EVALUATION GUIDELINES

for Contemporary Industrial Arts Programs

16th Yearbook

American Council on Industrial Arts Teacher Education

1967

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A Staff Project of the
Department of Industrial Education and Technology
Ball State University
Muncie, Indiana

Editors:
LLOYD P. NELSON
Dean of the College of Fine and Applied Arts
WILLIAM T. SARGENT
Head of the Department

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Foreword

The problem of evaluating contemporary industrial arts programs or, for that matter, any educational program, presents many complex difficulties not readily soluble through ordinary means. Admittedly, there are excellent programs, mediocre programs and poor programs, but categorizing them correctly depends upon factors which are hard to identify specifically and measure accurately. A neophyte evaluator might well seize upon some external criteria against which to perform the process without realizing that the very essence of a program resides uniquely in the teaching activities and the ways in which facilities and resources are employed in the process. Good instruction often has been provided by outstanding teachers who lacked adequate facilities and the ordinary resources; if given excellent facilities and rich resources, these same instructors could well have conducted truly exceptional offerings.

Evaluation of all kinds of programs is now an important characteristic of contemporary educational practice. The authors of this Sixteenth Yearbook appropriately have approached this process by developing a set of *guidelines* to give direction to the evaluation of contemporary industrial arts programs. They have not prepared evaluative instruments with which to assess separate programs, but have provided the framework within which to conduct the appraisal. The writers have based their book on the assumption that evaluation must involve the teacher in an introspective process. This exercise in self-evaluation should develop the habit of continuous improvement.

The strengthening of industrial arts programs does not require overcoming an immediate, serious crisis in one concerted thrust. Instead, more effective programs will result from a continuing effort by classroom teachers who know the direction toward improvement.

Thus, Yearbook Sixteen might well become the basic text for preservice as well as in-service teacher education, since it provides model approaches, activities, facilities, and resources worthy of emulation or adoption by learners and practitioners alike.

The faculty of the Department of Industrial Education and Technology at Ball State University are to be commended for this yearbook. Unquestionably, the book reflects the prevailing philosophy of that department, and one well worth sharing with members of the Council.

The A.C.I.A.T.E. gratefully acknowledges the extensive efforts of the authors for their preparation of this volume. They have maintained the high professional standards of the yearbook series and have outlined for all of us an important new set of ideals, challenges, and objectives to direct our own progress.

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Contents

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Preface

This Sixteenth Yearbook is the last of a sequence of three yearbooks. The first of these, entitled *Action and Thought in Industrial Arts Education* (Yearbook XII) directs the profession's attention to what may be categorically called the "theory of industrial arts education." The second book in the sequence, *Approaches and Procedures in Industrial Arts* (Yearbook XIV), identifies teaching procedures and organizational practices, which are based upon a sound theoretical construct of industrial arts instruction.

Now, *Evaluation Guidelines for Contemporary Industrial Arts Programs,* third in the sequence, describes model approaches, activities, facilities, resources, teachers, and learners. This yearbook is not an evaluative instrument, since single evaluative instruments cannot really measure the effectiveness of all industrial arts programs in all locations at all levels. Instead, this yearbook suggests *guidelines* for evaluation. Furthermore, it proposes that evaluation in industrial arts should be an introspective process leading to a continuous improvement of instruction. This yearbook is intended for all industrial arts teachers at all levels of instruction and for students enrolled in preservice teacher education programs.

Questions at the end of each chapter are designed to provoke discussions among those who are genuinely interested in developing exceptional programs in industrial arts education. The writers firmly believe that there are no absolute and concise answers to the questions posed. Instead, serious consideration of these questions will undoubtedly prompt evaluation which, in turn, might stimulate professional improvement.

The ideas presented in this publication represent a *team effort* on the part of members of the Department of Industrial Education and Technology at Ball State University. First, numerous seminars on the topic assigned by the Yearbook Planning Committee of the American Council on Industrial Arts Teacher Education were held. Then each member of the faculty chose a sub-topic and prepared a position paper, which ultimately became a chapter. When the papers were shared with the total group involved, the ideas were extensively modified. Therefore, the content of the book, as a whole, reflects substantially the prevailing philosophy of the department.

Contributors to the yearbook are Kenneth H. Bergman, Henry A. Loats, William H. Middleton, Lloyd P. Nelson, Kenneth E. Poucher, Jake Reams, Claude E. Rieth, William T. Sargent, and Edgar S. Wagner. The writers hope that the challenge of persistent self-evaluation which was experienced in the preparation of this yearbook might activate a wide audience of professional colleagues into updating instruction in Industrial Arts Education.

LLOYD P. NELSON
WILLIAM T. SARGENT
Co-Editors

CHAPTER ONE

Contemporary Approaches to Teaching the Industrial Arts

What should the teacher consider as he employs *contemporary* approaches to teaching the industrial arts?

The professional industrial arts teacher must develop a rationale that will compel him to emphasize those learning approaches that are in keeping with the purposes and goals of post-modern industrial arts education. He must examine various approaches to learning and select those which appear to bear the most fruit for a given situation. In fact, in some situations he would conceivably utilize a combination of approaches.

Also the professional industrial arts teacher must evaluate later the approaches he selected in terms of the success of his learners, the changes in student behavior, and the realization of student-teacher goals.

> The further objective of improving and extending the culture seems to indicate a need for training in critical thinking and problem solving. While all school subjects should contribute to this end, industrial arts activities seem especially adapted for teaching by the problem solving technique.
>
> The industrial arts program also may make substantial contributions to the meeting of the basic requirements of individuals in the fields of group status needs, personal needs, and economic vocational needs.
>
> It appears, therefore, that a close relationship exists between the objectives of general education and the nature of industrial arts. (17, pp. 28-29).

Weber, in *The Role of Industrial Arts in Tomorrow's Schools,* discusses industrial arts as imperative to the student's development to lead the full life. (16, pp. 1-12). Regarding the fundamental skills needed by everyone who aspires to become a truly educated man and find the place or job in which he can be most effective, he views these as:

1. The skill of being flexible
2. The skill of being creative
3. The skill of making wise choices
4. The skill of understanding others
5. The skill of learning to know one's self
6. The skill of knowing how to learn

The industrial arts teacher must be able to create the proper climate for the discipline of the classroom. He also must be able to observe and to translate his observations into new ideas in educating children. An evaluation and definition of the objectives and bodies of knowledge for industrial arts (prepared through a National Commission on Industrial Arts Education and administered by the American Industrial Arts Association, a department of the National Education Association) is a step in the right direction.

In the meantime, what about some evaluations by the industrial arts teacher himself? Does he find objectives of industrial arts all that they should be?

The Changing Concepts of Learning

One of the things that is new about American culture is the overriding fact of change. Science and technology have brought tremendous changes to the lives of people. Probably one of the most important by-products of change is the explosion of knowledge.

Educators themselves have once more become concerned with the whole problem of how learners acquire knowledge. Questions such as these are being asked: What is the process of inquiry? How are the essential features of the process affected by the newer notions on subject matter? Some major assumptions growing out of the concern for new concepts of learning experiences are related by Downey. (5, pp. 25-26).

> Worthwhile learning takes place, not just in the traditional and formal teaching situations as was once assumed, but rather in a wide variety of situations and as a consequence of a wide variety of teaching techniques.
>
> These situations and techniques fall into three broad categories: (1) Learning through receiving knowledge from an "expert"—or being taught directly by a teacher; (2) Learning through sharing knowledge

with colleagues or discussing issues with classmates; and (3) Learning through discovering knowledge—or pursuing individual inquiry.

The industrial arts teacher must be concerned not only with questions of what *is* but also with questions of what *might be* or, more importantly, what *ought to be*. In fact, the teacher's methodology and purposes should not be limited by tradition or pedagogical folklore. He must be concerned with the correctness of his purposes as well as the effectiveness of his means. He must be a scientist, artist, technologist, and philosopher.

Importance of Goals

The teacher must see to it that his objectives and goals are functional, clearly defined, and understood. He must perpetuate desired learning experiences that will help each student develop his own human potential. If the teacher is to know his progress, he must have some systematic method for appraising the degree to which his students have grown in the desired direction.

Any assessment of a teacher's contribution to the educational growth of his students must be weighed within a context of contemporary educational thought. Therefore, it seems necessary to give at the outset of this treatise some consideration to modern industrial arts approaches. However, no attempt will be made to review the direction-giving movements dating back to the manual training antecedents of contemporary industrial arts. Such a study would be fascinating and even inspirational, but too extended a reference to such bygone emphases might only perpetuate the status quo or, worse yet, provoke regressive action.

Signs of Change

Historically speaking, though, industrial arts educators have supported a trend toward an up-to-date, overarching framework for teaching industrial arts. This trend, particularly in the latter half of the 1950's and throughout the 1960's, manifested itself in several ways.

First, teachers introduced in rapid succession four or five new approaches: Problem Solving, Research and Experimentation, Creativity and Design, Functions of Industry, and Concepts of American Industry. There are elements of commonality among these approaches. Yet, some industrial arts leaders tend to favor a particular approach because of specific advantages inherent in that approach.

Second, today's industrial arts teachers at all levels of instruction appear to be more conversant about contemporary approaches than teachers were a few years ago. Perhaps their knowledge reflects the fact that today more teachers pursue graduate study where they evaluate these innovations. Teachers also are reading more periodicals in the field. Besides, through a broader participation in a number of professional associations, they encounter a diversity of educational thought in industrial arts education.

A *third* manifestation of the importance placed on contemporary approaches to industrial arts teaching is the mutual goals that teachers and school administrators have for establishing programs "geared to the times." These goals are now practical because of federal support for various aspects of practical arts education. For example, the amended Higher Education Act, Title XI, passed by the eighty-ninth Congress, provides funds for industrial arts instructional materials and facilities. Moreover, in implementing these new space-age programs, school officials turn to professional personnel in industrial education for advice in planning educational experiences suited to the needs of the students.

Relating Approach and Method

For the readers's benefit, it seems necessary to clarify the meaning of the word "approach," to which reference is made throughout this chapter and elsewhere in this yearbook. "Approach" may be thought of as the climate in which learning takes place. It is an overarching direction-giver which moves a total field of specialization toward a more meaningful learning experience for students. It is, hopefully, an intellectual climate shared by teacher and students in order to enhance the teaching-learning bond.

"Approach," as applied to the educational specialty of industrial arts, is affected by at least four forces: (1) the inadequacy of student experiences to date, (2) intrinsic drive of the theorists for a more adequate experience than is now being provided, (3) impact of technological and economic changes, and (4) social pressures.

Any given approach also is characterized by the particular *methods* selected by the teacher. It is assumed that modern approaches commonly require a variety of methods, as shown in Fig. 1.

The approach and student are juxtaposed. The methods, which are combined in appropriate balance and harmony, influence the student's behavioral change. The "approach" may be likened to a symphony orchestra performance in which a variety of instruments is balanced. The teacher, like the conductor of an orchestra, calls for alternate emphasis and deemphasis of the various methods which compare to the orchestral instruments. "A little louder on the library references, and a little softer on the lecture," one may hear him say as he directs his industrial arts activity. A combining of two or three methods

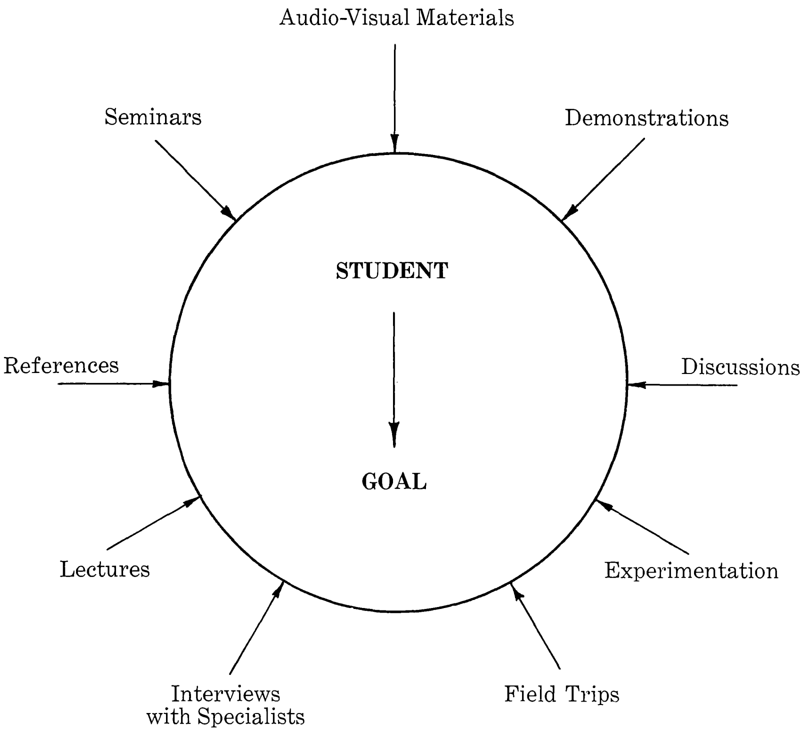

Fig. 1. A Focus on Methods Which Characterize Contemporary Approaches to Teaching Industrial Arts

and minimizing of two or three others would result in a different "tone" from that of the 1930's and 40's.

Even as music of the contemporary period has characteristics far different from those in classical compositions, so the contemporary approaches to the teaching of industrial arts at all levels have new and special characteristics. If teachers are sensitive to these characteristics and reflect them in their "conducting," students will respond to the approach, composed in the modern industrial and technological culture, and they will experience more significant learning.

Contemporary Approaches

Therefore, the alert industrial arts teacher would want to shift quickly from some traditional teaching practices to contemporary approaches which represent the industrial culture of this final third of the twentieth century. The contemporary approaches to learning permit students to rediscover "the joy, excitement and mystery of the [industrial] world we live in." (3, p. 45).

What are these contemporary approaches? Professional literature in the field of industrial arts written during this past decade identifies several contemporary approaches which involve students in meaningful activities related to the vast industrial complex of modern society.

Problem Solving

One of these approaches, developed by John Dewey fifty years ago, and more recently endorsed by persons in industrial arts as a means to improve instruction is problem solving. (11, p. 15).

What is problem solving? How does an activity of this nature affect the role of the teacher and the students in a classroom or laboratory? What educational values that are not found in traditional programs does the approach hold? Questions of this nature confront the teacher who wants to improve his teaching method but does not know a "newer way of doing it."

Problem solving is a new approach of conducting construction activities. It provides for student involvement in all major steps of the process—from identification of the problem to evaluation of the final solution. Ferns and Anderson in an article on the planned experiences of problem solving list six major steps that the industrial arts student should follow:

1. Identify the problem
2. Analyze the problem
4. Identify tentative solutions
4. Identify a final solution
5. Construct a solution
6. Evaluate the solution (7, pp. 12-13)

In the process of employing problem solving in industrial arts classes, the authors offer these suggestions:

1. Allow for class participation and discussion in identifying and analyzing the problem.
2. Avoid words such as *tie rack, cookie cutter* or *book end* when identifying the problem. Instead, use sentences describing the nature of the problem, such as "a storage device for men's belts and ties."
3. Help students analyze the problem in terms of appearance and function.
4. Encourage students to seek related information beyond the classroom from sources such as teachers of other subjects, dealers and suppliers, catalogs, industrial and professional journals, and industrial personnel.
5. Provide opportunities for students to sketch ideas and experiment with materials before they identify the final solution.
6. Schedule evaluation sessions during the construction and upon completion of the solution. Assessments by students tend to create an interest in self-improvement.

This problem solving approach as described by its proponents retains much of the traditional method. Industrial materials are still shaped and formed. Projects are still constructed. The major change lies in student participation in all the facets of the activity. Under the guidance of the teacher, it is the student who determines the nature of the product he is to build, the kind and amount of materials he will need, the steps he will follow in the construction process, and the value of the learning experience.

Problem solving activities can be conducted in all industrial arts areas and at all grade levels. Ferns and Anderson state that these activities should "begin early in industrial arts classes" and that "it is not necessary for students and teachers to know all operations in a given area before becoming involved."

The greatest gain in improving a student's skill in problem solving depends on well-planned learning experiences.

Through careful planning by the teacher and students, the benefits of the problem solving approach are unlimited.

Research and Experimentation

A second approach which the contemporary industrial arts teacher should include in his teaching program is called research and experimentation. Under the leadership of Professor Maley, University of Maryland, this approach has been a factor in changing the nature of today's industrial arts curriculum. Many teachers have introduced research and experimentation units into their programs.

The terms *problem solving* and *research* frequently are interchanged in describing these approaches. Several common aspects are associated with both. The difference lies in the ultimate goal of the student. Problem solving usually leads to the completion of a functional product (project), whereas research and experimentation activities involve the testing or comparing of industrial supplies and materials. Determining the strength of adhesives or establishing the heat conductivity of metals, for example, are typical activities found in a research and experimentation program.

The construction activities, a traditional characteristic of all industrial arts programs, are also an important aspect in programs emphasizing research and experimentation. Many experimental projects require special testing equipment which may be developed and constructed by students. Through these construction activities, students will gain a better understanding of tool and machine operations.

Advocates of this approach stress, however, several major aspects of the scientific process not found in the traditional industrial arts program:

1. The teacher becomes a guide in the learning process. He assists students in identifying sources of information.
2. The students are permitted a freedom of choice in selecting topics or problems of study.
3. The scope of the problem will usually involve more than one basic material or laboratory. Consequently, the gen-

eral shop with special laboratory equipment is more appropriate for this program. (10, pp. 12-16).

Creativity and Design Emphasis

A continuous challenge to teachers of all subjects is to provide classroom activities which allow students to be imaginative and creative. This challenge is particularly real to the industrial arts teacher whose subject relates to an ever-changing industrial-technological society. And yet too frequently the industrial arts teacher hesitates to emphasize the creativity and design approach in his classes because he feels that he:

1. Possesses no skill to create or design
2. Lacks the ability to teach design
3. Believes that his students are not capable of learning design principles or techniques. (1, p. 10).

Fortunately, there are many industrial arts teachers who have successfully initiated activities encouraging creativity and design in their classrooms. The success of this approach, as with others, hinges upon the teacher devising opportunities that encourage his students to be creative in both sketching and construction activities.

As in any other learning activity, students need some guidance from the teacher as they develop, evaluate, and change their ideas on project designs. To be supportive, the teacher should observe these principles:

1. Recognize and reward new ideas developed by students and encourage free expression and continuation of their creative talents.
2. Encourage students to examine all the implications of their ideas and to test them systematically.
3. Encourage students to explore the knowledge of several fields by offering them a broad and comprehensive program.
4. Stimulate students to explore new ideas by providing a classroom atmosphere which is conducive to creative thinking.
5. Provide opportunities for students to manipulate materials, tools, and ideas.
6. Acquaint students with the process and techniques of being creative.

7. Plan classroom activities which cause students to think creatively.
8. Recognize and respect the creative efforts and accomplishments of every student. (4, pp. 14-16).

Functions of Industry Approach

Some leaders in the field of industrial arts education believe that a contemporary approach to teaching industrial arts should be based on the functions of industry. They urge teachers at all levels of industrial arts to relate the content and activities of their programs to industry:

1. To provide students with an understanding of modern industry.
2. To provide students with exploratory experiences leading to career choices.
3. To provide students with fundamental skills, relevant to industrial occupations, leading to occupational adjustment.

The industry approach proposes that the functions of industry be incorporated in the course content. The approach divides industry into two phases: "goods-producing" and "goods-servicing."

The functions of the "goods-producing" industry are identified by tracing the path of the product from its inception as an idea to its use by the consumer. These functions can be simulated in an industrial arts laboratory:

1. *Research and Development* entails market and product research of materials and processes. Refinement of the product requires extensive development.
2. *Planning for Production* includes the design of tools, jigs, fixtures, arrangement of machinery and plant, and control of quality.
3. *Manufacturing* emphasizes tool and machine operation, distribution of supplies, and safety.
4. *Distribution* relates to problems of product distribution, such as packaging, shipping, displaying, and selling.

The second phase of the functions of industry approach relates to the "goods-servicing" aspect of the industrial institution. Major functions of the servicing industries could also be reflected in industrial arts activities:

1. *Diagnosis* emphasizes the role of the industrial trouble-shooter who identifies and locates the cause of product failure.
2. *Correction* may require either simple or complex adjustments, replacements, or repairs.
3. *Testing* determines the degree of success that was accomplished with the correction procedures.

It is maintained that the major value of the functions of industry approach is that it creates opportunities for students to view the wholeness or unity of modern industry. (2, pp. 12-15).

Conceptual Approach

The conceptual approach to American industry is based on a five-year curriculum research project initiated by Face and others, at Stout State University, 1964. The broad objectives of this study of American industry 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.

This research project grew out of an expressed concern for the lack of coherent structure regarding the content of industrial arts courses. The leaders of the project propose that the basis for the *American Industry* program be an identification of basic concepts of several related industries. They go on to suggest that this program of American Industry, based on a knowledge and understanding of related concepts, should be regarded not as a modification but as a replacement of the traditional industrial arts content.

Some of the values listed for this conceptual approach to American industry are:

1. The American Industry study contributes to an understanding of the entire industrial institution.
2. A structure based on underlying concepts could result in a unified national curriculum and standardization of laboratory facilities.
3. Courses of study will be based on concepts which will govern the activities of the program.
4. Development of understanding the concepts will determine what facilities are needed. (6, p. 71).

Information which specifically describes the classroom activities of the American Industry program and the relationship of the teacher and students in these activities is not available at this time. At this early stage, the conceptual approach cannot be compared with other contemporary approaches. Therefore, for now, some questions must go unanswered: Is problem solving in the American Industry program similar to the problem solving approach described by Ferns and Anderson? How are classroom activities which lead to understanding of concepts identified and selected? Does solving industry-related problems involve research and experimentation as described by Maley? What importance is given to creativity and design in this study of American industry? To what extent is the mass production activity employed to develop concepts of American industry? How may current industrial arts programs be changed in regard to activities and facilities in order to depict the conceptual approach to American industry? Answers to these questions will no doubt be discovered when the following goals for this research study are finally realized:

1. Identification of problems involved in implementing the conceptual approach.
2. Revision of content materials related to the study of industry.
3. Expansion of a resource file of teaching materials available at Stout State University.
4. Development of standardized tests relating to the *American Industry* program.
5. Development of an *American Industry* program for the secondary schools.
6. Expansion of the project to include additional secondary schools.
7. Development of a teacher education program for the preparation of *American Industry* teachers.
8. Development of recommended facilities for an *American Industry* laboratory.
9. Identification and development of appropriate activities for teaching the concepts of industry.
10. Determination of the appropriate balance between classroom and laboratory activities of the *American Industry* program.

11. Determination of the effectiveness of the *American Industry* program for various student ability levels. (6, p. 72).

Common Elements of Contemporary Approaches

All of the contemporary approaches to teaching industrial arts have several common elements. Each approach calls for the application of ideas or the examination of concepts through the procedures of applied research used in modern industry. Students test and apply their own ideas to problems which have special significance to them, rather than accept a teacher-selected project with emphasis on specific skills and knowledge. Teacher responsibility centers around guiding students to select appropriate processes or methods relating to his activity.

The contemporary approaches to teaching industrial arts focus on the self-development of each student. The student accepts the responsibility for learning through creative activities, experimentation, and problem solving. The student is motivated to regard as important the proper use of materials, processes, tools, or machines because these relate to problems of special importance to him.

Traditional methods of teaching industrial arts are limited largely to demonstrations or "show and tell" techniques. In contrast, contemporary approaches involve the student in reading, planning, and writing activities. Textbooks and related references become significant resources to the student as he seeks answers to questions about construction materials and processes. In addition, writing skills become important when he prepares reports describing construction plans or research data.

Another common characteristic of the contemporary approaches is that the student is not confined to the facilities and resources of the classroom or laboratory. Instead, he is to consult with other teachers, librarians, and industrial personnel about his problem or project.

Industrial arts leaders support "the view of many school people that two indispensable ingredients for learning are high motivation and individualized instruction." (12, p. 49). Secretary McNamara, in describing a new policy for upgrading the educational qualifications of men inducted into the Armed Forces, stated:

Students clearly differ in their learning patterns. It is the educator's responsibility to deal with that pattern in each individual case and to build on it. More exactly, it is the educator's responsibility to create the most favorable conditions under which the student himself can build on his own learning pattern, and at his own pace. Ultimately, it is not the teacher who teaches at all. It is the student who teaches himself. (12, p. 49).

Secretary McNamara has emphasized the responsibility of each teacher to provide a climate for learning in his classroom. The industrial arts teacher can meet this responsibility by understanding and employing contemporary approaches to the teaching of industrial arts.

Questions for Evaluation

1. Some educational psychologists claim that the present educational process reflects little change in the methods of imparting knowledge. Would you support or refute this statement as it relates to industrial arts teaching?
2. If there are several elements common of the contemporary approaches, how may the industrial arts teacher combine these approaches in his classroom activities?
3. Reflect upon the specific teaching methods you have been using in your classes. To what extent does this particular combination of methods characterize a contemporary approach?
4. Which of the contemporary approaches to industrial arts instruction briefly described in this chapter most nearly relates to the "climate for learning" in your classes?
5. What factors inhibit the use of contemporary approaches in your program?
6. What psychological factors may inhibit an industrial arts teacher from conducting his program within the framework of contemporary approaches?
7. To what degree do you believe each of the contemporary approaches relates to students of high, average, or low academic level?

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CHAPTER TWO

Contemporary Industrial Arts Activities

The success of a contemporary industrial arts program depends upon the activities used in the class. No single activity, however, can be prescribed for all situations. The instructor is responsible for guiding the students into the best activity for any given situation. He should be informed about a variety of activities, alert to the individual differences within his classes, and aware of the physical facilities of his laboratory. He should set the objectives for his program and then utilize the most effective means to arrive at these objectives.

The intent of this chapter is to bring to the attention of the reader some of the factors that should be considered when planning activities. The material described in this chapter is concerned with all grade levels, kindergarten through twelfth grade, with some implications for the exceptional student.

Factors Affecting Student Activities

Because it is important to involve the student in order to arrange activities that will be of interest to him, activities should be student-teacher planned. Moreover, there are a number of factors to be considered in the planning, not one of these factors being mutually exclusive of the others.

Some of the more important factors affecting student activities are: (1) capabilities of students, (2) interests of students, (3) attitudes of students toward instructor, and (4) types of laboratories.

Capabilities of Students

The capabilities of students are dependent upon the interrelationship of a number of factors, such as physical maturation, emotional maturation, mental ability, and chronological age.

Physical maturation refers to the student's motor performance or his hand, mind, and eye coordination. Rogers says that motor performance reaches its peak during adolescence — in girls at about fifteen years of age and in boys at about age eighteen. In girls the growth spurt of strength begins at age eleven or twelve and tapers off at age thirteen or fourteen. In boys the growth spurt of strength comes two or three years later than that of girls and slows down gradually. (8, p. 85). Both sexes decline in gross physical activity during adolescence. Consequently, there is less enjoyment in sheer activity.

Readjustments, with accompanying awkwardness, are natural. These changes occur in spurts and do not affect all body parts alike. The significant skeletal changes are in the long bones and large muscle group, and poor coordination is found here.

Physical maturation is very closely related to emotional maturation and mental ability. In a study of mentally retarded children, Francis and Rarick report that the mean of performance scores for both educable boys and girls is two to four years behind the age norms of normal children. (1, p. 69). The authors assumed, however, that low performance scores might be due in part to motivational problems and failure to comprehend test instructions. Mussen and Jones state that physical retardation among boys has adverse effects on personality and that physical acceleration is conducive to better social and psychological adjustment. (5, p. 15).

Emotional maturation refers to how well the student adjusts to social pressures. The institution that most influences this factor is the home. Landis reports that children from democratic homes are more emotionally adjusted than children from authoritarian homes. (5, pp. 14-15). Authoritarian homes are more frequently associated with larger families. Bossard and Boll report that most maladjusted children come from homes in which the father is domineering. (5, p. 15).

A study by Hurlock reveals that heightened emotionality is caused by environmental and social factors. (6, pp. 74-77). The factors that predispose adolescents to intense emotionality are:

1. Unfavorable family relationships
2. Restraints resulting from parental supervision
3. Obstacles that prevent the adolescent from doing what he desires
4. Situations in which the individual feels inadequate
5. Social expectations of more mature behavior
6. Adjustment to new environments
7. Social adjustments to the other sex
8. School failure
9. Conflicts with family or friends
10. Vocational problems
11. Religious doubts
12. More mature insight

Mental ability refers to the student's ability to comprehend and carry out written and oral instructions. Where mental development is concerned, attitudes are important for various reasons. (8, p. 199). First, attitudes influence the individual's receptiveness to learning. Next, they give substance to fact. Finally an individual's attitude toward learning reflects his personal adjustment.

There is also a relationship between mental and physical growth. (4, p. 92). In spite of the medical care and services supplied to subnormal children, studies indicate that there is a higher incidence of physical defects of every kind among the subnormal children than among the children of normal intelligence.

Studies also show that there is a relationship between intelligence and occupation. Those people with the highest intelligence seem to choose occupations that deal with words and mathematical symbols, while those with the lowest intelligence choose occupations requiring very little thinking. (2, p. 147). Another study indicated that people with high intelligence have greater reasoning ability and a greater understanding of spatial relationships than those with low intelligence. (2, p. 149). Fuzak found that there is a slight negative correlation between intelligence and the strength of students, as indicated by a dynamometer test. (3, p. 57). Based upon 322 cases in junior high school, the product-moment correlation was $-.153$, which is insignificant.

The question confronting the industrial arts teacher is how to develop a program which meets the needs of students with different levels of ability. Homogeneous grouping and special classes seem to be the most common approach. Stanton and Cassidy compared the educable mentally retarded in regular and special programs from different school districts and found that children in regular classes did show significantly greater gains in academic achievement than did the special class children. (1, p. 71). The special class children were significantly superior to the regular class children on social adjustment as measured by a personality test.

Chronological age has some effect upon a student's ability to perform complex finger coordinative activities. Fuzak used a dynamometer test as a basis for determining a boy's readiness for more complex performances. (3, p. 58). The data strongly indicated that the level of physical maturity of a junior high school boy determines the level of his ability to perform complex finger coordinative activities. Between the dynamometer test and age, the product-moment correlation was +.425; between the dynamometer test and weight, +.548; and between the dynamometer test and height, +.529. These correlations are considered to be moderately significant; about twenty percent better than chance. (7, p. 230).

Interests of Students

As the age of the student increases, his interests follow definite patterns from instability and quickly waning interests to an expansion of new interests, a shifting set of values placed upon various interests, and finally, at the conclusion of the high school period, a stability of interest.

These interest patterns should take on a special meaning for the industrial arts teacher when he plans activities with his students. A child needs activities that are short in duration; the older student prefers activities that require more time. Both respond to activities that are varied and flexible. They like activities that possess an inherent germ of success. Interest patterns also are affected by age, physical development, sex, intelligence, environment, and social and economic status. (6, pp. 188 ff).

It is important for the teacher to consider also what Rogers has emphasized with regard to the development of student interests. (8, pp. 208-209). (1) Interests are often *created*, not merely discovered. (2) A student must be aided in acquiring the habit of *looking* for the interesting sides of whatever he is doing. (3) *Breadth* of experience is desirable, but all human beings tend to accept what they know and to reject the unfamiliar. (4) A student should be *encouraged* in what he is doing. This encouragement fosters greater interest in a task, whether it be machining a part or writing a theme. Derogatory criticism conversely nips enthusiasm in the bud. (5) Experiences should be tied to suitable forms of *self-realization* rather than to some supposedly objective standard demanded of all. A student should be encouraged to use self-expression or creativity in his work. (6) The way an opportunity is presented is crucial for its acceptance. (7) Yet a student has to learn to do some things, interesting or not, merely because these should be done.

Environment and socio-economic levels probably have the greatest effect on student interests. Environment, particularly its cultural pressures, determines which interests may develop into vocational goals and which become avocational activities.

Attitudes of Students toward Instructor

The major responsibility for developing a learning atmosphere in the laboratory rests with the instructor. Chapter one of this book compares him to the conductor of an orchestra. The general tone is set the first day of class, and the instructor must allow the individual student's interests and abilities to determine his activities. Fuzak indicated that many pupils develop a dislike for industrial arts because of their lack of readiness to perform a number of finger coordinative activities they are expected to undertake. (3, p. 77).

Fuzak continues:

> The junior high school industrial arts teacher should no longer ignore the readiness of his pupils to learn manipulative processes requiring complex finger coordinations. He should plan his teaching, and the learning experiences he develops, to accommodate a wide range of physical maturation and readiness on the part of his pupils.
>
> The junior high school industrial arts teacher should screen possible learning activities, so that those planned at earlier grade levels concentrate on large muscle coordinations, rather than upon complex finger coordinations.

Implications of a similar sort affect many portions of the junior high school program, where complex finger coordination activities are carried on. Attention should be given by these teachers to the physical readiness of their pupils to satisfactorily engage in the learning experiences provided. Many pupils are driven away from learning activities involving complex finger coordinations, because of their lack of physical readiness to perform them satisfactorily. Much of the time and effort they expend is wasted. This is probably true in particular of the more intelligent pupils. Many of them are somewhat accelerated in school, while duller pupils are somewhat retarded. This must be a deep concern of all teachers who teach activities requiring complex finger coordinations. (3, pp. 80-81).

Types of Laboratories

No matter what the extent of readiness may be—physically, mentally, or emotionally—nor how strong the student's intrinsic interest may be, his type of industrial arts activity is conditioned by the physical facility in which he is permitted to work. Chapter Four of this yearbook presents a comprehensive development of this point.

Activities Related to the Individual

An effective program is student centered. The activities should be varied and appropriate for specific learning situations. The following is a resume of some of the more common industrial arts activities.

Individual Product Construction

Historically speaking, the most common activity in the field of industrial arts has been the construction of teacher-selected projects by individual students. It should be emphasized that this is incongruous to the modern approaches in the teaching of the industrial arts. This is a worthy activity only if it reflects the readiness and interest of the individual student and if it relates to a significant problem which concerns the student. Characteristically, it seems desirable to minimize the individual, carry-home type of project as a student activity in the industrial arts laboratory. Rather, preference should be given to the involvement of more than one student in the design and fabrication of a particular product.

It may be argued, however, that in some small job shops, which are a significant part of our industrial culture, there still are people who carry a product through from its inception to completion. It seems justifiable, therefore, to retain the individual project construction as an activity in the modern industrial arts laboratory.

Before selecting or permitting this activity, the instructor should reflect on these questions: (1) What objectives will this activity fulfill? and (2) To what extent does this activity interpret industry? There is no doubt that there is considerable learning potential in individual product construction. There can be much planning involved, and there can be many problems identified and solved by this activity. The major question is whether the individual product construction technique is used as a means to the end or as the end itself.

Individual Research and Development

Individual research and development affords the student an opportunity to satisfy his curiosity about a material or a process. The student may conduct specific tests rather than make a product, or he may conduct research in the planning and construction of his product. Research and development could involve the rediscovery of fact or information as well as the performance of new or pure research.

In many cases, the instructor might hesitate to permit a student to work in areas unfamiliar to the instructor. The instructor should not expect to be well versed in everything. If a resourceful student wants to become involved in research and development in an unfamiliar subject, the instructor should serve as a resource person.

An illustration of a research and development activity would be an experiment for testing the strengths of various adhesives on a variety of materials and making suitable comparisons.

Independent Learning

Independent learning is a type of industrial arts activity permitting the student to progress as rapidly as he is able. During this activity the teacher must make available to the student a broad variety of resources. The instructor must offer special guidance when the student selects his problem and when he lays out a preliminary plan by which he hopes to reach a solution to the problem.

It may be conjectured that the student who has the ability to read with comprehension uses this technique in acquiring factual information which he may relate to the problem. Furthermore, the perceptive student may wish to talk with experts in a particular field about his problem. In addition to this, a student may wish to construct objects which will help him prove to himself the reliability of the hypotheses he may be testing.

The special responsibilities of the instructor, conducting independent learning techniques, are to counsel, guide, and direct. The instructor assists the student in evaluating the fact which he acquires and intends to use in the solution of his problem. Implicit in the instructor's role, is the need for assisting each individual student in testing the veracity of facts.

This type of teaching requires considerable planning and preparation on the part of the instructor. An activity of this nature is challenging to the academically able students. At no time would this activity be completely successful for all students, but it could reduce the amount of repetitive teaching which frequently is associated with conventional methods.

Maintenance

Maintenance of a variety of types of equipment is a laboratory experience which helps the student gain insight into the construction features of such equipment. It is regarded as a suitable activity for students at all age levels and levels of academic ability.

This type of activity enables the student to develop a skill which is not easily learned in construction activities. It may be assumed the reason for maintenance on any given piece of equipment is that it is out of order in some way. Assume, for example, that a student is working with an electric motor which will operate only if it is started by rotating its shaft by hand. Even before he disassembles this motor, it is essential for him to determine how the motor operates and the probable causes of malfunction. With this knowledge, he is able to move from general to specific causes of failure, to identify the problem, and to make the necessary repairs. It may be assumed that maintenance-type projects will motivate the student to learn the physical principles as well as construction details as related to the operation of particular types or categories of equipment.

Activities Related to the Group

Activities such as research and development, independent study, and maintenance, may be adapted to the group. The instructor needs to assess learning possibilities of each kind of activity in light of the number of students involved at a given time. In addition to the group activities which have been identified, two other types may be employed by the industrial arts teacher. These are concerned with the manufacture of products, namely, mass production and unit production.

Mass Production

Mass production or continuous production involves the joint efforts of several or all members of the class in setting up production lines for making a number of like items, such as water skis, toys for underprivileged children, or miniature rockets. A unique learning experience which takes place in this activity is the recognition of how much may be accomplished through a team effort.

Moreover, the total educational value of this activity is realized when the teacher plans the activity so that all phases of production are studied. The group would organize themselves into a corporation, sell stock, elect directors, apply for employment, interview employees, design products, conduct research, organize product survey teams, sell or take orders for products, manufacture products, distribute products, liquidate the corporation, and distribute profits or absorb losses, whether fictitious or real.

Pitfalls to avoid in the use of this activity are: (1) selecting a product too involved to complete in a specified time, (2) manufacturing items which take too much time or involve repetition that kills interest, (3) utilizing materials which are too expensive, (4) using poor judgement in planning or hastily planning the product and procedures, and (5) not involving the student in the planning.

Unit Production

Unit production or one-item production is the involvement of a number of students for the purpose of producing a single item, such as a laminating press, a dynamometer, or a television camera. In an activity of this nature, it is important that the students: (1) select a project large enough to involve the entire group, (2) identify a project which is accepted by group concensus, (3) agree upon the utilization of the completed project, and (4) plan and conduct related assignments efficiently.

If an industrial arts program is to provide students with an optimum of learning experiences, the teacher should (1) allow for student participation in selecting and planning activities, (2) recognize factors affecting student activities, and (3) provide for individual and group activities. Moreover, the teacher should continuously assess each activity to the extent it meets the interests and needs of the students involved.

Questions for Evaluation

1. Select any five students in your class.
   a. Describe their physical maturity in terms of such factors as size, stamina, and dexterity.
   b. Characterize their emotional maturity in such traits as span of attention, impulsiveness, and complacency.
   c. Compare the mental capabilities of these students in terms of intelligence quotient, apparent perceptiveness, and present achievement.
   d. What is the chronological age of each of these students? Are the traits listed in a, b, and c above commensurate with your expectation for students this age? If not, what specific methods are being employed to correct this?
2. Consider the activities in which the students in #1 above are presently engaged.
   a. How appropriate are these activities for each student in light of his level of physical, emotional, and mental maturation? What are the particular facets of these activities which make them appropriate in each case?
   b. To what extent are these students intrinsically interested in the activity in which they are engaged?
   c. How effective are the instructional methods in accomplishing contemporary objectives of industrial arts?
3. What new activities could be introduced in your classes which reflect the technology of modern industry?

4. If a major aim of education is to prepare people to live purposeful lives in a free democratic culture, to what extent should industrial arts students designate the classroom activities?

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CHAPTER THREE

Contemporary Industrial Arts Resources

Two extreme points of view affect the selection of resources considered appropriate to maximize learning in industrial arts.

One point of view holds that education is a process whereby a teacher dispenses knowledge to students via an acquired verbalism and an adequate textbook. He may even show an occasional film in order to elaborate on a fact or to comply with the notion that films should be shown at intervals. In this traditional method of instruction, the evaluation of resources is limited to the selection of a textbook which expounds the *latest* and most *complete gospel* on the course content.

A major weakness in this traditional method of instruction lies in the misuse of the textbook. The teacher using a *single* textbook routinely reviews the common daily assignment, stresses rote memorization of unrelated facts, and follows an old course outline which has remained static since its adoption. Such an approach stifles creativity, deadens motivation, and saps the intellectual vitality necessary to achieve maximum learning.

A second point of view holds that education is a process whereby the individual learns to master himself and his environment. This kind of instruction requires a variety in methodology in order to meet the needs and abilities of individuals. The second view assumes that learning occurs through the interaction of the individual with his total environment. Therefore, the standards for selecting resources become an evaluation problem which often defies analysis in a statistical sense.

Wagner and Christophel propose a standard for the second point of view when they state, ". . . only current materials make possible the development of the flexible curriculum which is needed to meet the needs of our changing world." (20, p. v). They add:

> Teachers are discovering that learning materials available from industry, governmental agencies, altruistic organizations and others are often more up-to-date, comprehensive in scope, and interest-arousing than corresponding sections of the traditional materials . . . (20, p. v).

Wagner and Christophel offer some helpful hints on such topics as appraisal of sponsored material, instructions on obtaining free material, criteria for selecting material, sources of free material, classification and filing, and the advantages of a vertical file. (20, pp. 1-7).

The selection of resources is complicated by the very nature of the industrial arts discipline. Industrial arts education seeks to interpret the industrial aspect of the American culture. This industrial aspect is dynamic, complicated by many explosive changes, and characterized by a rapid implementation of new developments. For a judicious selection of resources, the teacher must study these new developments and make some systematic attempt to obtain relevant, up-to-date resource materials.

Industrial arts education supports the trend toward making the student responsible for his own learning. Again in this area the teacher must first anticipate student interests and needs and then identify a wide range of available resources.

It is the purpose of this chapter, then, to describe various resources, to list some major resources, and to identify specifically some resources considered necessary for a quality program.

It would, of course, be up to the reader to evaluate introspectively the effectiveness of his own selection and utilization of resources in the light of the following information.

Business, Industry and Governmental Agencies

The field of industrial arts is particularly blessed with an almost inexhaustible supply of available resources, since industrial arts content is drawn from industry and technology. Materials from industry, business, and governmental agencies, therefore, could serve as a rich storehouse of solutions to problems pertinent to the field.

Production of educational materials by industry is a multimillion dollar enterprise, undergoing exponential expansion. Since World War II, business and industry's annual budget for school materials has been greater than the annual textbook budget of all schools in the country. Total corporate financial support for education in 1965 probably exceeded $250,000,000. At least one observer expects this contribution to double by 1970. (6, pp. iv-v).

A recent survey further points up the magnitude of these resources:

> By far the most popular form of business-industry aid to the schools is instructional materials for classroom use—and the diversity of materials offered is astounding. Sixty-seven percent of the companies surveyed have prepared and distributed informational booklets; sixty percent have provided filmstrips, slides, transparencies, films, recordings, and tapes. Thirty-nine percent have supplied books, such as company histories and textbooks, while thirty-four percent furnish samples of raw materials or finished products or both, and nearly a third offer a variety of displays and exhibits. Others make available maps, charts, and graphs in a variety of fields, bulletin board materials, newsletters and magazines, research and experiment guides, model construction kits, and programmed learning materials. (2, p. 57).

It is evident that the most valuable and yet *least tapped* potential for resources falls within this business, industry, and governmental agency category. (6, p. 5). One inhibiting factor in collecting these materials seems to be the problems of storage and retrieval, since these resources do come in an array of sizes, shapes, descriptions, variety in content, types and usefulness in terms of datedness.

On the other hand, one solution to the problems of storage might be a materials center. Higher education and many public school corporations maintain audio-visual centers where films, filmstrips, overhead projectors and the like are cataloged and disseminated. Some schools also have a teaching materials service which acquires catalogs and disseminates materials such as samples, displays, charts, models, and bulletin board materials.

Available also are vast numbers of brochures, pamphlets, booklets, monographs, technical briefs, and flyers which provide rich data for the solution of problems studied in contemporary industrial arts activities. The next topic describes specific resources.

Governmental Agency Publications

Resources are available from the following government agencies: Superintendent of Documents, United States Government Printing Office; Office of Technical Services, Commerce Department; and various other issuing offices, *e.g.*, U. S. Department of Health, Education and Welfare and the U. S. Department of Agriculture, Forest Products Laboratory.

A single comprehensive index to all current materials issued by governmental agencies is the *Monthly Catalog.* (19). It is published monthly and maintains both a monthly and an annual index. The publication is normally housed in either the periodical or reference section of school libraries. The *Monthly Catalog* gives complete bibliographical data for each entry, including such data as price and instructions for ordering. Several libraries within each state, including all state and land grant college libraries, are depositories for selected governmental publications. Each depository library determines the items it wishes to house and make available to all researchers. Some libraries ask for most of the depository items, while others request only a few.

A second and quite comprehensive index of government publications is the three-volume work *Guide to U. S. Government Serials and Periodicals,* documents index, 1964 edition. (1). Volume One is devoted to "Current Serials and Periodicals of Washington Agencies." Volume Two is concerned with "Releases and Other Ephemeral Material." Volume Three includes the complement of "Field Agency Publications." The first series appeared in 1962.

A third and more convenient, although limited, source for *Selected United States Government Publications* is published bi-weekly by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402. In order to receive this bi-weekly list of selected publications, the teacher merely needs to have his name placed on the mailing list.

Non-governmental sources which also identify government publications are standard reference works such as the *Applied Science and Technological Index, Education Index, Engineering Index,* and *Readers' Guide to Periodical Literature.* These familiar indexes need no further discussion.

The MacLean study investigates in detail sources of U. S. government publications and culminates in a bibliography of entries chosen as pertinent to industrial arts on the basis of carefully developed criteria. (15). The selected publications are subject-indexed and annotated.

Business and Industry Publications

As previously mentioned, business and industry furnish a continuous supply of resources of all types. Whenever they perfect new products, processes, materials, equipment, training methods, research data and such, they immediately advertise and disseminate the appropriate descriptive or technical data. This kind of data in the view of the writers, is one of the richest sources of information for potential problem solving experiences which undergird contemporary approaches to industrial arts education.

Some examples of business- and industry-sponsored free periodicals are *Dupont, Training, Lead, Lamp, Aerospace, Engineering Journal, Technical Education News, Steelways,* and *Steel Horizons.* (See Appendix A.) These publications contain technical articles and references to new products, processes, techniques, et cetera. Many include service cards for the convenience of the reader in requesting information and materials.

Certain publications such as *Industrial Equipment News* (IEN) are devoted entirely to what is new in equipment, products, and materials. This free monthly publication offers technical data, descriptive literature, and product information on a voluminous number of topics. (13).

Those teachers who would include in the classroom activities a study on the evaluation and development of industry and technology would want to place in the school library a number of carefully selected resources. Some of these might be: DuPont—*Automation and Employment, The Story of Technology, Man and His Work,* and others; Ford—*The Evolution of Mass Production;* General Electric Address Series — "The Mutual Interests of Employees and Management," "Inflation and Productivity," and others; General Motors—*American Battle for Abundance;* National Association of Manufacturers—*Industrial Research and Development;* United States Gypsum—*Ideas for Industry.* (See Appendix B.)

Instructional Media

The broad category of audio-visual materials is not new to education. In the one-room school house of early America, students learned mostly from the hornbook with its illustrated alphabet. A recent definition identifies audio-visual materials as those which do not depend primarily on the printed word. Audio-visual materials associate sensory experiences with the words and symbols of the language.

Cross and Cypher differentiate the grouping into separate categories—the visual aids and the audio aids:

> Visual aids are primarily those selected, controlled visual experiences which are presented to the learner for the purpose of providing him with a true and accurate visual picture or impression which, in turn will be recalled at appropriate later times by the learner. (4, p. 6).

They go on to say:

> Audio education experiences may be spoken words or they may be simply the characteristic sound, or call, or noise associated with a recallable previous experience. Actually, audible words, whether heard in direct speech or by recording or broadcast receivers, are used by the learner as stimuli to recall past experiences in the same manner as he uses visually received word symbols in reading. (4, p. 7).

By the above definitions, then, the audio-visual materials are really tools which are not a supplement but rather an integral part of the teaching-learning process.

Many writers on this subject tend to broaden the category and to list the following as materials: textbooks, motion pictures, filmstrips and slides, transparencies, opaque materials such as pictures, illustrations, murals, posters, paintings, sketches, photographs; maps, charts and graphs, programmed instruction materials, television, specimens and artifacts, models, cut-aways and mock-ups, demonstrations and experiments, recordings and dramatizations, and resource persons.

Whatever the definition used, some materials on the above listing invite additional consideration because of their particular characteristics.

The Textbook

The textbook has been the traditional manual for guiding learning experiences in the schools of our nation. Whenever the role of the textbook is questioned, there arises emotional comments, both pro and con. Some critics argue that frequently the textbook is used alone to the exclusion of a bountiful supply of other relevant resources. Others in defense of the textbook claim that it serves as a point of departure, a basis for organizing learning units, a systematic overview of a subject and a core around which other resources are focused. In specific cases, both views certainly have an element of truth. In fact, probably the majority of the profession would concede that the textbook has considerable value, particularly when supplemented with a variety of additional resources.

An example of the unfortunate dependence upon the textbook is illustrated by the following:

> In some classrooms they may still be prescribed like medicine—so many pages to be "learned" each day. Then the student is expected to repeat what he has memorized on an exam or in recitation . . . The textbook becomes a crutch for the poor teacher and an obstacle to the imaginative teacher who wants to communicate the excitement that new knowledge can bring. (16, p. 16).

An extreme reaction against the dependence on the textbook is its being discarded entirely. Such an arbitrary judgement has a good chance of being as faulty as an over-dependence upon the textbook.

> . . . They attempted to substitute direct experience of the students, supplemented by miscellaneous printed and audio-visual materials. Successful classroom performance under these conditions, however, requires an exceptional school and environment. It also requires an exceptional teacher. He must combine thorough knowledge of the subject with an expert's ability to adapt it to a particular grade level or level of student's ability. He must also be willing to put in long hours organizing the classroom work. (16, p, 16).

One of the significant shortcomings of textbooks in industrial education is that of obsolescence. Technical textbooks dealing with materials and processes become outdated quickly because of new discoveries and innovations which characterize contemporary industry and technology. While references to certain operations, processes or materials may remain relevant over several editions, others may be, and often are, out-of-date before the textbook is published. The value of a given textbook, then, is dependent upon the professional judgement of the teacher.

The professional judgement of the vigilant teacher is sharpened through participating in professional organizations, enrolling in in-service seminars, reading professional journals, and using in his classes a multitude of industrial resources in the form of booklets, technical data sheets, monographs, charts, films, transparencies, and sample materials—all available for just the asking.

Textbooks in the area of woods (particularly those sections on wood finishing and wood adhesives) serve as examples of datedness. Far too often, recently published textbooks or revised ones still retain too much of the old content. For example, instead of providing information about new finishes such as polyurethanes, vinyls, conversion types, film finishes, epoxies and polyesters, these textbooks still emphasize finishes such as varnish and shellac. In the area of adhesives, these same "new" textbooks allot too much space to fish, animal blood, and hide glues and too little space to modern adhesives such as phenolformaldehydes, resorcinols, melamines, phenolics, polyvinyls, aliphatics, and film adhesives. Unfortunately, textbooks with outdated content help perpetuate the status quo and are partially responsible for antiquated industrial education curricula. On the other hand, the perceptive teacher recognizes that no single resource is perfect and that supplementary resources are always indicated if maximized experience is the goal. It is, of course, unrealistic to expect the textbook to exhibit absolute currency when devoted to describing the materials and processes of a dynamic industrial complex. For this reason, the teacher must increasingly rely on the countless available industrial resources which *interpret industry* as it *is* rather than as it *was*.

Wagner and Christophel summarize with the following:

> . . . as the term "text" implies, the coverage of any given topic must be necessarily limited. Furthermore, a textbook can hardly be expected to be revised and brought up-to-date each year, while pamphlets and similar ephemeral materials are often of very recent origin. (20, p. vii).

Projected Media

It is both the responsibility and the obligation of the good teacher to utilize the best media in his instruction. The media selected as best is that which fulfills the recognized need of the learner. One such medium of particular value is the sound film.

Sound Film. The sound film is no longer considered a fad or frill, but an excellent complement to instruction. Rental films, which present authentic content attractively and clearly, are relatively inexpensive and readily available.

There is an excellent historical reference to films, entitled *Motion Pictures in Education,* by Ellis and Thornborough, 1923. (8). The authors critically analyzed the objections and advantages of using films for instruction and included a discussion of school systems using films profitably.

More recently, Wittich and Schuller in *Audio-Visual Materials: Their Nature and Use,* refer to a number of studies dated from 1929 to 1959 which substantiate the belief that appropriate films increase learning and retention of factual information. (21).

A film is appropriate when the information presented contributes to the attainment of course objectives. The film is of good quality when it contains authentic material presented in a well-organized fashion, and when it has excellent photography, color, and sound.

The film is not a complete entity but rather a supplementary tool. Therefore, in order for the students to derive maximum benefit, the instructor must set the stage. He should define new terminology and direct attention to new concepts in the film.

In showing the film, he should make an effort to eliminate distractions. The room should have good acoustics. It should be properly darkened, be at a comfortable temperature, and be arranged so each student has an unrestricted view of the screen.

His follow-up discussion should correct misconceptions and broaden understandings. The teacher should then provide a transition to related activities.

Properly used, this medium helps the teacher bring the world into the classroom in an interesting, attractive, and dynamic fashion.

Filmstrips and Slides. Filmstrips and slides are particularly valuable in explaining sequences or demonstrating processes.

These media have the advantage of permitting the teacher to alter the speed of presentation appropriate to the group, to dwell on a definite frame to clarify content, and to expand on the content according to the needs of the group.

A filmstrip or slide obviously cannot portray motions, but can be used advantageously where motion is of secondary importance.

Filmstrips and slides are relatively inexpensive when compared with sound films, as is the slide or filmstrip projector when compared with the sound motion picture projector. Filmstrips, slides and projectors are easily stored in a minimum of space.

The teacher may find it advantageous to make his own 35mm slides to meet his particular need. Slides should have three basic elements—visibility, simplicity, and continuity. Visibility depends upon the ability to compose and photograph. Simplicity relates to a single idea per frame. Each slide should enable the viewer to grasp quickly the central idea without being distracted from the oral presentation of the teacher. Continuity has reference to sequence which results in the development of a total concept.

Teacher-made filmstrips and slides have the advantage of availability and validity.

Transparencies. The major advantage of the transparency over the filmstrip or slide lies in its flexibility, because the instructor can add to or alter the features at will while facing the group. The chalkboard has long been used as an effective instructional aid, but suffers in comparison with the transparency due to the physical characteristics of the chalkboard, lack of technique by the instructor, and the resultant loss of direct eye contact. The transparency and the overhead projector are easy to use and are inherently suited to the convenient presentation of a variety of pictures, graphs, charts, and diagrams. The room needs to be dimmed only moderately, thus enabling viewers to take notes on the material presented.

A clear acetate or plastic sheet, usually 10″ x 10″, commonly is used for making transparencies. By careful register, transparencies of different colors can be overlaid to develop a sequence for effectively showing successive stages.

Also available are special acetate sheets and accompanying instructions which enable the teacher to transfer ink from a magazine page to the acetate, thereby securing a colored transparency. A variation of the technique uses polarized light to create an effect of animation, but at an added cost due to the addition of the motor-driven polarized disc and the polarized strips of the transparency.

Opaques. Opaque projectors have the advantage of producing images from flat materials such as illustrations in textbooks, pictures, drawings, specimens, and other non-transparent materials.

The opaque projector requires a room somewhat darker than that required for transparencies. This disadvantage may be offset by its adaptability to readily available and inexpensive materials.

The opaque projector can be used in conjunction with the chalkboard, enabling the instructor to trace on the board projected configurations that would be difficult and time-consuming to draw otherwise.

More recently available to teachers is some highly specialized equipment such as the micro-projector and the stereo-projector. Micro-projection is suited to the illustration of many phenomena such as stresses and strains and physical properties of materials. Due to present technical problems, stereo-projection equipment is not extensively used.

Autoinstructional Aids

Teaching machines or teaching-learning machines are devices designed for programmed instruction or autoinstruction. The literature is replete with the pros and cons on this medium.

Supporters claim that the machines provide the teacher with additional time for activities beyond instruction in basics. They concede that the disadvantages of machines lie in their initial cost and the unavailability of programs in all areas of instruction. Teaching machines have been successfully used for developing communication skills, teaching fundamental processes of mathematics and theoretical concepts in science, spelling, psychology, statistics, business skills, reading skills—primarily they are used to communicate information or ways of doing things. In fact, studies confirm that machines are advantageous for many types of content. Schramm states, "The limits of the topics which it is possible to study by means of programs are not yet known." (17, p. 6).

Cross and Cypher state that a number of problems must be solved before the fullest benefits can be derived from use of automation in the process of education. They list the following:

1. Determine the educational values and goals for which we wish to employ our instructional time and human and material resources.
2. Determine what parts of the education process may be most effectively and efficiently accomplished by machines and what parts may not properly be assigned to machine instruction.

3. Discover ways and means by which we can quickly and accurately measure an individual's learning needs and potential at any time or stage of his development.
4. Develop ways and means of preparing teachers to use machines properly and to seek for and discover new and better applications of mechanics to the educational process.
5. Develop ways and means of preparing teachers to help students make the best use of learning time and processes which are not mechanized. (4, p. 284).

Despite their current limitations, teaching machines are here to stay. Of course, they need continued refinement. But they already have demonstrated that programmed methods can contribute to education at all levels. In the near future, these machines will be used in a greater number of school programs, including industrial arts.

Television

Television has had a major effect on the formal and informal education of the American public. Many initially viewed television as a relatively inexpensive device which would lower the cost of education by reducing the number of teachers required. Practical experience in the use of educational television, has, to a large extent, refuted this notion. Television as a medium overlooks individual differences and potential, provides for no interaction between the stimulus and the viewer, fails to anticipate or correct for distractions, and falls short of effectiveness at some levels of instruction.

In spite of the above limitations, television certainly can make a contribution if used properly. With the shortage of teachers, increasing enrollments, lack of classroom space, and the expansion of knowledge, television in concert with other techniques should allow for maximized learning. Television makes practical a pooling of skills, with each teacher assuming that aspect of the total teaching for which he is best suited by ability, interest, and temperament.

Closed-circuit television would certainly be an effective means of communication between some central source such as the materials or resource center and the industrial arts classroom. For example, if a student wanted information about aliphatic adhesives, he would telephone the resource center requesting information on the topic. A resource center technician would secure and project the appropriate information to the laboratory through a closed-circuit channel.

As it is with other instructional devices, continued research is necessary for the fullest development of television.

Models and Mock-Ups

Models and mock-ups have a history of extensive use in the industrial arts laboratory. Models are three-dimensional representations of the real thing. They may be miniaturizations, full scale or enlargements. They may be cut-away to show interior configurations or features, or they may be constructed so that the exterior must be removed to reveal the interior. Mock-ups are devices illustrating certain elements of an entity, enabling the learner to visualize the specifics, sequence, or interrelationships. Mock-ups also may be cut-away.

The major disadvantages of models and mock-ups lie in the time needed to construct these devices and the lack of storage space in industrial arts laboratories. Besides, there is little reason for using a model if the real object is appropriate for classroom use. The model, by definition, is not authentic and, therefore, in certain instances, may even give an inadequate conception of reality.

The primary advantages of models and mock-ups relate to third-dimensional realism, simplification, the reduction of abstraction, and the removal of irrelevants. Therefore, time, funds, and storage notwithstanding, the potential of models and mock-ups as instructional devices in industrial arts is quite great.

Tape and Disc Recordings

Tape and disc recordings as instructional devices appeal only to the audio sense.

The recording can be advantageously used to assist in the presentation of factual or sequential information in a highly refined and consistent manner. The recording serves as an efficient self-evaluating device for the development of an audio presentation. Errors of pronunciation, intonation, amplitude, and enunciation can be heard during playback and subsequently corrected. Likewise, the organization of content and the continuity of ideas can be improved. One disadvantage of the recording, which is often overlooked, is the presence of visual distractions. One technique for reducing visual distractions while simultaneously increasing understanding involves the use of a complementary visual media.

Professional Organizations

Educational and industrial professional organizations are good resource agencies. The industrial arts professional organizations provide an excellent service to the industrial arts teacher and need no further elaboration.

Educational professional publications of specific interest to the industrial arts teacher include the *Journal of Industrial Arts Education* (formerly the *Industrial Arts Teacher*), the *American Vocational Journal,* the *Journal of Industrial Teacher Education,* the *American Council on Industrial Arts Teacher Education Yearbooks,* and the well-known publications of private enterprise, *Industrial Arts and Vocational Education* and *School Shop.* The American Industrial Arts Association sends special publications at nominal cost directly from the organization. These publications offer the teacher a broad spectrum of current and interesting topics.

What needs to be emphasized, also, is that industrial professional organizations can help the dynamic teacher. Personnel from these organizations form a rich reservoir of resource persons in intimate contact with contemporary industry and technology. Some organizations extend to industrial arts teachers an open invitation to meetings and membership.

The literature provided by these professional organizations is a means by which the industrial arts teacher can remain current in his knowledge of new techniques and processes of industry.

A few of the publications available through subscription, sponsored either by an association or private publisher, are: *Product Engineering, Ceramic Monthly, Lapidary Journal, Modern Plastics, Wood Construction and Building Materialist, Furniture Production, American Builder, Tool and Manufacturing Engineer, Metalworking, Visual Communications Instructor, Journal of Engineering Graphics, Machine and Tool Bluebook, Hydraulics and Pneumatics, Welding Design and Fabrication, Iron Age, SPE Journal, Industrial Arts Methods, Ground Support Equipment, Popular Mechanics,* and *Industrial Re-*

search. (See Appendix C.) It is readily apparent, even with such a cursory coverage, that the industrial arts teacher has a wide variety of resource materials available.

Industry believes in the value of education as evidenced by its willingness to provide resource personnel as well as a multitude of educational materials. Industry is often critical, and justifiably so, of the many industrial arts teachers who fail to avail themselves of its services.

It is the industrial arts teacher who ought to take the initial step in seeking professional services and collecting resource materials. He should feel personally responsible. Once he has made a request for help, he will discover to his advantage many additional avenues for resource potential.

Resource Storage Facilities and Personnel

The industrial arts teacher who collects an abundance of resource materials faces a storage problem. His problem becomes even larger when he uses contemporary approaches and needs not only convenient storage but also quick retrieval.

Some teachers recommend the following ways to solve the problems of storage. Instead of purchasing a number of costly films, Lahti uses cartridge films on specific concepts for individual or independent viewing. He also uses cartridge-loaded portable projectors to show these films. Lahti suggests using cartridge films for self-instruction:

> . . . Through self-instruction a student will be more free to work on individual projects for he will be able to get his skills, demonstration, or field trip when he needs it. He will not need to wait until the class, the film, the room, the instructor, and the equipment can be scheduled. (14, pp. 37-39).

Instead of maintaining a vertical file, some teachers keep in the industrial arts laboratory a unique kind of binder (18) for filing printed materials on topics such as instructions on use of equipment, processing information, pricing, safety regulations—topics which are fundamental to the day-by-day operation of a laboratory.

The teacher might solicit the help of a librarian on storing resource materials which are not used daily. Indeed, he ought to regard the library as a composite resource center—*i.e.*, a reference center, curriculum center, film center, teaching materials center, and technical assistance center. The teacher also should consult the librarian about techniques for handling audio-visual materials.

Computer systems could be installed to connect the industrial arts laboratory and library. Under this system, a student could phone for some specific material which in turn would be automatically retrieved and transmitted to an appropriate receiving facility in the laboratory.

There is no doubt about it! The alert industrial arts teacher has access for the asking to a wealth of resources. He should feel personally responsible for evaluating these resources and securing the appropriate ones.

Questions for Evaluation

1. What provisions have you made for a resource center in the industrial arts laboratory? How may this center be improved?
2. What provision has been made to organize booklets, pamphlets, technical data sheets so that they are available to students?
3. To what extent do your students use resource materials as supplementary material to a prescribed text?
4. What educational and industrial journals do you receive and make available to students?
5. List the types of resources you use in your teaching. How extensive are these resources in representing a wide spectrum of American industry?
6. How do you evaluate resource materials in order to determine their educational value?
7. To what extent do you:
   a. utilize community resources when teaching?
   b. invite industrial personnel to visit your classes as speakers?
   c. encourage students to visit local businesses and industries?
8. How frequently do you read:
   a. industrial arts professional journals?
   b. industrial or government publications related to industrial arts?
   c. professional journals on education in general?

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21. Wittich, Walter Arno and Charles Francis Schuller. *Audio-Visual Materials:* Their Nature and Use. New York: Harper and Brothers, 1962.

Appendix A

Typical free periodicals sponsored by business and industry.

Aerospace, Aerospace Industries Association of America, Inc., 1725 DeSales Street, N. W., Washington, D.C.

DuPont Magazine, E. I. du Pont de Nemours and Company, Wilmington, Delaware 19898.

Engineering Journal, General Motors Technical Center, General Motors Corporation, Warren, Michigan 48090.

Lamp, Standard Oil Company, 30 Rockefeller Plaza, New York, New York 10023.

Lead, Lead Industries Association, 292 Madison Avenue, New York, New York 10020.

Steel Horizons, Allegheny Ludlum Steel Corporation, Pittsburgh, Pennsylvania.

Steelways, American Iron and Steel Institute, 150 East Forty-second Street, New York, New York 10017.

Technical Education News, McGraw-Hill Book Company, 230 West 42nd St., New York, New York 10036.

Training in Business and Industry, Gellert-Wolfman Publishing Corporation, 33 West 60th Street, New York, New York 10023.

Appendix B

Typical resources sponsored by business and industry which are devoted to the development and understanding of industry and technology.

DuPont Series, Automation and Employment, *The Story of Technology, Man and His Work,* and others, E. I. DuPont de Nemours and Company, Wilmington, Delaware.

General Electric Address Series, "The Mutual Interests of Employees and Management," "Inflation and Productivity," and others, Relations Services Warehouse, Building #2, General Electric Company, Schenectady 5, New York.

General Motors Series, *Can I Be a Technician?, Can I Be a Scientist or Engineer?, Can I Get the Job,* and others. Educational Relations Section, Public Relations Staff, General Motors, Detroit, Michigan 48202.

Ideas for Industry, United States Gypsum, Chicago, Illinois. N.D.

Industrial Research and Development, National Association of Manufacturers, New York, New York. 1960.

Kettering, Charles F., and Allen Orth, *American Battle for Abundance.* General Motors, Detroit, 1955.

Manufacturers Association Series, *The Role of Competition, Wages and Prices, Capital and Economic Growth, Industry's Profits,* and others, National Association of Manufacturers, Education Department, 2 East 48th Street, New York 17, New York.

Preserving the Individual in An Age of Automation, The Connecticut Mutual Life Insurance Company, Hartford, Connecticut, 1963.

Small Business Administration Series, *Small Business and Government Research and Development, Improving Materials Handling* and others, U. S. Government Printing Office, Washington, D. C.

Speaking of Plastics Series, *The Story of Vinyls, The Story of Cellulosics, The Story of Polystyrene, The Story of Polyethylene,* and others, Educational Division, Fry Plastics

International, 8601 South Figueroa Street, Los Angeles 3, California.

The Evolution of Mass Production, Ford Motor Company, Dearborn, Michigan, 1956.

You and the Computer, General Electric Company, Schenectady 5, New York, 1965.

Appendix C

Typical periodicals sponsored by associations or private publishers. Available by subscription, but many are free to schools.

American Builder. Simmons-Boardman Publishing Company, Bristol, Connecticut 06012. $3.00 per year submitted to Subscription Department, *American Builder,* Emmet Street, Bristol, Conn. 06012.

Ceramic Monthly. Ceramics Monthly, 4175 High Street, Columbus, Ohio 43214. One year $6.00.

Furniture Production. Production Publishing Company, 804 Church Street, Nashville 3, Tennessee. $3.00 per year.

Graphic Arts Monthly. Graphic Arts Publishing Company, 7373 North Lincoln Avenue, Chicago, Illinois 60646. $7.00 per year, but free to schools and plants.

Ground Support Equipment. Compass Publications Incorporated, 617 Lynn Building, 1111 North 19th Street, Arlington, Virginia. $4.00 per year published quarterly.

Hydraulics and Pneumatics. Industrial Publishing Company, 812 Huron Road, Cleveland, Ohio 44115. $12.00 per year, submit to Hydraulics and Pneumatics, P. O. Box 5369-U, Cleveland, Ohio 44115.

Industrial Arts Methods. Syndicate Magazine, 25 West 45th Street, New York, New York 10036. (Controlled Circulation). Official magazine of the Technical Illustrators Management Association.

Industrial Photography. United Business Publications, Incorporated, 200 Madison Avenue, New York, New York 10016. $6.00 per year.

Inland Printer. American Lithographer. MacLean-Hunter Publishing Corporation, 300 West Adams Street, Chicago, Illinois 60606. $5.00 per year.

Journal of Engineering Graphics. Division of Engineering Graphics, American Society for Engineering Education. $2.00 annual for 3 issues submitted to William B. Rogers, Department of E.S. and G.S., U.S.M.A., West Point, New York.

Lapidary Journal. Lapidary Journal, Incorporated, 3564 Kittner Boulevard, San Diego, California. $5.25 for 12 issues.

Machine and Tool Bluebook. Hitchcock Publishing Company, Wheaton, Illinois. $7.50 per year.

Metalworking. Metalworking Publishing Company, Incorporated, 221 Columbus Avenue, Boston 16, Massachusetts. $6.00 per year.

Modern Plastics. McGraw-Hill, Incorporated, 330 West 42nd Street, New York, New York 10036. $10.00 per year, 12 issues.

Popular Mechanics. Hearst Corporation, 57th Street at 8th Avenue. New York, New York 10019. $4.00 per year, submit to Popular Mechanics, Box 646, New York, New York 10019.

Popular Science. Popular Science Publishing Company, 353 Fourth Avenue, New York 10, New York. $3.40 per year submitted to Subscription Department.

Product Engineering. McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, New York. $3.00 per year, published weekly.

Reproduction Methods. Gellert-Wolfman Publishing Corporation, 33 W. 60th St., New York, N.Y. 10023. $4.00 per year but sometimes free.

SPC Journal. Society of Plastics Engineers, Incorporated, 65 Prospect Street, Stamford, Connecticut 06902. $5.00 per year, issued monthly.

Visual Communications Instructor. Syndicate Magazine, Inc., 25 W. 45th St., New York, N.Y. 10036. Free to schools.

Welding Design and Fabrication. Industrial Publishing Company. Division of Pittsburgh Railways Company, 812 Huron Road, Cleveland, Ohio 44115. $8.50 per year.

Wood Construction and Building Materialist. Wood Construction Publishing Company, 28-30 Kinsey Road, Xenia, Ohio 45385. $2.00 per year.

CHAPTER FOUR

Contemporary Industrial Arts Facilities

If a modern industrialist were to tour some industrial arts laboratories, he might find it difficult to relate the equipment in those laboratories with the facilities in modern industrial plants. For example, he could reasonably expect to see equipment that is modern and in constant use. Yet he actually might observe the contrary. He might find in several laboratories outmoded smoking forges with "green" coal and lukewarm irons in the fire and wonder about the absence of up-to-date heat treating furnaces. It is probable that in another laboratory he would see ten sawdust-covered boys lined up like puppets before ten lathes, simultaneously turning wooden legs or lamp posts. Meanwhile two-thirds of the remaining costly equipment (such as saws, drill presses, and sanding machines) would be standing idle. He also might meet an automechanics teacher who would point out proudly to him fourteen different inoperative engines, which the students each term tear down and reassemble as they would a puzzle, hopeful that all the pieces would fit together without their coming up short or having some pieces left over. His general assessment of school facilities could very well be that many industrial arts laboratories do not reflect, even remotely, the industrial plants in the 1960's.

These industrial arts laboratories must be modernized to typify the final third of the twentieth century. Specific kinds of equipment must be installed for programs that reflect bold, contemporary industrial arts approaches, new activities, and many resources.

To modernize the physical facilities of his laboratory and to expose his students to contemporary industrial technology, the resourceful teacher might do one of two things. He might, on one hand, concentrate his effort on upgrading the equipment within his own laboratories. On the other hand, he might take his students to community facilities for some of the program's instructional activities. The dynamic teacher of the twentieth century would do both.

John Feirer, reviewing the problem of facilities for contemporary programs in the March, 1966 issue of *Industrial Arts and Vocational Education,* points out that the curriculum which implements new programs designed around technology, elements of industry, and research development, is only one side of an equilateral triangle. (4, p. 39). The other two, equally important sides are qualified teachers and suitable facilities. Some of the questions that Feirer raises with regard to facilities are:

1. What kinds of shops and laboratories are needed?
2. Is it possible to carry out these new curriculum programs in existing facilities?
3. What additional equipment is needed?
4. What new equipment not commercially available will be needed?

School Facilities

The most important aspect of school facilities for industrial arts should be flexibility—flexibility both in the rooms and in the equipment. Michael Russo in writing about area vocational schools makes the following significant generalization, which is equally applicable to industrial arts laboratories: "The word in contemporary vocational schooling is 'modular.' The well-planned school is one that can change with the times, one in which a room or facility can be added or eliminated without upheaval." (11, p. 18).

Anderson, in describing changes in school buildings, recommends several kinds of flexibility:

> First, the modern school building should be versatile—that is, it should lend itself to a variety of uses, both immediately and over the long run. Second, it should be capable of on-the-spot internal rearrangement (some architects use the metaphor "malleable" to describe this quality) with minimum effort . . . . Third, it should be capable of economical modernization when educational requirements change. "Convertibility" is the term generally used for this kind of flexibility. (1, p. 140).

During the second half of the twentieth century, *industrial plant facilities* have improved at an accelerated rate. This rate of change should obligate teachers and administrators of industrial arts to upgrade their own physical facilities in order to represent continually the technological aspect of modern culture in the total school setting. Of course, teachers should recognize the impossibility of duplicating in the school much of the highly sophisticated equipment used by industry. Still the teacher of industrial arts, in the selection of his machinery and in its arrangement, should follow as much as possible the practices of industry.

Many processes, which have been common to industry over a period of years, have been used by only a few industrial arts students, even in this decade. Consider, for example, the electrical discharge method of cutting metals—a process which has reduced hours of toil in the making of dies and doing other metal cutting. Consistent with the fantastic advances in the metalworking field, the electrical discharge machine (EDM) has become a conventional machine shop tool. With this equipment, which is in the same price range as a good milling machine, the operator can do an almost impossible metalworking task; he can machine hardened steels, tungsten carbide and all sorts of exotic metals just as easily as if he were machining mild steel.

Another process used by few students is the extrusion process found in both metal and synthetic industries. For the extrusion of synthetics, machinery is available in the same general price range as the electrical discharge machine described above. This machinery extrudes countless forms and coats wire with plastic materials having insulating and decorating qualities. Even less expensive is simpler equipment for the extrusion of ceramic materials.

In the woods industry, wood welding is a relatively new process for drying adhesive joints by a high-frequency alternating current. This capacitive heating process reduces clamping time to an almost negligible amount. Although this process typifies a modern industrial practice and the necessary equipment for wood welding is cheaper than two wood lathes, this process seldom is used in the school shop.

On a permanent rental basis, electrostatic spray equipment would cost no more than one wood turning lathe. Two distinct advantages of this electrostatic spray equipment are:

1. A reduced messiness in finishing rooms.
2. A reduced cost of finishing materials by eliminating over-spray.

These few illustrations serve to point out the equipment that is commonly found in industry but seldom found in industrial arts shops. Despite the rapid changes in industry in the last thirty years, the industrial arts facilities in the schools of America have not kept up with these changes. In some school shops, the average age of the equipment is well beyond what may be regarded as functional or safe in terms of modern industrial planning. Moreover, vestiges of the Sloyd and Russian systems still exist. In fact, if a depreciation system similar to that used in industry were applied to most industrial arts laboratory equipment, the present dollar value of the equipment would be negligible or non-existent.

Depreciation of Facilities

Although it is currently an uncommon practice in the administration of industrial arts laboratories, the use of depreciation techniques for a systematic retirement and replacement of instructional equipment is strongly recommended. Such a retirement and replacement system would make the teacher acutely aware of the appropriateness and the monetary worth of his laboratory facilities. It would force him to evaluate continuously his instructional machinery and instruments. It would also provide a graphic display of factual information which would support his requests for new equipment. (See Fig. 2 and Fig. 3.)

In establishing depreciation rates for school equipment, the teacher should consider three principal factors: initial cost, estimated life, and scrap value. He might use several methods to determine the rate of depreciation: percentage-on-original-cost, percentage-on-diminishing-value, years-digits, and units-of-production. (6, pp. 107-8, and 12, pp. 453-5).

The first three methods are most appropriate for establishing depreciation curves for industrial arts equipment. (See Table 1.)

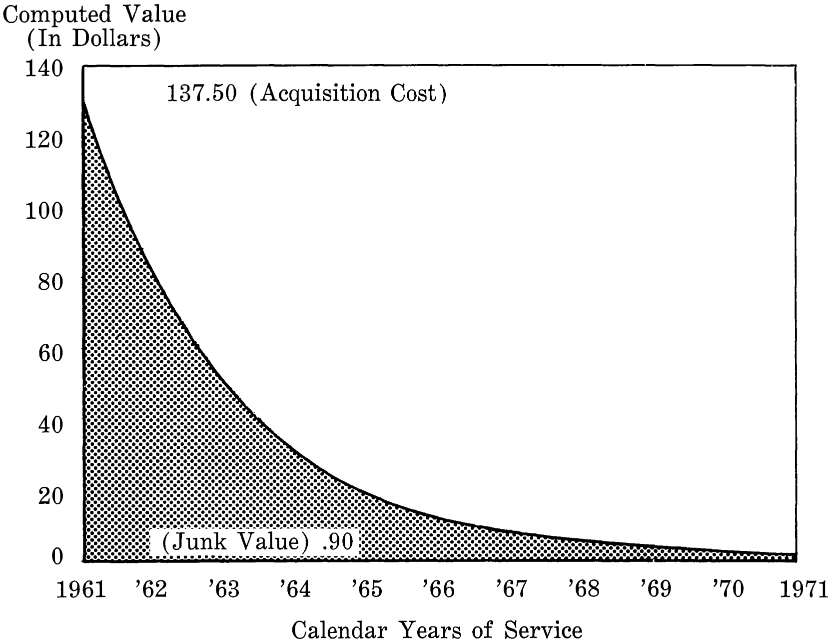

Fig. 2. Depreciation Graph for Voltohmyst WV-87B

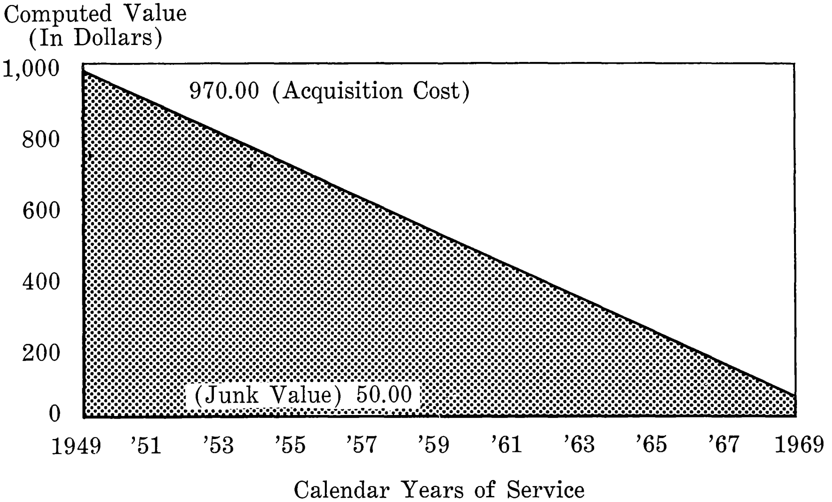

Fig. 3. Depreciation Graph for Hydraulic Press

TABLE 1
ILLUSTRATIONS OF VARIOUS METHODS OF DEPRECIATING EQUIPMENT

Year	*Percentage-on Original-Cost*		*Percentage-on Diminishing-Value*		*Years-Digits*		
	Dollar Value	*Depreciation (10% rate)*	*Dollar Value*	*Depreciation (10% rate)*	*Rate*	*Dollar Value*	*Depreciation*
Original cost	3000.00		3000.00			3000.00	
End of first year	2760.00	240.00	2550.00	450.00	10/55	2563.64	436.36
End of second year	2520.00	240.00	2168.00	382.00	9/55	2170.91	392.73
End of third year	2280.00	240.00	1843.00	325.00	8/55	1821.82	349.09
End of fourth year	2040.00	240.00	1567.00	276.00	7/55	1516.37	305.45
End of fifth year	1800.00	240.00	1332.00	235.00	6/55	1254.55	261.82
End of sixth year	1560.00	240.00	1132.00	200.00	5/55	1036.37	218.18
End of seventh year	1320.00	240.00	962.00	170.00	4/55	861.82	174.55
End of eighth year	1080.00	240.00	818.00	144.00	3/55	730.91	130.91
End of ninth year	840.00	240.00	695.00	123.00	2/55	643.64	87.27
End of tenth year	600.00	240.00	591.00	104.00	1/55	600.00	43.64
Total depreciation		2400.00		2409.00			2400.00

The *percentage-on-original-cost* method is the simplest and probably the most applicable. In this method, the difference between the acquisition cost and the scrap value is divided by the estimated useful life of the equipment in years. The result represents the amount of annual depreciation and produces a straight line graph. However, it should be emphasized that this method will not always give a true value of the equipment at any specific year because on most equipment the greatest depreciation occurs during its first year. For this reason, the *percentage-on-diminishing-value* (also called *declining-balance* or *double-declining-balance*) method is frequently substituted, using the following formula:

If V = the original value
V' = the residual or scrap value
x = the percentage of depreciation
n = the number of years

$$\text{Then } x = 1 - \sqrt[n]{\frac{V'}{V}}$$

Example: If \$3000 is the original cost and \$600 is the scrap value at the end of 10 years, then

$$x = 1 - \sqrt[10]{\frac{600}{3000}} = 1 - \sqrt[10]{0.2} = 1 - 0.85 = 0.15^{*}$$

In using the above formula, the teacher must determine the approximate scrap value of each piece of equipment and the estimated number of years it will be used. He should note also that a piece of equipment will never depreciate to zero value. (See Table 1.)

The *years-digits* method yields a final value outcome quite similar to the percentage-on-original-cost and percentage-on-diminishing-value methods. With the same data on equipment used in the two previous examples, the total depreciation in ten years shows a variance of only nine dollars among the three methods. (See Table 1.) The procedure for using the *years-digits* method is:

1. Determine the useful life of equipment in years (for example, 10).
2. Summate the years from 1 to 10 as follows:
   $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 = 55$
3. Divide the difference between the original and scrap values by 55. ($2400 \div 55 =$ \$43.636)
4. Compute the first year of depreciation by multiplying \$43.636 by ten.
5. Determine each succeeding year's depreciation by multiplying \$43.636 by 9, 8, 7, 6, 5, 4, 3, 2, 1 respectively. (See Table 1 for annual values.)

What factors should affect a teacher's selection of a method for evaluating the depreciation of a given piece of equipment? First, the teacher should consider the construction and intended use of the equipment. Portable electric equipment which frequently is lifted and set down would get wear and abuse not given to a heavier, stationary piece of equipment such as a large printing press.

* The 10th root of a number is most easily computed by dividing the logarithm of the number by 10. In this example, log of .2 = −1.30103 . To divide this by 10, move the characteristic behind the mantissa and add enough to make the characteristic divisible by 10:

$$\begin{array}{rr} .30103 & -1 \\ +9 & -9 \\ \hline 9.30103 & -10 \end{array}$$

1/10th of 9.30103 −10 = .930103 −1

From log tables derive .851346 for mantissa of .930103 . Since the characteristic is minus 1, x = 1 − .851346 = .148654, or a 15% depreciation on the declining balance each year.

The teacher should consider as a second important factor the rapid changes in design among some categories of equipment. One example of rapid change would be the rate of improvement in electronic test equipment. Illustrative of this point is the relatively recent advent of the oscilloscope as an integral part of automotive engine analyzers.

Third, the teacher should calculate the amount of use a specific piece of equipment may receive. He might not be able to compute this use accurately, but he should arrive at some quantitative estimate. He should consider not only the relative amount of time the machine will be used, but also the number of different students using the machine.

Consequently, the percentage-on-diminishing-value or years-digits methods would be appropriate for determining the value of equipment which is:

1. portable
2. quickly out-dated
3. used extensively by many students

The age and ability level of students using the equipment also should be considered by the teacher when he is selecting a method to determine depreciation. He may quite logically generalize that the somewhat uncoordinated younger students rather than older students would cause a machine to depreciate more in its first year of operation. Hence either the *percentage-on-diminishing-value* or *years-digits* methods would be more appropriate for estimating the depreciated value of equipment used by younger students, all other factors being equal.

How should the industrial arts teacher estimate the number of years of usefulness of his equipment? He might apply only the foregoing considerations in making a value judgement. Yet he might feel more secure in making final decisions after first sharing his estimates with other experienced teachers and industrial personnel.

It must be understood that depreciation is an accounting practice of industry to "use up" the investments in equipment as expenses and assign them to the various years that the equipment is used. The selection of one of the various methods depends upon the "lifetime" factors mentioned, as well as replacement policies and tax considerations.

In the school situation, there is typically no reason to introduce the complications of depreciation into the accounting system of the total institution. However, the concept of *diminishing value* does apply, and the regular calculation of present value in a systematic manner is an extremely useful tool when the teacher must justify the funds needed for adding and replacing instructional equipment.

The teacher and administrator must realize that in activities consistent with contemporary approaches to industrial arts education, the equipment *will wear out and become obsolete* and therefore ought to be retired on a *systematic basis* comparable to the practice used by industry.

What ought to be, of course, is ideal; *what is* is reality! Many teachers are confronted with the problem of not being able to replace the obsolete equipment immediately. Even in this situation, the teacher could make some improvements without delay which would *up-date* his program—even with the use of obsolescent equipment while planning and directing his systematic long-range modernization program. He could rearrange laboratory facilities into patterns of production and assembly lines similar to those found in industry. He also could industrialize his shop by placing simple, gravity conveyor systems between production stations.

When preparing his own long-range modernization plan, the teacher should acknowledge one fact—namely, that basic principles of modern industrial production or industrial research can be represented or illustrated without an excessive investment in equipment. James Rockwell even emphasizes the fact that for teaching basic principles of industrial production, simple equipment is more effective than highly refined, sophisticated equipment. (9, p. 35).

Types of Laboratories

The total industrial arts facility, in which modern approaches are possible, must provide for a variety of simultaneous activities. This may be accomplished in either of two plant layouts: the comprehensive general shop and the limited general shop.

The *comprehensive general shop* has a wide variety of equipment in a single room—an arrangement that enables students to have experience in shaping, forming, testing, and experimenting with many different materials. This type of facility seems most appropriate in schools with one or two rooms devoted to industrial arts.

In many modern schools with a larger student population, a plant layout of several *limited general shops* is justifiable. A limited general shop is a specialization area with specialized equipment for working with the material and the processes unique for that area. Moreover, this layout solicits a policy of open doors between the limited general shops for full utilization of all of the equipment.

This plant layout also requires more specialized teachers for each area, with the "open-door policy" actually making team teaching possible. The open-door policy fosters the concept of "our" students, rather than "my" students. Modern glass-paneled doors swinging on well-lubricated hinges between the shops would encourage students to seek the advice of specialists in particular areas and would give students an opportunity to use a variety of machines in solving some of their technical problems. The students, thereby, also may use the most appropriate machines for a particular job. The resulting diffusion of ideas under such a policy would enhance the learning experiences and stimulate new interests. In this type of operation, the teachers would also scan broader technical horizons and would become less parochial in their own thinking.

The idea of students moving from shop to shop, as problems with which they are working demand, should also reach beyond the confines of the industrial arts section of the school. In order to avoid costly duplication, some of the equipment found in other departments should be used. Reciprocally, industrial arts equipment should be used by students in other departments. The "open-door" concept, in other words, should extend beyond the boundaries of any department.

Two illustrations might help explain this "open-door" concept more specifically. Assume that a group of industrial arts students has selected as a problem the design and construction of a chair out of laminated wood. To enhance not only the comfort of that chair but also its beauty, suppose the students want to make an upholstered cushion. Logically, they ought to consult a specialist in the field of home economics about the fabric, color, and details of construction of the cushion. They should work on the job in the home economics laboratory, learning about cushion construction from the home economics students under the direction of the imaginative team of home economics and industrial arts teachers. Finally, the students ought to stitch the cushion on the heavy-duty sewing equipment appropriately located in the home economics laboratory where it is used regularly.

Another example of teacher cooperation would be the use of ovens in the home economics laboratory for heating synthetic materials preparatory to forming and shaping. Some industrial arts teachers might be inclined to take issue with this suggestion since the oven would not be a typical piece of industrial equipment. However, the *process* would be typical of the synthetics industry, and the teacher would be using what is available rather than lamenting the lack of industrial equipment. In fact, his encouraging the imaginative use of available equipment would foster student resourcefulness, a topic which is discussed at greater length in Chapter Six.

Science is fundamental to industrial production today. For this reason, school facilities typically found in the science department should be purposely used by industrial arts students. Smith and Rapp, in an article dealing with the testing of material, recommend a metallurgical monocular microscope because "it provides insight into the structural nature of certain materials." (13, p. 33). These authors point out that microscopes usually are available in science laboratories. Microscopic examination for cracks in functional parts of engines in industrial arts laboratories is a common industrial practice and one which may be learned through sharing science facilities.

Student-Constructed Facilities

A dynamic teacher should have a planned, long-range purchasing program for up-dating his industrial arts shop. He might also have some immediate need for special equipment described in professional journals such as *Industrial Arts and Vocational Education* and *School Shop*. If he is even somewhat enterprising, he might encourage his students to help him design and make some of this special equipment. This activity would profit both the students and the industrial arts laboratory:

1. The students would have extensive learning experiences in problem solving. In doing research and planning for

the design and construction of these facilities, they would learn about construction details of industrial equipment. This would be true especially when they would attempt to transmit power through the machine and as they would find ways of making periodic adjustments.

2. A piece of specially designed equipment often would do a better job than an industrially produced piece of equipment adapted to that job.
3. The expense would be minimal as compared with the cost of industrially produced equipment.

An illustration of student-constructed equipment is a simple analog or digital computer which can be used as a teaching machine. (14, p. 31). This equipment may also find application in science and mathematics classes.

A good construction problem for a group of students would be a TV camera. This camera has the added advantage of enhancing subsequent student and teacher demonstrations. In a special way, some of the following problems inherent in this construction project would stimulate the academically able students: development of electrical circuits within the camera, construction of an adjustable and portable rack for the camera, and presentation of demonstrations with the camera.

Some teachers may take issue with the practice of having industrial arts classes construct equipment for other departments in the school, but when such activities are carefully planned by the students under the direction of the teacher, significant educational experiences may result. Typical of this type of educational activity was Nickolich's project—the construction by mass production of hurdles for the physical education department. (7, pp. 42-43). This industrial arts teacher stated that by constructing this equipment, "Students had a better understanding of mass production . . . and learned to work together toward a common goal."

The Empty Shop

No treatise on the physical facilities for teaching industrial arts written in this decade should ignore the concept of the "empty shop" as a unique and very effective setting in which to employ the contemporary approaches emphasized throughout this yearbook. (1, p. 139). At the outset, such an arrangement sounds wasteful because of the connotation of the word "empty," but in truth this setting may be more functional than the permanently equipped laboratory. Imagine one shop area out of five or six in a modern, comprehensive school—an area that would be vacant, except for a few tables and chairs at which the students may sit. Around the empty room are numerous electrical power outlets and an extensive exhaust system to which roll-in equipment could be easily connected.

In this setting, the dynamic teacher could demonstrate the problem of developing a modern industrial plant for an efficient production of a product or products of common usefulness and interest to the students. Such an arrangement is in direct contrast to the usual industrial arts program where the activities are determined by the equipment which is already installed. In this new approach, the activity would determine what equipment would be necessary. Much of the movable equipment could be stored in an area adjacent to the empty room. Additional equipment would be borrowed from other laboratories and cooperating industries. Moreover, supplemental equipment could be improvised by the students for their production and assembly lines as well as their quality-control stations.

But the skeptic would say, "What provision has been made for meeting several classes at various periods throughout a given day?"

In response, attention is directed to the fact that many industrial plants produce goods on a three-shift basis, a practice which should be purposely incorporated into such an activity. Periods one, two and three in the morning could represent the three shifts producing either the same or different products on equipment that is appropriately arranged. Afternoon classes could represent shifts of their own or consider themselves in competition with the "morning company."

Periodically throughout the year, this shop would be vacated as changeovers are made for a complete new line or product. In the process of this changeover, the progressive teacher would endeavor to create production problems which would require as many new types of machines and inspection instruments as possible.

It should be emphasized that in a metropolitan system where there are several schools, a central pool of equipment would enrich this type of instruction by making available a greater variety of equipment to a broader range of students who are confronting technical production problems.

An essential part of this new approach to equipment utilization would be transporting students to modern industrial plants where they could make comparisons between their equipment and that used in industry and where they could view with a greater appreciation the arrangement and function of industrial equipment. In this sense, students are "using" machinery provided by corporate industry.

All the ingenuity and resourcefulness at his command are needed by the industrial arts teacher who is trying to up-date his program and his laboratory facilities. Consequently, if the teacher is to meet this challenge, he must:

1. Study the latest developments in industrial machines and equipment by reviewing professional and industrial journals regularly. (Chapter Three identifies the resources a teacher could use for this kind of information.)
2. Share school equipment on a cooperative basis with other teachers, both within and outside the department.
3. Replace systematically all of the outmoded laboratory facilities, basing his decisions on realistic depreciation formulas which he has developed.
4. Explore all possibilities of "using" local industrial facilities.

One of the more serious thoughts of James Thurber, author-humorist, gives solace to the teacher who is concerned about the contemporary aspect of industrial arts facilities. Thurber wrote, "Don't look back in anger or look ahead with fear but look around with awareness." The industrial arts teacher must cultivate a constant awareness of how industrial arts facilities should reflect modern industry.

Questions for Evaluation

1. To what extent do the facilities in your industrial arts classrooms or laboratories reflect industrial technology of the 1960's?
2. What action might you, as an industrial arts teacher, take to up-date the facilities in your program?

3. Identify research and development activities for which your students could construct equipment or facilities.
4. How may a teacher seek assistance from industrial personnel in replacing industrial arts equipment?
5. Replacement of equipment by industry is determined by depreciation curves based on *time* and *use.*
   a. How do you and your superintendent or supervisor determine the fair value of industrial arts equipment?
   b. To what extent is your equipment obsolete in terms of its present market value?
   c. What long-range plans have you submitted to your administrator for the purchase of new equipment?

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CHAPTER FIVE

Contemporary Industrial Arts and Teacher Effectiveness

The search for a definitive set of criteria that would differentiate the effective teacher from the ineffective has been, and probably will continue to be, one of the more important areas of educational research. Generally, the methods most commonly employed in teacher evaluation today evolved from practices common many years ago and usually followed movements in industry or psychological research.

To date, the most commonly used techniques for evaluating teachers have been merit ratings, measures of student change, and tests of abilities thought to be necessary for success in the teaching profession. To some extent, each of these techniques has met with a partial degree of success. Usually, however, the results of these evaluations are little better than the subjective evaluations of various segments of society. If these techniques are employed, caution must be used in separating the relevant from the irrelevant when appraising the results.

In this chapter, an attempt is made to discuss the strengths and weaknesses of these evaluative techniques and to speculate on a somewhat different approach to the problem of evaluation. Since the essence of effective teaching seems to lie within the individual rather than in the subject taught, evaluation in a general sense is discussed first, before teacher evaluation in the area of industrial education is explored.

Merit Ratings

The merit ratings commonly associated with teacher evaluation, for the most part, have utilized the rating scale as a device for measurement. Usually these scales have been broadly categorized into two types. The first of these is a *general*, all-inclusive type of rating that attempts to evaluate all aspects of teacher success. The second is a *specialized* type of rating that deals with specific traits, behavioral patterns and qualities that seem to reflect characteristics of a successful teacher. The first of these types is often criticized because it results in a rating that reflects a subjective, personal evaluation which fails to give any consideration to weighing the traits under observation. The second type of rating also is open to criticism because of the haphazard methods used in the selection and weighing of factors used in the evaluation.

Inherent in the use of rating scales are other problems that tend to invalidate the results. One such problem deals with the semantics in scale construction. All too often the use of poorly defined terms and ambiguous words or phrases reduces the objectivity of the scales. This weakness can be partially offset, however, by detailed definitions of all unusual words or by personal conferences with the raters.

A second definite drawback to the use of rating scales is the tendency for the rater to overrate the person being evaluated. This is the often-discussed "halo effect." A follow-up study by Goetsch is an excellent example of this phenomenon. (5, p. 422). In this study, 237 graduates of the Iowa State Teachers College were rated on twenty characteristics related to teaching. The results of this study show thirty percent of the teachers ranking superior, fifty-two percent ranking above average, fifteen percent ranking average, and three percent ranking below average. It would seem that regardless of how well Iowa State is capable of preparing its teachers, the higher end of the continuum definitely is overloaded in this study. Some evidence also points out that the tendency to overrate is proportional to the length of time that the rater has known the ratee. This was shown in a study of teaching success done by Knight. (9, p. 55).

Since there is little common understanding regarding the definition of effectiveness or ineffectiveness in the field of education, rating scales when used as evaluative devices tend to have notoriously low reliabilities. Educators differ greatly in their opinions and biases regarding which traits or characteristics are important. It is not uncommon to find one supervisor or principal who will rate a trait highly desirable for teacher competence while another will rate the same characteristic low. The reliability of rating scales also may be lowered by the change that takes place in the teachers themselves. In some instances, the ineffective teacher of one year may become an effective teacher the next.

Measures of Student Change

If it could be measured accurately and objectively, student change probably would be considered by many educators as the most valid criterion of teacher effectiveness. It must be remembered, however, that validity by its very nature implies at least a moderate degree of reliability, and the reliability of student change, when used as a criterion for measuring teacher effectiveness, has been found to be consistently low. In many important areas of growth, it is virtually impossible to measure student change. In addition to this problem, it is difficult to determine which teacher brought about the desired change, since in today's comprehensive school a given child may be influenced by several teachers each day.

As a criterion for teacher effectiveness, student change also is hampered by the delineation of which changes are desirable and which are undesirable. Some would consider a change from liberal attitudes to a conservative point of view desirable; others would consider a change of this nature undesirable. Similarly, changes in involvement in extra-curricular activities might be viewed as desirable by the teacher, while parents could deem these changes undesirable.

Perhaps the most effective measure of student change is a gain in the mastery of subject matter. Usually this is assessed by the pre- and post-test scores on some sort of standardized achievement tests. At one time, several states based promotion on whether or not students passed these tests. Teachers were then rated by the percentage of failures in their class. Although not prevalent in contemporary education, techniques quite similar to this kind of teacher evaluation still exist in many school systems.

Realizing that factors other than intelligence play a significant part in the amount of subject matter gain that a student may undergo in a given amount of time, modern educators have assessed this gain through a statistical analysis. Regression and similar statistics normally are used in this process. But the results are invalidated by the influence of parents, television, motivation, peer groups, and many other factors which are not measurable.

The use of subject matter gain as a criterion for teacher effectiveness also tends to force teachers to teach toward the material covered in the instrument used for measurement. This is true especially if the teacher knows beforehand that his teaching will be evaluated on the basis of how well his students do on the evaluative instrument. There is also a certain amount of ego involvement on the part of the teacher for his students to do well. A case in point, which is admitted by many secondary teachers, is the slanting of instruction toward the material covered on college entrance examinations.

Ability Tests

While perhaps the fact is redundant, it is nevertheless true that any attempt to assess the effectiveness of teachers must originate from a clearly defined statement that describes the successful teacher. Investigations have shown with discouraging frequency that this is quite difficult if not impossible.

> Two very important reasons why effective and ineffective teachers cannot be described with any assurance are the wide variations in the value concepts, underlying descriptions of desirable teaching objectives and the differences in teacher roles at different educational levels, in different subjects and with different pupils. (11, p. 298).

Furthermore, teacher examinations usually measure professional and subject matter information, mental capacities, cultural status, and professional interests. While these criteria may be important in evaluating a teacher's effectiveness, their measurement, relative to the differential weights each should carry, is still largely subjective and controvertible.

Finally, any kind of ability test must of necessity measure factors that "have been" rather than those that "will be." They work with the past rather than the future. This kind of assessment also tends to categorize and place teachers into certain molds which, to a certain extent, may inhibit creative efforts on the teacher's part. It is also conceivable that the teachers who themselves have been forced into molds, in turn, may try to force their students to conform to a particular pattern.

While the problems of research dealing with teacher evaluation can be appreciated, it still remains difficult to condone the use of invalid and unreliable instruments in practical situations. It is also difficult to imagine the administration of a comprehensive program of teacher evaluation, even if the instruments were infallible. Evaluation would require time, qualified personnel, teacher acceptance of the program, and a reasonable assurance of objectivity. It is also debatable whether or not such a program could result in favorable changes. Tenure laws would tend to prohibit the dismissal of any teacher whose experience and education are sufficient to allow tenure to be granted. Likewise, unfavorable ratings would generate dissatisfaction and low morale among those teachers not qualifying for merit pay increments based on favorable ratings.

The program of teacher evaluation under present circumstances, therefore, seems to be confronted by a threefold dilemma. First, the instruments available for this process are, to a large extent, unreliable. Second, the use of these instruments is time-consuming, and the utilization of their results in practical situations is questionable. Third, the image of effective teaching is a dynamic rather than a static concept that must adapt itself to a changing society as well as alter itself to conform to the various changes in contemporary educational thought.

Traditionally, the evaluation of teachers has been done by some person or persons representing the school administration. Perhaps this as much as any other factor has contributed to the ineffectiveness of the process. Teachers can be told how to teach; they can even be told to teach from a particular outline using a particular book with particular teaching methods, but if any improvement on the status quo is to be made, it must be self-motivated. With this in mind, the central thesis of this chapter advocates a systematic *self-evaluation* by the individual teacher.

Because the teacher may be prone to overestimate or underestimate his abilities, it is further recommended that he be assisted by *another person.* It should be remembered, however, that the position of this second person is that of a guide or sounding board and not of an evaluator. Perhaps the ideal situation for this would be a program that encompasses team teaching, where two teachers who work closely together may constructively criticize each other.

The need for a second person for this type of evaluation becomes increasingly clear with the realization that the teaching process happens *with* somebody and not *to* somebody. Interaction of some sort must preclude all other phases of teaching, for without it the learning process cannot even begin.

Many facets inherent in a systematic self-evaluation should be considered by the teacher before he can begin to assess his effectiveness. First he must define the concept of effectiveness to his satisfaction. He must decide whether this concept is defined: by the attributes of a teacher, by an observation of a teacher in a given situation, by an assessment of the outcomes resulting from instruction, or by all three. Having reached a conclusion on this point, he must then determine the criteria he will use in the evaluation.

Personal-Social Characteristics

All teachers, in varying degrees, have skills in semantics, deductive and inductive reasoning, scientific method, and other abilities necessary for the logical solutions to intellectual problems. These must be applied to the social interaction of the classroom before the teacher can consider himself effective.

> Some of the social skills that seem essential to teaching are: (a) the ability to accept, clarify, and make constructive use of ideas and feelings expressed by pupils; (b) the ability to summarize in a discussion as a method of guiding inquiry; (c) the ability to predict or at least speculate about both the emotional as well as the intellectual consequences of various alternatives when a decision is necessary; (d) the ability to ask questions about feelings and attitudes in such a way that purely defensive responses are avoided; (e) the ability to relate feelings and attitudes to intellectual tasks so that more realistic forces of motivation are created; (f) the ability to develop a sense of timing that is involved in knowing *when* to digress from the intellectual aspects of a task in order to face negative feelings realistically or make fuller use of positive feelings; (g) the ability to ask broad or narrow questions and the insight to predict the consequences of using either; and similar patterns of teacher behavior which are rarely taught in teacher preparation or in-service training courses. (6, p. 27).

As part of a study made by Jensen, a series of social attributes deemed necessary to teacher effectiveness were identified. These attributes were:

1. Shows understanding and sympathy in working with pupils.
2. Is friendly, democratic, and courteous in relationships with pupils.
3. Helps individuals with personal as well as educational problems.
4. Commends effort and gives generous praise for work well done.
5. Is able to anticipate reactions of others in social situations.
6. Encourages others to do their best. (7, p. 80).

In research done by Ryans, it was established that successful teachers were warm, understanding, and friendly. (10, p. 506). It also was established that teachers with favorable opinions of democratic classroom procedures were more effective than those with unfavorable opinions. Ryans also reports that the kinds of teacher behavior most often remembered by people deal with social or personal behavior rather than subject-matter or strictly intellectual traits.

It would seem, therefore, that in any introspective type of evaluation, the teacher must make some assessment of his social and personal behavior. Caution must be used, however, in assessing these characteristics because they are not scaler qualities and, consequently, are not additive. Inadequacies in one behavior cannot be offset by an abundance of another unrelated ability.

It seems reasonable to assume that teacher effectiveness is a composite of several uncorrelated characteristics, each with a minimum cut-off point below which no teacher can be effective. As an example, negativism and suspicion have been found to be minimal in teachers who are outstanding. (2, p. 83). It is plausible then that a teacher who is outstanding in all other respects could be ineffective if he were negative or suspicious beyond a given threshold.

Another aspect of self-evaluation on the part of a teacher might well include his ability to assess the amount of direction or structure a given class will require. Many contemporary educators advocate the unstructured, self-directed type of classroom atmosphere in all situations. Research has shown, however, that by blindly following this philosophy, a teacher could impede his effectiveness. The extent of structure in a classroom seems to have a close relationship with clarity and acceptance of goals. Flanders asserts that when goals are not clear, a greater amount of structure and guidance is necessary. (4, pp. 45-51). It has also been shown by Calvin, Hoffmann, and Harden that the degree of structure in any given situation is influenced by the intellectual ability of the students. Under the conditions present in an unstructured atmosphere, average students were handicapped to some degree while bright students were found to perform best in this situation. (3, p. 66). Clearly, an effective teacher must be one who can judge a given situation and adjust his approach and procedures to gain maximum learning conditions.

Communicative Abilities

Teaching is basically verbal behavior. It is spoken discourse and symbolic expression used in the act of communication of facts, ideas, opinions, and attitudes between the teacher and student. The focus of any communicative act, however, must be on the response. Stevens defines communications "as the discriminatory response of an organism to a stimulus." (12, p. 689). The organism must perceive the stimulus as having meaning to him and, consequently, must do something about it. If the receiver does not perceive the stimulus as having meaning to him, communication does not take place. When there is no response to the message, there has been no communication.

In order for a teacher to determine his effectiveness in communicative skill, he first must understand the seven basic steps or the model in the process of human communications. These basic steps are outlined by Johnson as follows:

A. Organization
   1. Message as conceived—The initiator apprehends, becomes aware of, or conceives the result of his perceptions through his sensory apparatus as filtered through his previous cognitive structure (values, experience, predispositions, etc.).
   2. Message as encoded—The messages previously perceived in the cortex are interpreted and put into symbolic meaning as a code.
   3. Message as transmitted—Physical stimuli sent to the receiver.

B. Media
   Media or carrier through which the receiver can detect the directed stimuli (hearing, seeing, visual, etc.).

C. Receiving
   1. Message as received, much as step one above.
   2. Message as decoded—Receiver translates, interprets stimuli into something meaningful to him. Reverse of two above.
   3. Message as assimilated—Message is incorporated into the consciousness of the receiver. (8, pp. 471-476).

As a diagram, these seven basic steps would appear as shown in Fig. 4.

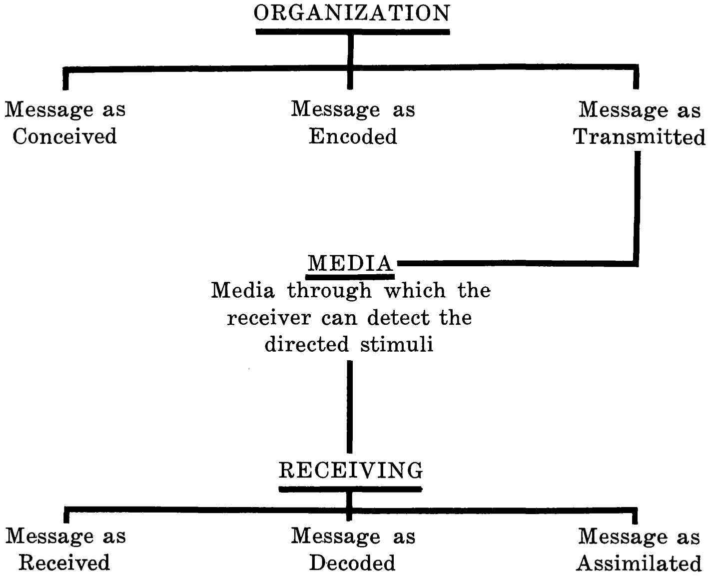

Fig. 4. Seven Basic Steps in Human Communication

This, of course, is only a single communicative act, and it should be noted that the receiver must make some response before it is complete.

While the verbal behavior of a teacher is vitally important to his effectiveness, it also must be remembered that individuals communicate by their physical behavior as well. The overt actions of a teacher can add to or detract from his effectiveness just as easily as his verbal discourse. Facial and bodily expressions often are the deciding factor in accentuating a certain concept to a level where it will be retained by the student. Similarly, actions can be used to show how something is done, as is the case when a coach shows the proper way to hold a golf club. In evaluating this aspect of teaching, the presence of a second person is indispensable.

There are several ways that a discerning teacher can determine the effectiveness of his communicative ability. Student, parental or administrative feedback, the ability of students to follow directions, or behavioral changes on the part of students which reflect the teacher's philosophy—all give the teacher some measure of how well he is communicating.

Perhaps the easiest, quickest, most direct, and most objective technique, however, may be found in the technique of questioning. Traditionally, the questioning technique has been used in both verbal and written forms. Verbal questions can be used during a presentation of new material or as a form of summation. Both offer the teacher an almost immediate source of appraisal for his communicative skills. Written questions usually take the form of a test or a review. An item analysis showing the difficulty and discriminating levels of each question affords statistical proof of the teacher's ability to communicate in writing. In both forms of questioning—oral and written—the extent of the students' accuracy in answering should provide the teacher with a measure of his effectiveness in communication.

Psychological Aspects of Teacher Evaluation

No one should question the proposition that learning theory is basic to the cause of education. Yet studies indicate that many teachers still equate learning with memorization, hard work, habit formation, conditioning, and so forth. In a recent survey of more than one hundred and fifty teachers, Weber asked, "What is your understanding of the nature of the learning process; how, in your opinion, do children learn?" The replies were listed in eight categories shown in the table below. (13, pp. 433-435).

Rank	*Category*	*Number of Replies*	*Percent Giving This Reply*
1	Children learn through drill and repetition.	73	47
2	Children learn by imitating others.	59	38
3	Do not know; had not thought about it.	51	33
4	Children learn by hard work.	40	26
5	Children learn by following directions of teachers.	33	21
6	Children learn by trial and error.	27	17
7	Children learn by maturation.	19	12
8	Miscellaneous.	11	7

While it is undeniable that people may learn by each of the methods listed here, it seems that the effectiveness of a teacher would be greatly reduced if he were to consider any of these as principal methods in the learning process.

A discussion of various theories of learning is beyond the scope of this chapter. Furthermore, no single theory can supply a definitive explanation of how humans learn. However, there are several points on which most educational psychologists agree, and these are the points that a teacher should use in assessing his effectiveness. These points are:

1. That motivation is essential; that learners should desire to learn or learning is not likely to occur.
2. That transfer of training is not likely to happen automatically; transfer of training is more likely to occur if experiences are meaningful in terms of goals of the learners.
3. That mere repetition, or exercise, or drill is not necessarily conducive to learning; but they are likely to be when repetition or drill is experienced because learners see that these activities are related to their goals.
4. That learning is not merely a matter of chance; while learning might be variable, it is usually related to goals or purposes of learners rather than to purposes of teachers.
5. That responses are modified by their consequences; plans of action which seem to propel learners toward their goals are more likely to be learned; those which seem to divert learners from their goals are less likely to be learned.
6. That learning is in part a process of discriminating one situation or plan of action from another in meaningful patterns which are related to the learners' goals. (13, p. 433).

This chapter should not be construed as advocating that teachers all become experts in learning theory. However, it seems likely that an effective teacher is one who believes learning to be something other than the stimulus and response of Pavlov's salivating dogs.

Teacher Evaluation in Industrial Education

A new focus in industrial education which directs the level of instruction at conceptual as well as practical planes seems to be gaining wide acceptance by many outstanding teachers in the field. The time when the effectiveness of a shop teacher could be evaluated by the skill and precision with which his students completed a given project is past. Actually, the concept of project making as a means of achieving the objectives of industrial education is being questioned by many people in positions of leadership. More attention is being given to the skills deemed necessary for effective classroom presentations rather than the skills needed for the manipulative processes of laboratory work. One may ask, therefore, which criteria, other than those mentioned previously, should an industrial educator consider when evaluating his effectiveness?

Valid criteria that lend themselves to teacher evaluation in a specific teaching area, in most cases, will be found in the content, methodology, techniques, innovations, and practices that are peculiar to that area. In the area of industrial education, therefore, criteria useful in teacher evaluation must in some way be characteristic of the various phases of modern industry. In turning to this part of society to determine which aspects of industry lend themselves to criteria suitable for a self-evaluation of his teaching effectiveness, the industrial educator must eliminate the specifics in favor of elements that are common to all industry. While it is not the purpose of this chapter to compile an exhaustive list of these elements, a few will be noted, and their relevance as possible criteria will be discussed.

One aspect of our modern industrial complex that seems to lend itself as a criterion for teacher evaluation is the ability of industry *to adapt* quickly to changing conditions. Similarly, the industrial educator, if he is to be effective, must be an open-minded individual capable of examining the ideas of others, experimenting with these ideas in his classes, and then altering his teaching to incorporate that which he feels will lead to better understanding on the part of his students. Those who have not made significant changes in teaching methodology in the past five years need to examine themselves in light of this criterion. Industrial arts teachers finally have reached a point where they consider the squaring of a block or the recognition of obsolete tools absurd.

A second aspect of modern industry that could serve as a criterion for assessing the effectiveness of an industrial educator is its *organizational competency.* While this criterion could be utilized in evaluating all school personnel, the equipment and supplies necessary for adequate industrial education programs make organizational ability especially relevant for assessing teacher effectiveness in this area. Furthermore, the nature of instruction in industrial education, where transitions must be made from practical to conceptual planes, demands a higher level of organizational skill than in most of the other teaching disciplines. This is especially true if units in mass production are incorporated in the teacher's plan of instruction.

A third aspect of today's industry that might be used as a criterion by industrial educators who are interested in determining their effectiveness as teachers is the *creative thought* with which industry approaches various problems. As was the case in organizational ability, creativeness, as a criterion for ascertaining teaching effectiveness, could be used by all teachers. It is especially apropos of the area of industrial education where thought is expressed in the planning, execution, and evaluation of some tangible object.

There are other aspects of modern industry that could serve equally well as criteria for evaluating teacher effectiveness in industrial education. *Knowledge and utilization of new materials, awareness of new trends in design,* and *consciousness of occupational trends* are some of these. The point to be made is that criteria for evaluation are available—but only to those teachers who are honestly interested in some sort of program of self-improvement.

In summary, it should be noted again that the effectiveness of classroom teaching is a measurable variable, but that the instruments used to measure it leave much to be desired. Furthermore, measurement of this variable is meaningless unless it is accompanied by some attempt toward improvement. This, in turn, must be self-motivated. It seems logical to assume, therefore, that the only type of effective teacher evaluation must be introspective and continuous in nature. The teacher must select his own criteria, develop his own scales for measurement, assess honestly the variables under consideration, and try not to rationalize the results.

Questions for Evaluation

1. What characteristics of an effective teacher do you consider important?
2. Which of the above characteristics do you have? Are there any that you think you lack?
3. What changes have you made in your methods of teaching during the past five years? What sense of achieve-

ment did you gain through these changes? Were some of these changes unproductive? Why?

4. What changes do you now contemplate making in your methodology in order to improve the "climate for learning" in your classroom?
5. Identify your professional contributions to industrial education in the past year.
6. How do your professional contributions compare with those of your fellow teachers?

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CHAPTER SIX

Implications for Student Growth

The foregoing chapters in this yearbook have described what may be considered a contemporary look in the industrial arts program with special attention to approaches, activities, resources, facilities and teacher effectiveness. There are many advantages to this kind of contemporary program, designed to foster student growth. A modern industrial arts program should help the student acquire special skills and attitudes that are essential in contemporary American industry with its multiplicity of materials and processes. A modern program should engender attitudes of empathy toward fellow workers. A good program should encourage a willingness to accept the many inevitable changes in the world of work—changes in vocations, in location, in application of time, and even in the social order in which one lives. This chapter emphasizes those phases of the modern program that foster in students many unique skills and special attitudes needed in contemporary industry and society.

Accuracy and Speed in Skill

One of the most controverted objectives of industrial arts throughout the relatively short history of the field has been skill development. Primarily, the controversy has centered on the extent of manual expertness with which a student is able to demonstrate the performance of a technical task. With regard to this objective, differences of opinion have increased in proportion to the increase in the use of new materials and in the use of improved processes for shaping them.

Obviously, a mathematics teacher might be rated ineffective if his students, upon completion of his course, could not apply numerical symbols to common problems of life. Equally, an industrial arts teacher might be considered ineffective if his students could not relate equipment usage to tangible problems in the home and elsewhere. The degree of competence is a question that persistently haunts the industrial arts teacher. To what extent should students be able to use tools and instruments after completing a given level of instruction? How much knowledge should students have about technical materials and products and processes needed daily?

There was a time when industrial arts educators felt that the student was proficient if he could perform a series of operations common to any given trade. Repetition of the operation became the method of developing competency and reinforcing mastery. As a result, instruction in industrial arts was fragmented through an overemphasis upon specific operations.

Now, there seems to be considerable evidence that repetition is not effective. One of the more recent presentations challenging the value of repetition is a report by Harold Stevenson at the Working Conference on Research on Children's Learning, Harvard University, 1963. (19, p. 24). In this report, Stevenson points out that "the readiness to repeat a response appears to vary negatively with the amount of effort or time required . . . ." He adds that an excessive amount of time spent on this fragmentary approach actually impedes the development of creativity in the innately curious students.

Skills involve two essential elements: *exactness* and *speed.* It is important to remember that these two elements should be balanced appropriately in any situation. This balance is a value judgement dependent upon the nature of the task. Consider, for example, the person who in aspiring for exactness spent several hours daily for a year overhauling a one-cylinder gasoline engine. When the overhaul was completed, the engine was in perfect condition. Yet, one could not call this person a skilled mechanic. His accuracy and exactness were praiseworthy, for these are traits which have high priority in this country's technological society. However, in this particular task, the amount of time he spent in the accomplishment of exactness was unreasonable.

Likewise, a magnetic inspection of highly stressed parts of a one-cylinder gasoline engine in an effort to locate possible (but improbable) internal cracks would not be justified for lawn mowers undergoing repair. On the other hand, such an inspection would be absolutely essential for an engine on a light aircraft. Not only is such an inspection required by the Federal Aviation Agency, but it also is really a moral responsibility. People in a carelessly maintained aircraft might lose their lives if the engine should fail because of an internal crack in a crucial part. The aerospace industry emphasizes that "accuracy is everything." In fact, aerospace companies maintain measurement standards laboratories which are patterned after those maintained by the National Bureau of Standards, because accurately calibrated tools are essential in making and assembling the hardware for aircraft. Calibrated test equipment is used to determine whether the manufactured hardware meets quality and reliability specifications. (1, p. 13).

The second aspect of *skill* is speed in performing the technical processes. If service personnel, responsible for repairing industrial products, were to be indiscreet in the thoroughness required, the cost of repair would be prohibitive. The willingness to make value judgements in regard to the relationship of speed and thoroughness represents an attitude which contemporary industrial arts teachers should encourage among students.

Speed is further affected by competency to perform a task in an orderly manner. This involves seeing the task in its totality and determining the most effective procedure in performing it.

In the past, industrial arts teachers emphasized a prescribed list of tool and machine operations and insisted on accuracy in the performance of these operations. They were willing to overlook the time element involved. As a result, the students, stultified in their resourcefulness by prescribed requirements, lost sight of the totality of the task, placed undue value on a multitude of operations, and ignored the resulting imbalance of accuracy and speed. Now, however, in today's high-powered technological society, a program that produces this imbalance of accuracy and speed is obsolete.

The New Skills

There is today a new skill that allows a student to move quickly and accurately (and almost habitually) through a mechanical process but requires the student to face new problems. This new skill is the *skill of resourcefulness.* Resourcefulness implies the ability to deal competently and confidently with new problems, resolving them in the most effective manner. From the teacher's standpoint, this skill is developed through a process *not of preaching but of practice.* It is as much an attitude as it is an ability. This new skill demands conceptualizing rather than a simple accumulating of facts. This skill, acquired in a special "climate of inquiry," must be created by the industrial arts teacher—not mechanistically, but naturally. The *teacher himself* should possess this skill.

An individual's resourcefulness is an attribute that defies obsolescence. Even though the technological operations of industry may change at an accelerated pace, this quality of resourcefulness is a constant, enabling an individual to make adequate adjustments and provide stable leadership in bringing about change.

Characteristic of the student who possesses the skill of resourcefulness is his willingness to accept new ideas. He not only welcomes new ideas, but he also contributes them in a total class activity. It is important for the teacher to "remember that an idea may be original for a student even if it is not truly original in the sense that nobody had it before." (8, p. 5). Hilgard illustrates this point by saying, "I have known professors so eager to impress students with their knowledge of the history of the subject that as soon as a student says something original, they top it by saying, 'You can find the same thing in William James.' This may be said in such a way as to put the student in the company of a great mind or slap him down as an ignoramus. How much better to say, 'What a good idea—why don't you see if you can develop it a little further?' " (8, p. 6). In the industrial arts laboratory, these new ideas would be for the most part technical in nature. This skill expresses itself in inventiveness. Where possible, the alert teacher will encourage activities which "become the nucleus of a program to train students to think, observe, and develop the ability to coordinate their thoughts with facts in the production of ideas." (9, p. 21).

Another important procedural skill closely akin to resourcefulness is the *skill of attacking and solving new problems.* These problem-solving skills are indispensable in this contemporary technological world. Yet, as recently as today, some industrial arts teachers have continued to encourage only prescribed procedural skills such as the orderly six-point procedure of "surface, edge, end, end, edge, surface" in squaring a board. (5, pp. 120-123). Fortunately, many of today's truly progressive teachers go beyond such simple procedures and focus on skills in solving new technical problems. These teachers provide an instructional atmosphere which tests problem-solving skills. During a unit, these teachers in observing and evaluating students ask:

1. Can the student identify or articulate an individual or group problem?
2. To what extent is the student able to analyze the problem in terms of individual elements which have to be eliminated one at a time?
3. Is the student able to hypothesize tentative solutions and eliminate irrelevant facts?
4. Can the student be decisive in identifying or selecting what appears to be the best solution?
5. Can the student do the necessary construction or make necessary repairs in solving the problem?
6. Can the student habitually evaluate the solution in order to determine if this was the best solution?

Here is how one resourceful industrial arts teacher created in his junior high school class an instructional atmosphere that provided experiences in problem solving. On this particular occasion, his class, having been grouped into competitive teams of three students each, decided on a common problem of spanning a given space with a structure having the highest possible strength-per-weight ratio.

Each of these teams had to express the problem clearly and distinctly in order to proceed with the solution. Second, in the analysis of the problem, each team considered vast numbers of materials which were available for use, methods of geometrically arranging these materials to increase strength, and methods of joining the materials. Third, each team identified, examined and finally rejected some of the materials and methods of joining. In some instances, they made crude models to assist themselves in this elimination process. Moreover, considerable research took place during this third step. Fourth, in the interest of time, they exercised the best judgement possible in identifying a planned final solution. Fifth, as quickly and as accurately as possible, they constructed a bridge to span the simulated chasm. Sixth, and finally, the teams, testing the models for the winning bridge, weighed their own models and tested them for strength while the competing teams looked on enthusiastically. Evaluation was made with student-improvised testing equipment—a bathroom scale and a drill press. Obviously, this kind of problem-solving project could provoke the epitome of student and teacher resourcefulness.

Attitudes of Cooperation, Tolerance, and Self-Respect

The informality of the industrial arts laboratory allows for experiences that produce attitudes of cooperation and respect. Contemporary approaches in industrial arts give students many opportunities to work together, to share ideas, to resolve conflicts over ideas, to compromise, to arrive at a concensus, and to practice tolerance.

Moreover, these contemporary approaches encourage repeated evaluation. Evaluation, in turn, requires some degree of self-analysis and self-criticism. Whenever a student discovers something praiseworthy in his own contributions to the group effort, he learns to respect himself. Contemporary approaches skillfully make this self-discovery possible and enable a student to construct for himself an acceptable self-image.

The teacher in this process must make one sacrifice. In an instructional setting where time is needed to resolve conflicts in ideas, there is less time for construction, maintenance, or experimental activities. "For one thing, problem solutions cannot be hurried. Ideas can be encouraged and welcomed and they will come in their own time. Thus, time for reflection is essential, and emphasis on speed of response can hardly be regarded as . . . good." (7, p. 61). The teacher who is not accustomed to employing contemporary approaches in his teaching of industrial arts might hesitate to "sacrifice" construction time. He might find it necessary to make this important adjustment in his own thinking before he is willing to allow plenty of time for problem-solving experiences.

It is also difficult to evaluate the progress of attitudinal changes in regard to cooperation, respect, self-reliance, and initiative. Fuzak (4) and Schemick (17) have developed techniques for measuring such attitudinal progress, but their evaluation methods (although reliable) are difficult to use in a classroom situation. Therefore, it is very important that a teacher intuitively evaluate the progress in attitudinal change not so much with instruments as subjectively on a continuous basis.

Materials, Processes, and Principles

What can be expected of industrial arts students in regard to a knowledge of and the ability to use industrial materials, processes, and principles? The students today have to know more about these matters than did their counterparts even a decade ago. These materials, processes, and principles are increasing at an accelerated rate, and it is logical that the students need to learn about the developments in a relatively short time. Yet many city- or state-approved courses and outlines engender a specificity of knowledge and a curricular confinement, antithetical to the demands of this expanded learning. These courses of study are prepared by earnest and sincere industrial arts educators who predetermine what the student "ought to know" and "be able to do" on the basis of their own past experiences in teaching in the industrial arts shops, rather than on the basis of their intimate knowledge of industrial practices.

Unfortunately, these courses of study tend to preserve the status quo. Even beginning teachers tend to depend on these prescriptive outlines because they regard such courses of study as authoritative and wish to conform to what seems to be expected of them.

The progressive industrial arts teacher would not clamp this kind of prescriptive barrier over the knowledge his students may acquire. If he expects to stimulate his students toward creative and productive thinking and independent action in regard to technical problems, the teacher must provide ways of liberating thought and action and allow students to learn "on their own." Calvin W. Taylor, a renowned psychologist who has done considerable scientific research for NASA, adds credence to the independent-learning point of view by the following observation in a recent report:

> One of our strongest suggestions to education is not to prescribe for students just more of the same. More of the same says we should lengthen the school week, add more weeks to the school year, and so on, but still

keep doing the same things. Let me give you one item from our biographical inventory used on Space Agency scientists that hints at what underlies this suggestion of ours. When the mature scientists were asked to reflect back on what happened when they were in school, the more creative ones said they learned more when they learned something on their own, something they were interested in, rather than when they learned either something presented in the classroom as part of the regular curriculum or something the teacher had assigned. Our thoughts are that there are additional kinds of learning and a wider variety of thinking that students should experience in education. Certainly we should not swamp the students' time to the extent that they cannot go out and do some of this other important learning on their own. (21, p. 250).

In this contemporary period can the industrial arts teacher play the role of Solomon? Can he profess wisdom to such an extent that he knows beforehand what the student should know and be able to do during a given period of time in an industrial arts course? No! It is doubtful that the most proficient industrial arts teacher in this decade has enough insight into the near-future requirements of his students to be so presumptuous. Such presumption would stifle both creativity and learning. Taylor emphasizes this point further:

On the challenging topic of the relation between knowledge and creativity, I obtained the following idea from one of my students, and I have merely been capable of making minor elaborations of it. He drew two concentric circles, sketching the outer circle with dotted lines, and said, "Let this outer circle represent all that man knows collectively. And let the smaller inner circle be one person's particular body of knowledge." For the moment, let us say that the smaller circle is a particular teacher's knowledge. For this teacher the smaller circle has been drawn right in the middle of the total body of knowledge; it represents the most firmly established body of knowledge—the safest body of knowledge. This teacher has not been involved in working with or accumulating any knowledge out in the fringe area.

One of the characteristics of the creatives is that they are striving for better and more comprehensive answers. If one of the students in this teacher's class, while growing in knowledge, starts to grow outside the teacher's circle but still in the same field of knowledge, what then? Let's not deny it, this really can happen whenever students are striving in a climate favorable to creativity.

Another interesting question is, how does one use this existing knowledge to be creative? One possibility is that we have to move somehow out to the fringe of knowledge. To what degree are we deliberately leading our students out to the fringe so they will have experience with the "leading edge" of knowledge and with knowledge at the different stages of development? To what degree are our students getting out to the fringe and having the experience of working out at this very fuzzy edge and learning what it's like out there? Stated in a very abstract way, what I would think is the relation between knowledge and creativity is this: To be creative in a field, one needs to be able to get out to the edge of knowledge, to know where he is, and to function successfully there to move forward the frontiers of knowledge. (21, pp. 256-257).

The student who is the "product" of contemporary industrial arts experiences centering around problems may have a greater knowledge of a broader range of materials and technical principles. He may be more discerning in regard to technical processes which are appropriate for a given occasion. Contrast the student who is given a blueprint for making a hammer with one who is given the problem of making a hammer. The first student is told the exact dimensions and the type of metal. Frequently he is given even the procedure for producing this hammer. The second student is expected to explore a broad range of materials from which he chooses one or more. In this selection process, he learns incidentally the characteristics of several metals and discovers that metals are described in terms of selected properties. He discovers in choosing a metal for the hammer head that he has to evaluate the material in terms of machinability, hardness, density, toughness, and similar properties. He thinks of these properties in terms of the intended use of the hammer. If the hammer must withstand great impact, he needs to investigate carbon and alloy steels which may be hardened to a great extent and yet possess a high degree of toughness as an assurance against shattering. If the hammer is designed to strike objects which should not be marred, he needs to investigate a group of nonferrous metals and alloys as well as synthetic materials and leather.

To learn about leverage and gripping effectiveness, the student uses the same investigative procedures he used in determining the material. Moreover, he has to evaluate methods of assembling the handle and head.

The first student might study a single, assigned lesson describing the characteristics of metals. In comparison, the second student, who must investigate many characteristics of metals and other materials on his own, obviously will learn more than the first student about materials and processes.

Another example can be cited in reference to the learning of principles. Students faced with the problem of repairing the outboard power plant for a small boat may follow the manufacturer's manuals in the disassembly, replacement of parts, and reassembly. However, to understand the problem, it is essential for them to know the principles of power development and transmission. These principles may be taught in an isolated lesson or two without an outboard engine in sight. But the students who must explore the principles related to the problem will learn more extensively and more effectively. Not only will they understand *how* the distributor and carburetor are adjusted, but they will know *why* these adjustments are necessary. These students may even discover ways to improve the design of such an engine!

Response to Change

Change is inevitable; it is the essence of history. The paradox in this statement is the fact that human nature seems to resist change because it creates a feeling of insecurity and frustration. It would seem that organized education is mandated to break down resistance to change. Or to express it differently, students as a result of their experiences in school must develop an attitude of accepting and coping with change — indeed, providing leadership in bringing it about in an orderly manner.

It should be emphasized that change and progress are not always synonymous terms. Many persons would agree that the annual changes by automotive manufacturers do not always represent progress. Often the changes are in the body form to improve the appearance, at least in the opinion of some designer. Such a change does not improve the function of the automobile. In fact, some of the changes in design have increased the accident rates on the nation's highways. Today a rebelling population is demanding improved safety features along with the new designs.

The National Commission on Technology, Automation, and Economic Progress reports that there is much evidence of change in our industrial society today. In the year 1964, forty-two million people left the labor force permanently or temporarily, while forty-three million others entered or reentered the labor force of this country. Of the total labor force of seventy-four million people, eight million or more changed jobs for one reason or another during the same year. (10, p. 17). These data do not include the more subtle changes in jobs and job content which are going on continually within companies and industries.

The Commission goes on to emphasize the following:

> In the coming "post-industrial society," a man may have to go through two or three work cycles of retraining or of new careers because of the continuing needs for new skills to keep abreast of new technologies and new intellectual techniques. Education for change has become a new watchword, almost a new cliche of the time. (10, p. 90).

In his first step toward confronting these realities, the thoughtful industrial arts teacher must look introspectively at the approach he is using in his classes. In the light of this new watchword, "education for change," the "thing-making" approach falls short in helping students develop attitudes which will enable them to cope with inevitable vocational changes in the future. The teacher who provides his students with blueprints or drawings out of magazines for projects may create a comfortable classroom situation for his students and himself by this orderly procedure. This comfortable atmosphere, though, is contrary to the frustrations that are associated with the vocational changes that the students must experience throughout their lifetime.

The empty-shop concept, described in Chapter Four of this yearbook, where students would arrange facilities and equipment for most effective production of a commodity of their choice, is one example of the type of approach which more adequately prepares students to respond to change. Three or four times during the year as new products are introduced for manufacture, students would experience the discomfort of a shutdown and re-tooling. They would learn the importance of rearranging a new line of equipment and feel the force of adjusting to a new assignment in their new firm. In addition to the mental activity of acquiring facts, this involvement in change would provide the emotional interaction which is the second element of a learning experience.

Further data indicate that in 1964, "about one out of fifteen persons moved his place of residence" as a result of vocational changes. (10, p. 17). Acutely aware of problems inherent in this mobility, the Commission assumed the obligation of recommending to management, labor, and government agencies ways to "facilitate occupational adjustment and geographic mobility." (10, p. 33). These agencies, directly concerned with the present labor force, must fully accept the fact that "constant displacement is the price of a dynamic economy" and should take enlightened measures to help the labor force accept this fact also.

Many of the students enrolled in industrial arts classes will choose vocations in industry. It is imperative, therefore, that the industrial arts teacher prepare his students, the labor force of tomorrow, for changes in an industrial society. Although the mobility of the labor force cannot be simulated to a great extent in the classroom, the students should discuss some of the problems intrinsic in vocational change. It ought to be easier to cultivate acceptance of change among students than it has been to cultivate this attitude among adults, anxious about constant displacement in their world of work.

The students also should study in industrial arts classes information about many occupations described in the *Dictionary of Occupational Titles*. They should identify, as well, the many opportunities in foreign countries brought about by a rapid expansion of the world market and its associated technological developments.

In addition to the certainty of change in both vocation and location, there is equal certainty of change in the application of one's time in the years ahead. As automation in the production of goods increases, the length of the workweek will decrease inversely. In recent years, automation has led to not only a reduced workweek but also an earlier retirement age. Moreover, the significantly longer life span of workers compounds the need for the industrial arts teacher to give attention to the problems involved in leisure time pursuits. News media and other channels of communication bulge daily with evidence that many people do not know how to use their leisure time constructively. These people, particularly those in heavily industrialized areas where large numbers of the working force have increased leisure time, need to find outlets in recreational activities developed within the industrial arts program.

The worthiness of any approach used in the teaching of industrial arts must be evaluated introspectively in terms of how effectively the approach caused students to become resourceful in dealing with new problems; knowledgeable about materials, processes, and principles of technology; respectful of their own and other's ideas; and responsive to innovation with a minimum of frustration and fumbling.

The degree to which such student growth could take place depends primarily on the classroom environment developed by the teacher. Realistically, the teacher should recognize that the task of manipulating the learning climate is unending and complex and even frustrating. Confronting this monumental task, the teacher would be wise to follow Dag Hammarskjold's advice:

> Never measure the height of a mountain until you have reached the top. Then you will see how low it was. (6, p. 7).

Questions for Evaluation

1. To what extent do you provide students with opportunities to develop resourcefulness in your classes?
2. To develop an understanding and insight of American industry is considered to be an objective unique to industrial arts. Identify specific activities of your program which are directed toward this objective.
3. Hilgard refers to a classroom atmosphere where "what happens is *caught* rather than *taught*." What is the role of the teacher in such a classroom?
4. What activities in your industrial arts classes alert your students to the need to prepare for and accept the changes which take place regularly in modern industry?
5. What provisions have you made in your industrial arts classes for students to "learn something on their own?"
6. What specific content in your courses of study do you believe all industrial arts students should learn?
7. List the criteria you use when selecting industrial arts content which should be learned by every student.

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CHAPTER SEVEN

The Functional Evaluating Team

Up to this point in the yearbook, the teacher has been identified as the prime evaluator of his industrial arts program. Indeed, the teacher is the person closest to the product of the program, namely the student. At the same time because "no man is an island unto himself" when it comes to effective evaluation, "it is unwise, and not particularly courageous, to thrust the whole burden of evaluation upon a harried classroom teacher." (3, p. 306). For this reason, other persons related in some way to the industrial arts program ought to participate in evaluation. With an appropriate kind of group involvement, the measuring process increases in reliability and scope. The teacher when evaluating alone may be likened to an hour glass, which measures with a reasonable degree of accuracy one hour of time. But a group of evaluators may be symbolized as an advanced electronic timer which adds credence to the hour-glass measurement and perhaps measures a greater span of time.

Therefore, for a more complete analysis of any industrial arts program, whether it be extensive (as in a large school) or limited, it is suggested that a team be assigned the task of evaluation. This evaluation team should direct its attention to three distinct categories in the following order: students, curriculum, and facility. The members of the team should examine these aspects of the program systematically, giving the students their first and closest consideration. Obviously, without students, there would be no program. Next, they should assess the strengths of the curriculum and note the kinds of carefully planned learning experiences that challenge students, the approaches that help students reach their educational potential, and the skills and attitudes that demonstrate student growth. Finally, these evaluators should determine if the facilities include some contemporary industrial equipment and support a dynamic curriculum.

Who Evaluates and How

At least seven evaluators from within and outside the school could serve as a functional evaluation team. (See Fig. 5.) The role each of these persons would play would vary. Thus it would be impossible to place the personnel on the evaluation team in rank order in regard to their contribution to the total evaluative process. It would seem logical, however, to place *students* first on this list of evaluators in order to reemphasize the concept that students are the most important part of the program.

Students

Of course, some critics, who find the idea of using students for evaluation a revolutionary one, may say, "How can students in their immaturity contribute to evaluation?" Actually, students are competent in evaluating some aspects of their own program. For one thing, they should conduct individually a periodic self-evaluation of their progress in the acquisition and application of technical skills and knowledge. Similarly, they should rate their peers with regard to these same capabilities.

Furthermore, students should be invited to provide ideas which would assist the progressive industrial arts teacher in enriching his courses. In regard to laboratory activities, such as the mass production of student-planned products, all students should be involved in the final evaluation of such a unit. Many students through their contacts outside the school are well acquainted with industrial equipment and should share this information when it relates to facility evaluation. They should be allowed to assess the facilities, to report the needs for special equipment, and even to construct some equipment. (See Chapter Four on student-constructed facilities.)

Teacher

Traditionally, the industrial arts teacher evaluates his *students* on the basis of written tests and project construction. The alert teacher also should use performance tests which consist essentially of problems to be solved in a given period of time.

Moreover, he should evaluate desired attitudinal changes in his students intuitively. He should consider oral and written reports as a significant part of student activity in an industrial arts program, and he should examine these reports for additional clues on the educational progress of his students.

The industrial arts teacher should evaluate his *curricula* on a continuing basis because he is responsible for originating and revising these curricula. The curriculum evaluation should encompass a three-dimensional framework: student interest and need, current industrial practice, and modern educational thought.

As an evaluator of instructional *equipment,* the teacher must systematically check equipment for obsolescence and endorse regular replacement. He should inspect continuously new types of equipment with an eye to updating his laboratory and program. He should assess the extent to which the open-door policy induces a flexible use of industrial arts equipment and should take positive steps to increase this flexibility. He should help identify the need for supplementary facilities, and he should stimulate his students to design and construct those facilities.

Principal

The administrative duties of the principal should include his acting in an advisory role in the evaluation of the industrial arts program. From an administrator's vantage point, he might be able to compare the educational growth of students in industrial arts classes with student growth in other areas of the total school program. In the role of an evaluator, the principal would be qualified to measure the extent of integration of curricular areas and to observe the interdepartmental use of equipment by the students. In his administrative function, he would be able to support the teacher in effecting a long-range plan for repair and replacement of instructional equipment.

Other Teachers

When team teaching occurs within the industrial arts department or across departmental lines, other teachers should evaluate the industrial arts students. These same teachers from other areas of instruction likewise must evaluate at least that part of the industrial arts curriculum which is integrated with theirs. Also, because they will be sharing facilities with the

Evaluated Elements	*E V A L U A T I O N*		
	Students	*Teacher*	*Principal*
Student	Evaluate self Evaluate peers	Evaluates performance and written tests Evaluates oral and written reports Observes student growth	Observes student growth
Curriculum	Contribute ideas for program activities Assist teacher with course planning	Originates courses of study Revises courses of study	Encourages integration of curriculum areas
Facility	Identify and recommend new equipment	Prepares systematic replacement schedule Identifies new equipment Observes open-door policy Encourages construction by students	Recommends systematic replacement within school Alerts teacher to new equipment Supports "cross-pollination" of equipment and laboratories

Fig. 5. Analysis of Evaluating Personnel and

T E A M			
Other Teachers	*Area Supervisor*	*State Supervisor*	*Advisory Board*
,imited ›bservation of ;tudent growth	Incidental observation of student growth	Incidental observation of student growth	Incidental observation of student growth
;upport integra- ;ion of course ;ontent with ndustrial arts ›rogram, *e.g.*, lesign, scientific ›rinciples, report vriting, economic ›rinciples	Assists in curriculum implementation Coordinates courses of study Encourages contemporary patterns	Promotes appropriate evaluation procedures	Incidental observation
₹ecognize open- loor policy ,imited assessment of equipment	Supports systematic replacement schedule within school and equipment pool Alerts teachers to new equipment	Identifies new types of equipment and other facilities Endorses systematic replacement	Supports systematic replacement schedule Identifies and recommends new types of industrial-related equipment

Evaluation Activities for Industrial Arts industrial arts teachers, they obviously should evaluate the equipment used in team teaching.

Not only should evaluation of the industrial arts program be the responsibility of personnel within a given school, but it also should be the responsibility of personnel, such as city and state supervisors of industrial arts and even advisory boards of laymen.

Supervisors

Area supervisors should assist teachers in securing and using appropriate techniques for student evaluation. This help should be extended particularly to beginning teachers who more than others need assistance in selecting appropriate evaluation devices. This area supervisor should be concerned with the quality of the total industrial arts program of the city; at the same time, he should want to preserve the uniqueness of each teacher's effort. Whenever he helps the teacher realize how uniqueness contributes to the overall curricular image, he is evaluating the curriculum. Because the supervisor is not teaching five or six classes a day, he has time to talk with manufacturers about new developments and to examine many types of new equipment. More knowledgeable than the classroom teacher, the supervisor should advise all teachers about updating their own facilities.

Although remote in his position in reference to the classroom teacher, the *state supervisor* has an important evaluative role that does affect the classroom. He should provide the evaluative leadership to councils and committees of professional industrial arts personnel from different geographic regions and all grade levels. To accomplish perpetual evaluation and improvement in industrial arts programs, he should conduct special studies on curriculum areas, equipment, and facilities.

Advisory Board

An advisory board of laymen could make its greatest contribution in evaluating the physical facilities of industrial arts instruction. This assumes that the board is composed of people from those aspects of industry which relate directly to industrial arts education. Some of these people could serve as consultants on building construction; others might advise as specialists on machinery; still others could assist as management experts in the development of systematic depreciation techniques for instructional equipment. Probably all these persons would have wider contacts than any school personnel in locating equipment useful in teaching industrial arts. They could be of inestimable help in the evaluation process.

Evaluation of all elements of the industrial arts program should be continuous and should involve students and professional people at various levels. Nevertheless, the primary responsibility for this never-ending assessment rests with the teacher.

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Epilog

Evaluation Guidelines for Contemporary Industrial Arts Programs seeks to challenge persons concerned with the teaching of industrial arts during these final decades of the twentieth century. The effectiveness of the challenge can be measured only by the extent to which teachers accept the challenge and make a continuous effort to improve their own program.

In the total educational complex, industrial arts makes claim to being the representative of aspects of industry in a vast society where all change is transient, meteoric, inevitable. If this representation is to remain an authentic one, it is imperative that industrial arts programs change through the efforts of teachers who accept their responsibility to youth.

John Donne, the famous seventeenth century poet and preacher, focused his analytical eye on his own role in mankind. Between hope and disillusionment, he saw himself not removed from man but a part of mankind. In one of his sermons he wrote:

> No man is an Iland, intire of itself; every man is a peece of the Continent, a part of the maine; if a Clod be washed away by the Sea, Europe is the lesse, as well as if a Promontorie were, as well as if a Manor of thy friends or of thine own were. Any man's death diminishes me, because I am involved in Mankind. And therefore never send to know for whom the bell tolls. It tolls for thee.[1]

The industrial arts teacher also is no island unto himself. He is a piece of the entire profession. Any failure to keep indus-

[1] Louis Untermeyer, *Lives of the Poets*. (New York: Simon and Schuster), 1959, p. 127.

trial arts programs representative of contemporary industrial society becomes the failure of all and diminishes all of the profession. Therefore, he should "never send to know for whom the bell tolls." It tolls for many. It tolls for students, busy squaring boards instead of discovering an exciting industrial world; it tolls for the teacher, lost in the process of emphasizing antiquated skills and obsolete facts; it tolls for the principal with his myopic concern for class schedules and faculty reports; it tolls for the supervisor, focusing on administrative details rather than on a climate for learning; it tolls for the board member, allergic to repercussions of increased tax rates; it tolls for the teacher educator, oblivious to technological developments outside his ivory tower. It tolls for anyone who diminishes the program.

The guidelines described in this yearbook are ideals, and like all ideals they are difficult to reach. However, positive direction will result through a sincere striving toward these ideals.

> Ideals are like stars; you will not succeed in touching them with your hands. But like the seafaring man on the desert of waters, you choose them as your guides, and following them you will reach your destiny.[2]

[2]Carl Schurz, Address, Faneuil Hall, Boston, April 18, 1859.

Index