exercise control only through annual meetings and through the directors whom they elect to represent them. The board of directors will declare annual dividends on the shares of stock, based on the earnings of the corporation.

No. 9 Board Member

The business of The American Baking Corporation is managed by its president, treasurer, secretary, vice president, and other management personnel employed by the board of directors to carry out its decisions.

No. 10 Board Member

The board of directors hired Mr. Green as president, Mr. Red as treasurer, Mr. Blue as secretary, and Mr. Black as vice president and general manager. We have delegated authority to the president and vice president to hire all other managerial personnel and employees.

No. 11 President

I am well qualified to be president of the American Baking Corporation. When the company was a partnership, I held the job of production supervisor under the authority of Mr. Jones. With my promotion to president, I am now responsible for structuring lower management personnel and for the overall operation of the corporation. I am to see that the policies of the Board are carried out.
No. 12 **Vice President and General Manager**

As vice president and general manager, I am responsible for organizing and coordinating all of the activities of the organization. I have the final decision-making function when disputes arise among the division heads of the corporation who report to me. I assure full communication between the president and the directors.

No. 13 **Director of Production Planning and Control**

As the director of production planning and control, I receive all materials being supplied to the plant. When the materials arrive, I make arrangements for moving them and storing them in an efficient way in the plant. I also arrange for shipping the baked products to the retail stores.

No. 14 **Comptroller**

As comptroller, I work with each director in making out the payroll. I also work with the corporation treasurer in maintaining the financial status of the corporation.

No. 15 **Sales Manager**

As sales manager I am responsible for preparing the sales program of the corporation. I must see that all salesmen are trained and supervised, and I develop and administer sales inventories. I also maintain sales and commission records. I assure the distribution of our baked products, and I work closely with the general manager on fulfilling our marketing and expansion objectives.

No. 16 **Personnel Director**

As personnel director, I assume the responsibility for the divisions in my department which are concerned with all personnel activities such as employment, medical services, insurance, recreation, public and labor relations, safety, plant protection, contests, salary administration, and training.
No. 17 Employment Manager

As employment manager, I must discover and maintain contact with labor supply. I supervise the interviewing and the testing program to select and place new employees. I work with the training director in the induction of new employees, and I maintain records of transfers, promotions, layoffs, and dismissals.

No. 18 Safety Director

As safety director, I direct and develop safety devices and safety procedures for the new American Baking Corporation. Periodically I inspect equipment, in order to decrease the occurrence of accidents. I also conduct safety contests and maintain accident records.

No. 19 Public Relations Manager

As public relations manager, I work with the personnel director to explain and interpret corporate labor policies and personnel programs to the employees and the public. I appraise public and employee attitudes toward the firm's industrial relations program, and I establish friendly relations with unions, business organizations, newspapers, and radio stations.

No. 20 Labor Relations Director

As the director of labor relations, I advise on formulating and coordinating industrial relations policies and procedures. I supervise the entire industrial relations program. Also, I assist in negotiation of union contracts and settle employee grievances.

No. 21 Director of Purchasing

As the director of purchasing, I coordinate the purchase and assure the supply of equipment, tools, raw materials, office supplies, and all other items needed by the corporation. I also work with the engineering and manufacturing departments to determine if the purchased items are satisfactory.
No. 22 Director of Quality Control

As the director of quality control, I set and maintain standards of the products. I conduct inspections to monitor the product and to make sure that it is produced to the standards. I make regular reports to the general manager on the status of production and also recommend possible corrections in the case of malfunctions.

No. 23 Director of Design and Engineering

As the director of engineering, I am responsible for all research, development, product design and engineering, manufacturing engineering, plant engineering, and testing. I direct and coordinate the activities of plant and production engineering and all research and development.

No. 24 Plant Engineer

I was hired to plan and organize the maintenance of the physical plant, equipment, and machines, and to operate the heating plant and other utilities. I am responsible for plant construction and services, and I supervise the actual construction. I keep the vice president of production fully advised of current developments in the materials and equipment required in plant maintenance and engineering.

No. 25 Director of Research and Development

As the director of research and development, I investigate new and improved uses and applications of our raw materials and equipment, in producing superior baked products without affecting the economy of production.

No. 26 Director of Product Design

As director of product design, I am responsible for the appearance of each product which the corporation offers for sale. Many shapes and many different decorating combinations are possible, but I must choose the design solutions which will help my corporation make a profit.
No. 27 Manufacturing Director

As manufacturing director, I am responsible to the vice president and general manager for the production and for the safe, efficient performance of all facilities, employees, and operations personnel in the plant. I control the work of several departments under my direction to insure desired production flow, satisfactory product quality, and the best use of manpower, raw materials, and equipment in line with the budget.

No. 28 Superintendent

As superintendent under the manufacturing director, I am responsible for the production of all our products at minimum cost. I directly supervise four foremen who have the employees reporting to them.

No. 29 Foreman

As a foreman of the bread division of the American Baking Corporation, I supervise the activities of 40 hourly employees in my division. I monitor continuously to assure the highest standards of quality of work. I instruct, assist, and give technical advice to employees when difficulties arise.

No. 30 Group Leader

As group leader, I am considered a management trainee. I set up machines, schedule breaks, handle disagreements among the employees, and assign work to employees and employees to jobs. I report to the foreman.
MANUFACTURING PERSONNEL TECHNOLOGY

Scan the advertisements provided and answer the questions pertaining on this work sheet. Work in pairs.

1. How many ads indicate that the company is trying to recruit applicants? (Remember, some may simply be product or sales ads)

2. How many ads mention working conditions for employees?

3. How many ads make mention of advancement possibilities within the company?

4. How many ads mention retirement benefits for employees?

5. How many ads mention that training will be provided by the company for hired persons?

6. How many ads mention what the hired person will do on the job?

7. Make a list of the qualifications needed by applicants which are mentioned in the ads.
   a. ____________________________  f. ____________________________
   b. ____________________________  g. ____________________________
   c. ____________________________  h. ____________________________
   d. ____________________________  i. ____________________________
   e. ____________________________  j. ____________________________

8. Make a list of the fringe benefits offered to workers that are mentioned in the ads.
   a. ____________________________  d. ____________________________
   b. ____________________________  e. ____________________________
   c. ____________________________  f. ____________________________
**Production Practices Content**

**Members of Your Group:**

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**Directions:**

As you see the frame and hear the narration, decide with your group whether the picture represents pre-processing, processing, or post-processing, and also decide which production practice is represented (such as forming, or installing, or handling, etc.). An example is given in the first frame. Mark your answers as correct or incorrect as you see them in the even numbered frames. At the end we will see which group got the highest score. Each group has about ten seconds to decide their answer and write it down (be fair).

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Count one point for each correct word. If your group got both words correct for a frame, give yourselves 1 point. **Total Correct Score**

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203
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UNIVERSITY MICROFILMS.
INTRODUCTION

YOUR INSTRUCTOR IS: Mr. Caley

You are one very important person, along with many other students, who has been chosen to work with some new learning materials. The purpose of the instruction you will receive during the next several class periods is to try out (test) some new teaching-learning materials that have been developed for use in industrial arts classes. The materials are designed to help you learn about the elements of manufacturing and information related to these elements.

In order for this material testing to be as accurate as possible, it is essential that you give your fullest cooperation to the teacher and to the instructions given to you. It is believed that you will find the lessons interesting and fun. Even if this is not the case, you are asked to give your attention and effort to learning the material because the results of this teaching and learning will affect their use at a later date.

You will not be graded on your achievement gained from the lessons. The testing will be used to evaluate how well students, like yourselves, learn from the course materials. Therefore, you can see how important it is that you do your very best on each test and in paying attention to your instructor. Please bring a pencil to class.
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DIRECTIONS

Read the following sentences in each item and decide which technological term or combination of technological terms most appropriately identifies what is happening in the sentence. Mark the one space on your answer sheet (a, b, c, or d) which corresponds to the letter in front of the term you believe correct. Work as fast as you can and do not go back to change answers. You will not be rushed so take as much time as you need. Please do not mark on the test booklet.
1. The controlling cycle is completed when this is done.
   a. cycling
   b. supplying
   c. organizing
   d. correcting

2. When the corporation was organized and structured we had to hire a person for every production job.
   a. incorporating
   b. correcting
   c. supplying
   d. identifying

3. Our techniques help new workers adjust to their job and help avoid unnecessary mistakes.
   a. adjusting
   b. correcting
   c. supplying
   d. inducting

4. Safety and comfort are concerns of physical surroundings in which the employees work.
   a. protecting
   b. working
   c. advancing
   d. hiring

5. When production decisions are made, all of our managers go through the stages of formulating, researching, designing, and engineering.
   a. decision making
   b. stage setting
   c. planning
   d. producing

6. This is a new shape for the product and notice the color combination.
   a. designing
   b. shaping
   c. coloring
   d. combining

7. A major task of manufacturing planners is to determine what its long range goals and objectives are to be.
   a. formulating
   b. structuring
   c. processing
   d. creating

GO TO NEXT PAGE--------DO NOT GO BACK TO CHANGE ANSWERS
8. We have persons looking into the situation to see if something new can be made which will help our company prosper.
   a. controlling
   b. prospering
   c. organizing
   d. researching

9. John didn't get any more money when he moved from the paint shop to the assembly line, but he did like the job better.
   a. processing
   b. advancing
   c. changing
   d. benefiting

10. Mike learned on the job while Bill was sent to another company to learn the needed skills.
    a. training
    b. working
    c. advancing
    d. transferring

11. Mike and John, the yard workers, place plastic sheeting over the bags of cement to keep them dry.
    a. storing
    b. warehousing
    c. handling
    d. protecting

12. The changes to materials go on during all stages of production.
    a. manufacturing
    b. processing
    c. working
    d. changing

13. A major task in manufacturing is that of preparing and getting the necessary inputs where they are needed, when they are needed, and in the correct quantity.
    a. post-processing
    b. processing
    c. pre-processing
    d. transporting

14. These practices extend the life and value of our manufactured products.
    a. post-processing
    b. protecting
    c. altering
    d. installing
15. It is very important that the quality of the radio be checked as it moves through the plant.
   a. assembling
   b. processing
   c. monitoring
   d. analyzing

16. Many men applied for the job so we had to choose the one who would be the best worker.
   a. choosing
   b. selecting
   c. working
   d. hiring

17. The foreman gave the new workers a tour through the plant and pointed out the various facilities.
   a. inducting
   b. touring
   c. sightseeing
   d. guiding

18. These practices change the job assignments of workers by giving them a better job or by reducing them to a lessor one.
   a. retiring
   b. working
   c. reducing
   d. advancing

19. John suggested that we use bolts instead of screws to fasten the pieces together.
   a. processing
   b. attaching
   c. combining
   d. bolting

20. There are many ways of getting materials efficiently from outside the plant into the warehouse.
   a. transporting
   b. warehousing
   c. moving
   d. handling

21. John takes his car to the dealer every once and a while to have it lubricated and checked.
   a. examining
   b. fixing
   c. correcting
   d. maintaining
22. The foreman in the factory must make arrangements to have an extra machine in case one breaks down.
   a. planning  
   b. arranging  
   c. substituting 
   d. manufacturing 

23. If managers did not perform this task, our factory would be nothing but complete confusion.
   a. processing 
   b. selecting 
   c. planning 
   d. recruiting 

24. The best solutions for the radio were selected, refined, and improved.
   a. reporting 
   b. solving 
   c. designing 
   d. selecting 

25. Original plans must often be changed as a result of unforeseen difficulties.
   a. correcting 
   b. changing 
   c. planning 
   d. monitoring 

26. The workers had to get new skills in order to operate the new machines.
   a. operating 
   b. machining 
   c. training  
   d. processing 

27. Many of these practices substantially change the form of materials.
   a. forming 
   b. processing 
   c. changing 
   d. separating 

28. All of these processes are done by classifying or by removing material.
   a. removing  
   b. pre-processing 
   c. processing 
   d. separating 

GO TO NEXT PAGE--------DO NOT GO BACK TO CHANGE ANSWERS
29. We found out that all of our latest model television sets had static after they operated awhile so we had to call them all back to the factory and change the circuit.
   a. fixing
   b. changing
   c. altering
   d. recalling

30. The machine performs the same function as the inspector by rejecting poor quality parts.
   a. planning
   b. organizing
   c. disposing
   d. controlling

31. Our company growth is largely due to the fine record we have in learning about new materials, processes, and products.
   a. experimenting
   b. researching
   c. recording
   d. discovering

32. People must be employed for each position in the company and materials and equipment must be obtained.
   a. supplying
   b. securing
   c. purchasing
   d. organizing

33. This action involves the supervision of all employees and the coordination of men, equipment, and materials.
   a. supervising
   b. coordinating
   c. equipping
   d. directing

34. We want our advertisement to inform people that the jobs are available.
   a. advertising
   b. selecting
   c. recruiting
   d. employing

35. The company policies, goals, and objectives have been established by the top management.
   a. planning
   b. organizing
   c. controlling
   d. selecting
36. The personnel man created a new time-keeping system for the workers.
   a. recording
   b. designing
   c. supplying
   d. structuring

37. The inspectors job is to check the products as they move through the production line.
   a. inspecting
   b. designing
   c. reporting
   d. monitoring

38. In our small company, the president also does the accounting and purchasing but there is also a superintendent and several production workers.
   a. purchasing
   b. managing
   c. structuring
   d. producing

39. Our personnel department explains to new employees what is expected of them.
   a. explaining
   b. inducting
   c. managing
   d. departmentalizing

40. The materials were placed in the warehouse until they would be needed.
   a. warehousing
   b. storing
   c. handling
   d. protecting

41. Before the sand could be used, all of the gravel had to be taken out.
   a. removing
   b. preparing
   c. adjusting
   d. separating

42. The problem now is, how do we contact persons who might be interested in taking the job?
   a. contacting
   b. recruiting
   c. employing
   d. working
43. Supervision and coordination go on at all levels of the organization and in each department of the company.
   a. directing
   b. supervising
   c. watching
   d. organizing

44. The company president and his advisors expect to market our products in every state within the next 20 years.
   a. marketing
   b. planning
   c. advising
   d. selling

45. We looked far into the future as well as the near future when we established our company.
   a. directing
   b. controlling
   c. organizing
   d. planning

46. Production processes must be planned.
   a. formulating
   b. engineering
   c. researching
   d. structuring

47. The foreman was told to phone the main office if anything went wrong on the assembly line.
   a. transmitting
   b. communicating
   c. reporting
   d. calling

48. One of our first tasks was to identify the work to be done and where it was to be done.
   a. identifying
   b. structuring
   c. working
   d. controlling

49. The supervisor directs the work, monitors the production, reports errors, and makes corrections.
   a. planning
   b. controlling
   c. correcting
   d. organizing

GO TO NEXT PAGE---------DO NOT GO BACK TO CHANGE ANSWERS
50. Our staff had to find out how strong the material was.
   a. analyzing
   b. testing
   c. strengthening
   d. researching

51. The flow of the work through the plant and the flow of materials is scheduled.
   a. engineering
   b. flowing
   c. determining
   d. materializing

52. This management function has two parts: They are called structuring and supplying.
   a. controlling
   b. planning
   c. engineering
   d. organizing

53. The inspector saw an error in the painting department and immediately told the plant superintendent.
   a. pre-processing
   b. reporting
   c. supplying
   d. formulating

54. The foreman coach the new workers as they perform their job.
   a. working
   b. advancing
   c. training
   d. managing

55. The surroundings in a factory tend to set the wage level and other benefits that employees well receive.
   a. advancing
   b. working
   c. paying
   d. earning

56. We used metal bending machines to make the folded top of the open pan.
   a. bending
   b. forming
   c. folding
   d. manufacturing
57. The hot steel is poured into molds where it hardens into the desired shape.
   a. forming
   b. molding
   c. shaping
   d. steel making

58. The practices of receiving, unpacking, handling, storing, and protecting do not change the form of the materials.
   a. processing
   b. providing
   c. post-processing
   d. pre-processing

59. The practices used here are installing, maintaining, repairing, and altering.
   a. post-processing
   b. fixing
   c. correcting
   d. pre-processing

60. This process involves recruiting, selecting, and inducting.
   a. training
   b. working
   c. hiring
   d. advancing

61. I received my last promotion two years before I retired.
   a. manufacturing technology
   b. promotion analysis
   c. manufacturing personnel technology
   d. retiring advancement

62. The knowledge needed for post-processing is the same as that needed for processing.
   a. technology
   b. manufacturing production technology
   c. processing technology
   d. knowledge input

63. This science is concerned with the skills of manufacturing.
   a. manufacturing management technology
   b. technology
   c. manufacturing production technology
   d. manufacturing technology
64. The actions found in this technology are common to all work and play.
   a. manufacturing production technology
   b. manufacturing personnel technology
   c. manufacturing management technology
   d. manufacturing technology

65. John planned and organized the work so that it would be carried out efficiently by the workers, then he controlled the quality of the work by inspecting it.
   a. manufacturing management technology
   b. inspection and quality control
   c. planning technology
   d. quality organization

66. All manufacturing employees are hired, trained, worked, advanced, and retired.
   a. earning a living
   b. employment technology
   c. training and advancement
   d. manufacturing personnel technology

67. There is a name for the science of planning, organizing, and controlling within the modern manufacturing system.
   a. planning, organizing, and controlling
   b. modern manufacturing technology
   c. manufacturing management technology
   d. management science

68. Mike had to be trained after we hired him, but now he is producing as well as our seasoned workers.
   a. manufacturing management technology
   b. manufacturing training technology
   c. manufacturing personnel technology
   d. training technology

69. This is a study of how all kinds of manufacturers, using different materials, make anything that can be done in a factory.
   a. material analysis
   b. manufacturing production technology
   c. factory production
   d. technological science.

70. All levels and types of management and production persons are greatly affected by these practices.
   a. managed production
   b. practice analysis technology
   c. technological controlling
   d. manufacturing personnel technology
71. John likes his working conditions, especially since the new cafeteria has been opened to the employees.
   a. food technology
   b. manufacturing personnel technology
   c. food service technology
   d. production technology

72. This science is concerned with the knowledge of efficient practices in manufacturing.
   a. practices technology
   b. efficiency technology
   c. efficient knowledge science
   d. manufacturing technology

PLEASE WAIT QUIETLY UNTIL EVERYONE HAS FINISHED

DO NOT GO BACK TO CHANGE ANSWERS
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