FOURTEENTH
YEARBOOK

APPROACHES AND PROCEDURES

In Industrial Arts

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ON
INDUSTRIAL
ARTS
TEACHER
EDUCATION

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A DIVISION OF THE AMERICAN INDUSTRIAL ARTS ASSOCIATION
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Foreword

The nature, structure and organization of the body of knowledge identified as industrial arts is emerging as the foremost problem facing this area of the education profession. Yearbook Thirteen identified this problem as one of the five areas selected for continued study and further research. Many educators believe *the lack of a universally accepted body of knowledge is thwarting the orderly and progressive development of industrial arts.* They question whether industrial arts should continue with its myriad of programs based on divergent and often conflicting philosophies; or whether one broad philosophy should be accepted with a body of knowledge which is adjustable to the varying needs of student and community but sufficiently consistent to establish content unique to industrial arts. The authors of this yearbook do not attempt to provide a panacea to this problem but do provide a thorough analysis of prevailing approaches to course content as well as a refreshing analysis of the "Conceptual Approach to American Industry."

The last half of the yearbook analyzes parts of two of the remaining areas of research identified in the thirteenth yearbook—methodology and physical setting. This was accomplished by permitting individual authors to select a new or unique approach to teaching industrial arts and analyzing this approach through classroom experimentation and critical thinking. The results have produced many insights into the development of creative thinking abilities and the use of mass production, programed instruction, team teaching, advanced class placement of capable students, and open laboratory scheduling.

In a unique approach, the yearbook editor and authors were selected from one educational institution. The editor's preface alludes to some of the advantages and problems resulting from this approach. However, the resulting continuity of the presentations in the yearbook provides a more than favorable evaluation of this procedure. Therefore, whenever feasible, future yearbook staffs will be selected from one teacher education department.

The preparation of a yearbook is a dedicated and time consuming endeavor. It represents a time of reflective thinking leading to a thorough analysis of the problems facing the profession. Personal sacrifices of time must be made in order to meet the rigorous schedules required to produce the yearbook. In the past, these activities have been spread among a number of teacher education staffs. However, Yearbook Fourteen has been edited and authored solely by the faculty and administration of Stout State University. The ACIATE gratefully acknowledges and appreciates this professional contribution and hopes the sacrifices are offset by the personal growth and development which resulted from this endeavor.

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Preface

To have all the writers of a Yearbook on one campus was considered by the Yearbook Planning Committee as a practice worthy of trial. It is sincerely hoped that this, the first with that makeup, will be found more than passably acceptable.

The seeming ease of communication with this structure, between the editor and the several writers, must be acknowledged. However, the problems facing any writer were found to be present, as one's usual assignments must be carried on, and in this instance were probably aggravated by an enrollment increase well beyond that which had been projected.

This Yearbook was originally conceived by the Committee to be concerned with implementing industrial arts, and a request was made for volunteers from the staff at Stout State University. It was decided in conference that this should not be a "methods" book in the usual sense. It evolved that the Yearbook might well take a look at what must be done if industrial arts is to fulfill its place as a curriculum area, and survey some practices in teaching industrial arts which are as yet not firmly accepted.

It should be made clear that the writers of the several chapters were not given any dictates to follow in what they should report—there being no official "method" at Stout State University to promote. In fact, effort was made to encourage those to contribute who could report on something new. It is regretted that several other promising new practices could not be reported here, due to commitments which precluded staff members from doing more writing.

As editor, more than the usual "Thanks" is extended to the ten authors for their willingness to participate in face of the increased demands of large enrollment upon their time, as this work would not have materialized without them. Special appreciation is extended to John A. Jarvis, Dean of Instruction, for his valuable counsel in planning and his assistance in preparing the manuscript.

G. S. Wall, *Editor*

CHAPTER ONE

Introduction and Critique

G. S. WALL, *Editor*

Overview

At the outset it may well be expressed that this yearbook is concerned with three broad aspects of industrial arts: (1) its place in education and the basis on which it should be organized as a curriculum area; (2) teaching procedures that will bring the desired development; and (3) organizational practices which promote efficiency. Whether the several chapters can be positively identified and labeled to fit even such a loose structure is not important—the important thing is that the reader define a concept of industrial arts for himself, be cognizant of some "new" and effective teaching practices, and finally introduce as much efficiency in operation as possible.

The first part (Chapters II, III and IV) is concerned with identifying industrial arts and its place in the scheme of education. The reader should not assume that Chapter II, "Industrial Arts and Education" provides a ready solution. It simply presents the author's concept of the relationship that could exist—industrial arts as a part of education. The reader will still be in a position to decide for himself, as will be brought out later in this chapter. Special emphasis should be placed on the chapter which deals with the question "Industrial Arts—What Is Its Body of Knowledge?" and the following chapter (IV) which deals with the application of the conceptual approach to the teaching of "industrial arts." Ample opportunity is presented in these two chapters for the reader to remove himself from being a "traditional" industrial arts educator.

The second part (Chapters V, VI and VII) presents first, some insights into developing creative thinking abilities which most readers will agree is a desired goal. This is followed by a report on applying the mass production technique using hand tools—at the junior high school level. Chapter VII provides excellent insight into the much heralded programed instruction. Each is oriented to applications in teaching industrial arts.

The last part (Chapters VIII, IX and X) is concerned with efficiency in operation; but, not at the expense of quality in education. Each of the three reports is focused on industrial arts teacher education, the first being a report of a study on the open laboratory plan of scheduling a technical course—industrial graphics. The report on team teaching, although not precisely parallel to the open laboratory plan of scheduling, utilizes the principle of lecture for large groups. The final chapter—advanced placement—reveals increased efficiency in the development of the students through wisely taking freshmen from where they are as a result of demonstrated high school achievement and permitting them to eliminate a prerequisite course in industrial graphics at the college level.

There will follow, in the remainder of this chapter, a few comments on each of the chapters, pointing out highlights, limitations, and inter-relationships.

Chapter Two. Industrial Arts and Education

It should be emphasized that the reader should not look at this chapter as providing a positive answer to the question concerning the nature and the place of industrial arts in the scheme of education. It is recognized that it may be considered by some as a brief for the "traditional" industrial arts. (Compare with Chapters III and IV.) However, in spite of the seeming emphasis on the heirarchy of purpose, functions, and objectives, there is ample opportunity for the reader to accept or reject its tenets in whole or in part.

The presence of functions of education—displacing as they do some of the long accepted objectives—should not be disturbing. However, when viewed individually there may well be concern as the "general development" function stands in lieu of "general education" which is therefore denied existence. This does not, however, deny the industrial arts instructor the right to emphasize this aspect in his teaching, even to the extent of excluding the "special development" function. Similarly the "special development" function stands in lieu of "vocational education" which likewise is denied existence. All of this simply stresses that education—the process which society provides on an organized basis in the schools—is an all encompassing development. Neither of the functions denies existence of the other. It should be recognized, that the age old question, as to whether industrial arts should provide any "special development" (vocational education), remains unanswered. The answer is to be found only in the minds of those who determine what society's concept of education is. There is little doubt in the mind of the editor-author that the "guidance service" function which was assumed by educators as being in its domain, will continue as a service to be rendered by the schools. To ignore or cast guidance aside may well result in "driving our pigs to a poor market."

The simplified statement of objectives—the acquisition of knowledge, the development of skills, and the development of attitudes—may be found by some to be overly simplified. Viewing them in light of their relationship in the heirarchy—purpose, functions and objectives—should, however, add to their significance, especially as they are intended to provide a measure of needed specificity. (Compare with Chapters III and IV.)

The questions at the close of the chapter should be reviewed with some caution by maintaining a "wait and see" attitude until the reader has read Chapters III and IV. These chapters will present some viewpoints which may help one answer some of the questions. (This is not intended to imply that the remaining chapters will have no bearing on the answers—they will. However, they will serve better to determine how one can attain the goals and do it efficiently rather than assist in determining what the content and objectives will be.)

Chapter Three. Industrial Arts—What Is Its Body of Knowledge?

The question posed by Swanson in the title "Industrial Arts—What Is Its Body of Knowledge?" turns out to be a challenge (or is it an indictment?) when he closes by writing that " . . . industrial arts cannot long delay the definition of a body of knowledge from which to draw its content."[1]

[1] All direct quotations in Chapter I will refer to the specific chapter being discussed.

The reader should recognize that Swanson presents no brief for what the objectives of industrial arts should be, nor does he identify its body of knowledge, *per se.* He does, however, present critical anaylses of four groups of proposals which " . . . define, explicitly, the body of knowledge from which content of industrial arts should be drawn." These groups are: life needs, crafts and trades, applied science, and study of industry. (Another approach to the study of industry is recognized but is not discussed as it is the subject of Chapter IV.)

Briefly, the "life needs" approach, which draws its content from a rather ill-defined area, can include almost any need of the citizen which is reasonably related to a technical area. Implicit in this discussion is rejection of the "life needs" ill-defined body of knowledge. However, it must be stated that without a set of objectives it is difficult to accept or reject the approach simply because the body of knowledge is ill-defined. If the objectives to be reached by the "life needs" proponents demand content from a spread of "technical" areas in life, aren't the boundaries likely to be indistinct?

Possibly the first question to be answered, if the present concept of industrial arts is not fulfilling its rightful service in education, would be: What are the objectives of industrial arts? which would then lead to defining the body of knowledge. Even of more serious consequence may be the implications in the following questions: Must the objectives of education be restricted to selection of content from a previously established body of knowledge? Who should determine the body of knowledge and upon what clearly defined basis should it be established? Is it wrong for education to create a body of knowledge on which it can draw to fulfill its service?

As concerns the crafts and trades approach, with its processes, tools, machines, materials, and products, Swanson implies the presence of a body of knowledge. This is brought about through the process of analysis which ". . . provides a neat, tight organization of subject matter . . ." He continues by enumerating several advantages to this approach, including:

> Content is relatively easy to identify and organize. . . . It is possible to assign a wide variety of purposes to the study of the source content. Some students may use it for learning a job, others may base further learning on it, and still others may develop problem solving abilities for use in future activities.

However, its major shortcoming according to Swanson ". . . is its atomism. Time does not allow study of all the 'parts' and often the relationship among the segments studied are not grasped." The paradox must be recognized that the atomism in this approach produces both advantages and disadvantages. Of more significance, however, are the closing words above: ". . . often the relationship among the segments studied are not grasped," which is what Swanson, Face, and Flug seek to overcome in presenting the conceptual approach to the study of American industry. (Chapter IV).

The third approach analyzed by Swanson is the teaching of "Industrial Arts as the Study of Applied Science (Technology)." He aptly describes the applied math and science approach as "an attempt to integrate and use learnings from other disciplines in the study of industrial arts." Swanson implies that the "Pre-Tech Lab" used in "The Richmond Plan" may not be industrial arts even though "it makes use of shop equipment" for the testing of principles learned in math or science. After briefly presenting the applied science approach in which "some parts of the disciplines of science have been adopted bodily for study in industrial arts," Swanson concludes that the applied math and science approach "may lead one to wonder about the need for industrial arts."

The fourth and final approach analyzed by Swanson is simply labeled: "Industrial Arts as a Study of Industry." Industry in this approach, "is defined as a complex of organizations which utilizes the basic resources of men, materials, machines and money to produce goods or provide services." (Compare with Chapter IV.)

In this discussion, Swanson capably simplifies "The Functions of Industry as a Basis for Industrial Education Programs" by W. M. Bateson and Jacob Stern as an approach which would restrict industrial education to a study of the production and service functions of industry. Similarly, he reveals that Henry R. Ziel's proposal is "based on the need to study the functions of industry rather than the isolated parts."

Also included in this "Study of Industry" classification are Delmer W. Olson's eight categories of industry; Paul W. DeVore's classification of man's major technical roles; and Ronald W. Stadt's "Study of Forces Generated by Industry."

Swanson concludes his analysis of this approach with:

> Proponents of drawing on industry as the source of content for industrial arts point out that it provides a more comprehensive body of knowledge than any of the previous proposals. Criticism [however] is often leveled on the basis that it is *too* broad and consequently offers little integrating force.

Finally to answer the question "Why Identify a Body of Knowledge?", Swanson writes that

> any subject worthy of time in the school must demonstrate that it is based on an organized body of knowledge . . . . A further purpose is in the integrating force it can provide . . . and [finally] to clarify its relationship to other bodies of knowledge.

One cannot help but agree that industrial arts should have a body of knowledge. However, the reader should not assume that none exists—industrial arts could not have been functioning for these many years without it. That revision or amendment leading to more precise identification may be needed can probably be assumed. However, when one reads that "Observers have long noted the great diversity of programs labeled industrial arts; some claim that such diversity is good," the question comes to mind—Does a clearly defined body of knowledge necessarily eliminate diversity or does it simply confine its spread?

Chapter Four. Conceptual Approach to American Industry

This chapter presents a current study in which concepts are used as a basis for organization and study of industry. The reader will promptly be confronted with a change in name as the authors, Face, Flug, and Swanson, propose "a new program, called *American Industry*," which is the title they would assign to this curriculum area as one to displace industrial arts.

The proponents advance two objectives for *American Industry* based on their acceptance of the central purpose of education—"development of the rational powers of man"—expressed by the Educational Policies Commission. The two objectives are: "(1) To develop an understanding of those concepts which directly apply to industry, and (2) to develop the ability to solve problems related to industry."

The reader should have no difficulty in accepting these as desirable major goals for *American Industry*. However, the crux of the matter hinges upon acceptance of *American Industry* in place of industrial arts. Unfortunately, more specific objectives of *American Industry* are not listed in the presentation. Thus, those who have more specific goals to be fulfilled by industrial arts cannot make a truly complete evaluation of it.

To provide the necessary structure in this approach, ". . . a unified, basic description of the several facets of industry . . ." is illustrated in a figure representing American Industry. It should be emphasized that industry is conceived by Swanson, Face, and Flug as being an institution—"a complex of organizations that utilizes the basic resources of men, materials, machines, and money to produce goods or provide services to meet the needs of man." (Also compare with Chapter III.)

It is the singleness of the institution—industry—which in itself is a basic, major concept, that provides the proponents with "a discipline in that it has an identifiable structure." Major facets (concepts) of industry, such as processes, materials and production are included in the figure, all of which add up to American industry—the institution. It may safely be concluded that the "body of knowledge" in this approach will be the same as that referred to in Chapter III by Swanson in his "Study of Industry" approach for industrial arts content.

Concepts are obviously the key to this approach. A concept is defined as "a psychological construct resulting from a variety of experiences (detached from the many situations giving rise to it), fixed by a word or idea, and having functional value to the individual in his thinking and behavior." The interesting, virtually self-explanatory exercise in concept formation which they include should lead to more understanding of a concept.

That unity can be approached and possibly reached through an organized array of concepts, which by their very nature represent an integration of the many processes, materials, and machines man utilizes is a very commendable goal. However, will the "variety of experiences" necessary for concept formation need to be restricted in view of the time available? Would this result in the same process of selection they attribute to "traditional" industrial arts?

Similarly with skills. How will the specific skills be restricted? If on a pre-determined basis—what is the basis? If not restricted—what of the time and facilities factors?

Without any thought of drawing a conclusion relative to the desirability of this approach in comparison to the others presented in Chapter III, the editor wishes to express the following opinion.

The conceptual approach to the study of industry has the potential to overcome a serious problem in society—that of displacement of workers and their subsequent need for retraining. If the conceptual approach will truly lead to understanding and application of knowledges and skills which cross boundaries of materials (wood, metal, plastics, etc.) and machines, the learners will have achieved truly general-industrial development. This statement implies that the special development function of education will need to be served; but, it need not be the *primary* function. However, it should not be interpreted as denying the same potential to the other approaches, including the most common concept of industrial arts—the "traditional" one. This, brings the focus of any evaluation back to: what are the functions and objectives of industrial arts in the scheme of education? One might well ask: How broad is industrial arts in comparison to *American Industry?* Will *American Industry* encroach on the domain of other disciplines?

It cannot be denied that the approach has merit. The profession should look forward to its full development in the years ahead.

Chapter Five. Developing Creative Thinking Abilities

This chapter should help industrial arts teachers overcome the "neglect of developing the creative thinking potential of students" which Sommers ascribes "to a lack of understanding about creative thinking abilities and how these can be developed in the classroom."

Although only brief space is devoted to defining creative thinking, Sommers does present his choice (too lengthy to present here) which should enable the reader to readily grasp the significance of the study he reports on developing creative thinking abilities. Sommers follows this by pointing out the problems involved in such development which he generalizes to be: "(1) The general environment of classroom and (2) specific learning activities." This leaves no doubt that the industrial arts teacher can do something about developing creative thinking abilities if he will do something about the *environment* and the *activities* in his laboratory or classroom.

Of particular note is the fact that Sommers set out to test whether or not "the use of specific teaching methods designed to increase certain creative thinking abilities will increase those abilities without affecting learning outcomes of an industrial arts laboratory type course." As a result he reports "a significant difference between the two groups (in favor of the experimental group) . . ."

Among the activities used in the study to promote the development of creative thinking abilities are brainstorming and sketch-storming. Other activities are also presented.

To add to the evidence applicable to industrial arts, a study by Anderson is reviewed in which it was shown that ". . . other methods in a different type of subject matter course could be effective . . ."; and revealing also that "a variety of learning activities could be used to improve creative thinking abilities..."

From his brief commentary on the implications for industrial arts, it is relatively easy to conclude that industrial arts teachers have a challenge to meet in the development of creative thinking abilities as Sommers states: "A major responsibility of the school is to develop the creative potential of all students." However, he reiterates that deliberate effort is necessary to accomplish this. That this effort is rewarding to both the student and teacher may be concluded from his statement that "increasing the creative potential of students does not necessarily mean sacrificing other learning activities."

The chapter closes with comments on some suggested references for those interested in further study and with a selected bibliography.

It should be noted that the two studies concerned with industrial arts students, reported by Sommers, were on the college level. This should not deter secondary teachers from applying such procedures for the same purpose. The very nature of the activities may prove to be more than stimulating exercises—they may well start the students on the road to *creative* thinking.

There should be no quarrel in accepting development of creative thinking as a goal as this is essential to problem solving.

Chapter Six. Mass Production with Hand Tools

At first the title—Mass Production with Hand Tools—seems to be an anachronism as this is an age of machines. However, Prichard promptly reveals that mass production with hand tools is carried on "to provide or stimulate an interest, insight or understanding of industry and its place in society." And, it is worth noting, this is being done at the junior high school level as he reports on its application by DeBrauske. He presents a good brief for adopting many aspects of industry—"jigs and fixtures, flow charts, division of labor . . ., work simplification, . . . and industrial psychology." This procedure, however, is not restricted to the theoretical study of mass production; it is also aimed at the development of basic skills with selected hand tools. (Compare with Chapters III and IV.)

As with any procedure, this requires preparation on the part of the teacher. Prichard presents some insight into selection of a project, the making of a pilot model and the preparation of jigs and fixtures. A list of fifteen principles for jig and fixture construction should prove to be helpful to those contemplating such activity.

The actual teaching of the unit, to which Prichard devotes most of the chapter, should give one a sound basis for planning and implementing the activity. Although it is not specified, it may safely be assumed that mass production with hand tools is not intended to be the sole type of instruction. It is implied that there is need for as much variety in teaching techniques as in the usual practice. However, much of merit is to be found "in that it is a group project and involves individuals getting along with their peers."

As Prichard brings out, the trial application indicated "that the students did enjoy this type of unit and thought they were more accurate with hand tools when aided by jigs and fixtures." Reactions from parents also revealed their approval.

Some questions, however, need to be answered, and the answers should enable industrial arts teachers to evaluate mass production with hand tools. These questions are: (1) Does it increase or decrease the amount of knowledge and understanding acquired by the learner? (2) What is the change, if any, in the nature of the knowledges—less of the technical with more emphasis on organization and operation of industry? (3)

Is there a reduction (or an increase) in manipulative development? (4) Must all or most of the planning, including the production of jigs and fixtures, be done by the teacher? Or, can planning and production of jigs and fixtures be designed to involve the students? (5) Is mass production with hand tools a retrogressive activity—in view of the "machine age"—or, will it make the "study of industry" more meaningful for junior high school youth?

Although Prichard offers DeBrauske's work as evidence, it seems that mass production with hand tools merits further and more detailed study along the lines indicated by the questions above.

Chapter Seven. Programed Instruction

Programed instruction is not a fad, a passing fancy, according to Ruehl and Hofer. In fact, it is reasonable to conclude on the basis of their presentation that the industrial arts teacher can and should do his share in aiding the "students to acquire certain intellectual abilities and skills which will enable them to meet everyday situations." This, as they express it, would mean that the students have "received an education and teachers have effectively completed their tremendous responsibility."

The authors make it clear that programed instruction is more than simple organization of the content "into small sequential steps," demanding "considerably more student involvement." It requires that "the author of the program . . . provide objective evidence of the program's effectiveness." The program may be "linear"—one in which all students follow the same path—or "branching"—one in which students may follow different paths.

The program may be presented through books or by the use of machines, the simple machines having no advantage over the books except added control over cheating. Complex machines, "especially the computer-operated machines, appear to have distinct advantages over programed books." The process, in either case, is step-by-step presentation of the material. The authors point out that "the mode of program presentation should be secondary to the selection of the program itself."

Studies reviewed by Ruehl and Hofer show that the Air Force Training Command is firmly convinced that programed instruction is effective. Its greatest concern is to develop programs which will meet the criterion that "90 percent of the trainees could make 90 percent or higher scores . . ." The industrial studies reviewed, also reveal substantial gains in the amount learned as well as a reduction in the time required for learning. Even when it comes to manipulative activity the gains made seem to justify programed instruction.

Unfortunately, the authors report that "studies of the effectiveness of programed instruction in the industrial arts area are quite limited." They could, however, report from one study that although no significant difference in informational achievement resulted from the use of programed instruction, a smaller amount of time was required by the eighth and ninth grade students studied to acquire the knowledge. As related to manipulative development, Hofer's study brought out that students following printed programed material required far less individual assistance than those who had the usual teacher demonstration.

One cannot help but concur with Ruehl and Hofer in their statement of implications of programed instruction for industrial arts because they state that it provides: (1) More effective study outside the school, (2) More opportunity for depth of study according to ability, (3) Learning at a speed appropriate for the individual, (4) Reduction in the amount of time needed to teach manipulative operations and, (5) Increased opportunity for problem solving development.

The value of programed instruction is epitomized in the simple statement: Industrial arts educators—don't wait, do it now!

Chapter Eight. Open Laboratory

The open laboratory plan of scheduling laboratory and classroom work in industrial graphics is, in effect, an effort to introduce more operational efficiency.

In essence, the open laboratory plan which Erickson reports, schedules four regular class sections to meet as a lecture section, which in turn is divided into two recitation/discussion sections. The laboratory work on graphics problems is completed by the students in the open laboratory or elsewhere according to the wishes of the student. The open laboratory is available, with qualified teaching assistants as consultants in charge, sixteen hours each week.

In the actual study, one of five sections served as the control group and the other four became the open laboratory (experimental) group.

Erickson's "major objective was to determine the effectiveness of the open laboratory technique on student achievement." As a result he found that student "achievement in quizzes, problems, the final achievement and final course grades" were equal for the two schedule plans. However, Erickson in evaluating the overall effect of the open laboratory plan in comparison to the conventional plan of operation came to the following conclusions, among others, that the laboratory plan provided: (1) More efficient use of instructional time and activity; (2) savings in instruction costs, and (3) improvement in the instructional atmosphere.

In this period of classroom and instructor shortage, Erickson's study should offer not only a remedy, but a means of improvement as well, as the students are not "short-changed" by the introduction of this efficient plan of operation. Contrarily, they may really be aided, if credence can be placed on the reaction of a student quoted by Erickson: "As in life, people must discipline themselves if they are to achieve."

Further, the plan not only reduces the number of instructors needed, but it provides them with more time to plan and organize their work.

There should be no doubt in the minds of industrial arts educators that adding efficiency (recognized as a continuing pursuit of American industry) is a worthy attainment which could well be added to that gained through programed instruction (Chapter VII), team teaching (Chapter IX), and advanced placement (Chapter X). It should be possible for secondary schools to apply the same principles to effect improvement in their situation. That these principles can be applied to other than industrial graphics, Erickson states: "the open laboratory procedure points out definte implications for other laboratory courses."

Chapter Nine. Team Teaching

In effect, *Team Teaching* as reported by Halfin and Kufahl is an application of the principle of large group instruction

(Chapter VIII) with the addition of a number of specialists providing the instruction.

After a brief review of background literature on team teaching, Halfin and Kufahl report on the development of a new course in metals for beginning students. It is noteworthy that in their desire to serve an increasing number of students more efficiently they found it necessary to develop a new course—one which will better serve to meet the objectives of the University.

The new course, which includes instruction in foundry, machine shop, sheet metal and welding, replaced the beginning course which was principally machine shop. The same total amount of time and credit was maintained. As four areas of metals are involved in the new course, the opportunity to utilize a specialist in each area obviously led to the "metals" team. A unit shop was available for each of the areas included so it simply became a matter of scheduling. Because the participants were concerned with eliminating unnecessary duplication, the added efficiency of large group instruction was introduced.

The resulting plan and schedule was simple—register 120 (four normal classes of 30 each) for the course; assign 30 students in each of four sub-sections, each of which would be rotated through each of the four laboratories during the term for nine days of laboratory instruction under a specialist; plan eight large group lectures during the term to be given by the four specialists—two given by each one; and schedule one day for a final examination.

Halfin and Kufahl report that an evaluation of the program finds the advantages outweighing the disadvantages. Outstanding advantages are: (1) Students prefer it; (2) There is improved organization and increased course content; (3) More preparation time is available for instructors; and (4) Wider content is provided for the students. Probably the most serious disadvantage is that "much of the typical material covered in shop work does not lend itself to large group instruction . . . . The topics for lecture must be of a general nature."

The application of team teaching poses problems to be overcome; this may be assumed. However, the reduction in lecture time required of each instructor will provide more time for preparation, and could well lead to the development of programed instruction material (Chapter VII). This could result in even better instruction and student growth.

It should be interesting to follow this development into the future to determine: (1) Whether the students truly get more insight and better exploration of the metals field. (2) How much of the several metals areas can be integrated (possibly as concepts as presented in Chapter IV) to provide additional unity to the course. (3) What would be the effect of the advanced placement program which the authors suggest. (See Chapter X.)

Certainly, one must agree with Halfin and Kufahl that team teaching (as developed for this purpose) "would not be feasible where only one section in a given area or department exists." The program is without doubt specially geared for larger departments, but these could be on either the secondary or higher education level.

Chapter Ten. Advanced Placement

Here again is an efficiency practice; one which, as Erickson expresses it, "is to take the student as it finds him and accomplish whatever may be done to meet his particular needs." Obviously, this can be accomplished in the area of industrial graphics, judged by the study reported here.

After a brief insight into the meaning of advanced placement and its possible application at Stout, Erickson first explains the method of study. This is followed by a detailed explanation of the development of the necessary qualifying examination. Finally, he reports on the study made when advanced placement was first made available to incoming freshmen during the 1962-63 school year.

The answer is found in how well advanced-placement students do in the second industrial graphics course in comparison with those students (the control group) who received a grade of "A" in its prerequisite course. Erickson reports that 22 advanced placement students earned a grade point average of 3.21 in comparison to the 3.17 grade point average earned by 24 students in the control group. Obviously, as Erickson expressed it, "advanced placement students do just as well in the second course as do those students who complete the basic (prerequisite) course with a grade of "A."

One cannot help but agree that the program will, among other things, provide opportunity for acceleration and further development; promote articulation between secondary school and higher education industrial graphics departments; and eliminate waste of time and effort on the part of those involved.

It will be interesting to see whether the succeeding advanced placement groups fare as well as did the initial group. Such additional evidence will be wanted by many before they accept it.

Can advanced placement be practiced in other industrial arts areas? There seems to be no logical reason for denying it a trial at least. Does advanced placement cause the student to lose something if he is an industrial arts teacher education major? The often expressed statement evoking this question is simply that "methods of teaching are always included in all of our laboratory courses."

No doubt, advanced placement, as it is with other efficiency practices (programed instruction, Chapter VII; open laboratory, Chapter VIII, and team teaching, Chapter IX) must show equal or increased development (in addition to any savings in time, money or effort) to be accepted.

CHAPTER TWO

Industrial Arts and Education

G. S. WALL

Introduction

This chapter is concerned with providing the reader with a basic framework for education—its purpose, functions and objectives—and the relationship of industrial arts to it. Poignant questions are presented at the close of the chapter. It is hoped these will aid the reader to better define his own basis for evaluating the presentations given in the succeeding chapters.

Education as conceived here, is the purposeful, organized effort provided by society through its institutions—schools, institutes, colleges, and universities, for individual development. Industrial arts is conceived as an integral part of education—not as a kind of education. As such, industrial arts is assumed to contribute materially to the purpose of education.

The *functions* of education—general development, special development, and guidance service—are described as more specific contributions to the purpose of education. Description of these functions, as they relate to industrial arts, are extended further to reveal its unique contribution to education.

Similarly, the major *objectives* of education—acquisition of knowledge, development of skills, and development of attitudes—are described as further specifics of the purpose of education. These objectives, as related to industrial arts, are presented in a similar manner.

The chapter closes with a brief insight into *levels* of education—elementary, secondary, and higher. This is presented so the reader may further define the purpose of industrial arts as education, by attaching a changing emphasis to chosen objectives or functions.

Definitive Descriptions

Education, the formal service provided by society, is of concern here. It is assumed to be broad and relatively all-inclusive. Industrial arts is that aspect of education commonly, but not necessarily uniformly, carried on in the schools as a curriculum area dealing with industries.

Education

Education may be defined as a process of development. It has as its overall purpose the development of the ability in the individual to think and solve problems to a degree such that he can fulfill his place in society. This should result in his being a happy, participating and contributing member of society.

The individual's contribution to society may be the rendering of a necessary service—teaching, for example; or producing something—working in a factory. It is recognized that he must also be a member of society, one who has a place other than as a producer or servicer since much of his time is spent at other activities. He is a member of a family, neighborhood, city, state, nation, and world. His contributions are manifold; both as a producer and simply as a member of society.

Education should strive to bring out the maximum worth of each individual. Obviously, the inherited mental and physical endowments in the individual limit his development, but education should aim for the optimum in each person. Education must of necessity, then, help the individual choose his specific area of service as well as develop himself for general worthy membership in society.

The development of the individual is not divided—one phase as a worker and the other simply as a member of society. The two are inseparable. Members of society should live while they work, should work while they live. This simply implies that education is a unitary service, one concerned with the whole of the individual—his physical, mental, occupational, and social development. It is only for purposes of discussion and convenience that education is delimited as being of different kinds and offered at different levels.

Education is a process of development leading the individual to become a thinking, problem solving, well adjusted, and contented member of society who participates as a member in general and produces or renders a needed service to the optimum of his inherited capacities.

Industrial Arts

Industrial arts is one of the areas of American culture which has been distinguished as an integral part of education. It is concerned with the study of the industries in this culture. Today, as a curriculum area, it is a composite made up of *selected* industries. It may well be that it *should* represent all industrial technology.

The purpose of industrial arts, as an integral part of education, is the development of the individual as related to industries. This, however, is restricted to the area of industries selected. As such, it parallels other curriculum areas found in education, such as science. (The specific functions it should serve are discussed later.) Obviously, this development should lead to problem solving, this ability being brought about through the study of industries. It may be assumed that by restricting content to a given area, in this case—industries, the resulting development will be limited. But, then, this is true for each of the curriculum areas included in education. Collectively, the individual's development is broad; hence, industrial arts serves the purpose of education.

Whether industrial arts should serve the individual in his development as a producer or simply as a member of society in general is debatable. It may be assumed that industrial arts, as an integral part of education, should assist the individual in making a life choice (occupational or other).

The selection of content for industrial arts and the amount to be selected remains a problem just as it is for education itself. Education includes the study of industries because it represents one phase of the culture and will thus serve in the needed development of individuals. Those educators concerned with the study of industries must select content (and subsequently teach it) for the optimum development of the individual.

This chapter, however, is not concerned with the selection of content from the specific industries or for certain courses in industrial arts. It is sufficient to state that among the many potential industries are the following: aircraft, automobile, building, chemical, ceramic, electric, fishing, furniture, graphic arts, lumbering, metal manufacturing, petroleum, power, textiles, and transportation. It may be assumed that there are others and that important major subdivisions are also worthy of separate listing.

Functions

In stating the purpose of education—to develop the problem solving ability of the individual so that he will be a happy contributing member of society—there arises a need for more details as this is very broad. This specificity is gained in part through describing the major functions of education. Obviously, industrial arts should also function toward more specific goals. This section on functions shall serve to provide additional insight into the overall purpose and will include a brief description of the three functions: (1) general development, (2) special development, and (3) guidance service.

General Development

A *complete* education must provide the individual with optimum development in those knowledges, skills and attitudes which are needed by all individuals. Illustrative of this development are computational and communicative skills and knowledges which have long been accepted as essential for everyone. To these both the lay public and the professional educators have long seen fit to add many other areas of the culture to the educational offering for all. Among these are the natural sciences, social sciences, arts and practical arts.

Here again it is good to remind the reader that the selection of areas to be included in the complete education program or industrial arts program is not of concern in this chapter. The bases are manifold and would more properly be treated elsewhere.

Industrial arts is, of course, admirably suited to serve the function of general development as it derives its content from such an important aspect of the culture. Knowledge of how American industries operate, what they produce, how they do it, where they are located, and who utilizes the product or services are some of the aspects which can be studied. The breadth as well as the depth of such study is a matter of choice, based to a large extent on the time available and the level at which it is being undertaken.

Special Development

Just as general development is considered an essential function of a *complete* education so it is with the special development function. Special development is conceived here as that which is essential for all those who are to render service to or produce for society in one of the occupational areas. Obviously, there would be many special development areas; but, each individual studies only one. Thus, special development may be provided for a profession, *e.g.*, lawyer; a trade, *e.g.* carpenter; or a business position, *e.g.* accountant. That there may be subdivisions in each area that will serve as a relatively complete special development may be assumed: *e.g.* nursing in the health area. Therefore, special development areas will be numerous and by subdividing may be even further greatly increased in number.

Industrial arts conceived as a composite encompassing all industrial technology includes the content for special development in many occupations. Decisions concerning its specific purposes and the subsequent selection of content and methods of teaching determine whether it could serve the function of special development. If it is to serve also as general development, this would demand its study in a certain way; *viz.* teaching *how* to perform acts and *how* to apply the knowledges.

Guidance Service

This function of education simply provides the learner with knowledge of himself in relation to the many areas in which he might participate or serve. This along with counsel from others will enable him to make wise decisions. Such decisions will include, among others, occupational, educational, social, or civic choices. This service is essential if education is to fulfill that part of its purpose which states: " . . . within the limits of his inherited capacities."

Obviously much of the necessary insight may be gained in the study of the cultural area which is serving either or both the general and special development functions. For example, the learner in an industrial arts course may learn that he lacks the ability to perform, or the ability to understand and apply the knowledge, or that he dislikes or has no interest in such activity. Coupled with this are insights about his potential gained through tests and counseling.

Objectives

Just as functions help to define the purpose of education, objectives help to define the functions. For this purpose, only three major or broad objectives are presented. These might well be even more specific and detailed as will be implied in the brief examples given. The three major objectives are: (1) acquisition of knowledge, (2) development of skills, and (3) development of attitudes.

Acquisition of Knowledge

The acquisition of knowledge is a long established goal of education. Implied in this, of course, is the application of such knowledges, as "knowledge for knowledge sake" is not desirable. Knowledge is a basis for thinking. Without knowledge, problems could not be solved. Such information and its application may serve any one or all of the functions of education—general, special or guidance.

Knowledge of the past, the cultural heritage, is essential to the general development of all. Having such knowledge enables the individual to understand and appreciate current beliefs and practices. Knowledge may be historical, sociological, moral or spiritual, scientific, artistic, liberal or cultural. Such knowledge, however, is not restricted to the distant past, but includes contemporary understandings as well. In any event this knowledge is considered valuable to all and therefore contributes to fulfill the general development function of education.

The acquisition of knowledge, however, is not confined to serving general development alone. The special development of the individual would be far short of fulfillment without knowledge. Such knowledge also includes that which is valuable for an understanding and appreciation of the special area in which the individual will serve. This may simply be more depth than that knowledge which serves the general function. Similarly, it could be that special development requires more breadth. Thus, in industrial arts, knowledge of where the raw material is obtained, how it is processed, where and how it is manufactured into the finished product and finally how it is utilized by the consumer would enrich the individual in a special area of culture—one of the industries represented. Because industrial arts is many faceted this could apply to the many industries.

In serving the special development function, the acquisition of knowledge provides the worker with that essential ingredient, the *know,* which combined with his ability to perform—the *how* —enables him to solve the problems so that he can serve his society. Such knowledges are specific and relatively narrow in that they are applicable in the special area. It should be noted, however, that some knowledge may be in the nature of principles which apply to several areas, yet are rightfully special knowledges for the individual.

Throughout education, regardless of whether the general or special function is being emphasized, knowledge gained about the activities of man enables the individual to make a decision. Such knowledge need not be taught as guidance information to be effective. Much of the decision is based on the individual's ability to understand and apply the knowledge; hence, he might well learn it as knowledge for special development purposes. All teachers should point out the application of certain knowledge in life situations, both social and occupational.

The acquisition of knowledge in industrial arts can serve all these functions in the development of the individual. Obviously, realizing its need and application in industry can help him decide on a choice of occupation. If he gets the necessary depth of understanding and application so as to permit him to use it as a work knowledge, he has received some special development. If he is provided with less depth, it may contribute only to his general development.

To illustrate: That abrasives are of two kinds—natural and synthetic—and that there are several in each category; that these are selected and used for removal of materials such as wood, leather, fiber, ceramics and metal; that they may be bonded to paper or cloth, in blocks or wheels, or utilized in some instances in powder or granular form, all serve as interesting general knowledge of abrasives and their use in industry. To learn where and how abrasive products are produced will add to his general knowledge. When he learns that abrasives are bonded with different adhesives to serve under different conditions he may find this to be valuable consumer knowledge. There is no doubt he could apply it in a work situation which makes it special knowledge of a technical nature. If further study of the nature of the work done reveals that there are certain hazards involved it may serve as valuable guidance information. It is all, however, knowledge concerned with the same thing—abrasives—yet it can serve each of the functions depending upon the content selected.

Development of Skills

At the outset it should be recognized that skills may be mental or physical. Thus, computational, reading, writing and speaking skills may well be considered mental as the physical aspect is seemingly insignificant. The skillful application of the process of addition or multiplication demands more knowledge than finger dexterity. Knowledge of words is essential to the skillful reader; the physical eye movements are important, but the mental process is paramount. Simply vocalizing does not make a skillful speaker or conversationalist; it requires thoughtful knowledge and its application. Writing is not merely a matter of physical movement without thought directing it.

Physical skills range from relative insignificance in some processes that all individuals may perform, to those which are virtually the whole of the operation. Physical manipulation can be performed easily, correctly and speedily by some because they have the necessary coordination and practice to attain such a level. Coupled with this is a knowledge of when, where, and why movements should be made. The physical or manipulative activity needed to perform the skill, the operation, or the process may through practice become virtually a habit, seemingly requiring no deliberate thought. This is the case in tying a shoelace. Certain skills are so simple that hardly any thought is required for the act itself. For example, cutting skin or flesh with a scalpel, or cutting wood with a knife, or removing wood with a router, or removing part of a tooth with a dental burr may be simple performances. However the surgeon does not simply cut the skin and flesh unless it serves the particular circumstances; the wood carver considers the ultimate shape desired and the particular piece of wood on which he is working; similarly with the application of the router and the dental burr. Manipulation alone does not suffice; skillful performance requires the application of knowledge.

The tradesman through a combination of many simple skills and knowledges can plan and execute, bringing to a satisfactory conclusion the work that he is assigned. If he can do no planning or cannot apply knowledges to solve the work problem he is simply an operator, albeit a skillful one. The combination of skills may be complex, making the manipulation seemingly of paramount importance. In other cases the skills remain simple and the knowledge takes on the greater significance as in the case of the technician who upon finally locating the defective unit in an electronics system, solves the problem by removing a screw or bolt, lifting out the unit and replacing it, followed by tightening the fastener. At a still different level, the engineer who planned the system in the first place must be skillful in the mental "manipulation" of the knowledges so that it will serve the purpose desired.

Industrial arts, depending upon the choice of functions to be served and the subsequent emphasis to be given to knowledges, can lead to the development of skills varying from the simple acts to some that are complex. All of these may be useful in fulfilling either or both, the general and special functions. That the development will be valuable for guidance purposes can readily be assumed.

Development of Attitudes

The use of the single word "attitudes" as an objective of education needs elaboration. It is intended to encompass all actions and reactions to other persons and things as distinguished from what he knows about or can do with such things. Personal traits or characteristics would be included. Desirable attitudes include traits such as: citizenship, or one's recognition and willingness to abide by rules and regulations; the ability to get along with others; cooperativeness; respect for the rights and property of others; one's work habits; even his honesty, integrity, sense of values, persistence, precision, and thoroughness. Attitudes may result from or even enhance the development of skills and the acquisition of knowledge.

The fact that a student is capable of performing a skill does not mean that he is a skillful worker. He may be indifferent or lazy so he doesn't attain the goal. The student may know better but he proceeds, casting all thoughtfulness aside simply because he is impetuous or cantankerous.

Industrial arts affords as many, possibly more, opportunities to bring about development of attitudes as do other curriculum areas. The decision to be made here is whether or not it is a goal of industrial arts, and, if so, how much should it be emphasized.

Specific Objectives. One may well wonder about the specific objectives for the industrial arts curriculum area and its separate subject fields—are such to be ignored or dismissed entirely? Categorically, no. Specifics are needed at all levels from the lesson, the unit, the course and on up through the curriculum area and finally education. (Incidentally, education being a part of living, the ultimate top level would be the objectives of living in this society.)

No attempt is made here to develop or present specific objectives as it is felt that the three broad objectives (skill, knowledge and attitudes) serve to evaluate proposals and practices in industrial arts. A thoughtful evaluation of *the purpose of education, the three functions of education, and the three objectives of education* should reveal that objectives for any curriculum area or its subjects are inherent in them. All that is needed is the specificity obtained by naming the area or subject or unit as exemplified in the simple examples that follow.

Skill in the use of industrial hand tools and machines might be accepted as an objective of industrial arts. The word "industrial" differentiates it from "business" or "home," for these respective curriculum areas. Even more specific is the use of "woodworking", "metal working", "drafting", or "graphic arts" in the same basic statement.

Similarly, the acquisition and application of industrial knowledges mark it as an objective for industrial arts. Simply substituting "wood industry", "metal industry" sets it as an objective for the subject.

Likewise with attitudes as an objective. The development of good attitudes in an industrial situation is applicable to the whole of industrial arts as a curriculum area. In this instance, the broad term *attitudes* can become more specific by substituting "cooperation", "punctuality", "getting along with others" or other terms which are, in effect, a result of attitudes. Still another measure of specificity would be brought about by the substitution of a subject field for "industrial" as exemplified in the preceding paragraphs.

It should be borne in mind that the *purpose* of education is really an all encompassing objective or goal and that the *functions* of education are, in effect, sub-objectives of the *purpose.* Specific statements of functions are similarly obtained by stating: "general development in understanding about industry"; "special development for industry"; and "guidance service related to American industries" might be given as the functions industrial arts is to serve.

That a new set of objectives for industrial arts as a curriculum area and its several subject fields could be developed, may be assumed. However, as previously stated, further detailing is unnecessary for the anticipated evaluation of the succeeding chapters.

Two Deciding Factors

There will follow some brief statements concerning *time* and *level* as factors to consider in making decisions concerning the inclusion and the emphasis to be given the functions and objectives of education that might be served by industrial arts. This is based on the assumption that industrial arts is an integral part of education and it must serve in the growth and development of the student to the fullest possible extent.

Level

For this purpose four levels of education are recognized—elementary, junior high school, senior high school, and higher education.

Elementary. There is little doubt that industrial arts at the elementary school level should emphasize the general development function of education. The age of the learners, in light of society's practices, precludes the need for the special development function. Industrial arts may serve to develop simple "skills" and the acquisition of additional knowledge of industry. However, such skills and knowledges should probably be thought of as contributing to the general development of the child and only incidentally, if at all, to his special development. Industrial arts can provide an initial and very elementary guidance function—largely information about the learner for future use. All areas of instruction should serve this function. It may also be safely assumed that industrial arts at the elementary level will prove to be as effective in recognizing the attitudes of the learner as will any other area and will provide the opportunity for the proper correction or change, as well as growth and development of such attitudes.

The scope of the elementary program is likely to be limited when viewed in terms of the whole industrial arts offering found in the schools. This is probably true as to the number of industries included, how many of the varied activities in any industry are presented, and the extent to which each unit is studied and applied.

Junior High School. Industrial arts at the junior high school level for the same reasons basically serves the general development and guidance functions with little or no emphasis being given to serving the special development function.

Greater breadth as well as depth in the study of industries in comparison to the elementary school offering may well be evidenced in the junior high school offering. Knowledge and its application in problem solving situations should be more evident. These situations may well be applicable to life in general and teach principles characteristic of more than one occupational area. Knowledge of materials found in everyday life—in the home—or as used in industry exemplifies this.

Similarly, manipulative skills may well be general or in a number of special occupational areas. For example, such areas might teach the correct understanding and safe use of certain hand tools as found in the home and in industry.

The guidance function of education should receive considerable attention at this level. This is not, however, to be interpreted as meaning the learner must make final decisions concerning his life; but, rather that he should get insights which will enable him, as he matures and continues his education, to eventually make the decision. Obviously, industrial arts can supply some insights into industry. The learner may eventually act according to his likes and dislikes, his successes or shortcomings experienced in this area. The school, of necessity, should be gathering much valuable personal data which will serve in later counseling.

Industrial arts at the junior high school level can and should contribute to the continued development of good attitudes—both general and special.

Senior High School. The industrial arts offering at the senior high school level should further increase the three dimensions of the study of industries. More industries, and both wider and deeper development in skills and attitudes and acquisition of knowledges are included. The relative emphasis to be given to serving the functions of education and attaining its objectives is of serious consequence.

On the extreme boundaries will be found those who would confine the development to the general function and those who would restrict it to the special function. There is little doubt that all would agree that the guidance service function of education should be served. Obviously there is a point somewhere between the extremes that senior high school industrial arts will emphasize. Usually this point is closer to one extreme than the other. The ingredients in skills, knowledges and attitudes are there. The amount of development that results, however, is determined by design—either to limit it to what comes naturally, as a concomitant, or as a result of a stated purpose.

Whether this is a decision to be universally applied or one made by the industrial arts educator according to the local situation and the individuals being served will not be decided here. In all probability the decision will be concerned with how much emphasis general development or special development is to receive. It is difficult to picture a present day industrial arts shop or laboratory, equipped with the tools, machines, and materials which are representative of those found in the several industries, failing to serve all three functions of education.

This follows through to the major objectives—development of skill, acquisition of knowledge, and development of good attitudes. Obviously, industrial arts on the senior high school level, because of the increased maturity of the learners, is in a better position to extend the development of the individual toward the three goals. More specificity is provided in that the skills, whether mental (problem solving) or physical, are industrially related. For example, the correct use of a tool or operation of a machine used in industry may represent a physical skill. Certain simple acts may be developed to the level of performance found in experienced workers; other, more complex, acts may fall far short of such attainment. The correct and rapid solving of a problem, such as locating the cause of a malfunction, is a mental skill. In either instance the skillful accomplishment may call for both mental and physical skills. These may, in some instances, serve either or both general and special development as well as the guidance function.

The knowledges to be acquired in senior high school industrial arts should provide more breadth and depth in more industries. These may serve one or all three functions. Here again, specific knowledge to be acquired is determined by the area or the subject within it. For example, the broad knowledge topic—"Manufacture of Steel"—would be logical for study of the metal industries, regardless of the specific subject, *e.g.*, machine shop.

Similarly, the attitudes to be developed should be related to the area of the subject. Thus, developing the attitude which results in relative exactness must be appropriate—the precision needed in registering for multicolor printing; or, the exactness needed in making a packing crate.

Higher Education. Industrial arts at the college level may be either general or special development in function. Purposes are likely to be more specific at this level than at the other levels. Some courses are offered primarily to serve the general development of the student. However, because the primary purpose of the college is more commonly occupational preparation, industrial arts is more generally offered to serve the special development function—of special concern here is teacher preparation.

At this level the question is likely to be a matter of degree of development in the skills and the acquisition of knowledges pertinent to the industries included. The number of industries may be restricted to only a few or they may be many depending upon the time available for the professional preparation. It must be borne in mind that the professional preparation includes in addition to the skills, knowledges, and attitudes of the industrial arts curriculum area, the development of the individual as a teacher which demands another set of occupational skills, knowledges and attitudes. The amount of time available is an important factor in making the decision as to how much development will be provided.

Time

The element of time available for attaining a definite measure of development is a basic consideration at all levels. At the higher education level the degree-requirement time is generally considered to be four academic years, during which a prescribed number of credits are to be earned. Each credit is generally accepted as demanding a certain amount of time on the part of the student.

In light of the fact that a degree demands pursuit of one-third to one-half of the total credits in general development and the remainder divided about equally between the development in the professional teacher preparation and the industrial arts curriculum area, it is obvious that the time available for the latter is limited. It is at this point that the decision is to be made on whether greater emphasis shall be placed on the development of skills or on the objective of acquisition of knowledge; but, the time available for the total remains the same. Skills, whether manipulative or mental, require time for application and practice—generally the greater the degree of expertness in performance wanted, the greater will be the time needed.

But, knowledges also require time to be acquired. This, however, is dependent upon the number or spread of knowledges and the depth to which they are understood. These quickly lead to application as mental skills in planning and solving a problem; hence, it is difficult to separate skills—in the broad sense—from knowledges.

Although the function to be emphasized on the other levels may differ from higher education the problem still remains—the decision must recognize the amount of time available. Hence, it is safe to conclude that industrial arts, whether at the elementary, junior or senior high school, or higher education level, must limit its service, just as any other curriculum area, according to the time allotted to it.

Industrial arts educators may readily express "There just isn't enough time to do all these things." However, if industrial arts is assumed to be an integral part of education it is difficult to assume "time" as an eliminator of any one of the functions to be served. It may restrict or limit and cause the educator to place differing emphases on them; but, not one should be eliminated entirely.

Some Questions

In order that the reader may better decide which of the *functions* and *objectives* he should *emphasize* in industrial arts and also to help him evaluate the presentations in the chapters that follow, the following questions are presented.

1. Should industrial arts be considered as an integral phase of education? Or, is it simply a supplementary service?
2. Should industrial arts contribute to each of the functions of education? If not, which should be eliminated? If so, to what degree should each be emphasized?
3. Should industrial arts contribute to the attainment of the three major objectives of education? If not, which should be eliminated? If so, to what degree should each be emphasized? Can one objective be emphasized for some individuals and another be emphasized for others? In the same class? In different classes?
4. What constitutes industrial arts? Is it a composite of all industrial technology or only selected industries? Must these remain as separate entities or should certain industries be truly integrated or synthesized in a single "industrial" subject?
5. What is the effect of the level at which industrial arts is taught—elementary, secondary and higher—on its fulfillment of the functions? Should the emphasis given to a function change for each level or should the emphasis change within a level according to situation? (Refer to No. 2.) Similarly, what is the effect of level on objectives? (Refer to No. 3.)
6. Should industrial arts be primarily a shop or laboratory type activity with very little emphasis on the classroom type activity? Or the opposite? Should either type of activity be eliminated completely?
7. Should industrial arts serve its functions and attain its objectives in the development of students in the same time allotted to other subjects in other curriculum areas? Or, should it have more time? Or, less time?
8. How "real" should industrial arts be with regard to machines, tools, materials, processes, and product or service?

Precisely as they are in the industries represented? Representative, but not precisely like the industries?

9. Should industrial arts be integrated with one or more other curriculum areas? Or, simply correlated? Or, remain autonomous?

10. Should industrial arts concern itself with development of the special—industrial—skills exclusively? Or, general skills exclusively? Or, to what degree should each be emphasized? Similarly, what should be its concern with the acquisition of knowledge? Development of attitudes?

11. Does industrial arts provide a unique opportunity for educational development, something that comes through method and not solely its content? It it does, is this service so important as to outweigh the value of the industrial arts content itself?

CHAPTER THREE

Industrial Arts -- What Is Its Body of Knowledge?

ROBERT S. SWANSON

Introduction

There has been no shortage of proposals for industrial arts curricula in the almost one hundred years since the foundation of the St. Louis Manual Training School, and since World War II the number has increased. A few of the proposals are broad in scope and deal with many basic issues; others are very narrow and address themselves to one or two aspects, such as teaching methods, or to some group of students, for example those bound for college engineering curricula.

Observers have long noted the great diversity of programs labeled industrial arts; some claim that such diversity is good. Perhaps a great cause of the variety in program implementation is the lack of a defined and generally accepted body of knowledge from which to draw content for industrial arts. Until this body of content is identified, programs will continue to range from instruction in repairing leaky faucets, to the practice of skills in welding, to the making of mechanical drawings, to the review of the means by which iron and steel are made, to an analysis of the financial structure of industry, or similar units. Attempts to obtain a consistent program will be futile. Again, some may say that a consistent program is neither desirable nor possible.

Before launching into the analysis of sources of content, it is necessary to discuss the relationship of the objectives of industrial arts to the source of its content.

It is a truism to state that a program should be based on its objectives and few would argue the validity of the idea. Important as objectives are, they will not be discussed here. The basic problem of this chapter is to identify and classify the proposals for what constitutes the *body of knowledge* from which industrial arts should draw its content. Once the discipline has been identified, the objectives function as means of choosing individual items of content, methods of approach, and evaluation. Objectives are not means of defining the discipline; they determine course approach.

Confusion as to the place of objectives often results because, in many cases, the practical objective of courses is "to teach the course content." This has led to the idea that objectives, course content, and the underlying body of knowledge are one and the same. The result is that many courses involve a step-by-step unfolding of a body of knowledge from its beginning and proceeding as far as time allows. This brings the common complaint of chemistry taught as though the student were to study it from beginning to end to become a chemist, mathematics for future mathematicians, and woodworking for future cabinetmakers. To decry this practice is *not* to negate the need to define the body of knowledge from which content should be drawn.

This chapter is concerned with an analysis of the proposals that have attempted to define, explicitly or implicitly, the body of knowledge from which the content of industrial arts should be drawn.

Proposals, and practice, have divided into four groups in this respect. Industrial arts has been visualized as:

1. The study of common life needs created by or related to industrial and technological advance.
2. The study of crafts or trades, processes, tools, machines, materials and products.
3. The study of applications of mathematics and the sciences.
4. The study of industry.

Industrial Arts as the Study of Common Life Needs Created by Industry and Technology

All forms of education have claimed in some way to prepare students for life; some approaches have taken a rather indirect route and viewed life preparation in a very general sense.

The proposals that came to be termed *Life Adjustment Education* stemmed from a statement made by Dr. Charles A. Prosser in 1945 at a conference of the Division of Vocational Education of the U. S. Office of Education. Prosser listed these often since quoted percentages: the high schools are preparing 20 percent of the students for college and the vocational schools are preparing 20 percent for the skilled trades, but the remaining 60 percent are not receiving the "life adjustment training they need and to which they are entitled as American citizens."[1] He suggested a series of conferences to make proposals for the "sixty percent." Many conferences were held and proposals made for all areas of education, including industrial arts.

A comprehensive book, edited by Harl R. Douglass, explains the development and philosophy of the life adjustment education movement and contains chapters describing the place of each subject field in the total program.

The chapter, "Industrial Arts as Education for Life Adjustment" was written by Louis V. Newkirk and explains industrial arts as it would be taught for "life adjustment."

The body of knowledge from which content should be drawn under this approach is best indicated by Newkirk's visualization of how student achievement would be identified: He says,

> For example, if a boy's mother needs a new rose trellis can he design and build one? If the faucet leaks in the bathroom, can a girl diagnose the difficulty and repair the faucet? If the family needs a new car, television set, bedroom set, or electric toaster, can the boy or girl help select a well designed and efficient product? When boys and girls have leisure time in their homes do they have a home workshop and occupy their time in building useful and attractive craft projects?[2]

More recently, Brown made a similar case.

> If we know anything at all about today's American, we know that he is a tool- and material-using being—and not only, or perhaps even mainly —in his chosen vocation. He has a home to care for and shape to his needs and pleasure, an automobile and many other mechanical devices to maintain, and he has no intention of denying himself the satisfactions inherent in creative activity. . . . The duty of the school to teach each individual to

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[1] Harl R. Douglass (editor), *Education for Life Adjustment.* (New York: The Ronald Press Co., 1950), p. 3.

[2] *Ibid,* p. 203.

work safely and imaginatively is unassailable and has been recognized whenever statements of the objectives of education have been prepared.[3]

It might be said that "life adjustment" industrial arts will emphasize preparing students to do better those everyday things they will be called upon to do.

The body of knowledge from which industrial arts will draw its content under this approach is the "life needs" of the citizenry. These are located by analyzing those activities in which citizens commonly participate to determine what parts of them require knowledge and skills related to technical areas.

This approach has given rise to such industrial arts activities as home mechanics, consumer education, and hobby and recreational activities. It has the shortcoming of leaving rather ill defined the boundaries of the area. For example, is driver education a legitimate activity for study in industrial arts? It is a "life need" of citizens and it is, in a way, technical in nature.

Industrial Arts as the Study of Crafts or Trades, Processes, Tools, Machines, Materials, and Products

Almost any definition of industrial arts includes mention of the study of occupations, tools, machines, processes, materials, and products of industry. While there is no person or group that proposes this as *the* study, probably a large share of the operating programs consist of it. In practice, many programs are teaching these aspects of industry and technology, and the operational objective is simply "to provide experience with some of the tools, machines, processes, materials, and products of industry." The proposed uses to which this knowledge will be put vary from vocational to general.

One of the early descriptions of content according to this approach was given by Bennett[4] in 1917 when he said five "manual arts" encompassed the field. These were the graphic arts, the mechanic arts, the plastic arts, the textile arts, and the bookmaking arts. Many of the content selection approaches since have been concerned with expanding and bringing these arts up to date in terms of technical developments.

[3] Robert D. Brown, "The Many Facets of Industrial Arts," *Industrial Arts & Vocational Education,* 53:23, September, 1964.

[4] Charles A. Bennett. *The Manual Arts.* (Peoria, Illinois: Manual Arts Press—now Chas. A. Bennett Co., Inc., 1917), pp. 11-21.

Two general schemes have been used to organize the content of industrial arts in this category:

1. According to materials used.
2. According to trade, craft, or occupational groups.

Most programs use some combination of the two. Often the materials to be used set the broad areas and the trade or occupational classifications provide the sub-groupings within the areas.

Programs organized in this fashion have such broad categories as metals and woods. Within the study of metals are the crafts of welding, machine shop, sheet metal and foundry. Under woodworking the crafts of carpentry, cabinet making, and pattern making are studied.

Major publications of two professional organizations have used this approach. The American Vocational Association's *A Guide to Improving Instruction in Industrial Arts*[5] and the 1963 publication of the American Council of Industrial Arts Supervisors, *Industrial Arts Education*[6], both imply, in terms of the areas of instruction named, that industrial arts draws its content from occupational groups and/or materials used. Many state bulletins offer much the same approach.

In an editorial in *Industrial Arts & Vocational Education* magazine, Feirer states in talking about the senior high school level of industrial arts: "Major families of occupations ought to be represented by each shop or laboratory area . . ."[7]

The most important means of identifying the individual units of instruction within the areas has been the analysis technique. First used for this purpose by Allen and Selvidge, it was refined and explained in concise detail by Fryklund. He defines analysis: "It is a technique by means of which the essential elements of an occupation, or any part of an occupation or activity, are identified and listed for instructional purposes."[8] By means of this system, three types of instructional elements

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[5] *A Guide to Improving Instruction in Industrial Arts.* (Washington, D. C.: American Vocational Association, 1953), pp. 45-98.

[6] American Council of Industrial Arts Supervisors. *Industrial Arts Education.* (Bloomington, Illinois: McKnight & McKnight Publishing Co., 1963), pp. 17-31.

[7] John L. Feirer, "The Challenge of the Senior High School," *Industrial Arts & Vocational Education,* 53:21, September, 1964.

[8] Verne C. Fryklund, *Analysis Technique for Instructors.* (Milwaukee: The Bruce Publishing Co., 1956), p. 1.

are identified: jobs or work assignments, operations, and related information. The system provides a neat, tight organization of subject matter and for this reason has been widely used.

There are obvious advantages to visualizing industrial arts as the study of tools, processes, materials and operations. Content is relatively easy to identify and organize; the kind of facility needed can be readily justified; and the preparation of teachers (at least in their technical competence) is clear. Further, it is possible to assign a wide variety of purposes to the study of the same content. Some students may use it for learning a job, others may base further learning on it, and still others may develop problem-solving abilities for use in future activities.

Perhaps the major shortcoming is its atomism. Time does not allow study of all the "parts" and often relationships among the segments studied are not grasped. In addition, common practice allows students to specialize in one area after a somewhat brief experience with several, depending on the extent of the school's program. Keeping a program up to date usually involves adding new operations and knowledge within the pattern of existing areas—the addition of completely new areas is difficult.

Industrial Arts as the Study of Applied Science (Technology)

For some, industrial arts is the study of the applications of science to the solutions of man's problems—the study of technology. For many years industrial arts has made use of mathematics and science in its content. The claim that industrial arts students must make use of principles of mathematics and science has long been made. To say that these disciplines have been "the" body of knowledge from which industrial arts draws its content would hardly be accurate, however.

Industrial arts curriculum builders have followed three general approaches in drawing content from mathematics and science.

1. Special emphasis on problems calling for applications of mathematics and science.
2. Illustration and testing of scientific-mathematical principles.
3. Bodily adoption of certain parts of mathematics and science.

Special Emphasis on Problems In Mathematics and Science

Instructional activities are analyzed to locate typical problems that call for the application of mathematics or science in their solutions. The central idea is to draw problems from established industrial arts courses that call for the use of principles from these disciplines. For example, a common arithmetic problem in woodworking is the calculation of board feet.

In a recent publication, seven industrial arts areas were analyzed to locate common problems calling for applications of mathematics. Among the areas of auto mechanics, drafting, electricity-radio, graphic arts, handicrafts, metal, and wood, 263 typical problems were identified, the mathematics called for listed, and the solutions to the problems given.[9]

Under this approach many course outlines or lessons have lists of "related math and science." This approach often leads to units or courses in "shop math" or "applied physics." It does not involve a study of principles of mathematics or science as such, but rather of applications relating to already established courses. It is an attempt to integrate and use learnings from other disciplines in the study of industrial arts.

A Testing Laboratory for Principles of Mathematics and Science

A second approach has been to study the principles of mathematics and science and use the shop or laboratory as a testing ground. Most physics courses make use of a laboratory, but the nature of the experiments is quite different from those done in the industrial arts shop or laboratory to test principles.

The description of an experimental "Pre-Tech Lab" program provides some insight.

> The shop is used only as a testing ground for principles of math and science. The program is oriented to problem solving rather than a project centered program that is designed to develop shop skills.[10]
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> The Tech Lab will function primarily as a reinforcing and motivating situation where students will construct test equipment and models to better express certain scientific functions.[11]

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[9] *Mathematics and Industrial Arts Education.* (Sacramento: California State Department of Education, 1960).

[10] "The Richmond Plan," unpublished report of a pre-technology program. (Richmond, California: Richmond Union High School District, 1962).

[11] *Ibid.*

Sample work assignments described in the publication are:

a. Design an aid to show force vectors.

b. Design and construct a device to explain dynamic and static balance and equilibrium.

c. Design and build a working model of a brake shoe and drum.[12]

Some may say that this is not industrial arts, but it can be said that the approach draws its content rather directly and consistently from an established discipline and it makes use of shop equipment.

Adoption of Certain Segments of Mathematics and Science

A third approach has been much more common in recent extensions and upgrading of industrial arts curricula. Some parts of the disciplines of science have been adopted bodily for study in industrial arts. Many programs have added electricity and electronics. Hydraulics, mechanics, and pneumatics, under the general title of "power mechanics," is a currently popular addition. The body of knowledge studied is drawn primarily from physics and not from the trades of the electrician or the auto mechanic. In this approach industrial arts has truly drawn its content from science. Increasing technological advance coupled with the fact that science programs now include more theory, have encouraged industrial arts programs to increasingly move in this direction. Of all the efforts which have achieved rather wide-spread acceptance in practice, this probably comes closest to drawing its content directly from a well defined and established body of knowledge.

It is interesting to note that this approach has been applied mainly in areas where the amount of manipulative content is small. For example, the study of electronics involves only a few manipulative skills and a large amount of theoretical knowledge. This approach extended widely in industrial arts could conceivably make the following changes:

1. Woodworking could become applied physics (strength of materials) or applied chemistry (wood utilization).
2. Drafting could become descriptive geometry.
3. Plastics could become applied organic chemistry.

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[12] *Ibid.*

The advantages of making industrial arts wholely or partially applied science are apparent. These disciplines have established a structure and identified content. Pure science can be better understood as its applications are seen. Greater understanding of principles makes them even more widely applicable. In this view, industrial arts is related to science in much the way that engineering is—it calls on scientific theory in the solution of practical problems.

The adoption of science as the sole source of content may lead one to wonder about the need for industrial arts. Would the students' time be better spent in further study of these disciplines rather than industrial arts? Then, too, doesn't industrial arts have need to call forth principles from disciplines such as sociology, economics, and language?

Industrial Arts as the Study of Industry

Many of the more recent proposals are aimed at studying the various facets of industrial arts in a manner to contribute to a general understanding of industry. As used in this sense, industry is defined as a complex of organizations which utilize the basic resources of men, materials, machines, and money to produce goods or provide services.

To facilitate the study of such a complex phenomenon as industry, three schemes for subdividing it have been proposed:

1. A division into its functional parts.
2. A division by principal products, services and/or materials.
3. A study of the forces generated by industry.

The Study of Industry According to Its Functional Parts

Bateson and Stern have recently based a proposal for the study of industry on two broad functions of industry—production and service. They see the role of industry as being ". . . to *produce* and *service* the products which man requires to satisfy his material needs."[13]

The production function involves the activities of research, product development, planning for production, and manufacturing, custom or mass production. The service function consists

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[13] W. M. Bateson and Jacob Stern, "The Functions of Industry as a Basis for Industrial Education Programs," *Journal of Industrial Teacher Education*, 1:12, Fall, 1963.

of diagnosis, correction by adjustment, replacement or repair, and testing. These aspects have a thread of consistency, regardless of product or service involved, and should constitute the study of industrial education, according to the proponents. The distribution of goods and services, while related to their production, is the province of distributive education.

Ziel makes a somewhat different program proposal based on the need to study the functions of industry rather than isolated parts.

> . . . Regardless of the nature of the institution's role, whether it be raw material, product, or service there are some common denominators inherent in all. These denominators take cognizance of the organization that is assembled in response to the technological demands to perform the functions of the institution.[14]

Ziel's proposed program consists of four stages:

1. Stage one would be devoted to a general interpretation of the significance and interdependence of tools, machines, and materials.
2. Stage two would introduce a sample of the most current technological processes.
3. Stage three would stimulate conditions which interpret the many forces which are responsive to the demands of a technological process and the influence of these on the finished product and the employee as he functions in an organization.
4. Stage four would allow concentration on a particular current technology.

A research project currently in its developmental stage, funded by a national organization, is making a study of industry on the conceptual approach basis. The attempt in this approach has been to abstract concepts which cut across all types of industries. The content of industrial arts then becomes the study and understanding of these concepts. This approach is explained in detail in Chapter Four and thus will not be discussed here.

The Study of Industry by Groups In Terms of Products, Services, or Materials

Several proposals for industrial arts have attempted to group the thousands of individual industrial establishments according

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[14] Henry R. Ziel, "The World of Work Interpreted by an Industrial Arts Program," unpublished paper, University of Illinois, Urbana, Illinois.

to types of products or services involved or principal materials used. The emphasis is still on the study of the industry and not on isolated parts of various industries or trades.

One of the most extensive proposals in this category appeared in 1934 as *A Prospectus for Industrial Arts in Ohio*[15] under the authorship of Warner. It has since been revised many times in theses, state bulletins, and convention publications, and appeared in very detailed form in a book by Olson, *Industrial Arts and Technology,* in 1963.

Olson begins his search for content by identifying eight categories of industry: manufacturing, construction, power, transportation, electronics, research, services, and management. "These groups are assumed to account for all American industry that would be essential for a curriculum study in industrial arts."[16]

Several of these broad categories were further subdivided. For example, manufacturing is determined to consist of the ceramics, the chemicals, the foods, the graphic arts, the leather, the metals, the paper, the plastics, the rubber, the textiles, the tools and machines, and the woods industries.

To gain generality and put the details into meaningful context, Olson analyzes the groups of industries to locate curricular components. Combination and condensation provide a master list of 100 of them. Illustrative of the components are advertising, computers, equipment, labor, physics, and recreation.

An approach from a somewhat different rationale comes to a similar conclusion as regards the body of knowledge from which industrial arts should draw its content. DeVore[17] proposes that industrial arts is the study of man in his struggles with technology.

Historically, he classified man's major technical efforts by showing him in seven roles:

1. As a builder
2. As a communicator
3. As a producer

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[15] *A Prospectus for Industrial Arts in Ohio.* (Columbus, Ohio: The Ohio Education Association and The State Dept. of Education, 1934).

[16] Delmar W. Olson, *Industrial Arts and Technology,* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), p. 95.

[17] Paul W. DeVore, *Technology, An Intellectual Discipline,* Bulletin No. 5 (Washington, D.C.: American Industrial Arts Association, 1964).

4. As a transporter
5. As a developer
6. As an organizer and manager of work
7. As a craftsman

He states that each of these activities of man encompasses a vast storehouse of knowledge containing implications for the economic, social, consumer, historical, and cultural elements of civilization. The curriculum resulting from the outlined body of knowledge would center around a study of the:

1. construction industries
2. communications industries
3. manufacturing industries
4. transportation industries
5. research and development industries
6. organization and management of work
7. craft and service industries

The Study of Forces

A recent proposal in a doctoral thesis by Stadt, states that industrial arts should aim "to create an awareness of the hidden, subtle forces which are generated by industry . . . and to lend intelligibility to those forces."[18]

It appears that this proposal would be radically different from others in that it would not involve the study, at least very directly, of the actual production of goods and services but rather the effects of such production on society.

The author starts with the premise that ". . . units of subject matter constitute justifiable components of the total instructional program only insofar as they communicate intellectually refined and/or esthetically discriminated materials which lend intelligibility to hidden, subtle forces in the environment."[19] He extends this to industrial arts to say that it must be demonstrated that a significant number of important forces are generated by industry and must be established that sufficient quantities of refined materials exist to make those forces understandable to pupils.

To illustrate, Stadt uses an example of an economic force

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[18] Ronald W. Stadt, "A Method of Selecting Content for Lending Intelligibility to Industry: A Critique and Proposal," unpublished doctoral thesis, University of Illinois, Urbana, Illinois, 1962.

[19] *Ibid.*, p. 90.

generated by industry. "Industry has been largely responsible for the standard of living we enjoy. It has become financially possible for large numbers of the population to purchase many goods and services."[20] This, then, is a force to be studied. Materials which would lend understanding to this force are "(1) theories which represent attempts to explain industry's role in the overall economy, . . . and (2) theories which represent attempts to develop principles for economic decision making within the corporation."[21]

The author outlines the means by which content should be selected by a research team of educators and subject matter experts from the various disciplines.

Proponents of drawing from industry as the source of content for industrial arts point out that it provides a more comprehensive body of knowledge than any of the previous proposals. Criticism is often leveled on the basis that it is *too* broad and consequently offers little integrating force. Current work by proponents is aimed at showing a clear-cut definition and structure of "industry" to overcome this criticism.

Why Identify a Body of Knowledge?

The reader will recognize one or more of the described sources of content in programs with which he is familiar. Many programs in operation have taken an eclectic approach and drawn some content from life needs, some from occupations, some from science, and some from industry. The eclectic claims that he draws the best from all and thus attains the optimum.

What then are the advantages of selecting and defining a body of knowledge from which to draw content for industrial arts?

In the first place, it seems that any subject worthy of time in the school must demonstrate that it is based on an organized body of knowledge which is important and that it is uniquely prepared to transmit and interpret this knowledge. It is not the purpose of this chapter to defend a particular body of knowledge as the basis for industrial arts but merely to identify those that have been used. It will be recognized that some of those described

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[20] *Ibid.*, p. 92.

[21] *Ibid.*, p. 93.

are more comprehensive than others and this can be regarded as either advantageous or disadvantageous.

A further purpose in defining a body of knowledge is in the integrating force it can provide. Bruner[22] speaks of this as he discusses the importance of the structure of knowledge. Any subject involves the study of many details; unless they are organized and fitted into a framework they are not easily comprehended and used.

The identification of a body of knowledge clarifies its relationship to other bodies of knowledge. As an illustration, when one studies economics he will become involved with some mathematical principles, ratios for example. If he lacks sufficient understanding of ratios, he must learn about them in order to understand the economic principle employing this specific. But as he proceeds to study the concept of ratios in depth he is soon dealing with the body of knowledge known as mathematics and he has left the realm of economics. So, too, in industrial arts. As the student studies the design and strength of wood structures he must understand the means by which screws hold. To understand this, it is necessary to consider a principle of physics, the inclined plane. However, as the inclined plane is studied in the abstract, it is physics and not industrial arts, that is being studied.

It seems to this author that industrial arts cannot long delay the definition and acceptance of a body of knowledge from which to draw its content.

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[22] Jerome S. Bruner, *The Process of Education.* (Cambridge, Massachusetts: Harvard University Press, 1961), p. 23.

CHAPTER FOUR

Conceptual Approach to American Industry

WESLEY L. FACE, EUGENE R. F. FLUG,
and ROBERT S. SWANSON

Introduction

During the school year 1962-63, a group of professors and administrators at Stout State University decided that it was time to do more than talk theoretically about changes which ought to be made in the traditional programs of industrial arts education. They agreed that there was need to experiment with a radical restructuring of the theoretical orientation of industrial arts, but that this must be accompanied by field testing as a necessary means of accepting, discarding or revising new ideas.

Small group discussions soon grew into an organized faculty seminar. A faculty member was given released time to begin developing a procedure for the further study and implementation of a new program, called *American Industry,*[1] firmly based in a theory of education which was logical in structure, cognizant of current psychological findings, and guided by a consistent philosophy of education. *American Industry,* a curriculum area, is conceived as a discipline in that it has an identifiable structure.

A proposal was submitted to the U. S. Office of Education for financial support. The ensuing grant was used primarily to carry the program through the initial planning stages. Concur-

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[1] Throughout this chapter the italicized term, *American Industry,* will refer to the title given to this curriculum area, and the term industry will refer to the institution which exists in American society.

rently a plan of implementation was formulated to train ten selected industrial arts teachers to field test the program. A one-year proposal for the implementation of the field study was approved by the Ford Foundation, resulting in an additional grant of monies.

During the summer of 1964, an eight-week workshop was held with ten teachers representing eight secondary schools in Wisconsin and Minnesota. At the time of this writing, the experiment is well under way in eight schools with offerings by these ten teachers, varying in length from six weeks to a full year in grades seven through twelve.

The first year is looked upon as a developmental year and it must be reported that while there is enthusiasm among those faculty members who have been most closely involved in the initial stages of the project, there is a measure of honest skepticism on the part of others. This is seen as a healthy challenge which will best be answered by the results of the field tests in the classrooms and laboratories.

The experimental nature of the program of implementation should be kept in mind as the reader reviews the following statements of rationale.

Objectives of the Study of American Industry

The objectives seen for the program in *American Industry* have grown from a careful study of existing statements of the purposes of American secondary schools.

An early statement of objectives by the Commission on the Reorganization of Secondary Education proposed a set of seven cardinal principles including: health; command of fundamental processes; worthy home membership; vocational competence; effective citizenship; worthy use of leisure; and ethical character. In 1938, these seven principles were reduced by the Educational Policies Commission to include: self realization, human relationship, economic efficiency, and civic responsibility.

Acceptance of these broad goals, dipping into every facet of human life, had led the schools to assume many responsibilities which were formerly considered the domain of other institutions in our society. While it was recognized that the schools must consider all these factors, there had been a growing concern that the primary mission of the schools had become obscured. As a result of this concern, the Educational Policies Commission, in 1961, isolated the central purpose of education as the development of the rational powers of man.[2] The Commission clearly stated that this was not necessarily a unique contribution of education, nor was it the sole purpose. It represented rather, an attempt to convey the idea that *the rational powers are central to all other qualities of the human spirit.* This position is clarified in the following statement made by the Commission:

> A person with developed rational powers has the means to be aware of all facets of his existence. In this sense he can live to the fullest. He can escape captivity to his emotions and irrational states. He can enrich his emotional life and direct it toward ever higher standards of taste and enjoyment. He can enjoy the political and economic freedoms of the democratic society. He can free himself from the bondage of ignorance and unawareness. He can make of himself a free man.[3]

A corollary of the central purpose of developing the rational powers of man lies in the responsibility of the schools to acquire, preserve, and disseminate those knowledges which have been developed and refined by the human intellect, and which interact with man's environment.

The broad objectives of the *American Industry* program were derived directly from an acceptance of this clarified purpose of education. They are:

1. To develop an understanding of those concepts which directly apply to industry.
2. To develop the ability to solve problems related to industry.

Justification for the inclusion of a study of industry in the public schools was seen in the emergence of technology as an ever more potent force in the molding of society. The problems of the future are inseparable from increasing industrialization and young people must be led to an adequate understanding of these forces which impinge upon their daily lives.

The Structure of American Industry

Bruner, as well as Burton, Kimball, and Wing, implies that any body of knowledge to be considered an intellectual discipline

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[2] Educational Policies Commission, *The Central Purpose of American Education.* (Washington, D.C.: National Education Association, 1961), p. 4.

[3] *Ibid.*, p. 9.

possesses a framework or structure that can be identified and expressed in terms of the concepts involved.[4]

Nelson, in a review of the supporting literature, indicates that an understanding of the structure of a subject improves the quality of learning by:

1. providing simplicity,
2. making details meaningful and easily remembered,
3. revealing relationships,
4. providing unity of knowledge,
5. enabling individuals to organize learning for transfer,
6. enabling students to experience discovery,
7. providing meaningful learning to students of all abilities, and
8. developing in students the ability to think.[5]

Sommers, in commenting on the lack of unity in industrial arts, stated, ". . . we are failing to fulfill our mission for lack of a vigorously derived set of underlying principles that realistically gives structure to our product—our industrial arts offerings."[6]

The recognition of this basic lack of coherent structure, represented in the content taught in the typical industrial arts shop, led directly to what was felt to be one of the primary strengths of the program of *American Industry*. Whereas, the typical industrial arts offerings have been based upon an analysis of selected trades in order to identify specific manipulative operations and related information, the approach upon which the program of *American Industry* is based aims at identifying basic concepts common to a variety of industries. For example, all forms of fastening can be categorized under three major concepts: Fastening by adhesion, by cohesion, or by mechanical linkage. In the program of *American Industry,* a student would be concerned with attempting to develop an understanding of the basic attributes of, say, fastening by mechanical linkage, rather than learning how to fasten by the use of wood screws. The student possessing the knowledge of the basic attributes of

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[4] Jerome Bruner, "Structures in Learning." *NEA Journal,* March 1963, p. 26 and William H. Burton, R. B. Kimball, and R. L. Wing, *Education For Effective Thinking.* (New York: Appleton-Century Crafts, Inc., 1960), p. 154.

[5] Nancy Smith Nelson, The Conceptual Approach to Teaching. (A report submitted to the School of Home Economics, University of Wisconsin, 1964), p. 2.

[6] Wesley S. Sommers, "Toward Excellence in Industrial Arts," *Industrial Arts and Vocational Education.* 51: 20, November, 1962.

fastening by mechanical linkage stands in a better position to make a reasonable choice of fasteners when dealing with a variety of materials other than wood.

Structure, as used here, simply refers to a unified, basic description of the several facets of industry as found in contemporary American society. Industry is conceived in this structure as consisting of several major areas, each of which is further subdivided into still smaller units. Industry, for the purpose of this project, is defined as a complex of organizations that utilizes the basic resources of men, materials, machines, and money to produce goods or provide services to meet the needs of man. Fig. 1 graphically presents this tentative analysis. The breakdown does not stop here; it continues to still smaller units, until the ultimate goal is reached—a minor concept. It should be emphasized that each level, division, and subdivision, represents a concept—something to be studied for understandings.

It must be stressed that this structure, unlike those of many other proposals, attempts to categorize *understandings* rather

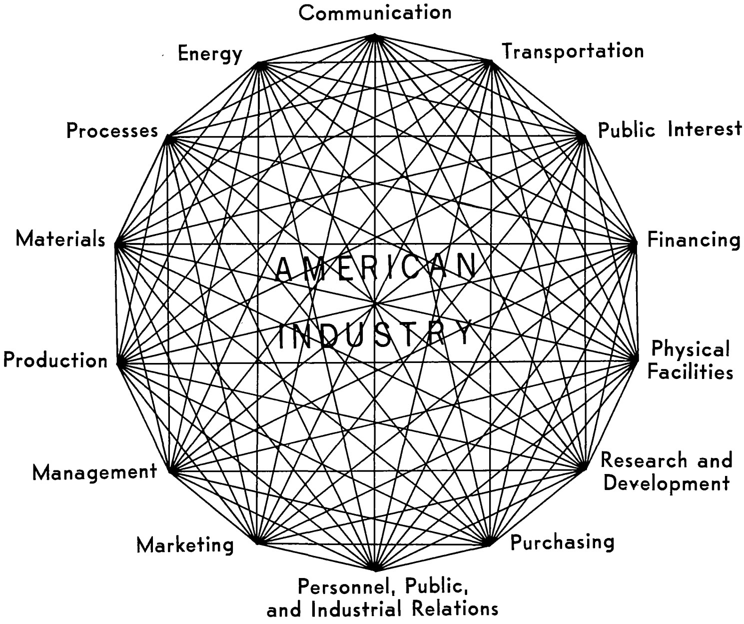

Fig. 1. Structure of Industry Showing Major Concepts (Tentative)

than categorizing specific industries, materials, or occupations. Thus, understandings of concepts derived from this structure would be universally applicable in any specific industry which encompasses it. It is this, the commonality of the concept, which makes the conceptual approach valuable as a means of developing *American Industry* as a replacement for industrial arts.

The Conceptual Approach to American Industry

The increasing complexity of this technological age, leading to massive accumulations of knowledge, has made untenable the atomistic approach to the development of teaching content. It must be recognized that the dynamic nature of knowledge makes continuous demands for change on the part of man. Some of these changes are minor and will demand little that is new to obtain understanding if the individual has a clear concept of the old. Other, more major changes, may almost completely replace an old concept. This concentration upon the acquisition of concepts, should, however, enhance the possibility of retention, transfer, and application of knowledge to new and different situations.

Definition

After a rather exhaustive review of the literature on conceptual learning, the following working definition of a concept was developed for the purposes of this project. A concept is a psychological construct resulting from a variety of experiences (detached from the many situations giving rise to it), fixed by a word or idea, and having functional value to the individual in his thinking and behavior. Since concepts are the materials and tools of thought processes, most scholars in this field would agree that concepts are the most precious products of the educational process.

Concepts may be grasped at all levels of understanding from concrete to abstract; from vague to clear; from inexact to definite. Due to the wide range of understanding which is possible when developing concepts, this program, more than any other, is cognizant of the variance of individual differences in students. One student may have a very low level of understanding of a given concept and another a much higher level. The important consideration, however, is that they both have some understanding.

McDonald speaks of two types of concepts. Informal concepts are seen as those which man forms independently and haphazardly as he interacts with his environment. Formal concepts are identified as those which the school systematically attempts to develop.[7] The task ahead lies in identifying the formal concepts which will complete the structure of industry shown in the figure. There are several methods used in the formation of concepts, one of these being presented in the exercise included here.

Concept Formation

In order to understand more clearly the nature of a concept, one must look at the way in which concepts are formed. The accompanying exercise on forming a concept of adhesion should lead one to a better understanding of a concept. (It is suggested that the reader actually complete the exercise, thereby enabling him to better appreciate how a concept is formed.)

An Exercise in Concept Formation

Directions: In this task you will form the concept of adhesion through successive trials. During each trial, place a card or piece of paper along the light line below the trial. After you have made your response, move the cover down to the next trial.

In each trial you will look at the statement and try to determine whether or not it is an application of fastening by adhesion. After a few trials, you will begin to form hypotheses about what fastening with adhesion really is. By testing these through succeeding trials, you will gradually discover which properties or attributes describe the concept under study. In the end, you should have an improved concept of fastening by adhesion.

Trial 1

A. Gluing two boards together is adhesion.

B. Is nailing of two boards together fastening by adhesion?

Yes .... No ....

Trial 2

A. Trial 1B is not fastening by adhesion.

B. Is cementing of leather fastening by adhesion?

Yes .... No ....

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[7] Frederick J. McDonald, *Educational Psychology.* (San Francisco: Wadsworth Publishing Co., Inc., 1959), p. 133.

Trial 3

A. Trial 2B is fastening by adhesion.

B. Is bolting metal together fastening by adhesion?

Yes .... No ....

Trial 4

A. Trial 3B is not fastening by adhesion.

B. Is riveting metal together fastening by adhesion?

Yes .... No ....

Trial 5

A. Trial 4B is not fastening by adhesion.

B. Is pasting paper together fastening by adhesion?

Yes .... No ....

Trial 6

A. Trial 5B is fastening by adhesion.

B. Is holding two pieces of wood together with screws fastening by adhesion?

Yes .... No ....

Trial 7

A. Trial 6B is not fastening by adhesion.

B. Is gluing wood together with animal hide glue fastening by adhesion?

Yes .... No ....

Trial 8

A. Trial 7B is fastening by adhesion.

B. Is welding of metal fastening by adhesion?

Yes .... No ....

Trial 9

A. Trial 8B is not fastening by adhesion.

B. Is sewing of textiles fastening by adhesion?

Yes .... No ....

Trial 10

A. Trial 9B is not fastening by adhesion.

B. Is cementing together of textiles fastening by adhesion?

Yes .... No ....

Trial 11

A. Trial 10B is fastening by adhesion.

B. Is thermowelding of plastic fastening by adhesion?

Yes .... No ....

Trial 12

A. Trial 11B is not fastening by adhesion.

B. Is contact cementing of Formica fastening by adhesion?

Yes .... No ....

Trial 13

A. Trial 12B is fastening by adhesion.

B. Is soldering of metal fastening by adhesion?

Yes .... No ....

Trial 14

A. Trial 13B is fastening by adhesion.

B. Is gluing wood together with polyvinyl glue fastening by adhesion?

Yes .... No ....

Trial 15

A. Trial 14B is fastening by adhesion.

B. Is brazing metal fastening by adhesion?

Yes .... No ....

Trial 16

A. Trial 15B is fastening by adhesion.

B. Is holding two pieces of metal together with epoxy resin fastening by adhesion?

Yes .... No ....

Trial 17

A. Trial 16B is fastening by adhesion.

SUMMARY: In your own words, describe your understanding of the concept of fastening by adhesion.

The concept of adhesion resulting from this exercise would probably be similar to the following definition: adhesion is the joining of materials with an unlike substance in a continuous bond involving molecular force.

It should be noted that the formation of a concept is not devoid of the acquisition and the critical evaluation of specific knowledges. However, the resulting concept is applicable to many more situations than the specific knowledges giving rise to it.

Before one could progress in the development of this concept it is necessary to have *a basic system of concepts,* built upon previous experience, to call upon to help categorize the various processes presented. Secondly, one has to *react to the material* presented; it is necessary to *take an active part in the process.* This point deserves further emphasis. The need for active participation in concept formation is repeatedly stressed in writings on the subject. The nature of the activities required varies, dependent upon the learner's degree of sophistication in the subject matter under study. In the early stages of the acquisition of new learning, direct involvement is essential. For this reason, the industrial arts laboratory has been chosen as the place in which to introduce the study of industry.

It should be pointed out that it is doubtful that every reader who completed the exercise in the development of the concept of adhesion will have a complete understanding of the concept. The person who had a strong background of experience in physics would have been most likely to include the factor of molecular force in his definition, even though the exercise did not elicit this attribute of the concept of adhesion.

Basic to concept formation is the role played by the senses in perceiving objects, events, and attributes. Keith pointed out the abstract nature of a concept developed through perception, but rooted in reality: "The concept is not cut off from concrete reality, it is simply the mind's way of thinking the many into one or as philosophers say, *finding unity in variety* (italics not in the original)."[8]

[8] John A. H. Keith, *Elementary Education.* (Chicago: Scott, Foresman and Co., 1947), pp. 128-9.

Some Concepts — Examples

Several selected examples of the many concepts which have been identified within the total structure of American industry are as follows:

Management—The task of planning, coordinating, motivating, and controlling the efforts of others toward a specific goal.

Industrial Relations—The determination and coordination of relations with employees and the public to promote the best interests of man and the organization.

Purchasing—The function of the liaison agency operating between the plant organization and outside vendors on all matters of procurement.

Image transfer—The basic reproductive process occuring during a "run" in printing, in which a design from a master surface (such as type, various kinds of plates, a negative, or a tracing) is duplicated by means of ink, powdered pigment, or special sensitivity. The transfer may be direct or be indirect as in offset lithography.

Open-pit mining—A method of extracting ore deposits located at or near the earth's surface.

Hardness—The ability of a material to resist crushing, denting or piercing.

Air Traffic Control—The control of aircraft with respect to speed, direction, elevation, departure, and arrival.

Destructive Testing—A check on mechanical and physical properties by destroying the test specimen under controlled conditions.

Shearing—The removal of a continuous chip through the movement of a sharpened edge along a straight line path.

Extruding—The forming of materials by forcing a material through a die of the desired shape.

These sample concepts are representative of the great variety of concepts which are being identified in the attempts to refine the structure of industry. The immensity of the task of bringing unity out of the complex variety of knowledge to be found in industry requires continuing efforts in this direction.

The Study of American Industry **as a Replacement for the Traditional Industrial Arts Program**

The evolving program of *American Industry* is not envisioned as merely a new approach, or addition, to present industrial arts offerings, but rather as displacing the traditional programs in the secondary schools. The thinking of leaders in the field as expressed in professional publications and convention proceedings, in addition to personal observations of the writers over the last ten years, has brought a full realization of the need for a drastic re-orientation. The traditional industrial arts programs in evidence reflect a lack of logical consistency growing out of a variety of educational philosophies.

A summary comparison of some of the essential characteristics of *American Industry* and Industrial Arts may be seen in the following:

Traditional Industrial Arts	American Industry
1. Composed of a detailed study of knowledges concerned with production in specific industries for pre-vocational or avocational purposes.	Composed of a study of the knowledges contributing to an understanding of the total institution of industry for general educational purposes.
2. The selection of specific industries from among the many possible choices has led to a multiplicity of laboratory and curriculum patterns, making a coherent, unified, national program most difficult to achieve.	The identification of a structure composed of underlying concepts should make possible the development of a coherent, unified, national curriculum and the standardization of laboratory facilities.
3. Pre-selected skills, representative of the industry under study, are identified and serve as the orientation for the course of study.	Concepts serve as the orientation for the course of study. Specific skills are introduced as they become necessary in the activities designed for the development of the concept.
4. Attempts to duplicate the tools and machines of industry necessary to develop pre-selected skills and specific knowledges.	Makes no attempt to duplicate the tools and machines of industry, but utilizes what facilities are needed to develop understandings of concepts.

Plans for the Further Development and Evaluation of American Industry

The ten teachers involved in the program are developing teaching-learning units and testing them in their classrooms. Each school is visited by the project directors at least once each month, after which all teachers are called back to the university for a one day seminar, exchanging ideas and discussing problems.

The following project goals have been established:

1. Identify the problems involved in implementing the study of industry using the conceptual approach.
2. Revise the content materials and refine the structure of industry. Specialists in other disciplines, as well as from industry, will be consulted regarding those points at which the developing body of knowledge of industry impinges upon their areas of specialty.
3. Expand the resource file of teaching materials through the cooperation of the Stout Audio-Visual Center as well as leading industries and trade associations.
4. Develop a series of standardized test questions for the *American Industry* program.
5. Develop a suggested program of *American Industry* for the general secondary school. An attempt will be made to develop three levels,—beginning, intermediate, and advanced. This should come as an outgrowth of the field experiences.
6. Expand the project, if successful, to include other secondary schools.
7. Design an experimental teacher education program to accompany the broadened program.
8. Develop recommended facilities for an *American Industry* laboratory specifically for the study of industry.
9. Determine and develop the kinds of activities most appropriate for teaching the concepts of industry.
10. Determine an appropriate balance between classroom and laboratory activities in the *American Industry* program.
11. Develop means of determining the effectiveness of the program of *American Industry* for various student ability levels.

It is expected that during the pilot study a great number of additional questions will emerge. As these questions are identified the goals of the continuing implementation will be expanded to seek answers. It must be re-emphasized that the program is still in the developmental stages; however, the project staff is confident that the basic rationale provides the needed direction. Whether or not it meets full acceptance, all those involved in the project are proceeding with the exhilarating feeling that they have accepted the challenge of defining the discipline represented by *American Industry.*

CHAPTER FIVE

Developing Creative Thinking Abilities

WESLEY S. SOMMERS

Introduction

> Certainly we cannot say that one is fully functioning mentally, if the abilities involved in creative thinking remain undeveloped or are paralyzed. These are the abilities involved in becoming aware of problems, thinking up possible solutions, and testing them. If their functioning is impaired, one's capacity for coping with life's problems is indeed marginal.[1]

The above statement by Torrance identifies one of the most important, and most neglected, responsibilities of the school. This neglect of developing the creative thinking potential of students can be traced to a lack of understanding about creative thinking abilities and how these can be developed within the classroom. Yet, there is definite research evidence that indicates that such abilities can be developed within the classroom—and further, that this can be accomplished without sacrificing traditional learning objectives.

The purpose of this chapter is to provide some understanding of the improvement of creative thinking abilities through deliberate effort. Hopefully, the discussion will also stimulate industrial arts educators to take up the challenge in their own spheres of influence. It is encouraging to note that two groundbreaking studies in this area were conducted by industrial arts educators (Sommers and Anderson).

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[1] E. Paul Torrance, *Guiding Creative Talent.* (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1962), p. 3.

The discussion of this chapter will be related primarily to the Stout study conducted during the fall of 1960 (Sommers). Additional evidence, applicable to industrial arts, is also reported (Anderson). Although space limitations preclude a textbook treatment of creative thinking, the sections on *Defining Creative Thinking*, *Improving Creative Thinking Abilities*, and *Suggested References* should provide a better understanding of the feasibility of improving creative thinking within the classroom, and resources that can be used to develop a specific approach.

Defining Creative Thinking

One of the greatest difficulties in conducting experimental research concerning creativity is the lack of an objective definition of creativity—a definition that will lend itself to the construction of a valid measuring instrument. Over one hundred definitions of creativity were studied in preparing for the study, plus many reviews of definitions. The results of this review yielded a confusion of varied and shaded meanings.

One investigator found thirty-two meanings associated with the term creativity (Rhodes). One of the most helpful discussions identified five levels of creativity: expressive creativity, productive creativity, inventive creativity, innovative creativity, and emergentive creativity (Taylor). Perhaps Wilson's comment after his review of definitions is as helpful as any: " . . . the production of something new is a central element in all these definitions and that creativity as a process is inferred from the product."[2]

It became apparent from the review of literature that the broad concept of creativity did not lend itself to experimental evaluation, therefore the more specific area of creative thinking was identified for use in the study. Torrance's definition of creative thinking seemed most appropriate:

> We have chosen to define creative thinking as the process of sensing gaps or disturbing, missing elements; forming ideas or hypotheses concerning them; testing these hypotheses; and communicating the results, possibly modifying and retesting the hypotheses. We have been quite willing to subsume in this definition the major features of most other

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[2] Robert C. Wilson, "Creativity," *Education of the Gifted.* Nelson B. Henry, editor, Fifty-seventh Yearbook of the National Society for the Study of Education, Part II. (Chicago: The National Society for the Study of Education, 1958), p. 110.

definitions which have been proposed. The production of something new is included in all of these definitions.[3]

Improving Creative Thinking Abilities

Two things were considered in structuring the treatment of the experimental group of the experiment at Stout in order to facilitate the development of creative thinking abilities: the general environment of the classroom, and specific learning activities.

Rogers suggested two conditions related to the general environment which would tend to foster creativity: psychological safety and psychological freedom. *Psychological safety* is engendered by accepting the individual student and his ideas as being of unconditional worth. *Psychological freedom* is encouraged by permitting the individual a complete freedom of symbolic expression. Although such conditions are difficult to establish completely in the classroom, they provided direction for establishing a general class environment.

The specific learning activities that were used to develop these creative thinking abilities were constructed on the assumption that such activities could be designed so as to yield concurrent learning outcomes in both subject matter and creative thinking. This assumption is supported by one of Tyler's principles for the selection of learning experiences in curriculum development: "A fifth principle is that the same learning experience will usually bring about several outcomes . . . Every experience is likely to bring about more than one learning objective."[4]

The guides used in constructing creative learning activities for the Stout study were: The primary mental abilities related to creative thinking as given by Guilford and the suggested learning activities listed by Wilson, by Parnes (1963), and by Von Fange. Wilson's recommended activities perhaps most concisely identify the major considerations. He suggested that brainstorming be used to provide an atmosphere permissive of new ideas. He also suggested activities that would: stimulate sensitivity to problems; encourage ideational fluency; encour-

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[3] E. P. Torrance and others, *Assessing the Creative Thinking Abilities of Children.* (Minneapolis: Bureau of Educational Research, University of Minnesota, 1960), p. 3.

[4] Ralph W. Tyler, *Basic Principles of Curriculum and Instruction.* (Chicago: The University of Chicago Press, 1950), pp. 43-44.

age originality; encourage redefinitional ability; and develop a pupil's understanding of creativity (Wilson).

Developing Creative Thinking

The Sommers Study

Prior to this Stout Study there existed some experimental research to support the belief that specific training could be effective in increasing abilities associated with creative thinking. However, there appeared to be no experimental evidence to indicate that these abilities could be developed within existing subject matter courses without affecting traditional learning outcomes. Because of increasing demands on existing school programs it was felt that rather than add special courses in creativity it would be preferable to develop creative thinking abilities within existing courses. Therefore, in the fall of 1960 an experimental study was conducted at Stout State College to investigate the feasibility of improving creative thinking within the framework of existing subject matter courses (Sommers).

The following assumptions were considered basic to the study:

1. That the abilities involved in being creative are universal, *i.e.*, everyone possesses these abilities to some degree.
2. That these abilities can be increased by training.
3. That one of the legitimate functions of the school is to provide such training.
4. That it is desirable to develop creative thinking abilities within the framework of existing school curricula.

Hypothesis and Population. The major hypothesis of the experiment was: The use of specific teaching methods designed to increase certain creative thinking abilities will increase those abilities without affecting learning outcomes of an industrial arts laboratory type course.

The experimental population consisted of male freshman students at Stout State College. The students included in the experiment were randomly selected from that population. The subject matter area selected was drafting; the subject matter course was Freehand Drawing.

Two groups of students were identified, a control group and an experimental group. The control group was taught with the usual methods of the course. The experimental group followed the same unit course outline, but several creative learning exercises were substituted for standard activity units. The experiment was conducted during the first academic quarter, and was repeated with different groups during the second quarter.

The experimental hypotheses were tested by use of an analysis of covariance technique which allowed comparisons of gains in learning adjusted for differences in scores achieved on the pretest. A locally constructed test was used to evaluate gains in subject matter understanding. The Test of Imagination (Form DX), prepared by the Bureau of Educational Research at the University of Minnesota, (Torrance and others) was used to evaluate gains in creative thinking. This test yielded a total creative thinking score, and individual scores on the following abilities associated with creative thinking: spontaneous flexibility, ideational fluency, originality, inventive level, and adequacy. It should be noted that the conclusions reached through this experiment refer to creative thinking as specifically defined by the scores yielded by this test.

Conclusion. The comparisons of results between the two groups found a significant difference between the two groups (in favor of the experimental group) in both gains in subject matter understanding and the total creative thinking score. The conclusions of the experiment were that measures of creative thinking could be improved within an industrial arts laboratory type course by the use of specific methods designed to improve those abilities, and that the use of those methods would not negatively affect subject matter learning. Naturally certain limitations must be kept in mind when interpreting the results: the experimental population, the nature of the subject matter involved, and the fact that the experiment was concerned with "measures of creative thinking ability" as defined by the criterion instrument, and not the broad concept of creativity.

Creative Learning Activities. The specific creative learning activities used in the Stout study followed the guides suggested by Wilson. All except the first were designed to develop subject matter understanding and skills in addition to improving creative thinking abilities.

The first creative learning activity was an introduction to the concept of creativity. This consisted of a discussion of the nature of creativity and the abilities associated with creative thinking. The class was introduced to "brainstorming" through discussion and participation in two brainstorming sessions—the first session being conducted by the instructor, the second was conducted by students in several small groups. The purposes of these sessions were to: help improve the students' understanding of creativity; help develop the creative thinking abilities of ideational fluency, ideational flexibility, originality, and sensitivity to problems; and help establish conditions of psychological safety and freedom in the class environment.

The next creative learning activity was "alphabet design." It was used to develop lettering skills and understanding of basic characteristics of alphabet design. The students were introduced to the technique of "sketchstorming"—a variation of brainstorming appropriate to producing a quantity of visual ideas. The development of original alphabet designs from their sketchstorming ideas introduced students to the creative problem solving procedure as well as further developing ideational fluency and flexibility, and originality.

Another activity, "cut-up cubes," used sketchstorming to develop skills and understanding of linear perspective. This activity was also concerned with ideational fluency and flexibility.

Two other activities involved the students in working as individuals within problem solving teams: "the wire coat hanger" and the "surplus pie pan" problems. In both of these activities the students used sketchstorming to generate ideas individually, and then pooled these ideas with those of their group to establish the best creative solution to the particular problem. A major purpose of both of these activities was to further develop ideational fluency and flexibility, originality, and creative problem solving abilities.

The "wire coat hanger" problem required the students to find the best possible uses for a large quantity of wire coat hangers—other than for their original purpose of hanging coats. This activity was used to develop the creative ability of redefinition in addition to skills in three-dimensional shaping.

The "surplus pie pan" problem was similar to the preceding except that it was used to develop competencies in representing circles and curves in perspective. Again a major purpose was to develop redefinition abilities.

Other Possible Activities. Although the freehand drawing course might seem unusually appropriate for the development of creative thinking abilities, most industrial arts courses can incorporate learning activities that will develop both subject matter and creative thinking competencies. The important thing to consider is the development of one or more creative thinking abilities through the use of a specific activity, and the establishing of a class environment that encourages students to "think up" and present many new ideas.

As an illustration consider the ability of ideational fluency —producing many ideas from one stimulus. This ability can be developed through many different activities. When students are presented with a new type of material and its properties, they could be asked to list as many ideas as they can for its use. When discussing safety the students could brainstorm for ideas to increase "safety awareness" in the shop. When presenting a new project have the students list ideas as to how the project can be improved, or how the processing could be improved. And, of course, student-designed projects lend themselves very well to developing a whole group of creative thinking abilities.

Activities that develop both subject matter competencies and creative thinking abilities can be incorporated into any industrial arts course. Perhaps one of the most effective ways of developing creative learning activities for a course is to have the instructor and his colleagues brainstorm for such activities —it is even possible for the industrial arts instructor to increase his own creative thinking potential.

The Anderson Study

In 1963 Anderson conducted "An Experimental Evaluation of Two Methods for Developing Creative Problem Solving Abilities in an Industrial Arts Course" at Mankato State College.

The Stout study uncovered experimental evidence to support a belief that creative thinking abilities could be developed within the framework of existing subject matter courses; a beginning rationale for such efforts was formulated; and some techniques for accomplishing these goals were developed. However, the limitations of the study should also be noted: the population was limited; the subject matter and type of teaching situation were limited; no effort was made to determine efficacy of varied creative learning activities; and no attempt was made to measure persistence of learning gains.

Although the Stout study has importance as a groundbreaking study, Anderson must be credited with adding to the basic application in industrial arts. He pointed out that:

> Though similar to the Sommers study, the present study differs in several respects . . . . The present study was conducted in a general education industrial arts course with classwork of a very dissimilar nature.
>
> . . . Although based on much the same theoretical rationale as that used by Sommers, the actual teaching methods designed to increase creativity were very dissimilar in this study.
>
> . . . The effort in the present study was to obtain information on the effectiveness of the treatment at different college aptitude levels.
>
> . . . Examination of the results of a pilot study was used in an empirical attempt to select subscores most useful in measuring the abilities developed by the treatments used . . . . This method should provide clues as to the type of abilities susceptible to improvements by the treatments used.
>
> . . . The test protocols used in the present study were scored in the writer's home by two individuals with no previous training in this work.[5]

The importance of Anderson's study to understanding of the development of creative thinking abilities is considerable. First, he provided evidence that other methods in a different type of subject matter course could be effective in increasing creative thinking abilities without negatively affecting subject matter learning. In addition he: showed that a variety of learning activities could be used to improve creative thinking abilities; helped to refine the criterion measures that can be used in evaluation; established that protocols could be effectively scored by the investigator (which should facilitate additional research in this area); and, in general, broadened the total understanding in this area.

Implication for Industrial Arts

The preceding discussion has identified several points that are important to industrial arts:

1) A major responsibility of the school is to develop the creative potential of all students;

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[5] Donald N. Anderson, "An Experimental Evaluation of Two Methods for Developing Creative Problem Solving Abilities in an Industrial Arts Course," (unpublished Ph.D. thesis, University of Minnesota, Minneapolis, 1963), pp. 79-81.

2) The creative potential of students can be increased through deliberate effort; and
3) Increasing the creative potential of students does not necessarily mean sacrificing other learning outcomes.

Perhaps few abilities are more in demand in today's world than those associated with creative technology; and probably one of the greatest general needs of today is to understand the relationship of creativity to the ever-changing physical environment. The two studies (Sommers and Anderson) are important to industrial arts not only because of the experimental evidence they provided concerning the development of creative thinking, but because they have identified industrial arts as an area most certainly suited to the development of creative competencies related to technology.

The implication for industrial arts educators should be clear and decisive. If industrial arts teachers are to be able to help their students improve creative thinking abilities, the industrial arts teacher educators must provide the necessary instruction for those teachers. It is clearly the duty of industrial arts teacher educators to provide the classes and workshops necessary to prepare tomorrow's teachers, as well as today's teachers in the field, for the challenge of improving creative thinking competencies related to American technology.

Suggested References for Further Reading

The following references are given as a guide to the person who wishes to increase his understanding of the area of creative thinking. They are not meant to be considered as the best, or most authoritative, rather they should provide good entrees to this area.

Perhaps the best single source for developing a "feel" for the area of creative thinking is *A Source Book for Creative Thinking* (Parnes & Harding, 1962). This book includes some of the classic writings in the area, and provides an excellent listing of persons who have done significant study and writing in the field.

For those interested in the research background in this area the reviews of literature by Sommers (1961) and Anderson (1963) should be quite helpful. Their bibliographies provide a large quantity of basic sources of information. In addition, *The Bibliography re Nature and Nurture of Creative Behavior*

(Parnes, 1964) provides an excellent selection of annotated research studies.

References concerning methods of improving creative thinking are numerous, but possibly the following are good to begin with: *Guiding Creative Talent* (Torrance, 1962); *Applied Imagination* (Osborn, 1961); *Professional Creativity* (Von Fange, 1959); and the work book and various course materials that can be obtained from the Creative Education Foundation.[6]

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CHAPTER SIX

Mass Production with Hand Tools

NEAL W. PRICHARD

Introduction

Mass production involving only hand tools can be quite succesful in junior high school industrial arts classes. It is the intent of this chapter to describe just how such a unit has been taught and hopefully to provide sufficient information to encourage others to include similar units of instruction. Much of the information and all the illustrations presented in this chapter were obtained from Mr. John Debrauske, an industrial arts instructor in the Urban Junior High School of Sheboygan, Wisconsin. It should be added that this information is not just theory but was actually tried by Debrauske and was found to be very succesful.

The chapter is subdivided into three major sections. These sections are: *first,* the relationship to industrial arts objectives, *second,* the teacher preparation before the unit of mass production, and *third,* the teaching of the unit. The chapter closes with a brief summary and a selected bibliography. It should be emphasized that this description depicts the first opportunity students have had with industrial arts and mass production.

Industrial Arts Objectives and Mass Production

One of the objectives of industrial arts stated on most listings, whether prepared by a professional organization or the individual teacher, is to provide or stimulate an interest, insight, or understanding of industry and its place in society. In an attempt to achieve the implied behavioral changes in students, the industrial arts teacher might present a unit on industry in the twentieth century and possibly the developments that led to this industrial society. If the teacher traces the history of the industrial revolution, mass production involving the concept of interchangeable parts becomes paramount.

This important concept has not challenged the traditional approach to industrial arts teaching until quite recently when some industrial arts educators felt the need for a greater emphasis of this concept. During the past decade an increased awareness of mass production and its implication for industrial arts has appeared in the professional literature. The writers of this literature have, however, been concerned with mass production for the advanced industrial arts students who have developed a degree of skill in using machines. Little, if anything, can be found involving mass production with hand tools.

This apparent void in the literature, which is assumed by the writer to be indicative of the practice in the classroom, seems rather paradoxical since mass production began with hand tools and simple machines during the eighteenth century. Since it was possible for Whitney, Terry, and others to mass produce successfully using hand tools, why does industrial arts completely ignore what has been done and could be done?

Another aspect involving familiarization with industry is the engineering, management, sales, and distribution parts of industry; not merely the manipulative skills used by production in industry. Certainly if industrial arts teachers are attempting to acquaint students with industry, as it was in the past and is today, the students should be aware of jigs and fixtures, flow charts and diagrams, the division of labor theory and personnel work, work simplification involving time and motion study, and industrial psychology. The direct contact with many of these industrial concepts is attainable through mass production involving hand tools presented here.

Another objective stated by industrial arts educators is the development of a degree of skill in the use of hand tools by the student. A psychological fact accepted by industrial arts educators and yet constantly violated by them is that students learn easier and more quickly when beginning with simple tasks and then proceeding to complex tasks, preferably based upon the simple tasks previously learned. Woodworking instructors, for example, frequently hand the seventh grade student a small block of wood and tell him to square it using the hand plane and try square. If the instructor's objective is to acquaint the student and develop a degree of skill, why start the student on tasks which, at best, are not easily accomplished?

The system of mass production presented here will acquaint students with selected hand tools and aid them in the development of basic skills with these tools starting with very readily accomplished tasks. Included will be only those tasks that are needed for the performance using jigs and fixtures that have been developed by the instructor.

Teacher Preparation before the Unit

The key to success with hand tool mass production is adequate preparation before beginning the unit. The various steps in preparation are not unique with this system of mass production as they follow the normal procedure used by industry and as reported in industrial arts literature describing mass production projects with machines. Each of the steps will be described briefly since detailed instructions and suggestions can be found in the references included in the selected bibliography.

Selection of the Project

As this is the first experience the students will have with mass production and since their skills are somewhat limited on the beginning course level, it is desirable to select a project that is only a one piece project—one that requires no parts that must join closely. The jigs and fixtures do assure close accuracy.

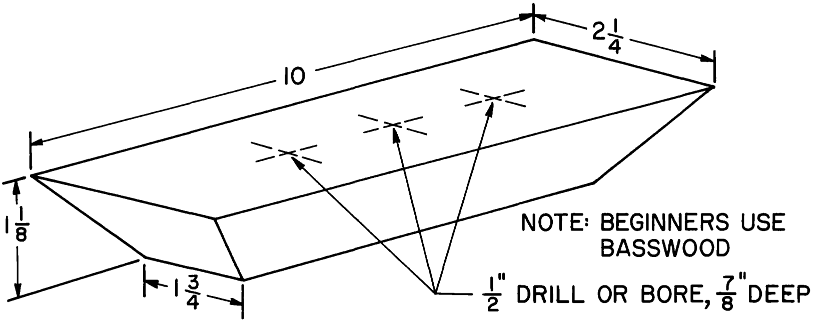


Fig. 2. Selected Mass Production Project—a Candleholder

However, with more than one part, the length of time required to complete the project may be too long, resulting in loss of motivation. A sample one-piece project appears in Fig. 2.

Pilot Model or Prototype

The instructor should make a pilot model of the finished product, before the construction of the various needed jigs and fixtures is to be started. This will permit modification of the project design before the construction of any jigs and fixtures. The sequence again is exactly the same as is used in American industry. The model can actually be held by the jigs and fixtures so there is the one constant to assure positive measurements which aids in the construction of the devices.

Preparation of Jigs and Fixtures

It is imperative that the teacher prepare the jigs and fixtures needed for the project before the unit begins. The teacher will need to determine the various operations needed to complete the project and then design the necessary jigs and fixtures for these operations. A list of principles for the construction of jigs and fixtures was prepared by Debrauske (1963) and appears below to aid the instructor in the design and preparation of these devices.

Principles For Jig and Fixture Construction

1. Jigs and fixtures must be designed to provide a guiding action before the cutting tool actually makes contact with the product part.
2. Jigs and fixtures should be constructed of durable material to withstand heavy and frequent use.
3. Jigs and fixtures should be constructed of materials that have good dimensional stability to keep product parts within close tolerances of actual size.
4. Jigs and fixtures should be constructed so as to keep from damaging or causing undue wear on the tools they were made to guide.
5. Jigs and fixtures should be designed to utilize as few clamping devices as possible — preferably limited to bench vises.
6. Dowels for opening and closing jigs and fixtures:
   a. should be long enough to keep jigs and fixtures together even when opening to insert stock.
   b. should not be glued to jigs and fixtures to facilitate removal upon breakage.
7. Jigs and fixtures should be constructed to hold securely those parts being held and to keep them from jarring loose.
8. All sharp arrises and corners on jigs and fixtures should be rounded to prevent any undue injury to the operator.

9. All jigs and fixtures should be designed to provide maximum safety for the operator.

10. Jigs and fixtures should be designed to provide maximum ease of installation of parts to be formed.

11. Jigs and fixtures should be designed to provide maximum accuracy in holding parts in proper position for sizing and location cuts.

12. Jigs and fixtures should be designed to offer ease of inspection pertinent to holding of parts in proper position.

13. Cut-off fixtures should be designed to enable the operator to utilize a fixture in cutting off various lengths.

14. Jigs and fixtures must be designed to afford maximum accuracy of squareness of parts.

15. Jigs and fixtures should at times be developed to hold more than one part of the same kind and size to be cut.

After the jigs and fixtures have been constructed, it is essential that the instructor test them. It is highly desirable that some of the students try them so the necessary modifications can be completed before the actual production unit begins.

Fig. 3 shows some of the details necessary in preparing a jig. Its use in the boring operation is shown in Fig. 4. A fixture for the same project is shown in Fig. 5. Its application in the planing operation is illustrated in Fig. 6.

It is also desirable to run some simple time studies on the use of jigs and fixtures in the production line; through this it is possible to determine how many are needed to assure a

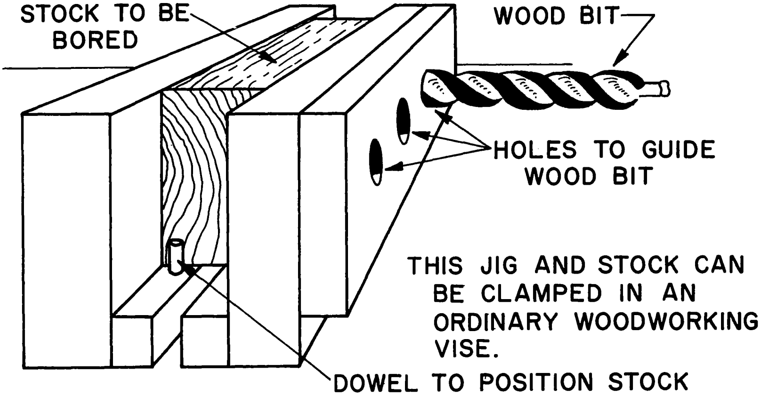


Fig. 3. Jig to Position Stock and Guide Bit

smooth flow of materials through the production line. The time study on the project illustrated revealed that it took one minute to cut the stock to length and five minutes to plane a bevel. It was therefore deemed necessary to have five jigs for planing the bevel in order to achieve a smooth flow of materials in the line.

Teaching the Unit

There are numerous teaching techniques that can be used in teaching the unit. This type of project has one advantage over many of the activities in the junior high school in that

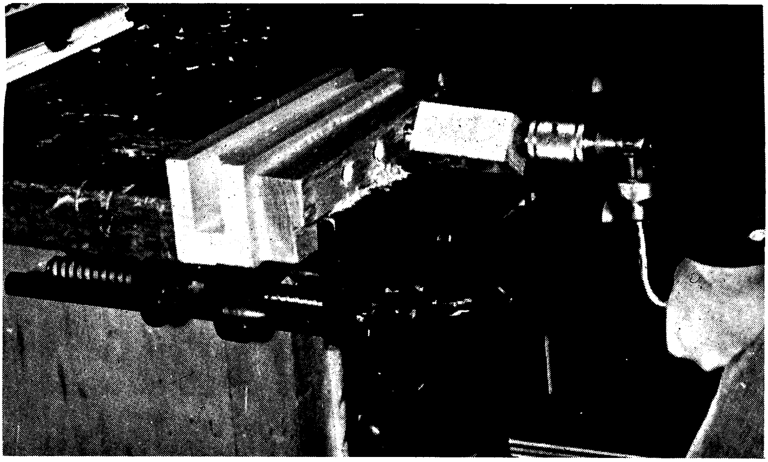


Fig. 4. Boring Jig in Use

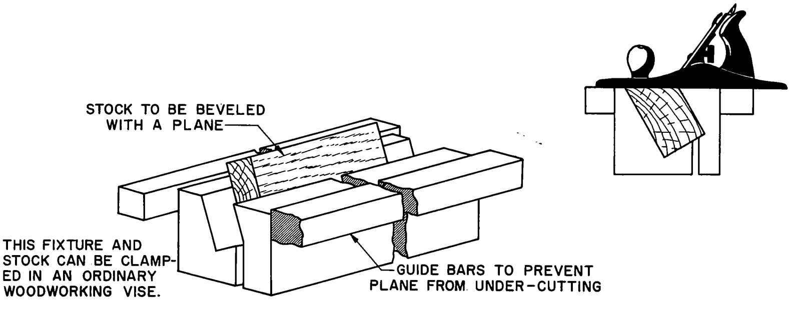


Fig. 5. Fixture to Hold Stock for Planing and Later for Sanding

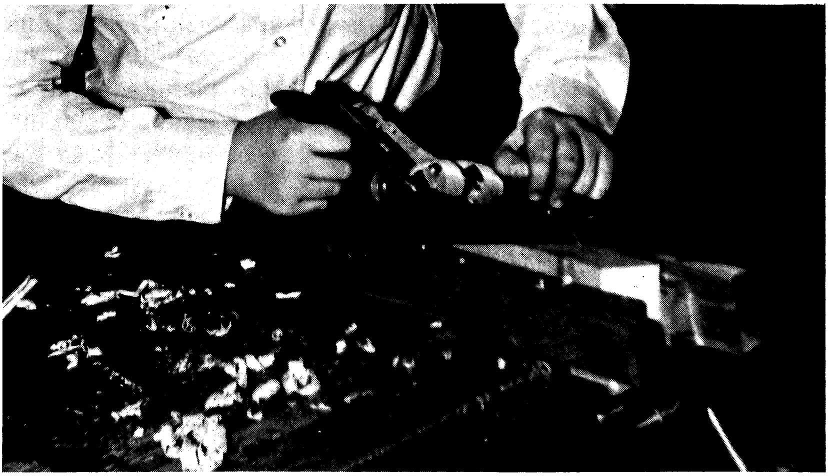


Fig. 6. Planing Fixture in Use

it is a group project and involves individuals getting along with their peers. This incidentally is an attainment the industrial psychologists say is sadly lacking with many individuals in society today and thus is the number-one cause for people losing their jobs. This should very definitely be emphasized throughout the entire unit so that the students realize the teamwork necessary and the coordination needed to produce items in industry.

The outline for the unit should include the following topics:

1. Introduction to mass production
2. Objectives of the unit
3. The project and how to make it
4. Jigs and fixtures
5. Plant layout
6. Personnel
7. Training session
8. Trial session
9. Production session
10. Evaluation

Each of these topics will be discussed briefly for further clarification. It is again emphasized that the references listed in the bibliography give greater insight and detail about each of the topics.

Introduction to Mass Production

Motivation at the beginning is extremely important for any unit in education. This can be accomplished effectively with this unit by a short history of mass production and the developments during the industrial revolution. It could be augmented by films, film strips, speakers from industry, field trips to local industries, panel discussions, individual reports, and numerous other methods familiar to educators.

Objectives

Since students learn better when they have participated in the determination of the goals, it is very desirable for the instructor to develop the goals with the students. Through directed discussion the goals could be made more meaningful to the students and the goals become even more important at the completion of the unit when the students and instructor evaluate their progress.

The Project and How to Make It

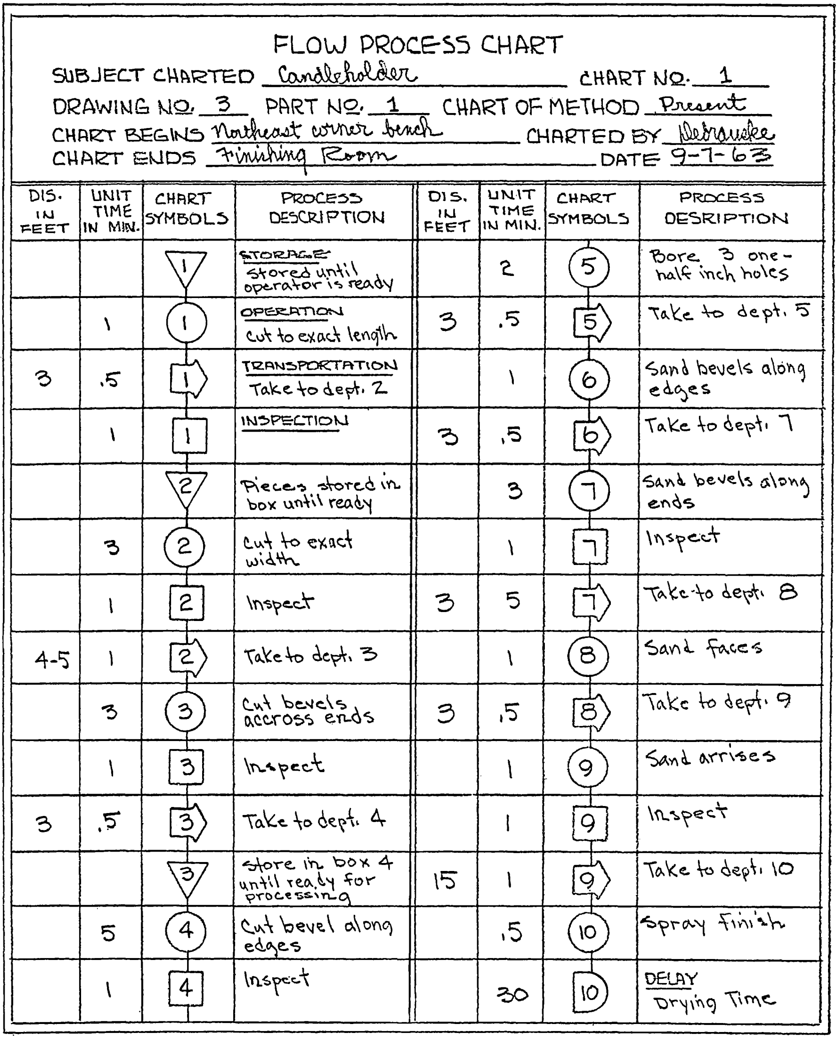
For a beginning group of students, it is desirable for the instructor to select the project so that he may achieve the objectives he has set for the entire course. It would be good for advanced students to have the opportunity to select a project if another mass production project were to be attempted. Drawings of the project and the pilot model should be presented to the students with some explanation as to the reasons for the selection of the particular project.

Jigs and Fixtures

A series of demonstrations can quickly acquaint students with the use of the jigs and fixtures and of their real value. Timing two demonstrations could quickly impress the value of the jigs and fixtures. The demonstration without the use of jigs and fixtures that required layout and cutting to a line would certainly take considerably more time than the other with the use of jigs or fixtures requiring no layout or special skill. It should also be pointed out that the time involved to make the jigs and fixtures, the tooling up process, would make it impractical except for producing quantities.

Plant Layout and Routing

This phase of production planning could present the students an excellent opportunity for problem solving. Students



FLOW PROCESS CHART

SUBJECT CHARTED Candleholder CHART NO. 1
DRAWING NO. 3 PART NO. 1 CHART OF METHOD Present
CHART BEGINS Northeast corner bench CHARTED BY Debrauske
CHART ENDS Finishing Room DATE 9-7-63

DIS. IN FEET	UNIT TIME IN MIN.	CHART SYMBOLS	PROCESS DESCRIPTION	DIS. IN FEET	UNIT TIME IN MIN.	CHART SYMBOLS	PROCESS DESRIPTION
		▽1	STORAGE Stored until operator is ready		2	⑤	Bore 3 one-half inch holes
	1	①	OPERATION Cut to exact length	3	.5	⇨5	Take to dept. 5
3	.5	⇨1	TRANSPORTATION Take to dept. 2		1	⑥	Sand bevels along edges
	1	□1	INSPECTION	3	.5	⇨6	Take to dept. 7
		▽2	Pieces stored in box until ready		3	⑦	Sand bevels along ends
	3	②	Cut to exact width		1	□7	Inspect
	1	□2	Inspect	3	5	⇨7	Take to dept. 8
4-5	1	⇨2	Take to dept. 3		1	⑧	Sand faces
	3	③	Cut bevels accross ends	3	.5	⇨8	Take to dept. 9
	1	□3	Inspect		1	⑨	Sand arrises
3	.5	⇨3	Take to dept. 4		1	□9	Inspect
		▽3	store in box 4 until ready for processing	15	1	⇨9	Take to dept. 10
	5	④	Cut bevel along edges		.5	⑩	Spray finish
	1	□4	Inspect		30	◗10	DELAY Drying Time

Fig. 7. Flow Chart Using ASME Symbols

can be guided by the instructor into solving the most efficient location for work and inspection stations and then placing these on scale drawings of the actual shop. Flow charts and flow diagrams should be prepared for the correct routing using the proper symbols. The American Society for Mechanical Engi-

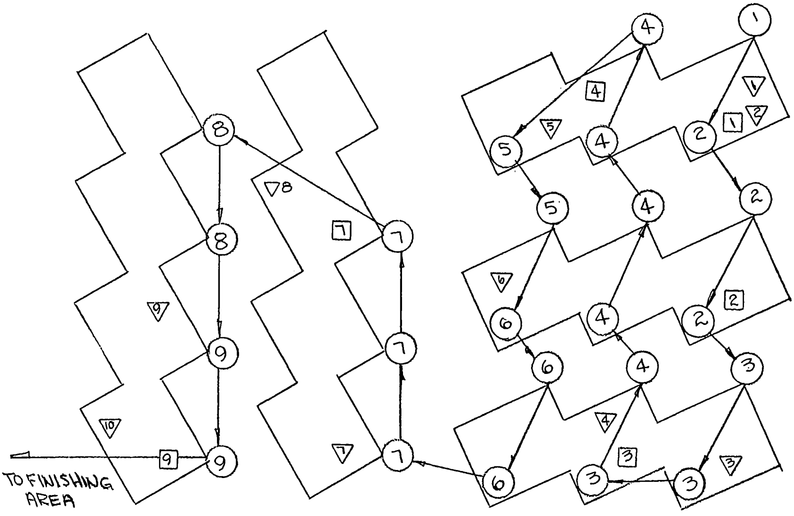


Fig. 8. Flow Diagram for Candleholder Production

This shows the location of each work station, the operation completed there, and the direction of material flow through the shop.

neers has adopted standard symbols. (Roscoe, 1955) for this flow of materials. The flow chart for producing the candle holder appears in Fig. 7. The flow diagram is shown in Fig. 8.

Personnel

Students can gain a real understanding of this phase of industry by completing personnel forms with their special skills and education noted or conspicuously absent. The students can then select the various tool operators, foremen, supervisors, inspectors, and other needed personnel for the production run. It is possible that several students would hold more than one position thus allowing the better students more challenging activities to compensate for their individual differences.

Training Session

After the location of the work stations has been established and the work positions filled it is essential to train the personnel. The number of periods required for training would vary with the complexity of the project which would increase the number of jigs and fixtures required. Student ability certainly is another factor involved here. If the student foremen and supervisors have been previously instructed on their responsibilities it is possible for them to instruct their workers, thus allowing the instructor to supervise the entire group rather than demonstrating one operation at a time.

Trial Session

A trial session is very desirable with the primary purpose being to check for smooth flow of the materials throughout the production line. It is in essence a test of the flow charts and diagrams, and provides an opportunity to check the time studies that were taken. The trial session can also provide the instructor with an opportunity to introduce production charts, the various methods used in the payment of the workers including incentive or hourly rate or profit sharing, and other examples of department and reimbursement production and finance. The students should be highly motivated to actually try the production since they are often more interested in doing rather than knowing and planning.

Production Session

Since some of the items produced during the trial session should be acceptable, the production schedule should be reexamined. After the number produced and the time required has been determined, the period needed for production can be established. The instructor should make allowance for some scrap and this should be understood by the students. During the production session it may be desirable for the students to change jobs occasionally. By changing jobs the student has opportunity to use different jigs or fixtures, become familiar with different skill requirements, and reduce some of his monotony. The presence of monotony in industry should be mentioned but this factor could be detrimental with young students whose attention spans are limited.

Evaluation

Evaluation should not be an afterthought or omitted until the end of the unit. Evaluation should be present daily so that the students and the instructor can be aware of the progress being made on the accomplishment of their objectives stated at the beginning of the unit. Evaluation by the instructor might include such things as class discussions, observation and rating, paper and pencil tests, identification tests (particularly good for future inspectors), students writing their likes and dislikes and other reactions, and certainly close evaluation during inspection of the items being produced.

This evaluation can involve self-evaluation and student evaluation of their peers. Students could complete self-evaluation sheets that had previously been prepared by the instructor or by themselves. This could be included along with a time card for the student or for the operation being performed. This could be an excellent opportunity for incentive wage discussions. The student foreman and other leaders would need to evaluate their peers which could be challenging for the leader and the worker. Likes and dislikes and other student reactions of the mass production unit could also be interesting evaluations. Debrauske (1964 study) asked students to respond to several questions so that it was possible to ascertain their feelings about the unit. No names were placed on any of the papers. The results clearly indicated that the students did enjoy this type of unit and thought they definitely were more accurate with hand tools when aided by jigs and fixtures.

Parental reaction to this type of unit could be influential on the instructor and certainly influential on the child. One method that would be enlightening to the parents would be an open house with the students actually in operation. Newspaper publicity, both school and community, should reach the parents so that later it would be possible to elicit their reactions from local communications and their child. Debrauske (1964 study) used the community and the school newspapers for publicity and then asked for parental opinion. Several statements are included that typified the attitudes of the parents.

> "We're sure glad our son is studying about some of the problems he will be faced with outside of school."
>
> "It teaches children how to work together in a group, and how to take orders."
>
> "I think it is a good idea for at least one project."

Summary

Mass production with hand tools can be an effective unit for students in industrial arts. The unit involving jigs and fixtures, flow charts and flow diagrams, and other industrial concepts should aid the student in his understanding of industry.

The use of jigs and fixtures can make the introductory use of hand tools quite simple compared to the conventional methods used in industrial arts.

Adequate teacher preparation before the unit is a must. The steps that should be followed by the teacher are essentially the same as those followed by industry and those mentioned in machine mass production units found in professional publications. The steps for preparation include:

1. Selection of the project
2. Construction of a pilot model
3. Preparation of the jigs and fixtures

The actual teaching of the unit should involve considerable participation by the students under constant leadership by student leaders and the instructor. The steps to follow for the unit are:

1. Introduction to mass production
2. Objectives
3. The project and how to make it
4. Jigs and fixtures
5. Plant layout
6. Personnel
7. Training session
8. Trial production session
9. Production session
10. Discussion and evaluation

Constant evaluation is essential for this unit. It can involve active participation by the students and the instructor. Parents should be informed of the unit so that it is possible to obtain their influence on the students and to elicit their opinions of the unit upon completion.

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CHAPTER SEVEN

Programed Instruction

PHILIP W. RUEHL and ARMAND G. HOFER

Introduction

A relatively new teaching technique, programed instruction, appears to have great potential in assisting industrial arts teachers to meet the challenge of developing in students a better understanding of our industrial society and their role in it.

The vital responsibility teachers have in education cannot be confined to the mere presentation of facts, for a student can receive this type of knowledge from a textbook. The true role of educators is the aiding of students to acquire certain intellectual abilities and skills which will enable them to meet everyday situations. These abilities and skills concern the comprehension of the facts already learned, and the logical application of the subject matter through careful analysis, synthesis, and evaluation of the task performed. When a student has acquired these skills, he truly has received an education and teachers have effectively completed their tremendous responsibility.

During the past ten years, teachers have been motivated by a new teaching technique to refocus their thinking and to reflect upon their effectiveness as teachers. This technique is programed instruction—a revolution from traditional instruction. Because of the limitations of time and space, only a brief description of what programed instruction is and how it works will be presented. For those not familiar with programed instruction desiring further information about it, several references such as *Teaching Machines and Programmed Instruction* (Fry)[1] are available which present more detailed information.

A Brief Description

Definition

Programed instruction differs from traditional instruction in that there is considerably more student involvement in the process of learning and that very careful analysis and organization in the program content is required. To be classified as programed instruction, the content must be divided into small sequential steps, be presented one step at a time, require frequent responses (tests and exercises) from the learner, and provide for immediate knowledge of whether the responses were correct. In addition, the program must be so presented that the student can complete it at his own rate of comprehension. Only those programs which have been carefully prepared and evaluated as to their effectiveness can rightfully be considered programed instruction. Many so-called programs have been written but not evaluated. Unless the author of the program can provide objective evidence of the program's effectiveness, the material should be considered only as an attempt at content reorganization.

At present, two types of programs exist: The constructed response or *linear* type, and the multiple choice *or branching* type (Fry, p. 3). The linear type is so designed that as a student proceeds through the program he is able to provide the correct response to the stimulus at least 95 percent of the time. Each student takes the same path through the material in this type of program. However, in the multiple choice type, all students do not take the same path. Students who quickly grasp what is being taught (answer the questions correctly) go through the program in larger steps and at a faster pace. The students who do not understand a given unit of presentation are directed through another series (or branch) of information and questions which further explain the original presentation.

Method of Presentation

Programed instruction requires presentation of only the material a student is to read at one time and also requires him to respond (be active in the learning process) before he can

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[1] References cited are listed at end of chapter.

continue through the material. The required control may be accomplished by books of a special format or by machines designed to control the student's access to the units of information, the questions, and the confirmation of the correct answers.

Books. Programed textbooks provide a convenient and easy method of presenting programs. Programed books may be used to present either the linear or the multiple choice type programs. The linear style presents a statement or question which requires a student constructed response, then exposes the correct answer. The student compares his response with the correct answer, and if correct, proceeds to the next item in the sequence. In the multiple choice type text, a concept is presented on one page along with a multiple choice question. The student selects the answer he feels to be the correct one and is then directed to some other page for confirmation of his answer. If the answer was correct, he studies the new material printed on the same page. If an incorrect answer was selected, the student is directed to a page that not only indicates that he made an incorrect choice, but also explains why his choice was the wrong one. He is then directed to return to the original page and select a new response. This *scrambled text* mode readily provides for branching within the program.

Machines. Not all programs are taught with texts. The teaching machine has been closely associated with programed instruction. Simple machines offer no advantages over programed books, except that they offer more control over student cheating (looking ahead for the correct answer or proceeding with new material without attempting to answer the questions). The more complex teaching machines, especially the computer operated machines, appear to have distinct advantages over programed books. Computer-based machines can present a number of different types of stimuli including audio and motion picture films and also can be much more refined in their branching techniques by basing the decision as to whether branching is necessary on the responses to several questions rather than on the answer to a single question. As with textbooks, teaching machines must accept programs and present them in a step by step procedure. Each step is presented separately with provision for student response. The correct answer is then revealed and if the student's answer is correct the next step in the program is presented.

The mechanics of the machine may be simple or complex depending on the requirements of the program. As branching is introduced into the program, the complexity of the machine increases. A high degree of branching requires the use of a computer to present the program in the proper sequence.

A constructed-response type of program does not easily lend itself to branching by machines because the number of possible answers is large. Multiple choice questions, on the other hand, have a limited number of answers and provide flexibility in machine design. One type of machine available for drill purposes first presents the complete program, then repeats the program as many times as necessary for the student to learn the material; however, each time the program is presented the material previously learned is omitted, thereby focusing the student's attention on the unlearned information. Another type of machine presents material both visually and audibly. The visual part of the program is projected on a small screen from a 35 mm slide while a magnetic tape is played for sound. This system provides an opportunity to present very complex operations in a given sequence.

Many machines are available to the teacher. However, the program selected will dictate the type of machine to be used because standardization in program size and feed method has not yet been achieved. This restriction of a program for a particular machine automatically limits the teacher in his selection of a program.

Choice of Method. Each method of program presentation has certain advantages and disadvantages which must be looked at in light of how the user intends to teach with the program. If the student attitude is proper (so cheating is not a problem), the programed text is simple to use, inexpensive, portable, and readily available. If, however, the program is to be used in a competitive situation where cheating may be a problem, machine presentation may be superior to texts. Teaching machines also help to meet individual differences through the use of the branching technique. The mode of program presentation would be secondary to the selection of the program itself. The study by Roe and others pointed out rather clearly that the mode of program presentation did not result in any significant difference in learning, but that programed instruction was superior to teaching done in the traditional manner (Roe and others, p. 16).

Reports on Effectiveness

As has been mentioned previously, programed materials have a number of advantages over other methods of presentation such as lectures and textbooks. How well these theoretical advantages actually work out has been the object of many studies in public schools, military schools, and in industry.

Two of the important theoretical advantages of programed instruction are: it can produce better results in amount learned, and it can do so at a saving of time to the student and teacher. While studies show varying results, a generalization on these two points is that programed materials should be at least as effective as teacher and textbook presentation in amount learned and retained, and programed instruction should require approximately the same or slightly less study time. This does not seem to be a particularly strong recommendation, but programed instruction permits much more flexibility in instruction and a considerable saving of time for the teacher. The flexibility that programed instruction makes possible is an important characteristic which will be discussed later.

Military and Industrial Studies

To indicate the results an industrial arts teacher might expect from programed instruction, several applications of programed instruction will be briefly reviewed. The Air Force Training Command concluded after a number of studies that it was no longer necessary to conduct expensive comparisons of programed instruction with regular classroom procedure because the effectiveness of programed instruction was well established (Schramm, p. 13). The results of their studies indicated that for them, programed instruction produced an 11 percent increase in learning and 33 percent saving in time. Instead of conducting further studies of the effectiveness of programed instruction, a criterion for the quality of programed instruction was established. Programs were to be developed until 90 percent of the trainees could make 90 percent or higher scores on the performance criterion for the unit.

Industry, like the military, has tried programed instruction as a means of solving the increasing training problem brought about by the rapidly expanding technology. In industrial training, programed instruction has been accepted as an effective method of teaching and is widely used for teaching all types of materials. Industry offers programed instruction in basic subjects such as psychology, and in management training and manipulative skills. International Business Machines reported significantly better test scores and 40 percent less time after programing a lecture class on its 7070 data processing system (Hughes and McNamara, pp. 59-67). Eastman Kodak Company programed psychology lectures for supervisors and found that the trainees remembered twice as much information. DuPont estimated a 25 percent increase in learning in 25 percent less time by the use of programed materials ("Robot-run Training Programs," pp. 84-86).

In the area of instruction for manipulative operations, many industries have used a method of presentation involving slides and synchronized tape. In some cases this method has been used to teach personnel manipulative operations where the training device is not used after the initial learning period. In other cases of particularly long, complex sequences, the operators always follow the instructions presented by the machine. Some writers insist that this method of instruction technically is not programed instruction. However, the operators do learn from this form of instruction more effectively than from instruction by supervisors. Most companies report savings of 25 to 50 percent in training time with this form of presentation ("Robot Instructors," p. 99). Where used for continuous instruction in the assembly of electronic units, the audio-slide instruction devices have contributed to substantial gains in both quality and quantity of production (Hill, pp. 15-20). One of the side benefits of programing manipulative instruction is careful planning of the job (Chapman pp. 21-23).

Industrial applications of programed instruction can be compared to the types of information taught in industrial arts classes, except that in some cases the industrial training is short intensive training in depth in a given area, while the industrial arts counterpart tends to be more general. Some types of industrial training, particularly manipulative, are highly repetitive, while industrial arts training is much less repetitive.

Industrial Arts Studies

Studies of the effectiveness of programed instruction in the industrial arts area are quite limited. However, the effectiveness of programed instruction for teaching verbal material in industrial arts classes should not be much different from applications in other subject areas.

To compare the effectiveness of programed materials for teaching related information in industrial arts classes, two matched groups of eighth and ninth grade students enrolled in comprehensive general shop were studied (McMurry). One group received instruction entirely from printed linear programed materials, while the other group received instruction through informational assignment sheets and class discussion. The study extended over a nine-week period. No significant differences were found in the informational achievement resulting from the two methods of presentation. A significantly smaller amount of time was required by both the students and the teacher when the instruction was presented by programed materials.

In another study, the effectiveness of a form of printed programed instruction was compared with the usual demonstration procedure for teaching manipulative operations (Hofer). Four metalworking operations were taught to seventh grade boys who had never seen the operations performed or the equipment involved. Students with instructions from printed materials were able to produce work of the same quality as students who had seen a well prepared teacher demonstration. They learned and remembered approximately the same amount of information about the operation with both methods of presentation. However, students performing the operations from memory immediately after a demonstration required an average of 68 percent more individual assistance during performance than the students performing the operations from the printed programed materials.

Those who are well acquainted with programed instruction consider that it has been well established that programed materials are an effective means of teaching, even though the quality of programed materials has not reached a very high state of development. They recommend that emphasis should presently be placed on finding the best means of using programed materials. Just what part programed materials will play in presenting instruction in industrial arts classes is presently speculation, but several possibilities will be presented.

Applications

Changes in society, such as population expansion, the growth of technology, the extension of knowledge, and the world-wide rivalry of ideologies all point to changes needed in schools. Some suggestions as to the nature of these changes (with resultant implications for programed instruction) are presented in the publication—*Study Guide: Focus on Change* (Trump and others). A guide in changing the schools should be "maximum attainment within each person's ability rather than "equal right of all." More emphasis is needed on developing the ability of each person to continue his education after he has completed his formal schooling. A suggested reorganization of the schools for the future would require students to spend an average of 40 percent of their time in independent study. The school week would include 18 hours of scheduled class time, 12 hours in large groups of one hundred to one hundred fifty, and 6 hours in small discussion groups of about fifteen, plus 12 hours of individual study. The curriculum would be based on the assumption that every area of human knowledge has significant contributions to make to each student's intellectual growth, and that the school should provide education for all, plus education in depth for the more talented students. The best method for bringing about the desired education should be used (Trump).

If the suggestions presented by Trump are accepted as a guide toward developing schools for the future, appropriate changes in the content and method of teaching industrial arts must be made. In the future, subjects may not be as clearly defined as they are at present, but if industrial arts is to be an interpretation of industry where all students are taught basic concepts and the more able students study industry in more breadth and depth, changes in the present program will be necessary. Much more technical information in the study of materials and processes will need to be taught, and study of industry in terms of economics, organization, mass production, and automation should probably be included. Developing an understanding of all of these areas is a real challenge and one that will demand the most effective use of every teaching method. Programed instruction can meet this challenge in several ways. One contribution is that experience with programing has the side effect of improving the organization and presentation of all forms of instruction. Material in programed form will make a major contribution to the basic education for all and will allow study in depth by the more able individual through efficient presentation and by providing flexibility in instruction.

If schools actually develop in the direction that Trump suggests, large group meetings will be devoted to films, lectures and illustrative demonstrations. Small group meetings will be devoted to laboratory work and discussions. Individual study time will be devoted to basic materials preliminary to the large group meetings, and to individual study in depth in a number of areas. A major problem with this type of organization will be the complex variety of instruction needed, combined with the varying abilities of the students. Programed materials can make a contribution in all of these areas by covering the material thoroughly and quickly, and at the same time making it possible to handle individual differences in speed and interest.

There are many ways in which programed materials should be able to contribute to improving the efficiency of both present and future industrial arts instruction. A few specific examples are described below:

1. Programed instruction will make study outside the school hours more effective. The programed material, will be interesting, easy to follow, and will emphasize the important points.

2. Teaching technical information about industrial materials and processes will work well with programed materials. The basic material will be covered in individual study preliminary to films or lectures by the teacher. This will in turn allow more efficient use of class time. The better students will continue in divergent directions for study in depth as far as their abilities permit, while the slower students may review the basic materials as many times as necessary for comprehension.

3. Perhaps the present organization of some phases of industrial arts teaching will be changed entirely by the widespread use of programed instruction. With the development of sophisticated computer-based teaching machines that have the ability to present a variety of media, students could learn the technical information and concepts of the course by individual

work on teaching machines. Students would not have lectures, class discussions or fixed study assignments. Each student would study at his own speed until he reached an acceptable level of comprehension.

4. Industrial arts instruction will probably always include some form of direct experience with industrial materials and processes. Part of this experience will conceivably be in the building of individual and group projects, although the projects might differ from present types. The experience with materials and processes may take the form of experiments and tests of materials. It is difficult to present instruction on how to perform manipulative operations to classes that are always in need of a large range of assistance because of differences in student speed and ability and the variations in projects. It appears that in the future, the instruction demanded in this area will become more complicated. Self-instructional materials for teaching manipulative operations should go a long way toward relieving the problem in this area of instruction by providing a means of presentation that is available when each student needs it, and by allowing each individual to proceed at his own rate. Some of the "prerequisites" required in the past, such as mastering all hand tools before using machines, are not necessary at all. Students can, in fact, succeed in many areas with little or no background of experience in other areas. Limitations in course content which were due to the manipulative operations involved should be considerably relieved with the aid of self-instructional material.

5. Teachers are being urged to include problem solving as a part of the content of industrial arts courses. Problem solving requires the student to have a background of information upon which to base his decisions. Programed instruction offers the student an efficient means of securing the background information necessary for problem solving.

In reviewing the present state of development it has been found that 80 percent of the currently produced programs are in printed form. The current trend in printed programed materials is to bind them in relatively small units, rather than in a complete course, to allow more flexibility in their use. The number of programs available for school use has developed rather slowly. This in itself is a hindrance to finding the best means of using programed instruction. The reason for the slow development of programs seems to be due to the relatively large amount of time and expense necessary to produce programs, and to the lack of trained programers.

Summary

In the past ten years much time and money has been spent on the study and development of programed instruction. From the many studies that have been conducted on the effectiveness of programed instruction, it appears to be well established that properly programed materials are an effective tool of instruction and are capable of presenting instruction on a variety of materials.

All questions about programed instruction have not been resolved, such as the place of machines and the most efficient use of branching and linear programs. Of most concern is how to use the potential of programed instruction to assist in providing the best possible learning experience in industrial arts classes.

As industry grows more complex, the task of teaching about industry becomes more difficult. This challenge requires careful selection of content and taking advantage of the potential of programed instruction. The use of programed materials makes it possible for the teacher to spend more of his time on the higher levels of instruction and enables the students to progress farther in a given length of time.

If the field of industrial arts has within it related technical knowledge that can be taught through programed instruction, then it is the industrial arts teacher who must extend himself enough to see that programs become available. Some technically trained person must aid the program writer to construct suitable programs. Will that someone be you? When a program becomes available, will you be ready to implement the program? Take time to see how you can use your abilities and training to greatest advantage in promoting programed instruction in the field of industrial arts.

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CHAPTER EIGHT

Open Laboratory

KENNETH J. ERICKSON

Introduction

The expanding enrollment in colleges and universities presents many problems which can be subdivided and classified under more specific headings: *first,* determination and establishment of effective student-instructor ratios, *second,* experimentation with new approaches to instructional procedures, *third,* functional utilization of existing classroom facilities, and *fourth,* efficient utilization of faculty in view of existing shortages.

This complex problem, stated in simple terms, represents the challenge offered by Micheels:

> We live in a time of explosions. I can think of no better word to use in describing the great changes taking place wherever one looks. There are explosive changes in population, cities and suburbs, underdeveloped nations, overdeveloped nationalisms, production, distribution, atoms, galaxies, satellites, and what have you.
>
> All of these changes directly concern colleges and universities, primarily because they grow from the great explosion of knowledge. Add to this the exploding population in our schools and the result is a complex problem, but one that can be stated in simple terms: How will we teach more and more subject matter to more and more students in less and less time.[1]

In December, 1961, the Industrial Graphics Department of Stout State College (now University), proposed the introduction and subsequent evaluation of an instructional procedure

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[1] William J. Micheels, "The Role of Stout State College," in *Grappling With Ideas.* (Stout State College Press, Menomonie, 1962) p. 13.

which in some respects encompasses the problem classifications cited above.

This resulted in a research grant by the Board of Regents for Wisconsin State Colleges enabling the study reported here to be completed.

While this procedure fails to provide the ultimate solution to the total problem, a positive step has been taken to meet the challenge of teaching more subject matter to more students in less time with equal success. The purpose of the study was to investigate the feasibility of the open laboratory technique in teaching a basic course in industrial graphics (drafting). The general problem was to compare the effectiveness of a new instructional procedure—open laboratory techniques—with the effectiveness of the conventional laboratory method on student achievement in a basic graphics course.

Differences in Conventional and Open Laboratory Procedures

Conventional Laboratory

Under the conventional laboratory method, a teacher meets with approximately twenty-four students in a graphics laboratory, and instructional activity is carried on in the laboratory with the exception of certain reference reading assignments. The length of the laboratory period is two hours per day for a total of ten hours per week for nine weeks. Two semester credits are earned in this "quarter" term.[2] Instructional activity consists of lectures, projected audio-visual aids, teaching aids, demonstrations, reading industrial prints, drafting practice, and testing. Most of the laboratory time is spent in individual instruction and supervising the development of skills and techniques in drafting practice.

Open Laboratory

Under the open laboratory procedure, four freshmen graphics sections or a total of seventy-two students were involved. These sections were grouped into a single lecture section which met twice each week for a fifty-minute lecture delivered by a senior instructor, chosen from the regular faculty members. Lectures were conducted in a room adequately equipped with theater-type seats fitted with a writing surface. The room had excellent facilities for audio-visual instruction and included a

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[2] The "quarter" at Stout represents one-half of the usual semester.

chalkboard, large projection screen, and a lecture stand. Attendance at the lecture was checked each period.

The lecture section was divided into two recitation sections, each composed of thirty-six students. These recitation periods were held weekly, conducted by the senior instructor. The graphics laboratory used was equipped with drafting tables and surfaces, twelve drafting machines, a chalkboard, and a screen for audio-visual instruction. Audio-visual equipment was brought into the laboratory when required from a nearby storage area.

One of the two weekly recitation periods was designated as a quiz period. Quizzes and the final examination were prepared by staff members of the Industrial Graphics Department. During the quarter, three objective quizzes covering the material from the lectures and reading assignments, three performance tests designed to measure the student's ability to perceive spatial relations in terms of two- and three-view objects, and two quizzes designed to evaluate the ability to read and interpret industrial prints were administered.

The other weekly recitation periods were devoted to informal discussion of lectures, review and further clarification of lecture content, manipulative demonstrations in the use of drafting instruments, explanation and direction of problem assignments, and discussion of related information. One recitation period was used to administer the Minnesota Paper Form Board Test at the beginning of the course.

Students were not assigned to an open laboratory period, but were given the option of completing assigned graphics problems at a time and place of their own choosing. One graphics laboratory, which was used for recitation purposes was designated as the "open laboratory." This facility was open and available for student use sixteen hours each week, these open hours having been determined after examination of the class schedules of each participating section. The open laboratory was under the supervision of teaching assistants; each teaching assistant being assigned to the laboratory for a period of eight hours per week. The teaching assistants selected were highly qualified in the area of graphics.

The teaching assistants were directed not to constantly check or attempt to control student progress. Students, in turn, were informed that the responsibility of the teaching assistant was to offer advice in the solution of graphics problems, but that such advice must be requested. In addition, the assistants graded quizzes and problems, all of which were returned to the student in the open laboratory. Provision was made for the student to arrange for a personal appointment with the senior instructor to discuss problems related to his graphics study.

The Study

Groups Participating

Five classes of freshman students were selected for the study at the start. These included sections 1, 2, 3, 4, and 17. The administrative method of assigning students to laboratory sections is by random assignment, with the exception of two special sections for transfer students and those students participating in athletics.

In conducting the experimental study, Section 2 was taught by the conventional procedure and was called the "conventional section." Sections 1, 3, 4, and 17 were taught by the experimental approach and were classified as the "open laboratory sections."

Two tests of significance were used with all hypotheses of the study. One test was the *Kruskal-Wallace One-Way Analysis of Variance.*[3] This technique tests the null hypothesis that k samples come from identical populations with respect to averages. The second test of significance used was the *Chi-Square Test for k Independent Samples.*[4] This technique tests the null hypothesis that k samples have come from the same or identical populations.

It was decided to test whether the five participating sections could be regarded as equal in terms of age, units of high school drafting, industrial experience, previous college experience, and military service. For this purpose the following null hypotheses were tested:

1. The five sections are not significantly different in age.
2. The five sections are not significantly different in number of units of high school drafting.
3. The five sections are not significantly different in number of years of military service.

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[3] Sidney Siegel, *Nonparametric Statistics for the Behavorial Sciences.* New York: McGraw-Hill Book Co., 1956, p. 184.

[4] Merle W. Tate, *Statistics in Education.* New York: The Macmillan Co., 1955, p. 476.

An assumption was made that the five sections could be regarded equal in terms of previous college and industrial experience. Seventy-five of the eighty-eight students had no previous college experience and seventy-seven of the students possessed no previous industrial experience of at least twelve consecutive months.

On the basis of the personal data, the test results of the three null hypotheses, and the assumption as regards college training and previous industrial experience, the five sections were regarded as equal in terms of high school drafting, industrial experience, college training, and military experience, but not age. Null hypothesis No. 1 was rejected and a further study of Section 17 indicated that the mean age of the twenty-seven members of the section was 21.07 as compared to 18.47 for the other combined sections. Since Section 17 was the transfer section, and included most of the older students and those with previous college experience, the group was eliminated for purposes of comparing student achievement under the conventional and open laboratory procedures.

The Achievement by the Four Groups

The major objective of the study was to determine the effectiveness of the open laboratory technique on student achievement. Identical instructional materials, lectures, problems, and evaluation instruments were administered to both the conventional and the open laboratory sections. Final grades in the course were based on the following three criteria: *first,* scores on graphics quizzes, *second,* scores on graphics problems, and *third,* scores on the final examination. Final course grades were determined by the *McCall T-Score* method. Quiz scores were weighted by one; problem and final examination scores were weighted by four.

To determine the effectiveness of the open laboratory technique on student achievement, the following null hypotheses were tested:

1. The conventional section and the open laboratory sections are not significantly different in final achievement as shown by total scores on graphics *quizzes.*
2. The conventional section and the open laboratory sections are not significantly different in final achievement as shown by total scores on graphics *problems.*

3. The conventional section and the open laboratory sections are not significantly different in final achievement as shown by total scores on the *final examination.*
4. The conventional section and the open laboratory sections are not significantly different in final achievement as shown by *final grades* received in the course.

The application of the tests of significance to data used in testing the null hypotheses resulted in the acceptance of all four. The results were that the conventional and open laboratory sections were equal in terms of achievement in quizzes, problems, the final examination, and final course grades.

Conclusions

A number of significant conclusions evolved as a result of the study.

1. *More efficient use of instructional time and activity:* The percentage of time devoted to the two major instructional activities, lecture and laboratory problems, is increased by 7 and 5 per cent respectively by the introduction of the open laboratory procedure.
2. *More efficient use of the instructor's time:* The senior instructor is relieved of 60 per cent of the time previously devoted to instructional activity. Approximately 50 per cent of this time was spent in routine laboratory responsibilities. This reduction resulted in better utilization of the instructor's time in the preparation of course materials, upgrading and revising existing materials, research, and effective coordination of the program.
3. *Opportunities for qualified graduate students:* The use of teaching assistants affords the opportunity for outstanding graduate students to participate in an instructional program which not only supplements their graduate course work, but provides teaching experience in working with beginning students under the guidance of an experienced senior staff member.
4. *Lack of significant difference in student achievement:* A major objective of the study was to determine if significant differences in student achievement exist among the two procedures. As no differences exist between the two groups in terms of achievement on graphics problems, the final examination, and final course grades, it was concluded

that no significant difference in total achievement exists between the two teaching procedures.

5. *Savings in instruction costs:*
   Four freshman graphics sections composed of twenty-four students would require assignment of two senior instructors under the conventional plan. A single senior instructor and two teaching assistants can effectively handle the same number and even more under the open laboratory procedure.
6. *Flexibility of room and laboratory assignments:*
   Existing space limitations require the utilization of two rooms under the open laboratory procedure for twenty-two hours per week. The conventional laboratory was used forty hours per week. An attendance survey indicated the open laboratory was used somewhat below expectations. Future implementation of the procedure will require fewer open hours or a smaller number of work stations.
7. *Improvement of instructional atmosphere:*
   Conducting lectures in a room especially designed for this purpose contributes to the effectiveness of instruction. While this hypothesis was not tested, the teaching staff observed a more studious atmosphere prevailing when students were seated comfortably in a room adequately equipped for effective audio-visual instruction.
8. *Implications for other laboratory courses:*
   While the open laboratory procedure points out definite implications for other laboratory courses, instructors will need to evaluate the procedure in terms of their specialized areas and the nature of the laboratory activity which needs to be conducted.

One of the most significant conclusions regarding the procedure was expressed by a student on a questionnaire that students were requested to submit He stated: "As in life, people must discipline themselves if they are to achieve. We were guided in our learning, but the work was left up to the individual, not spoon-fed by an instructor. Knowledge acquired through self-discipline is not as easily forgotten as facts stated by an instructor."

CHAPTER NINE

Team Teaching

HAROLD H. HALFIN and MARVIN M. KUFAHL

A Little Background

> "We will do today what we did yesterday unless there are very good reasons for doing otherwise.
>
> The reasons which are necessary if we do not do today what we did yesterday are derived from dissatisfaction with what we did yesterday or with what happened to us yesterday."[1]

Boulding uses this to describe his laws of economic behavior in his book *The Image*. These words might apply equally well to the field of teaching. During the past decade or, more specifically, since that climactic day that the world entered the space age, there has been a rapid movement towards the improvement of instruction. The initial Russian triumph in space gave a "very good reason to do otherwise," and also a good reason to be dissatisfied "with what happened to us yesterday."

The developments since that day have touched upon many phases of teaching and educational methods. Each of these developments attempted in some way to make teaching more effective through better understanding of the basic learning theories, better selection of information that is thought to be of importance, and better use of facilities, materials, and professional personnel. The changes, ideas, and methods that have been tried during the past decade have been numerous. Some of these have succeeded, some have not; some were given a fair chance, yet others that may have proven successful were not

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[1] Kenneth E. Boulding, *The Image*. (Ann Arbor: University of Michigan Press, 1956), pp. 86-87.

recognized. Team teaching is one such method that has been tried and is proving successful.

The Team Teaching Concept

The original idea of team teaching emerged in the early 1950's. As the program developed, various colleges and universities, among them Harvard, the University of Wisconsin, and the University of Chicago, became interested and set up pilot programs in their neighboring communities. Since 1960 many school administrations throughout the United States have reorganized their primary and secondary programs and are using team teaching.

The available literature provides many definitions for team teaching. *The Educators Encyclopedia* defines team teaching basically as being:

> . . . a method of organizing groups of students for instruction so they will receive the benefit of instruction from the most capable teacher in a particular field and also will receive the benefit of increased intellectual stimulation by contact with several personalities rather than one individual teacher.[2]

Another definition indicates that team teaching takes place "whenever two or more teachers work together to develop and/or present one or a series of lessons."[3] Shaplin and Olds describe team teaching as:

> . . . a type of instructional organization involving teaching personnel and students assigned to them, in which two or more teachers are given responsibility, working together, for all or a significant part of the instruction of the same group of students.[4]

From the preceding definitions it would seem that team teaching is a basic method of organization, its main function being to provide a more effective means of presenting information and developing students: but without any major changes in instructional or content material.

The programs of team teaching vary widely from school system to school system, so it is difficult to say what the ideal

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[2] E. W. Smith, S. W. Krouse, Jr., and M. M. Atkinson, *The Educators Encyclopedia.* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961), p. 647.

[3] Vincent Bernucci and others, "Team Teaching and Large Group Instruction in Industrial Arts," *Industrial Arts and Vocational Education,* Vol. 52 (May, 1963) p. 26.

[4] J. T. Shaplin and H. F. Olds, Jr. (editors), *Team Teaching.* (New York: Harper & Row Publishers, 1964), p. 15.

situation should be. The operation of a typical team situation in a secondary school is best described by Brownell and Taylor:

> The faculty teams consist of teachers from an academic discipline who assume responsibility for a small or great portion of the academic education of their students. Each team meets regularly to organize instruction, to develop common policies and purposes, to share information concerning students, and to plan field trips and the use of community resource persons. The student teams comprise ninety to two-hundred students who have chosen a similar program of courses. The block scheduling of team students and teachers permits variations in the length and sequence of classes. When a flexible schedule, or a program to eradicate a study deficiency, or a carefully designed inter-relationship of materials is desired for team students, it is planned and carried out by the faculty team. Team students who are together for two to five periods a day sharing a common program with the same teachers, develop a mutual understanding. Using this knowledge, the team teachers plan their courses, and work on a problem which confronts a team's students, concentrating their combined efforts on a healthy solution. If they wish, they can bring a student in for group counseling, thereby offering evidence to the student that all of the teachers have an equal interest in him and that they are ready to help him. If necessary, all the team teachers can meet with a parent to talk about his youngster's performance. Under the team leader's direction, the team constitutes a clearly indentifiable instructional unit and student group within the total school.[5]

Equally important with the operation of a team teaching program is the organization of the program. The experiments now in operation using team teaching utilize many variations for organization depending upon the scope of the program. One of the best known programs of a total school organized for team teaching is the Franklin School in Lexington, Massachusetts, an elementary school. The organization plan is called a hierarchical, multi-age elementary team. The faculty were organized so as to delegate the various responsibilities within the team. The responsibilities were delegated as follows:

Team Leader:	A master teacher with leadership qualities in charge of the team including its administrative duties.
Senior Teacher:	A master teacher with a specialized ability in a particular area.

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[5] Brownell, J. A. and Taylor, H. A., "Theoretical Perspectives for Teaching Teams." *Phi Delta Kappan,* Vol. XLIII (January, 1962) p. 150.

Teacher: A qualified, experienced or inexperienced teacher.

Intern: A trainee in a program of teacher education.

Teacher Aide: A person to aid in supervision of instruction.

Clerical Aide: A non-professional person to assist with routine work of the team operation.

The Franklin School is divided into three teams with each team responsible for two grade levels. Fig. 9 shows the complete organization of the school. It should be noted that three additional senior teaching positions in the fields of art, music, and physical education are included to assist all the teams in these specialized subjects.[6]

The field of Industrial Education has a team teaching program in operation at Andrew Hill High School, San Jose, California. The industrial arts staff, realizing the need for more exploration in the field of industry, approached the need through the use of team teaching. This program is a method of organi-

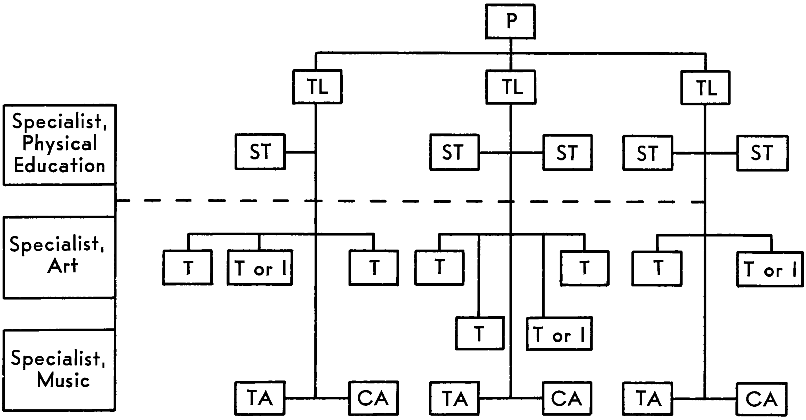

Fig. 9. The Lexington Structure for Team Teaching

Code: P-Principal, TL-Team Leader, ST-Senior Teacher, T-Teacher, I-Intern, TA-Teacher Aide, CA-Clerical Aide. (From Shaplin and Olds, *op.cit.*)

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[6] Shaplin and Olds, *op. cit.*, p. 196.

zation within one area or department. The areas involved at Andrew Hill are woodworking, drafting, general metals, and electronics. The staff wanted to maintain these basic areas but still explore other areas. The approach was to set aside two periods a week in which the four classes would meet in a large room for the class called American Industry. During these periods each staff member prepared and presented one or two lectures to the total group throughout the year. At this same time the other staff members could be working on their own assigned lectures to be given at a later date. Extensive use of outside resources and visual aids were incorporated. The topics for the large groups concerned areas of industry including: Materials, Language of Industry, Topics That Apply to All Industry, Production Elements of American Industry, and Future of American Industry. With this arrangement many other areas were discussed while still allowing for some shop work in the original areas.[7]

No matter what method of organization or operation the teaching team decides upon, there are definite advantages justifying its use. Brownell and Taylor list the following as advantages:

> Practical and effective in-service education through frequent team meetings.
>
> The use of aides to release teachers from routine duties.
>
> Teachers' involvement in planning and developing team curriculum because of the team structure.
>
> Because of team structure, the ability of the team to form large and small groups for instruction, from one teacher for one student, to one teacher for 200 students.
>
> Because of team structure, the ability to vary the length of instructional period to suit content and interest span.
>
> Improved guidance from the planned exchange of information about students and intimate atmosphere within the team.
>
> Improved correlation of subject matter because of cooperative planning in team meetings.
>
> Through team leaders and team meetings, identification and use of community resource persons.
>
> The planning of field trips for team students in team meetings and less interference of field trips with other teacher's classes.
>
> Because of team structure, the best use of teacher talent.[8]

[7] Bernucci and others, *op. cit.*, pp. 26-27.

[8] Brownell and Taylor, *op. cit.*, p. 151.

Every idea may have its list of advantages: however, every idea also has its share of difficulties or disadvantages. The problems, although primarily administrative in nature, are still problems and are deterents to the program. Brownell and Taylor go on to list these difficulties:

> Finding teachers who can function harmoniously as a team.
>
> Finding strong team leaders.
>
> Scheduling team classes in secondary schools and organizing flexible grouping in the elementary schools.
>
> Initiating effects of teams on existing departments and grade level organization.
>
> Creating new and different administrative roles and problems.
>
> Forcing independent and creative teachers into groups which inhibit their freedom.
>
> Lowering the morale of non-team teachers.
>
> Locating, training, and supervising teachers' aides.[9]

Additional difficulties are listed by Anderson as follows:

> To begin a program of this type, adequate time for planning is very important.
>
> With more than one person teaching each student it is difficult to evaluate each student.
>
> There are the curriculum problems, scheduling of students to the many different classes, controlling the size of the groups for effective teaching, scheduling the use of available space and necessary equipment.[10]

As has been presented in the preceding material, most of the team teaching programs have been organized at the primary and secondary level. The program appears to function equally well on a total school system basis as it does in one department or area. At the same time it would seem obvious that it would not be feasible where only one section in a given area or department exists.

There follows, in the next section, a brief report of a team teaching program developed and now in practice at Stout State University. That it arose because of concern over the increasing number of students to be served and a feeling of dissatisfaction with the then current exploratory course adds to its worth, as it is in effect a test of efficiency.

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[9] *Ibid.*, p. 152.

[10] Anderson, R. H., "Team Teaching," *N. E. A. Journal*, Vol. 50 (April, 1961) p. 47.

Team Teaching of Metals

Purpose

"How will we teach more and more subject matter to more and more students in less and less time?",[11] was a challenge presented by Micheels in his inaugural address upon his appointment as president of Stout State University.

With this challenge in mind the metals department began scrutinizing the freshman metals course to determine if something could be done to upgrade the offerings of this course. After some study it became evident that one logical approach to improvement would be found in team teaching. Through this it would be possible for several master teachers to bring together their talents and knowledge to better the development of this specific course.

The traditional, elementary or beginning metals course is one in which skill development was important with emphasis usually on the area of machine shop. This gives a very narrow perspective of the metalworking occupations and does not meet the objectives of a beginning course—that of being exploratory—or giving an understanding of the family of metals industries. A broader concept is considered to be desirable for industrial arts teacher education.

Freshman or beginning courses in industrial education may well be assumed to provide the following, as stated purposes at Stout State University:

1. To develop fundamental skills and knowledges that relate to the selection, care, and use of industrial tools, materials, products and services.
2. To develop a deeper understanding of the basic families of industries—their organization, function, operation, interrelationships, and occupational structure.
3. To provide exploratory shop experiences which will enable students to better select a college major in terms of their own interests and capabilities.
4. To offer broad shop experiences that will help provide a foundation for those students who wish to major in a particular area and to enrich or supplement the programs

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[11] William J. Micheels, from his inaugural address delivered at Stout State University, Menomonie, Wisconsin, 1960.

of those students who wish to major in other areas of specialization.

5. To develop the basic skills and knowledge that are necessary for efficient shop maintenance and organization.
6. To provide an opportunity for students to become more aware of basic problems in shop teaching and supervision.[12]

With the above purposes in mind, the metals department had several meetings to determine the nature and scope of a metalworking course that would best give the freshman student a better understanding and insight into the metalworking trades.

The Available Facilities and Faculty

The six laboratories in the metals department at Stout State University are of the unit type with one exception, general metals, which is a general unit laboratory. The other laboratories are: (1) foundry, (2) welding, (3) sheet metal, (4) beginning machine shop, and (5) advanced machine shop.

These various laboratories are equipped to handle thirty students, providing a work station for each student.

Technical (laboratory) courses are regularly scheduled for a double period of one-hundred-twenty minutes, five days a week for nine weeks, making a total of ninety hours of instruction, for which two semester credits are awarded.

There are seven instructors in the department each having one or two specialties in the field of metals.

The old or traditional course required of freshmen, provided the student with nine weeks of machine shop instruction.

The Course for Team Teaching

After several departmental meetings it was concluded that the areas most representative of the metalworking trades were machine shop, foundry, welding, and sheet metal. The time available was divided by allotting *nine days* for each of the four shops, and *eight days* for lectures, leaving *one day*. As each of the four laboratories is equipped to handle thirty students, plans were made to schedule, at the same hour, one-hundred-twenty students for the new beginning metals course.

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[12] A summary of the purposes that should be served by the required shop sequence, as approved by the Stout State University Curriculum Committee in 1963.

This course, however, is designed to give each student nine days of instruction in each of four areas: machine shop, foundry, welding, and sheet metal. If a student is assigned to the machine shop area, he will receive nine days of instruction. Then he is rotated to the foundry for nine days. Subsequently, he is rotated to welding and sheet metal for nine days in each of these areas.

Interspersed throughout the course of forty-five days are eight lectures given by the team of teachers. The lectures are rotated with each instructor giving two of the general lectures during the term. These lectures are given to all freshman sections regardless of the laboratory section currently attended. Through this procedure the teacher has only two lecture preparations to make. In the traditional method each teacher would have to prepare and present all lectures to the class. This would involve eight lectures to each of four different sections or a total of thirty-two lectures. It is obvious that this approach releases time for the teacher and gives him more time to prepare for the teaching he does in the laboratory.

Periodic quizzes are administered during the scheduled lecture periods. A final examination is given at the close of the term.

Each teacher involved in the team teaching approach is required to attend the group lectures. There are three reasons for requiring the attendance of the team instructors at each lecture: (1) to answer any questions applicable to his particular area; (2) to eliminate or reduce unnecessary repetition of material; (3) to promote and further increase coordination of the four areas.

Each week the team teachers meet to discuss any problems that may have been encountered during the previous week and to amend, if necessary, the general plan for the following week. Experience has revealed that this meeting provides an excellent opportunity for the team to discuss the students, their weaknesses and strengths, leading to much better understanding of them as individuals.

Some Conclusions about the Team Teaching Approach

The team of teachers responsible for the freshman metals course at Stout feel that the advantages of the plan far outweigh the disadvantages; that the course as it is presently taught meets the needs of the college freshman and fulfills those purposes stated by the Curriculum Committee in 1963, as previously cited.

Some of the advantages of the team teaching approach are:

1. The students at Stout State University prefer the team-teaching approach as compared to the traditional approach of one shop class under one instructor.[13]
2. Freshmen get to know more instructors the first year.
3. Students are taught by a teacher specialized to teach in a given area.
4. There is more economical use of time on the part of the teacher as he has fewer lecture preparations. The quality of teaching increases because of more intensive preparation on the part of the teacher.
5. A wider and more economical use of multi-media devices can be brought about in teaching a large group, *e.g.* closed-circuit television.
6. Since the primary aim of the freshman course is exploratory, this approach provides greater exploration.
7. This method much better serves to familiarize the students with a much broader area of the metals industry.
8. When team teaching and large group instruction are combined, the potential for expanding the material to be covered is much greater.
9. Through the cooperative effort of the instructors involved in this approach, there is constant evaluation and upgrading of the course being taught.
10. There is greater utilization of the laboratories, and freshmen become acquainted with more than one laboratory their first year.

Some of the disadvantages of this approach as determined by the team of teachers are:

1. Where four different instructors are involved, the final evaluation of the student does present a problem.
2. Much of the typical material covered in shop work does not lend itself to large group instruction. Having the shop facilities at hand helps in some areas of instruction. The topics for lectures must be of a general nature.

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[13] John F. Botsford, "A Study of Team Teaching and Engineering Approaches to Freshman Metalworking, IE 102," (unpublished paper, Stout State College, Menomonie, Wisconsin, 1964).

3. Provision must be made for a room to give the instruction to a large group. At Stout the instruction has been given in the auditorium which is not the best arrangement as multi-media devices have to be brought to and returned from the auditorium.
4. There needs to be provision for advanced placement in metals for many students who have completed sufficient exploratory courses in high school.

Summary

The instructors involved in the team teaching approach to teaching the metals area are in agreement that it does serve the freshman course much better than the traditional one-laboratory approach. There are problems in setting up this type of course, but each time it is taught it becomes more stimulating to those involved.

The students prefer the approach as compared to the traditional one because it acquaints them with more than one instructor and it gives them the opportunity to work in more than one laboratory.

With large group instruction under the guidance of more than one instructor, certainly the instruction should be more meaningful and fruitful to the student.

CHAPTER TEN

Advanced Placement

KENNETH J. ERICKSON

The Basis for the Study

One of the foremost responsibilities of education in America is to take the student as it finds him and accomplish whatever may be done to meet his particular needs. This is essentially what was proposed in a study conducted by the Industrial Graphics Department of Stout State College (now University), supported by a grant received from the Wisconsin State College Board of Regents. The purpose of the research was to determine whether a program of advanced placement should be continued for freshman students who are required to take a basic industrial graphics course. The intent of this was to provide qualified students with an opportunity to participate in an enriched, more challenging and meaningful experience in industrial graphics (drafting). Also, the study was to develop a procedure which could serve as a basis for advanced placement in similar skill-type courses unique to the field of industrial education.

The theory of advanced placement is not new. For years, the College Board Advanced Placement Program has provided for such placement in some twelve subjects. The subjects have generally included mathematics, science, foreign languages, and English. Advanced placement programs with emphasis on acceleration in industrial education are limited. In this study advanced placement permits a student, upon meeting specific predetermined standards, to be placed in an advanced course without first completing the prerequisite basic course. However, it should be noted the actual college program is not completed in less time than normal.

Advanced placement in industrial graphics is based on the hypothesis that incoming freshman men with a strong background of secondary school drafting in combination with a good rank in their respective high school classes should have the opportunity to accelerate their technical program in industrial graphics. That a beginning course could be regarded as both elementary and repetitious for certain students provides the basis for advanced placement.

IE-101, Drafting, is a basic course offered by the Industrial Graphics Department and required of freshmen majoring in Industrial Education and Industrial Technology. Students enrolled in the course are a heterogeneous group in respect to previous industrial graphics experience at the secondary school level. This experience may vary from none at all to as many as four academic years. This was brought out in an informal survey, conducted during the 1961-62 term among fifty-nine students. This survey indicated that 24 percent possessed from nine to eighteen weeks of high school drafting; 25 percent had one year of this training; 13 percent had completed two to four years; and 22 percent had no high school drafting.

Staff members of the Industrial Graphics department who have taught the basic course concluded that certain students could advantageously have been allowed to enroll directly in the second required graphics course without participation in the first. Supporting rationale for this conclusion is briefly summarized as follows:

1. IE-101, Drafting, is a nine week basic course similar in structure to a well-organized high school course of one year in length.
2. Students in IE-101 who possess an acceptable graphics background are engaged in a repetitious study suitable for beginners.
3. A more homogeneous grouping will result in an improved attitude by eliminating the necessity for those students with little or no graphics training to compete with those who have a secondary school background.
4. The instructional program would benefit by a more comprehensive and conscientious effort on the part of the instructor if content is not considered a general review by those students with past high school experiences in graphics.

5. A decrease in the number of required basic graphics sections would release senior instructors for assignment to advanced courses.
6. The existence of the program could conceivably upgrade the quality of instruction on the secondary level because instructors will be aware that certain prospective students may qualify for the advanced placement program.

The Method of Study

The type of research employed was an analysis of complex casual relationships by selected casual comparative and correlation methods. The purpose of employing this method was (1) to determine casual relationships, and (2) to provide a method of prediction. The type of control over the situation, the source of data, and the approach employed was an uncontrolled direct-observation by the cross-sectional approach.

Basically, the procedure employed for the collection of data follows:

1. The advanced placement testing instruments were based upon the course content of IE-101, Drafting.
2. The Advanced Placement Qualifying Examination and the Minnesota Paper Form Board (Form MA) were administered to a sample of fourth-quarter students enrolled in IE-101.[1]
3. The Advanced Placement Qualifying Examination was scored and a discrimination value for each written test item was determined; the items remained the same, were revised, or were omitted depending upon the respective individual discrimination value.
4. A validity coefficient was determined by comparing the Advanced Placement Qualifying Examination scores with selected standard measures.
5. A reliability coefficient was determined for the Advanced Placement Qualifying Examination.
6. The examinations were rescored on the basis of the results of the discrimination index findings.
7. A coefficient of correlation was determined for the relationship between the advanced placement qualifying examination

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[1] "Quarter" as used at Stout State University refers to one-half of the usual semester. By doubling the weekly time demand, semester credits are earned in a "quarter."

and a combination of the respective high school ranks and number of secondary school units of drafting.

8. The top students of the original sample were selected based upon their final grades in the IE-101 course.
9. Based upon the secondary school backgrounds of these students, predictions regarding future classes were made accordingly.

Several assumptions and limitations were involved in this study. These assumptions were as follows:

1. The students in the sample sections form a true sample of the classes normally enrolled.
2. The final grades earned by all of the students in the sample sections were determined on sound objective bases; hence, the students from these sections receiving a final grade of "B" or better are the top students of the sections with regard to their knowledge and skill of drafting required by IE-101.
3. The top students of the sample sections would have qualified to write the Advanced Placement Qualifying Examination had their records been evaluated previous to the selection of candidates for advanced placement testing.

Two limitations were recognized in evaluating the sample groups. These are:

1. The number of Industrial Graphics students in the final sample from which data was drawn for the purpose of prediction was small.
2. Final grades for the course which served as a basis for determining the top level students in the sample were issued by two instructors.

A restriction, worthy of note, is that only regular beginning freshman men were considered for participation in the study. Special, transfer, and foreign students were omitted.

The Sample Study

Original Qualifying Examination

During the fourth quarter of the 1961-62 term, the Industrial Graphics Department initiated the advanced placement testing program. This step was to develop a qualifying examination which could be used in a program of advanced placement for incoming freshmen for the 1962-63 year.

The advanced placement testing instruments were designed by the Industrial Graphics Department based upon the course content of IE-101, Drafting. The Advanced Placement Qualifying Examination and the Minnesota Paper Form Board (Form MA) were administered to the students enrolled in IE-101. Based on the results obtained from these students, the Advanced Placement Qualifying Examination was analyzed for item discrimination, validity, and reliability. What follows is (1) a description of the original examination, (2) the procedure for arriving at each of the above mentioned factors, and (3) a description of the revised examination.

No attempt is made to describe the background material necessary for a thorough understanding of the statistical procedures employed herein. Actual test results have been used in all procedures followed.

The original Advanced Placement Qualifying Examination consisted of two main sections: (1) written and (2) performance. The examination involved 239 total points—119 points on the written section and 120 points on the performance section.

The written section of the examination was divided into six different areas of basic graphics:

1. Drafting Instruments, Equipment, and Media
2. Lettering
3. Geometric Constructions
4. Orthographic Projection
5. Pictorial Representation
6. Dimensioning

Each of these areas was analyzed based upon the content offered in IE-101, Drafting, and the test questions were constructed accordingly.

The performance section of the examination was evaluated on the basis of thirteen criteria. Each criterion was weighted on the basis of the emphasis placed on that characteristic in IE-101. The individual criterion and the weight assigned to each are:

1. Proper Selection and Accuracy of Views (15)
2. Centering Problem in Working Space (5)
3. Line Weight (10)
4. Representation of Hidden Surfaces (10)

5. Utilization and Placement of Center Lines (10)
6. Points of Tangency (5)
7. Lettering (5)
8. Dimensioning Techniques
    - A. Arrowheads (5)
    - B. Relationship of Overall and Intermediate Dimensions (5)
    - C. Relationship of Dimensions to Object and to One Another (15)
    - D. Radii and Cylindrical Surfaces (10)
    - E. Machine Operations (5)
    - F. Numeral and Fraction Placement (10)

Thirty-six students completed both sections of the Advanced Placement Qualifying Examination. The calculation of the mean and the standard deviation of the written, performance, and total score distributions produced the following results:

	Mean	*Standard Deviation*
Written	77.03	9.95
Performance	73.92	27.39
Total	150.95	34.2

These results were employed throughout the preliminary analysis of the original Advanced Placement Qualifying Examination.

Item discrimination refers to a quality possessed by a test item enabling it to distinguish between the good and the poor students. Several methods of assigning "D" values (discrimination values) to individual test items exist. The method employed in this study was a simplified nomograph method derived by Lawshe.[2]

He developed a nomograph whereby "D" values can be assigned to individual test items. The procedure for determining those values necessary to the identification of the discrimination value for each individual test item is as follows:

1. Arrange the test papers in descending order by scores.
2. Divide the test papers into two groups, an upper and a lower group.
3. On a chart or table, determine for each student the items he has marked correctly.

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[2] C. H. Lawshe, Jr., *Principles of Personnel Testing*. (New York: McGraw-Hill Book Co., 1948).

4. Compute the percentage of each group marking an item correctly.
5. Finally, locate the two percentage points on the right and left sides of the nomograph, connect them with a straight edge, and identify the resulting "D" value.

Item discrimination indices were determined for all test items of the written section. The test papers were arranged in descending order and a visual note was made of the dividing point separating the upper and lower groups. A table was prepared which identified those items which were marked correctly by each student. At this point, the percentages of each group marking each item were calculated. After a percentage was determined for each group, the two group percentages (upper and lower) were located on the nomograph and a "D" value for each item was assigned. Lawshe suggests that test items having a "D" value of less than 0.4 should be analyzed and depending upon the purpose of the particular test item, it should either remain, be revised, or be omitted.[3] An analysis of those test items which were determined to have had a "D" value of below 0.4 was conducted. Each of these items, on the basis of what it was designed to have measured, was either revised or omitted, or it remained the same.

The reliability of the original Advanced Placement Qualifying Examination was determined by the analysis of variance method employing the Kuder-Richardson technique. The calculation of the coefficients of reliability (r) produced the following results:

	Coefficient of Reliability (r)
Written	r = .730
Performance	r = .973
Total Exam	r = .961

The coefficient of reliability of the total examination signifies a strong indication that it is internally homogeneous and that the items are internally consistent.

The statistical validity of the original Advanced Placement Qualifying Examination was determined by calculating a validity coefficient found by comparing the original examination

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[3] C. H. Lawshe, Jr., *Principles of Personnel Testing.* (New York: McGraw-Hill Book Co., 1948, p. 190. Cited by William J. Micheels and M. Ray Karnes, *Measuring Educational Achievement.* (New York: McGraw-Hill Book Co., 1950), p. 481.

total scores with respective Minnesota Paper Form Board scores. Since the examination was designed to be based upon the content of IE-101, the final grades received by the students in that course were also employed as a standard of comparison to determine statistical validity. The Pearson product-moment method of determining the coefficient of correlation was employed. The calculation of the validity coefficients (r^V) produced the following results:

	Validity Coefficient r^V
Minnesota Paper Form Board	$r^V = .29$
Final Grades	$r^V = .63$

The comparison between the total scores of the original Advanced Placement Qualifying Examination and respective Minnesota Paper Form Board scores indicates that mechanical aptitude is not necessarily an indication of the ability to write a good score on the Advanced Placement Qualifying Examination. The comparison between the total scores of the Advanced Placement Qualifying Examination and the respective final grades received by students in IE-101 indicates that a fair correlation does exist and that the examination measures what it was designed to measure, the content of IE-101. It also indicates that a high score on the examination is generally predictive of success in Industrial Graphics to the extent of the content offered in IE-101.

Revised Qualifying Examination

Based upon the results of the analysis which was conducted following the assignment of item discrimination values, the original Advanced Placement Qualifying Examination was revised. No revisions were made regarding the basic structure of the examination; however, the total points for the written section, due to the omission of non-discriminating items, were reduced to 106. Likewise, in order that equal weight would remain to be assigned to each section, the total points of the performance section were also adjusted to 106 points. Because the weights assigned to each of the areas evaluated in the performance examination were revised, a new evaluation form was constructed. The basic structure of the form was not changed.

At this point, the written sections of the examination papers were rescored in accordance with the revisions made on the original Advanced Placement Qualifying Examination. However, the performance section of the examination remained unchanged for the purpose of statistical calculations since no revision of content was made. With this as a basis, the distribution of the sum of the students' scores on the rescored written examination and the original performance examination was determined. The calculation of the mean and the standard deviation of the written, performance, and the total score distributions produced the following results:

	Mean	*Standard Deviation*
Written	66.31	9.46
Performance	73.92	27.39
Total	140.42	34.2

The reliability of the revised Advanced Placement Qualifying Examination was determined by the analysis of variance method again employing the Kuder-Richardson technique. The calculation of the coefficient of reliability (r) resulted in the following:

	Coefficient of Reliability (r)
Written	r = .764
Performance	r = .973
Total Exam	r = .962

As was the case of the original examination, the coefficient of reliability of the total revised Advanced Placement Qualifying Examination signifies a strong indication of internal homogeneity and consistency among test items.

The statistical validity of the revised examination was determined by calculating a validity coefficient found by comparing the total scores received with respective Minnesota Paper Form Board scores and the final grades received by students in IE-101. The Pearson product-moment method of determining coefficients of correlation was employed. The calculation of the validity coefficient (r^v) resulted in the following:

	Validity Coefficient
Minnesota Paper Form Board	$r^v = .06$
Final Grades	$r^v = .70$

As a result of the comparison between the revised Advanced Placement Qualifying Examination and the respective Minnesota Paper Form Board scores, the indication of a low correlation between these two factors evolved. On the basis of the results of this study, it can generally be concluded that mechanical aptitude is not predictive of success on the revised examination. However, as a result of the comparison of the revised examination scores and the respective final grades received in IE-101, it can generally be concluded that a high score on the revised Advanced Placement Qualifying Examination is predictive of success in IE-101. Because of this fact, it can further be concluded that the revised examination is valid since it measures what it was designed to measure, the amount of knowledge and skill a person has regarding Industrial Graphics with respect to the content offered in IE-101.

The 1962-63 Study

The Basis

Two criteria served as a basis for the selection of incoming freshmen as participants in the advanced placement program. These are: (1) final high school rank, and (2) the number of secondary school units of drafting. The method of identifying a cutting point (above which a combination of the two criteria must fall in order that a person may be eligible to write the Advanced Placement Qualifying Examination) has been determined.

Based upon the results of data collected with respect to the students enrolled in Industrial Graphics during the fourth quarter of the 1961-62 term, a relationship between the scores earned by students on the Advanced Placement Qualifying Examination and a combination of their respective high school ranks and number of secondary school units of drafting was determined.[4] The coefficient of correlation by the Pearson product-moment was found to be $r = .47$. The comparison indicates that a fair correlation does exist and that a high average score of a combination of high school rank and number of secondary school units of drafting is generally predictive of an ability to write a good score on the Advanced Placement Qualifying Examination.

[4] The high school ranks were converted to a percentile rank (PR), and both the high school rank and the number of secondary school units of drafting were averaged after conversion to T-scores.

The top seventeen students in the sample of thirty-six were selected, for observation, on the basis of their receiving a final grade of "B" or better in IE-101. An assumption was made at this point that these students would have been eligible to write the Advanced Placement Qualifying Examination had their records been evaluated previous to the selection of candidates for advanced placement testing. Each student's respective high school rank and number of units of secondary school drafting were converted to a T-score and averaged. On this basis, an average T-score of 54 resulted and this score was determined to be, for the purpose of selecting students for advanced placement testing, the cutting point.

The Students

The records of all incoming freshman men enrolled for the regular session of the 1962-63 term at Stout State College were evaluated. The high school ranks and the respective number of secondary school units of drafting of each student were averaged by the T-score method. Those students whose average T-score, based upon the two criteria, resulted in a 54 or over were selected to participate in advanced placement testing in Industrial Graphics for the 1962-63 term. Of 226 freshman men enrolled for the year beginning September, 1962, 78 were selected.

The 78 students were invited to participate in the testing program by means of a letter mailed to the participant. If the student wished to participate, he was directed to select an examination proctor at his former high school. The proctor was recommended to be one of the following; the high school principal or vice-principal, a guidance counselor, an industrial arts teacher, or an academic subject teacher. The student was directed to return the name and address of the pre-selected proctor and the complete set of examinations, consisting of the two-hour written section and the two-hour performance section, were mailed directly to the proctor.

Of the 78 students who were invited to participate in the testing program, a positive response was received from 69, nine having declined to take the examination for personal reasons. Eight failed to respond to the notification mailing. Sixty-one examinations were mailed to the pre-selected proctors. Two examinations were not returned and two were received later than the established completion date and were therefore disqualified. The fifty-seven completed examinations were scored and raw scores of the three selective criteria were converted to T-scores. The selective criteria were derived from the results of the written section, the performance section, and the percentile rank in respective high school graduating classes. The distribution of total T-scores, which ranged from 189 to 115, was studied and a decision was made to select the top twenty-three students as qualified and thereby authorized to enroll directly in IE-201 (Design) instead of the basic course, IE-101. The selection of the students was based on a distribution employing a range of five grades (A to F). A total T-score of 189 to 160 was found to be the range for a grade of either A or B.

The Advanced Course

Advanced placement as it applies to this study refers to a program whereby a student may, upon meeting specific predetermined standards, be placed into an advanced course without first completing the prerequisite for that course. The student will receive no credit for the course which he has written off in order to proceed directly to the advanced course. By this procedure, the student may apply those credits, which he has written off, toward advanced work. Through the advanced placement program, the actual school program is not completed in any less than the normal term. This is the primary difference between an advanced placement program and an acceleration program.

IE-201, Design, is a course required of all Industrial Education and Industrial Technology majors at Stout. It is second in a sequence of two required courses in graphics and is taken during the sophomore year. Very little relationship exists between the two courses, IE-101 and IE-201, in terms of content. In view of the underlying concept of advanced placement, as regards this study, no effort was made to identify specific majors and concentrations planned by qualified students. Therefore, because IE-201 is required of all Industrial Education and Industrial Technology majors, the qualified students were enrolled in IE-201 during the freshman year of 1962-63.

Note: This procedure was again used during the 1963-64 and the 1964-65 terms. The procedure serves as a basis to identify additional studies of a follow-up nature as soon as necessary data is compiled regarding the achievement of those students who qualify for the program. The intent of this report is to present the procedural steps used to design a series of qualifying instruments, to determine a method whereby students may be selected to write the qualifying examination, and to describe the selective process used in identifying students who qualify for the program. No data on these years are available as yet.

The Findings

To determine the possible effect of advanced placement on subsequent achievement in advanced drafting courses, a comparison was made between the grades earned in IE-201, Design, by advanced placement students and those who completed IE-101, Drafting, with a grade of "A." Students were those involved in advanced placement in 1962-63 and those earning "A" in IE-101 Drafting, during 1962-63.

A comparison of the achievement in IE-201, Design, by advanced placement students with students who had completed IE-101, Drafting, with a grade of "A" during 1962-63 is presented in the tabulation below:

	The 22 Advanced Placement Students	*The 24 Students Receiving "A" in IE-101*
Grade Point Average*	3.21	3.17

*Based on a point scale, A = 4.

The obvious conclusion is that advanced placement students do just as well in the second course as do those students who complete the basic course with a grade of "A".

The Conclusions

As a result of the preparation of this study and the experience gained in conducting the program for the past three years, several conclusions have evolved:

1. Advanced placement in industrial graphics provides qualified students an opportunity to accelerate their technical program with a more enriched, challenging, and meaningful experience in graphics.
2. As the Advanced Placement Program in industrial graphics becomes more and more extensive, secondary school teachers

of related industrial areas and college personnel will begin to work on a more cooperative basis.

3. Working with advanced groups of students will serve as a stimulus for college personnel to take steps to high achievement.
4. Advanced placement will tend to eliminate duplication of studies and waste of time by students and teachers.
5. Students who have been advanced will be given the opportunity to schedule more advanced courses.

The Future

Although no extensive follow-up studies have been conducted, a significant change has been made in the procedure beginning with those students who qualify for the program during the 1964-65 term. Students accepted for advanced placement in Industrial Graphics will be awarded two semester hours of credit in IE-101, Drafting, with a grade of "A". This action is supported by the basic hypothesis formulated while the initial study was being conducted—that students who qualified would have achieved at the highest level had they actually taken the course. The experiences of the College Entrance Examination Board has suggested that colleges must reward advanced placement students for their high achievement with as much generosity as is reasonable.

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