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AN INDUSTRIAL ARTS CURRICULUM PROJECT FOR THE JUNIOR HIGH SCHOOL.

BY- TOWERS, EDWARD R.
OHIO STATE UNIV., COLUMBUS

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DESCRIPTORS- *INDUSTRIAL ARTS, CURRICULUM DEVELOPMENT, *CURRICULUM RESEARCH, *INDUSTRY, *EDUCATIONAL OBJECTIVES, *EDUCATIONAL THEORIES, COURSE ORGANIZATION, GRADE 7, GRADE 8, LITERATURE REVIEWS, INDUSTRIAL ARTS CURRICULUM PROJECT, PRAXIOLOGY, INDUSTRIAL TECHNOLOGY,

THE GENERAL PURPOSE OF THE PROJECT IS TO EFFECT CURRICULUM CHANGE IN INDUSTRIAL ARTS. DURING THE FIRST PHASE, COVERED BY THIS REPORT, EFFORTS WERE DIRECTED TOWARD CONCEPTUALIZING A STRUCTURE OF INDUSTRY AS A BASIS FOR CONTENT IN INDUSTRIAL ARTS, AND TRANSLATING THIS STRUCTURE INTO A SYLLABUS WHICH OUTLINES A JUNIOR HIGH SCHOOL PROGRAM OF INDUSTRIAL ARTS. TO ACCOMPLISH THESE IT WAS NECESSARY TO DEVELOP A RATIONALE WHICH WAS REVISED AS A RESULT OF CONSIDERATION BY AN ADVISORY COMMITTEE, TASK FORCE GROUPS, AND RESPONSES FROM 100 LEADERS IN EDUCATION WHO ANSWERED A DETAILED QUESTIONNAIRE. THE RESULTING RATIONALE (VT 003 203) WAS USED IN DISSEMINATION LECTURES. FEEDBACK FROM THESE WAS A DETERMINANT IN DEVELOPING DAILY INSTRUCTIONAL OBJECTIVES (VT 003 202), A TEACHING PROGRAM FOR "INDUSTRIAL TECHNOLOGY, THE WORLD OF CONSTRUCTION" (VT 003 210), AND A DETAILED OUTLINE OF THE STUDENT'S READING ASSIGNMENTS FOR THE FIRST YEAR OF THE PROGRAM (VT 003 204). A COPY OF THE RATING SCALE USED IN SOME OF THE DISSEMINATION SESSIONS AND A SUMMARY OF RESULTS ARE INCLUDED. (EM)

FINAL REPORT
Project No. 5-0059-2-32
Contract No. OE-5-85-066

AN INDUSTRIAL ARTS CURRICULUM PROJECT FOR THE JUNIOR HIGH SCHOOL

December 1966

U.S. DEPARTMENT OF
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Office of Education
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AN INDUSTRIAL ARTS CURRICULUM PROJECT FOR THE JUNIOR HIGH SCHOOL

Project No. 5-0059-2-32
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Edward R. Towers, Director
Donald G. Lux, Associate Director
Willis E. Ray, Associate Director

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The Ohio State University

Columbus, Ohio

CONTENTS

INTRODUCTION

This Final Report is presented in compliance with the requirements of the U.S. Office of Education Contract No. OE-5-85-066. Contained in this report are the results of the efforts of the Project staff for the period of June 1, 1965 through November 30, 1966. The Project is being continued through Grant No. OEG-3-7-070003-1608 from the U.S. Office of Education for the period of December 1, 1966, through June 30, 1969.

I. BACKGROUND

A striking fact is that curriculum development efforts in vocational education are not focused on preparing the majority of our youth for employment. There is intense activity on many fronts to meet the vocational needs of the college-bound, of the handicapped, of those preparing for entry into skilled trades, of the culturally and economically disadvantaged, and of many other minority groups among school-aged youth. Despite this activity, the majority of high school students take a general program and, immediately upon completing it, make themselves available on a labor market which they little understand. Another large group, finding no satisfaction in the general program, drops out of school. This situation results in a wasteful period of unemployment, occupational instability, and a dependence on learning from the "school of hard knocks" what should have been taught in high school. Juvenile crime rates appear to be another indication that youth who cannot find satisfactory adjustment either in school or in the world of work are social dynamite.

Special high school programs to prepare students for specific goals such as entrance to college, entrance to a skilled trade, or for office employment can be evaluated by determining how many in each program obtain initial and continuing success. Similarly, the general program for the majority of high school youth should be evaluated on how effectively it prepares students for efficiently gaining employment which can enable them to assume their roles as productive citizens.

It is proclaimed widely that the general high school program is not providing youth with a realistic image of either their occupational potential or of the nature and needs of the labor market. Similarly, it is declared that the highly specialized job training programs do not meet the vocational needs of the majority of high school youth. The disproportionate and rapidly growing number of these youth in the ranks of the unemployed seems to support these contentions.

What can the schools do to alleviate this problem? Career days, classes in occupational information, and regular academic courses have not provided an adequate answer. Unfortunately, industrial education, either in the generalized form (industrial arts) or in the specialized form (trade and industrial), also has been ineffective in achieving with the majority its primary aims of occupational orientation and the development of vocational abilities. However, industrial arts hold a heretofore unrealized promise of being able to provide educational experiences through which all individuals can gain knowledge about the structure, relationships, opportunities, and requirements with respect to industry.

Industrial arts has been plagued by the same content problems as faced by other subject areas such as physics and mathematics. Much industrial arts content is obsolete and should be discarded as unrelated to the contemporary scene. The content lags far behind technological and industrial development, thereby failing to reflect modern industry and its impact on the worker. But most important, the failings of industrial arts can be attributed to the fact that a defensible structure of the content of the field has not been identified.

II. PROBLEM

Industrial arts education, as a well established and vitally important curriculum area, has been affected by the general thrust toward curriculum improvement. Concerned as they are with industrial processes, materials, products, and occupations, industrial arts personnel are increasingly aware of the growing gap between industrial reality and its representation in the total educational program. More particularly, it has become quite evident that many of the traditional approaches to industrial arts education are incapable of providing students with an adequate understanding of the impact of industry upon our modern man-made world and upon industrial personnel.

New curriculum designs have been proposed by individuals, and some developmental programs have been initiated. These have met with mixed acceptance and success. It is generally recognized that the central question involved in bringing about a major change in industrial arts education is the question of instructional content. That is, in view of the dynamic and complex character of modern industry, what are the appropriate units of instruction in industrial arts? If such traditional courses as metalworking, woodworking, and drafting are no longer appropriate to the task, what courses are? Those who have attempted to answer these questions have been confronted by problems which have challenged their limited resources. The blocks to developing a new program of industrial arts have been:

1. failure to develop a fundamental structure of the field,
2. absence of textbooks and other instructional materials,
3. lack of appropriate laboratory facilities and equipment,
4. scarcity of research and demonstration projects, and
5. outmoded teacher education programs.

These blocks to curriculum improvement call for a comprehensive project which will rigorously define content; develop a package of teaching materials; field test, demonstrate, and disseminate these materials; and organize teacher education programs. Through the procedures subsequently delineated, this Project will make possible a fundamental breakthrough which can provide a powerful thrust on the national scene.

In today's schools, industrial arts teachers have near total freedom of curriculum planning. Available textbooks and other materials for industrial arts, unlike many subject fields, lend little support to an articulated program. What results is largely a mixture of unrelated fragments of selected trades together with some random selection of the newer technologies. The materials developed through this Project will lend system and order to these fragments and provide important form and configuration.

Perhaps the greatest challenge faced by traditional education is in respect to the rapidly changing world of work. It is difficult to predict the future of any narrow occupational category within industry. Therefore, the educational pattern of the schools must provide programs which will have built-in transfer of learning features which provide the flexibility and adaptability so needed for occupational, psychological, social, and economic adjustment.

A properly conceived program of industrial arts at the junior high school level will provide a sound foundation for vocational education at advanced levels. The materials developed in this Project will enable pupils to organize and systematize their thinking regarding industry. The structure of industry that was developed during the first phase of the Project will provide the means to simplify, analyze, and synthesize the "big ideas" related to "efficient doing" in industry.

The most difficult and uneconomical subject matter to learn is that material in which no pattern is recognizable. If this total effort is successful, industrial arts as a curriculum area will have a cohesive, comprehensive, and internally consistent framework from which pupils can draw meaningful insights into that complex and productive societal enterprise--modern industry. The benefits of such insights in terms of enlightened citizenship, educational-occupational guidance, and integration with the culture and the world of work would indeed be substantial.

There are more than 40,000 industrial arts teachers and more than 4,000,000 pupils currently enrolled in industrial arts programs. Many of these programs need to be reformed if they are to help youth gain a knowledge of their modern man-made world and those who shape it. It might be predicted that greater initial and subsequent change will be achieved through making current programs more effective by: (1) launching a massive effort to remove the blocks to curriculum improvement, (2) creating and installing an improved program which can be adopted within the reality of the present school structure, (3) enhancing adoption probability by demonstrating the validity of the new program using existing teachers and facilities, and (4) having a new program better indicate the need and direction for an ideal program of the future.

III. SELECTED REVIEW OF RELATED RESEARCH

The investigators are aware of one allied research project in progress with Ford Foundation and U.S. Office of Education (S-068) support (9). In it there is an attempt to develop an industrial arts curriculum based on fundamental concepts of American industry.

Other previous work related to the Project may be considered under the following headings: theory formulation, guidelines for curriculum revision, curriculum design proposals, and curriculum resource studies. References may be found on pages 28 through 31.

Theory formulation. Bonser's (4) work during the first decade of the 20th century is recognized as laying the foundation for contemporary curriculum theory. In 1926 he defined industrial arts as ". . . a study of the changes made by man in the forms of materials to increase their values, and of the problems of life related to these changes." His emphasis on changes wrought by man in materials, and the problems associated with these changes was significantly modified in a 1937 Bulletin of the U.S. Office of Education (33). This Bulletin referred to industrial arts as ". . . a phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contribution of those engaged in industry." Further refinement along these lines was provided by Warner (34), when he proposed that industrial arts was industrial technology and that its major divisions were power, transportation, communications, manufacturing, construction, and management.

These early proposals and definitions constituted initial steps in the development of an appropriate theoretical framework for industrial arts. While they have been provocative, it is generally recognized that they were not followed by a systematic and acceptable investigation of the structure of industry. Consequently, no widespread curriculum implementation emerged from these tentative beginnings.

The lack of a generally accepted focus for curriculum in industrial arts led Lindbeck (18) to observe that there is little factual evidence supporting the claims made for industrial arts. He maintained that there existed no acceptable theoretical framework for this subject matter field. Baird (1), attempted to relate John Dewey's philosophy to industrial arts. He found that insofar as industrial arts programs are based on experimentation, investigation, critical thinking, planning, and research, they would reflect man's needs in his social environment. Baird's emphasis on methodological questions overlooks Dewey's parallel concern for appropriate content. Wockenfuss (35) tested the hypothesis that the bases of industrial arts are more properly sociological than technical. On this basis he concluded that learning experiences related to tools, materials, processes, and products of industry were appropriate; and he recommended emphasis on (1) industry as a social institution, (2) the occupations of industry, (3) health and safety practices of industry, and (4) industrial labor relations.

Guidelines for curriculum revision. Hornbake (13) and Evans (8) attempted to stimulate curriculum revision and to clarify the problems involved. With regard to curricular emphasis, Hornbake pointed out that science and technology are dominant forces in contemporary life, and industrial arts programs must reflect these vital social forces. He urged that a profession is "obligated to state what unique service (it) renders. . . . This delineation can occur only as the basic purposes, the content and the practices of the profession are made explicit." Hornbake also insisted that the profession must demand of its members, "an acceptance of the basic purposes, an acceptance of the major areas of content and an acceptance of a minimum standard of student qualifications." Evans directed himself to the question of the means by which content may be identified for industrial arts programs. Accepting the basic proposition that the proper source of content is industry, he observed that while the techniques of trade analysis may remain appropriate for highly specialized vocational programs, its use in identifying content for the more general industrial arts was definitely inadequate. He maintained that resource agents from fields such as industrial sociology, economics, industrial psychology, industrial anthropology, industrial organization, and labor-management relations be involved with industrial education personnel in the task of developing an acceptable structure for curriculum.

Curriculum design proposals. Numerous curriculum proposals have been advanced which purport to draw the practices of industrial arts programs closer to the theoretical postulates that have been advanced for the subject area. They range in sophistication and refinement from carefully conceived and considerably detailed major proposals, to crude "armchair" outlines. Olson's Technology and Industrial Arts (24) stemming from Warner's Laboratory of Industries approach is perhaps the most highly developed of these curriculum proposals. Utilizing a classification of industries designed by the Bureau of the Census, he developed a curriculum design around so-called basic industries groups. Olson's approach neglects the problem of the emergence of new industries and suffers from an arbitrary selection from the total industrial universe. In this concept, industrial functions (e.g., management) are classified side by side with materials (e.g., metals, woods) and process (e.g., graphic arts) categories.

Bateson (2) and Stern (30), recognizing these internal inconsistencies as well as the indefensible concentration on specific industry groups, presented the Functions of Industry concept. They suggested that all goods-producing industries fulfill certain universal "functions" in the process of developing, manufacturing, and marketing their products. These were identified as (1) Fundamental and Applied Industrial Research, (2) Product and Process Development, (3) Planning for Production, (4) Manufacturing, and (5) Distribution. Similar universal functions were posited for the goods-servicing industries. These involved: (1) Diagnosis, (2) Correction, and (3) Testing. This attempt to generalize across industry groupings is based on the activities of industrial establishments rather than on the specific materials or processes involved in the product. While Stern's research (1964) on goods-producing industrial establishments provides tentative validation for the concept, considerable work must yet be done to refine and field test this curriculum proposal.

Other curricular proposals for industrial arts have been developed and presented to the profession. While these have not been based on a comprehensive analysis and synthesis of industry, they indicate a sensitivity to the problem and advance programmatic solutions. Horton (14) studied the effectiveness of the mass-production technique of teaching industrial arts. Maley and Keeny (21) reported on a program which emphasized research and experimentation in industrial arts. While these approaches may be methodologically superior to traditional practices, they are not based on a comprehensive and defensible structure of the body of knowledge in the field.

Curriculum proposals to more adequately interpret or depict industrial activities have been presented by Yoho (36), Hackett (11), Duffy (7), Ziel (37), Streichler and Duffy (31), and Micheels, Sommers, et al. (23). These proposals share a common concern for the failure of industrial arts to focus its content on industry and technology. Each advocates a curriculum design consisting of course titles whose content is more implied than categorically stated. None of these curriculum proposals are based upon a validated construct of industry, and none have been methodically refined and field tested.

Curriculum resource studies. In addition to these broad designs for curriculum, researchers have sensed the organizational inadequacy in the subject matter and have arbitrarily or of necessity refined bits and pieces of curriculum in numerous resource studies. Theses and dissertations at The Ohio State University from 1947 to the present have made content analyses on topics such as electrical manufacturing, transportation, communications, and power. These studies (an outgrowth of the Laboratory of Industries approach) examined larger content areas than selected skilled trades, which are the traditional source of content. However, they lacked common criteria for the selection of content, thereby losing cumulative potential. Most importantly, they arbitrarily selected their particular piece of the total content without answering questions about the relationship of the part to the whole. While this procedure may result in defensible curriculum parts, collectively it yields an indefensible and distorted view of industry as a social entity.

This review of the literature on curriculum in industrial arts, while of necessity is incomplete, indicates the undeveloped condition that retards progress in this subject area. The first phase of the Industrial Arts Curriculum Project was designed to investigate the field of industry and to develop a taxonomically consistent, comprehensive and defensible structure of knowledge from which appropriate content for industrial arts curriculum can be drawn. While such a structure will have applicability throughout the educational spectrum, specific attention was given in this phase to the development of an educationally valid syllabus for the junior high school level.

IV. OBJECTIVES

The general purpose of the Industrial Arts Curriculum Project is to effect curriculum change in industrial arts. Guba and Clark have proposed a classification schema of processes related to and necessary for change in education as shown in Table 1, page 9. This table depicts the stages through which effective curriculum projects are likely to pass. Using this schema, it is possible to describe the steps to be followed in achieving the purpose of curriculum change.

This report covers the first phase of the Project. The two objectives of phase one were: (1) to conceptualize a structure of industry as a basis for content in industrial arts, and (2) to translate this structure into a syllabus which outlines a junior high school program of industrial arts. In order to accomplish these objectives, it was necessary to develop a rationale for conceptualizing a structure of industry (Attachment A) and a rationale for selecting learning experiences (Attachment A) from a structured body of knowledge. Subsequent phases of the Project will require the syllabus to be engineered into an innovation package.

Table 1*

A CLASSIFICATION SCHEMA OF PROCESSES RELATED TO AND NECESSARY FOR CHANGE IN EDUCATION

	RESEARCH	DEVELOPMENT		DIFFUSION		ADOPTION		
		INVENTION	DESIGN	DISSEMINATION	DEMONSTRATION	TRIAL	INSTALLATION	INSTITUTIONALIZATION
OBJECTIVE	To advance knowledge	To formulate a new solution to an operating problem or to a class of operating problems, i.e., to innovate	To order and to systematize the components of the invented solution; to construct an innovation package for institutional use, i.e., to engineer	To create widespread awareness of the invention among practitioners, i.e., to inform	To afford an opportunity to examine and assess operating qualities of the invention, i.e., to build conviction	To build familiarity with the invention and provide a basis for assessing the quality, value, fit, and utility of the invention in a particular institution, i.e., to test	To fit the characteristics of the invention to the characteristics of the adopting institution, i.e., to operationalize	To assimilate the invention as an integral and accepted component of the system, i.e., to establish
CRITERIA	Validity (internal and external)	Face Validity (appropriateness) --- Estimated Viability --- Impact (relative contribution)	Institutional Feasibility --- Generalizability --- Performance	Intelligibility --- Fidelity --- Pervasiveness --- Impact (extent to which it affects key targets)	Credibility --- Convenience --- Evidential Assessment	Adaptability --- Feasibility --- Action	Effectiveness --- Efficiency ---	Continuity --- Valuation --- Support
RELATION TO CHANGE	Provides basis for invention	Produces the invention	Engineers and packages the invention	Informs about the invention	Builds conviction about the invention	Tries out the invention in the context of a particular situation	Operationalizes the invention for use in a specific institution	Establishes the invention as a part of an ongoing program; converts it to a "non-innovation"

* From a paper by Guba, E.G. and Clark, D.L. An Examination of Potential Change Roles in Education, Columbus, Ohio, The Ohio State University, 1965 (multilith).

METHOD

Recent efforts on the application of PERT (an acronym for Program Evaluation and Review Technique) have indicated that this technique results in more detailed planning and effective administration and control of educational research. Therefore PERT was used in planning the first phase of this Project. It was found that approximately 18 months would be required to complete the first phase of the total Project. A descriptive procedure for the two parts of Phase I follows.

I. CONCEPTUALIZATION OF STRUCTURE

In order to develop a structure of the content of industrial arts, the Project staff first made a comprehensive literature analysis and produced an annotated bibliography. A review was made of as many different categorization systems of industry as possible, e.g., the Standard Industrial Classification Manual, the Dictionary of Occupational Titles, and the Census of Manufactures. These and other similar systems were studied for common elements and differences of categorization and classification.

During this review, the Project staff began developing a set of criteria for determining structure. These criteria involved scope, limitations, and sequence. Upon completion of the literature analysis and the development of criteria, the Project staff developed a working paper on the structure of content with examples of fundamental concepts and principles.

Consultants were employed throughout to assist the staff in these activities. These consultants were selected from the following fields to provide an interdisciplinary approach to the conceptualization of the structure: philosophy, sociology, psychology, economics, physical science, engineering, and industrial management, labor, and business organizations.

After being considered by the Advisory Committee at its first meeting, the working paper on structure was distributed to members of an initial Task Force. This Task Force considered the suggested draft structure and made appropriate modifications. Following this, a series of Task Force groups further identified the concepts and principles within each major division of the structure. A final Task Force conference was held to review the overall structure, the divisions within the structure, and the concepts and principles contained therein.

The Task Force members were selected after consultation with the Advisory Committee. The personnel of the Task Force groups were drawn from such substantive areas of industry as industrial design, industrial engineering, civil engineering, mechanical engineering, electrical engineering, aeronautical engineering, metallurgical engineering, industrial psychology and industrial organization and management.

The Project staff next prepared a revised draft of the paper entitled, "A Rationale and Structure for Industrial Arts Subject Matter" (Attachment A). This draft, together with a detailed opinionnaire, (Appendix A), was sent to approximately 100 leaders in education, e.g., state and local supervisors, school administrators, teacher educators, and selected teachers. The reactions of this peer group were presented to the second meeting of the Advisory Committee and are shown in Appendix B.

After making the recommended revisions, the paper was duplicated and distributed. Dissemination lectures were held at selected colleges and universities. Feedback from these lectures and evaluation sessions assisted the Project staff in planning the syllabus conferences.

II. DEVELOPMENT OF SYLLABUS

The next step, after having developed a structure within which the major concepts have been placed in taxonomical order, was the development of a syllabus for the junior high school. In order to complete this task, it was necessary to first identify the criteria for selecting and organizing learning experiences from a structured body of knowledge. Six factors were identified which were to provide guidelines for the selection and organization of learning experiences. These six factors were: (1) The Structure of the Body of Knowledge, (2) Desired Behavioral Change or Objectives of Instruction, (3) The Nature of the Learner, (4) School Facilities and Materials, (5) Instructional Procedures and Materials, and (6) Measurement and Evaluation.

Following this development, the next task was to identify the criteria for developing curriculum materials. A conference group was then organized to develop daily objectives (Attachment B) for the first year's course in construction. Using the criteria and the daily objectives, a teaching program (Attachment C) was developed for a first year program of industrial arts in the junior high school. This program entitled Industrial Technology, The World of Construction, was completed, reviewed by the Advisory Committee, and modified.

The next step in the development of the syllabus consisted of a series of conferences resulting in a detailed outline of the reading assignments (Attachment D). Throughout this process numerous consultants were used from the substantive areas of construction and educational methodology.

RESULTS

From the beginning, three assumptions as to the nature of industrial arts were made:

1. Industrial arts is a study of industry. It is an essential part of the education of all students in order that they may better understand their industrial environment and make wise decisions affecting their occupational goals.

2. Man has been and remains curious about industry, its materials, processes, organization, research, and services.

3. Industry is so vast a societal institution that it is neces ,ary, for instructional purposes, to place an emphasis on conceptualizing a fundamental structure of the field, i.e., a system of basic principles, concepts, and unifying themes.

Further assumptions were made as the study progressed:

1. For purposes of analysis, man's knowledge can be categorized and ordered logically.

2. To provide for the most effective and efficient transmission of knowledge, the educator should codify and structure disciplined bodies of knowledge.

3. The structure of a body of knowledge can be developed before the total curriculum is designed.

4. All domains of man's knowledge must be included in an effective general educational program.

In carrying on the Project, these assumptions dictated a search to determine if there is an identifiable body of industrial knowledge and, if so, its structure.

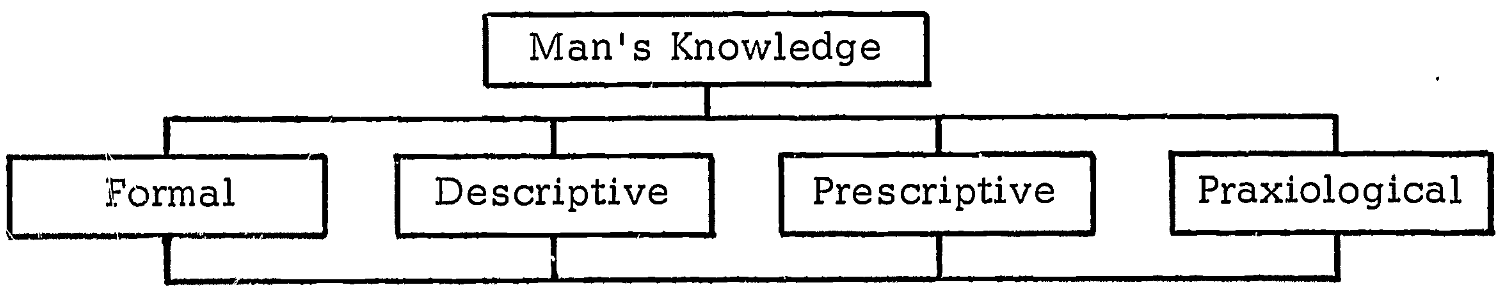
To adequately structure a body of knowledge requires that: 1) the context must be defined, i.e., the boundaries or limitations must be established; 2) the elements must be identified in a meaningful order; 3) the sum of the elements must equal the context; and 4) the relationships between elements must be discernible.

Industrial arts education, by its very name, is a study of industry. Accepting this as a postulate, it follows then that the fundamental question to be answered is, "What is industry?" In order to answer this question in a logical manner, it is necessary to ask another question: "Does industry have a body of knowledge?" This question in turn leads to the most fundamental question of all: "Into what divisions might man's total knowledge be categorized?"

The Structure of Man's Knowledge. Attempts to classify or categorize the vast body of accumulated and recorded knowledge are difficult, since there is controversy as to the nature of knowledge and because knowledge is always in a state of development. Man's knowledge may be conceptualized and ordered into four domains or classes as shown by E. Maccia (19) in Figure I.

Figure I

The Four Domains of Man's Knowledge



The first domain is formal knowledge. The established disciplines within formal knowledge serve as tools which are used to order all knowledge and, therefore, could be abstracted out as form or arrangement (syntactics). Logic, mathematics, and linguistics are examples of such fundamental disciplines.

The second domain is descriptive knowledge. The key term that may be used to identify descriptive knowledge would be "sciences." The sciences seek and establish facts about phenomena and events and describe their interrelationships. All of the disciplines that comprise the physical sciences, the biological sciences, and the social sciences represent descriptive knowledge.

The third domain of man's knowledge may be termed prescriptive knowledge. Disciplines within the humanities and fine arts seek to provide man with a system (or systems) of values--judgments as to whether phenomena or events ought to be--whether true and/or good and/or beautiful.

The fourth domain of man's knowledge, one which is rarely recognized, is praxiological knowledge. In the secondary school, courses in the practical arts and vocational education are attempts at organization of such knowledge. This domain is represented in higher education by the various professional schools and departments. Among them would be medicine, law, engineering, management marketing, education, dentistry, dairy technology, pharmacy, and many others. These so-called applied or derived fields of knowledge draw upon the formal, descriptive, and prescriptive domains as <u>necessary</u> but <u>insufficient</u> background for full status in the practicing profession. Practice (or internship), <u>per se</u>, is necessary also for proper training; but, together with formal, descriptive, and prescriptive knowledge, it is not sufficient. These disciplines demand a clinical or professional body of subject matter. This body of knowledge is termed <u>theory of practice</u>, <u>knowledge of practice</u>, or <u>praxiology</u>--man's ways of doing which bring about what is valued or what ought to be through action.

<u>The term "praxiology"</u> comes from the Greek 'praxis' meaning <u>to do</u>, or the practice of an art, science, or technical occupation. The suffix 'ology', connoting a science or branch of knowledge, completes the full meaning: the knowledge of man's practices.

The case herein made for the recognition of praxiology does not imply any de-emphasis of the formal, descriptive, and prescriptive domains of knowledge. They form, however, only a portion of the base upon which the praxiological studies rest. In addition, the element of practical experience is critical. It must be pointed out that a "knowledge of practice" does not reduce the need for "knowledge" or for "practice." All three ingredients--1) knowledge (traditional knowledge of formal, descriptive, and prescriptive), 2) knowledge of practice (less traditional or less recognized knowledge), and 3) practice--are necessary for a complete educational program.

Praxiology may be equated with technology only if one of the least common of several meanings of the latter word is used. Technology may be taken to mean "hardware," technics of operating hardware, a combination of the preceding, or "the science of the application of knowledge to practical purposes." Only in the latter instance is technology synonymous with praxiology. Thus, it may be necessary to use the term praxiology rather than technology if the goal is to communicate precisely.

From the above, teachers, doctors, lawyers, mechanics, and farmers all are praxiologists. Few would class them all as technologists, and doctors themselves generally would not accept the label of technologist. Because technology has many meanings, the term "praxiology" serves better to convey a single meaning.

However, because the term technology has gained significant acceptance in industrial arts and in general literature, and because there is common usage of it, technology as it may be equated with praxiology will be used in this Project.

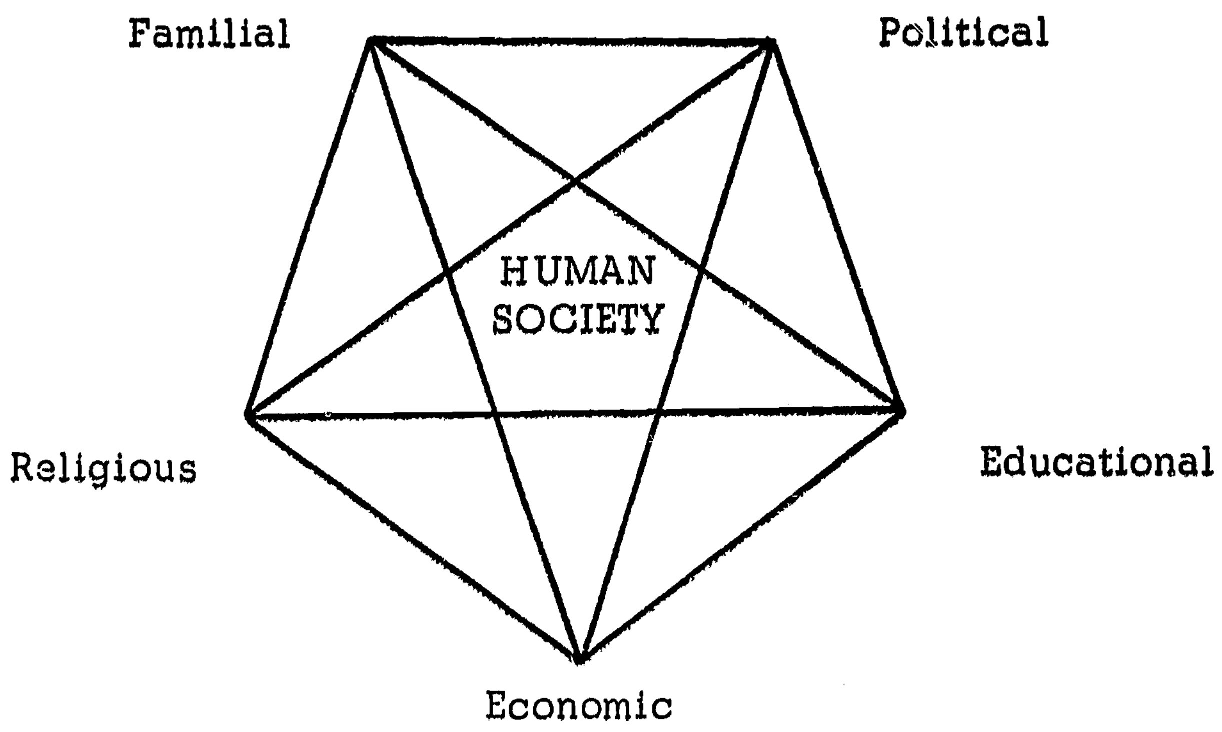
Development of Institutionalized Practice. Man's practices or patterns of action have developed as man himself has developed. As patterns of action have become formalized over the ages, fundamental social institutions have developed. Perhaps the most fundamental of primitive man's normative patterns of behavior was the institution of the family. The religious institution, with its evolving beliefs and practices, was also fundamental to early man. As society developed, the institution of the family was unable to accommodate all of man's practices.

Patterns relating to economic activity became formalized outside of the family. Relationships developed regarding government or politics as society became more complex. A formalized pattern of education has become more significant throughout the development of man and the consequent development of man's accumulated knowledge.

Cuber (6) indicates that sociologists generally agree that the five fundamental societal institutions of man are 1) familial, 2) religious, 3) economic, 4) political, and 5) educational.

Figure II

Basic Societal Institutions

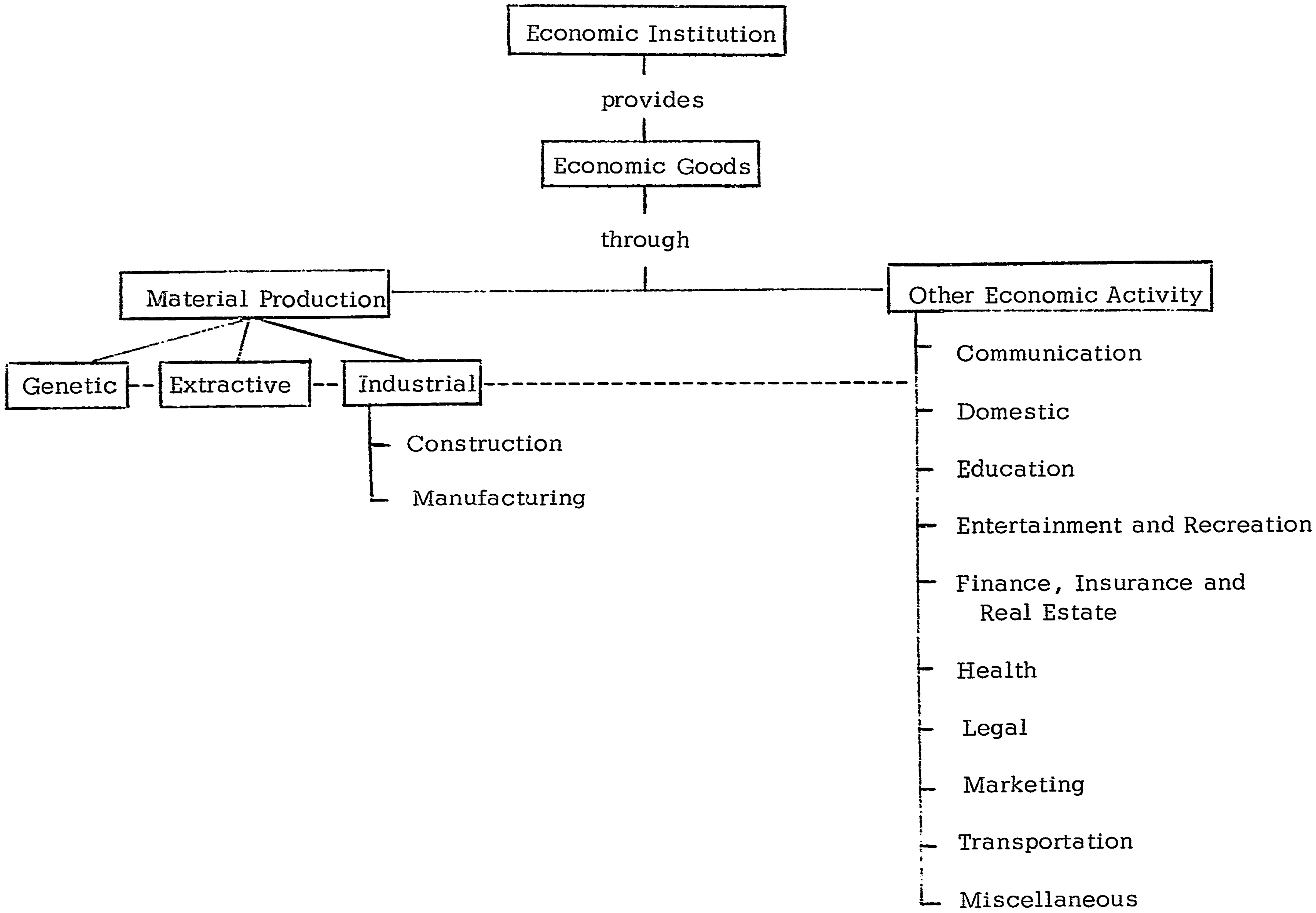


Assuming these five institutions are fundamental, they may serve as valuable constructs in conceptualizing man's practices. As in all categorization or classification schemes, these divisions are not precise since there are no sharp lines of demarcation and the functions often overlap. The interrelationships between and among these institutions are many.

Industry and the Economic Institution. To the layman, terms such as agriculture, business, and industry, taken collectively, grossly describe the field of man's economic activity. For purposes of more precise analysis, however, the elements of the economic institution must be more carefully conceptualized. A structure of the economic institution which lends intelligibility to its function is depicted in Figure III. Society has developed this particular institution to provide its economic goods, commonly divided into goods and services. This dichotomy is fallacious for the purposes of this Project. Therefore, in Figure III, economic goods are divided into material production and other economic activity.

Figure III

ELEMENTS OF THE ECONOMIC INSTITUTION



Even a casual review reveals that agricultural services are rendered by agriculture. To separate the practices of tree pruning or plowing from agricultural production because they are sometimes provided as services off the farm serves little or no function in communicating the theory of the practices. Similarly, to separate the practices of appliance repair from industrial production because they are sometimes performed in the home would serve no logical purpose in organizing the theory of those practices.

Services are provided by all the elements of the economic institution, thereby the term fails to qualify as a discrete category among the elements. As agriculture and industry provide services, so do banks, advertising agencies, and the schools. On this point, the Standard Industrial Classification Manual cannot be used for the purposes of this Project. Some establishments do engage primarily in service, and, for purposes of gathering data relative to their economic significance, a service category for these data may be appropriate. However, on a logical basis, particularly with reference to the source and nature of the practices of servicing material goods, services are integral to the material production elements which develop and refine the service practices.

In view of the above, the term "services" does not appear in Figure III. The elements of the economic institution all are considered to possess service practices which appropriately are studied within the total context of each particular element. Thus, manufacturing and construction services are structured and would be studied as part of each respective element.

Within the economic institution industry may be conceived as being that institutional element which substantially changes the form of materials to satisfy man's material wants. Industry essentially includes construction and manufacturing. While agriculture and mining also are engaged in material production, they do not essentially change the form of the materials produced. For this reason, they may be designated genetic or extractive material production.

Utilities commonly are structured as separate categories or in conjunction with selected services. Utilities do not appear in this manner in Figure III. Rather, they are subsumed, in manufacturing or in construction, as they relate to material production. Thus, the conversion of coal to steam to kilowatt hours of power is a manufacturing function, as is the operation of a waste treatment plant. On the other hand, the building of manufacturing or sanitary facilities is construction.

Figure IV presents the material production continuum which clarifies the relationships between the elements of material production. The genetic or extractive material production of agriculture, forestry, fisheries, mining, etc., may either provide materials to industry (construction and manufacturing) which substantially change the forms of these materials, or their production may be provided directly to the consumer. For example, peas may be sold fresh to the consumer or be processed in industry and then be distributed to the consumer. Similarly, coal may be provided directly to the consumer or it may be manufactured into briquets or converted to kilowatts and then passed to the consumer. Gravel may be provided directly to the consumer or it may be processed by manufacturing and construction to concrete and to a structure, respectively.

Industry does not provide services except as they are related to industrial material goods. These goods are serviced by installing, maintaining, repairing, and altering them after they have been processed. Thus, servicing may be considered a major portion of post-processing (see Figure VI, page 23). Industry provides the body of knowledge used by those service establishments and individuals engaged in the servicing of industrial material goods. That is, when industry produces automobiles or buildings, it provides the theory of practice for their efficient installation, use, alteration, maintenance, and repair by consumers, operators, and service men. Industry produces this body of knowledge and for this reason it is a part of the study of industry. The knowledge of financing and marketing, for example, also is used by service establishments, but it is not industrial knowledge.

In accordance with the above, a study of aircraft production, as a part of a study of industry, would include all that is involved in making and servicing aircraft. It also includes the development of operating practices. Industrial technology would not include a study of how an airline is planned, organized, and controlled or how it engages in other economic activity such as transportation.

In order to conceptualize the body of knowledge contained in industrial technology, a matrix approach has been devised as shown in Figure V. This approach provides a unique way of looking at the multi-dimensional elements of the body of knowledge. In the three-dimensional matrix approach, increasing levels of specificity may be added on one or any combination of the axes. If all

Figure IV

THE MATERIAL PRODUCTION CONTINUUM

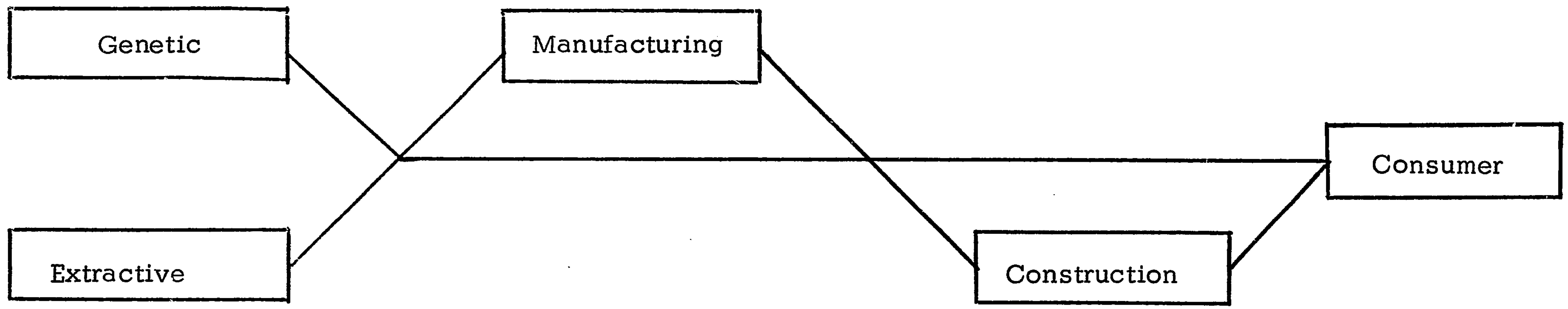
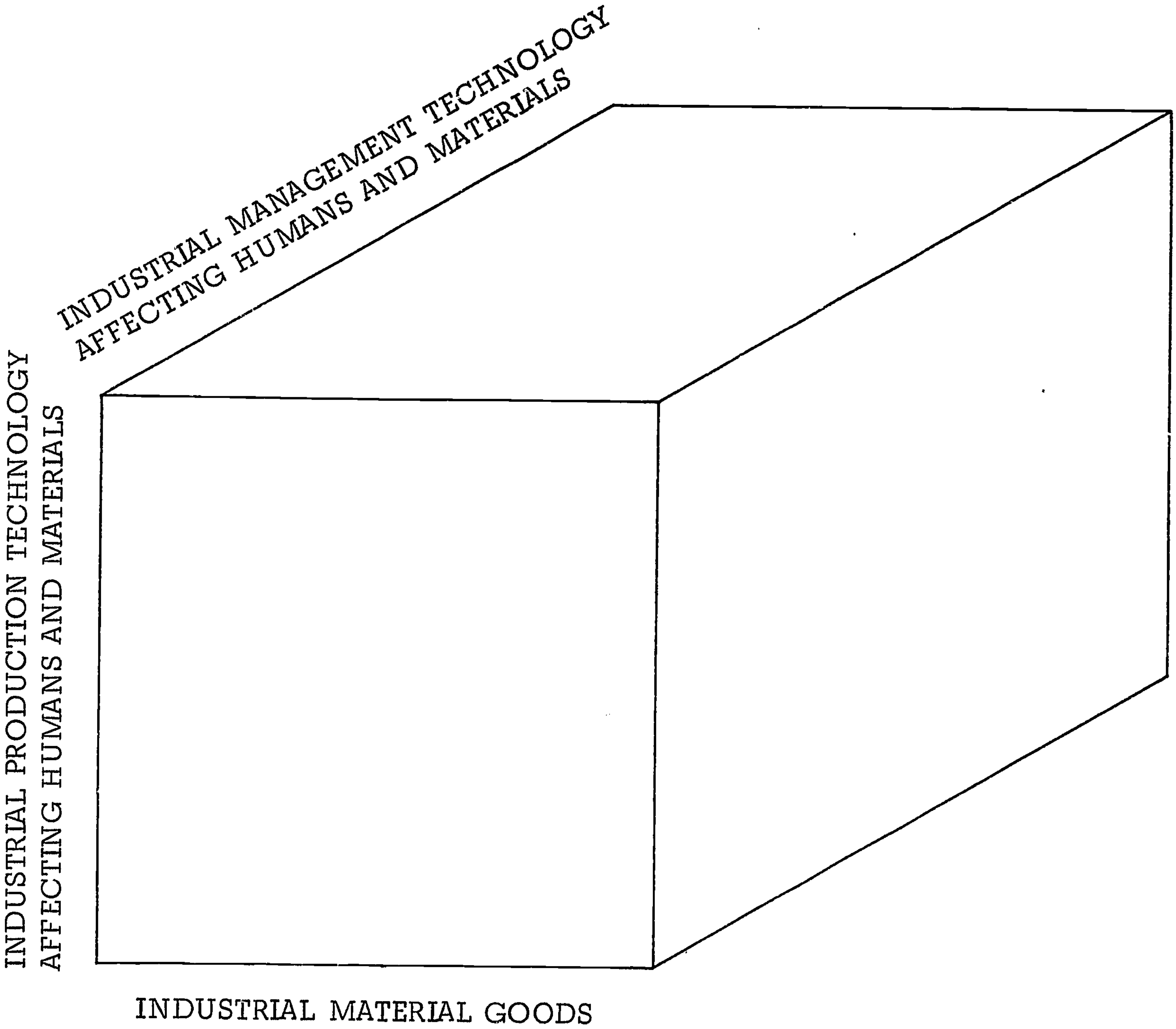


Figure V

FIRST ORDER MATRIX OF INDUSTRIAL TECHNOLOGY



three axes were developed, it would seem theoretically possible to select an almost infinite number of combinations from the matrix. The obvious advantage of this approach is the movement from the general to the specific.

Figure V, the first order matrix of industrial technology, indicates that industrial management practices combined with industrial production practices yield industrial material goods and affect humans and materials. Subsequent figures separately categorize those practices which primarily affect humans and those which primarily affect materials.

For analytical purposes, the practices which affect human behavior must be separated from the production setting although it is clear that the electroplating process, for example, cannot be separated from concerns for exhausting noxious fumes properly and for providing proper protective shielding for workers. However, industrial health is a universal concern throughout the establishment, and this fact is evident only when its many related practices are placed within some meaningful, all-encompassing construct. Thus, the broadest generalizations about industrial practices to affect worker safety may be identified independently of their specific applications throughout the production environment, and they may not be recognized simply from a random sampling or even from a total assemblage of the vast array of specific practices throughout industry.

Figure VI depicts the second order matrix only of that portion of industrial technology which primarily affects materials. This follows the pattern introduced in the Figure V, except that Industrial Material Goods have been separated into Manufactured and Constructed Industrial Material Goods. A sample third order matrix is shown in Figure VII. The shaded area from Figure VI has been expanded in this figure to show that formulating, researching, designing, and engineering are sub-elements under Planning; while preparing the site, building the structure, and completing the site are sub-elements under Processing. At this level, Constructed Industrial Material Goods are divided into buildings and non-buildings.

A separate but parallel structure of industrial practices which affect human behavior in industry is shown in Figure VIII. These practices are Planned, Organized, and Controlled by management as it affects humans through its practices of: Hiring, Training, Working,

Figure VI

SECOND ORDER MATRIX
OF INDUSTRIAL TECHNOLOGY AFFECTING MATERIALS

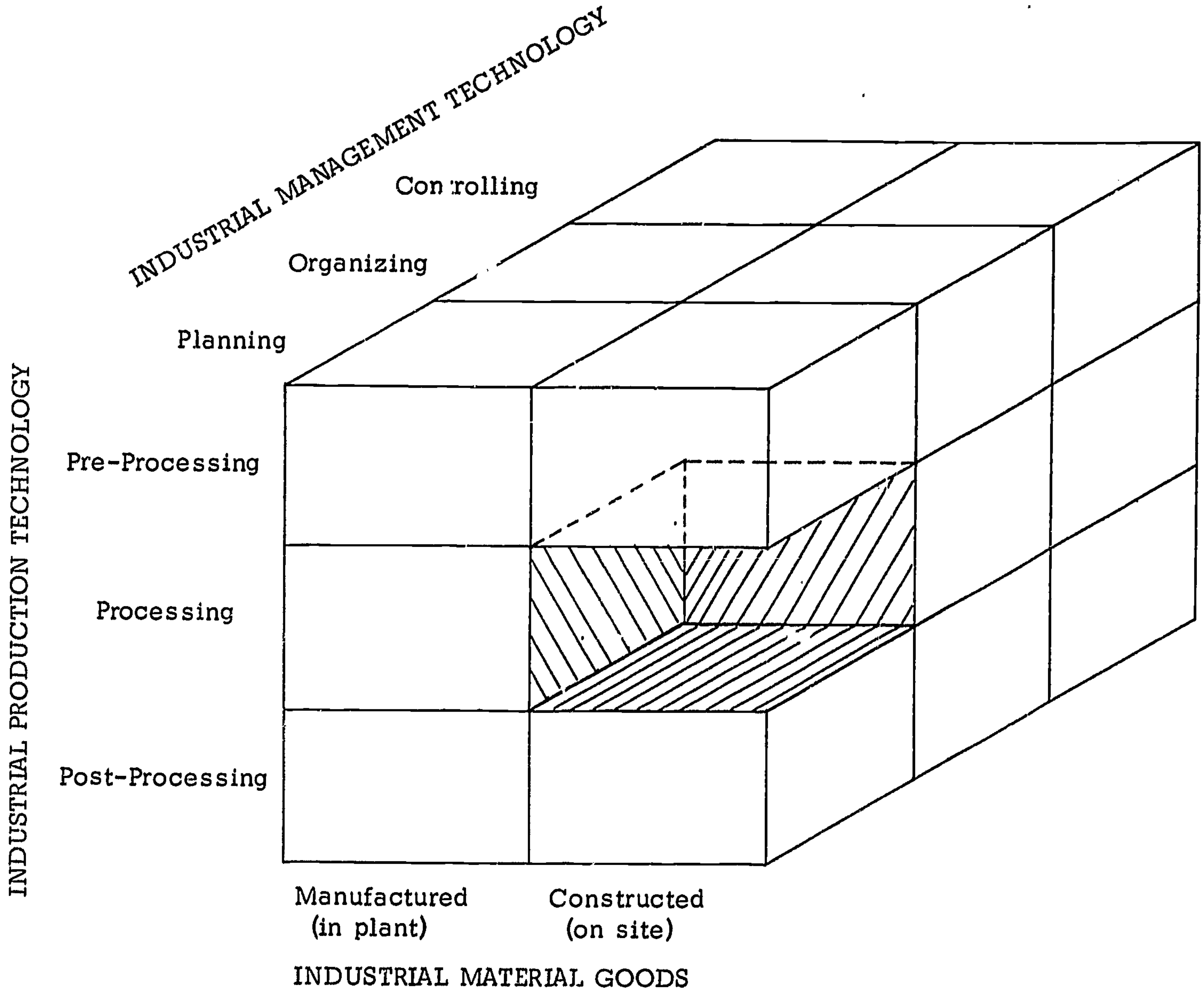


Figure VII

SAMPLE THIRD ORDER MATRIX
OF INDUSTRIAL TECHNOLOGY AFFECTING MATERIAL

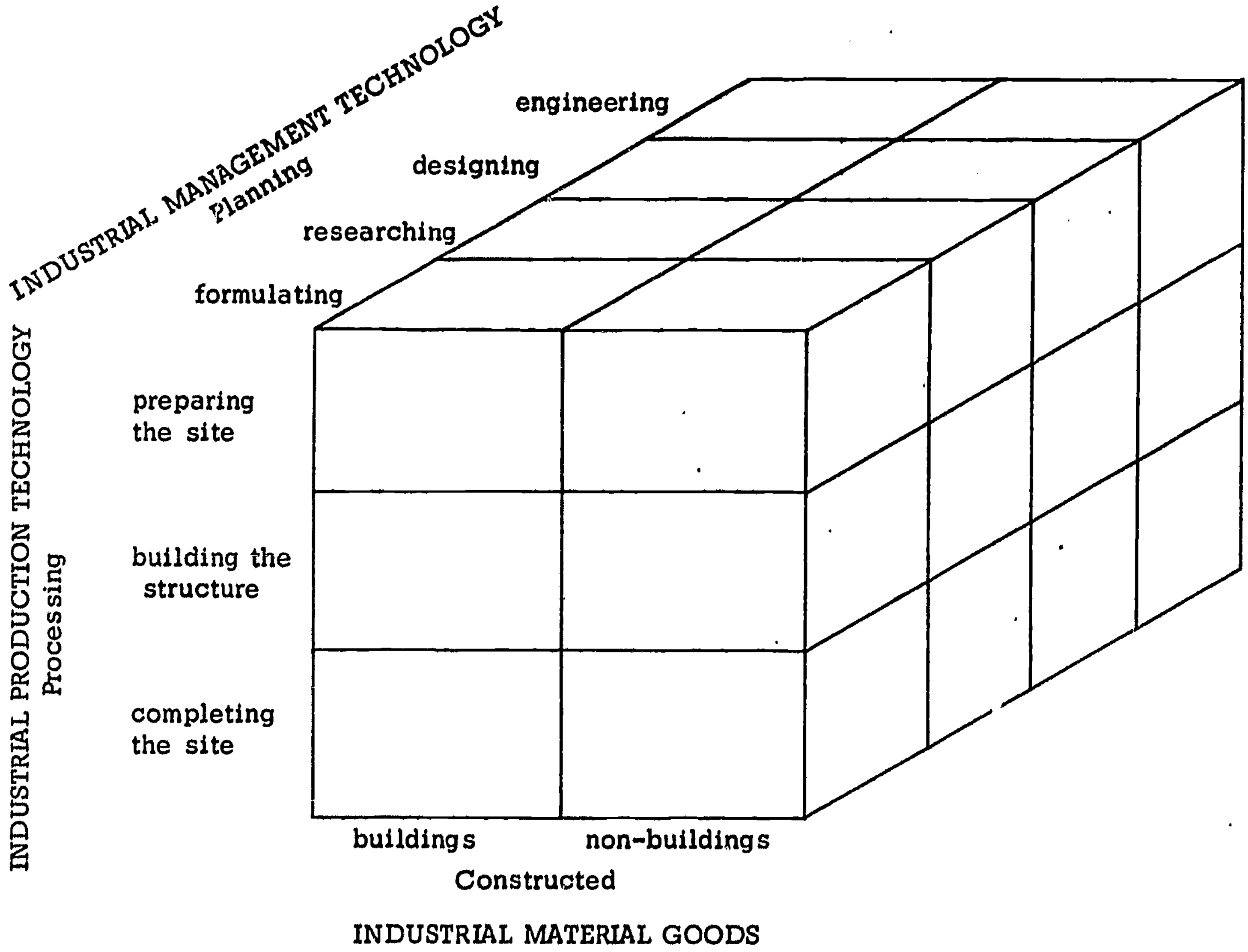
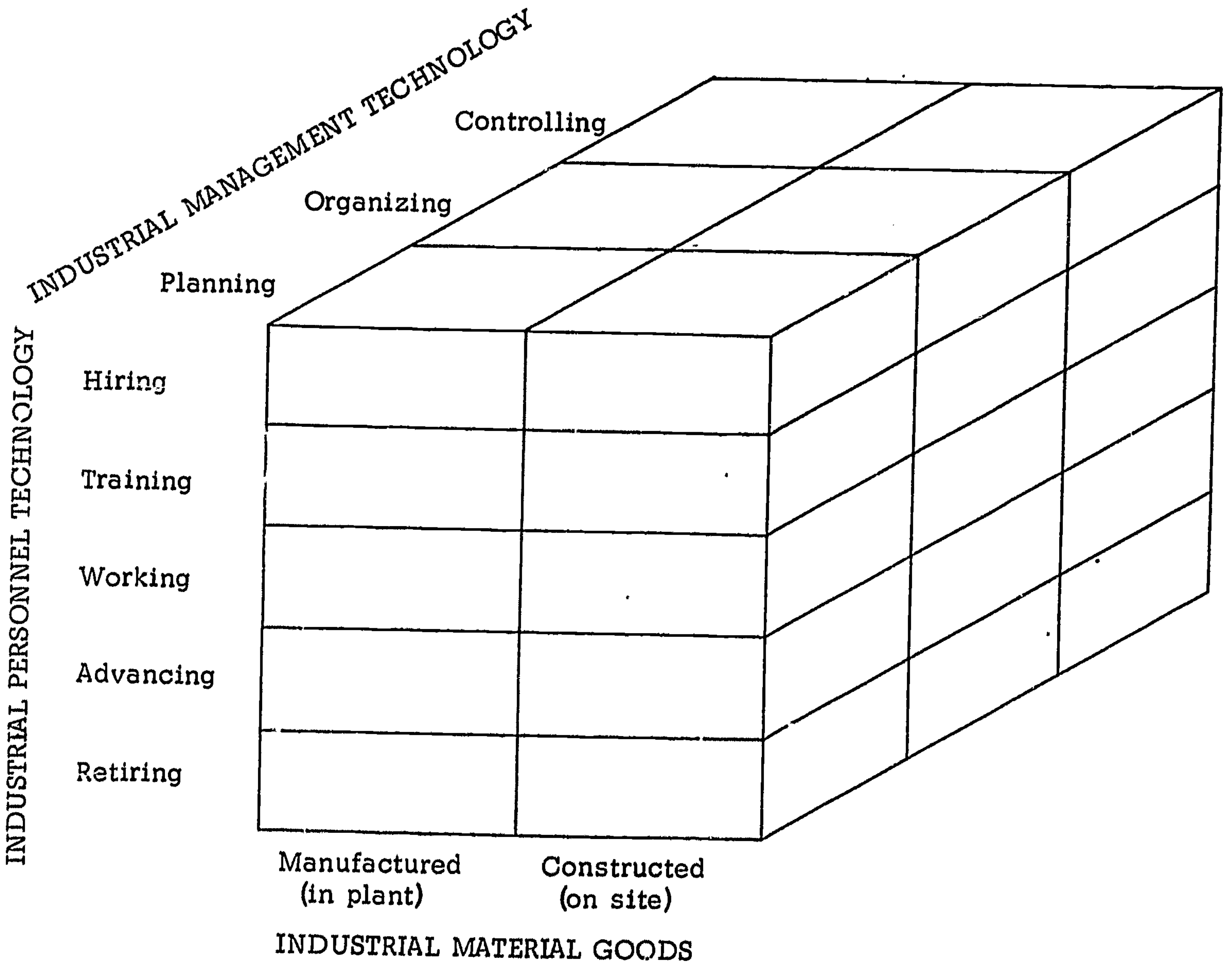


Figure VIII

SECOND ORDER MATRIX
OF INDUSTRIAL TECHNOLOGY AFFECTING HUMANS



Advancing (up, down, or out), and Retiring. These practices often are different in manufacturing and in construction. Their similarities and differences provide further insight into their nature.

It should be repeated that while one can look separately at industrial practices which primarily affect materials and those which primarily affect humans, their interrelationships in the production setting are at least as important as their separate entities. It is this latter fact which often is ignored when either type of practice is studied with disregard for the other, something the adequate industrial arts program should not do.

The matrix approach being used in this analysis provides a unique way of looking at the multiple dimensions of this body of knowledge.

Levels of specificity may be added to the model on all or on selected dimensions. It is possible, for example, to expand the "industrial production" axis to a high level of refinement, while retaining the generality of the "industrial goods" and the "industrial management" dimensions. If all three dimensions were extensively developed, it would be theoretically possible to select an infinite number of "tailor-made" combinations of subject matter from the matrix. Thus, while the primary responsibility of the Industrial Arts Curriculum Project is directed toward industrial arts at the junior high school level, the principal analytical device (the matrix of industrial technology) has potential applicability at all grade and sophistication levels.

The matrix approach described above may be equally helpful in the conceptualization and codification of other technologies. The rationale for the inclusion of a study of industrial technology in the school program suggests that these other technologies (e.g., marketing, transportation, and health) also should be studied in the school program. Although the structuring of the knowledge of all technologies should be undertaken by educators, that task is outside the scope of this Project. This is not to say that industrial arts students will not be exposed to selected and closely related concepts and practices from the total economic system when this is necessary to illuminate industrial technology and its interrelationships with other technologies within the total economic system.

Concluding Statement. The Generalized Model of Industrial Technology presented must not be construed as the ultimate or definitive structure for the body of knowledge from which industrial arts subject matter is to be selected. After thorough and extensive research, it represents the most advanced and most promising conceptual construct that the Project staff has been able to conceive. Its tentative quality is openly admitted, as all conceptual schemes are subject to review, refinement, and modification. Additional investigations, experimentation, and eventual widespread implementation will assist in evolving this structure. The reliability and validity of the generalized model will be enhanced to the extent that curriculum workers can be mobilized for its development.

SELECTED REFERENCES

1. Baird, R. J. "The Application of John Dewey's Philosophy to Industrial Arts." Unpublished doctoral dissertation, Michigan State University, 1960.

2. Bateson, W. M., and Stern, J. "Functions of Industry: Bases tor Vocational Guidance," School Shop, March, 1962.

3. Be.elson, B., and Steiner, G. A. Human Behavior--An Inventory of Scientific Findings. New York: Harcourt, Brace, and World, Inc., 1964.

4. Bonser, F. G., and Mossman, Lois C. Industrial Arts for Elementary Schools. New York: Macmillan, 1926.

5. Bureau of the Budget, Standard Industrial Classification Manual. Washington, D. C.: U.S. Government Printing Office, 1957.

6. Cuber, J. F. Sociology: A Synopsis of Principles. New York: Appleton-Century-Crofts, Inc., 1951.

7. Duffy, J. W. "Let's Revamp Industrial Arts Programs to Reflect Technological Needs," Industria. Arts and Vocational Education, November, 1963.

8. Evans, R. N. "Industry and the Content of Industrial Education," School Shop, April, 1962.

9. Face, W. L., and Flug, E.R.F. Development of a Conceptual Framework for the Teaching of Industrial Arts. U. S. Office of Education Cooperative Research Project No. S-068. Progress Report, January, 1965.

10. Gerbracht, C. "Communications: An Analysis to Determine Curriculum Emphasis in Industrial Education." Unpublished Master's thesis, The Ohio State University, 1948.

11. Hackett, D. F. "Study of American Industry is Essential to Liberalizing General Education," Industrial Arts and Vocational Education, April, 1964.

12. Hart, V.C. "Power: A Study of Problems and Projects for Industrial Arts Classes." Unpublished Master's thesis, The Ohio State University, 1947.

13. Hornbake, R. L. "Technology: Implications for Education," Industrial Arts Teacher, May-June, 1962.

14. Horton, M. W. "The Effectiveness of the Mass-Production Technique in Achieving Selected Objectives for Industrial Arts." Unpublished Master's thesis, Iowa State Teachers College, 1960.

15. Kleintjes, P. L. "A Transportation Program in Industrial Arts." Unpublished Master's thesis, The Ohio State University, 1947.

16. Kotarbinski, T. "Praxiological Sentences and How They are Proved," Section IV, Logic, Methodology, and Philosophy of Science. E. Nagel, et al. (eds.), Stanford, California: Stanford University Press, 1962.

17. Kotarbinski, T. Praxiology--An Introduction to the Science of Efficient Action. New York: Pergamon Press, 1965.

18. Lindbeck, J. R. "A Framework for Research in Industrial Arts." Unpublished doctoral dissertation, University of Minnesota, 1958.

19. Maccia, Elizabeth Steiner. Curriculum Theory and Policy. Occasional Paper 65-176, Educational Theory Center and Social Studies Curriculum Center, Columbus, Ohio: The Ohio State University, 1965. (a)

20. Maccia, Elizabeth Steiner. "Methodological Considerations in Curriculum Theory Building." Paper presented to a seminar of the ASCD Commission on Curriculum Theory, Chicago, Illinois, October, 1965. (b)

21. Maley, D., and Keeny, A. P. "Montgomery County, Maryland, Research and Experimentation in Industrial Arts," The Bulletin of the National Association of Secondary School Principals, February, 1962.

22. Mays, W. A. "The Junior Achievement Movement: An Examination of its Psychological, Economical, Political, and Educational Significance." Unpublished doctoral dissertation, The Ohio State University, 1954.

23. Micheels, W. J., Sommers, W. S., et al. The Minnesota Plan for Industrial Arts Teacher Education. Bloomington, Illinois: McKnight and McKnight Publishing Co., 1958.

24. Olson, D. W. "Technology and Industrial Arts: A Derivation of Subject Matter from Technology, with Implications for the Industrial Arts Program." Unpublished doctoral dissertation, The Ohio State University, 1957.

25. Phenix, P. H. "The Architectonics of Knowledge," Education and the Structure of Knowledge. S. Elam (ed.), Chicago: Rand McNally and Company. 1964.

26. Phenix, P. H. "The Disciplines as Curriculum Content," Curriculum Crossroads. D. Huebner (ed.), New York: Bureau of Publications, Teachers College, Columbua University, 1962.

27. Polanyi, M. Personal Knowledge, Toward a Post-Critical Philosophy. Harper Torchbooks, New York: Harper and Row Publishers, 1964.

28. Skolimowski, H. "Praxiology--The Science of Accomplished Acting," The Personalist, 1965 (no. 3), 46:348-65. Published by the School of Philosophy, University of Southern California. (a)

29. Skolimowski, H. "The Structure of Thinking in Technology." Paper presented to a joint session of the Society for the History of Tecnnology and the American Association for the Advancement of Science, San Francisco, California, December, 1965. (b)

30. Stern, J. "The Functions of Goods-Producing Industrial Establishments: A Validation of Selected Elements in a Definition of Industry as a Framework for Curriculum in Industrial Education." Unpublished doctoral dissertation, Wayne State University, 1964.

31. Streichler, J., and Duffy, J. W. "How to Interpret Industry in the Industrial Arts Laboratory," Industrial Arts and Vocational Education, April, 1963.

32. Tykociner, J. T. "Zetetics and Areas of Knowledge," Education and the Structure of Knowledge. S. Elam (ed.), Chicago: Rand McNally and Company, 1964.

33. United States Department of the Interior, Office of Education, Committee on Industrial Arts. Industrial arts, its interpretation in American schools. Washington, D. C.: U.S. Government Printing Office, 1937.

34. Warner, W. E., et al. A Curriculum to Reflect Technology. Columbus, Ohio: Industrial Arts Center, The Ohio State University, 1947.

35. Wockenfuss, W. A. "Sociological Bases for Industrial Arts for Secondary Schools." Unpublished doctoral dissertation, University of Florida, 1960.

36. Yoho, L. W. "Seeking Agreement and Direction for Industrial Arts through the Analysis Technique," School Shop, May, 1962.

37. Ziel, H. R. "Interpreting the World of Work in the Industrial Arts Program," Industrial Arts and Vocational Education, September, 1962.

APPENDIX A

INDUSTRIAL ARTS CURRICULUM PROJECT

Rating Scale

Please indicate the extent to which you agree or disagree with each of the following elements of the rationale and structure. Place an "x" in a selected blank after each item. If you wish to review a particular point, the numbers after each item refer to pertinent pages in the text.

	Strongly Agree	Agree	Un-decided	Dis-agree	Strongly Disagree
1. "Knowledge of practice" is a significant domain of man's knowledge. (8, 15)	_____	_____	_____	_____	_____
2. A new term to mean <u>only</u> "the science of the application of knowledge to practacal purposes" needs to be substituted for technology. (38)	_____	_____	_____	_____	_____
3. The economic institution is the societal instrument which exists to satisfy man's wants for economic goods (material and non-material). (39, 72)	_____	_____	_____	_____	_____
4. Industry is that subcategory of the economic system which substantially changes the form of materials; i.e., construction and manufacturing, to satisfy man's wants for goods. (40)	_____	_____	_____	_____	_____

Appendix A (continued)

	Strongly Agree	Agree	Un decided	Dis-agree	Strongly Disagree
5. Industrial Arts is an "organized study of industry." (42)	_____	_____	_____	_____	_____
6. The body of knowledge of industry consists of the principles of industrial management and production practice which are used to affect humans and materials within the establishment, to produce industrial material goods. (146, 148)	_____	_____	_____	_____	_____
7. Industrial management practices consist of subcategories of planning, organizing, and controlling. (149, 160)	_____	_____	_____	_____	_____
8. Production practices consist of the subcategories of pre-processing, processing, and post-processing. (149, 162)	_____	_____	_____	_____	_____
9. Practices which affect humans in the industrial enterprise, and their major subcategories, may be separately classified for analytical purposes. (147, 150, 175)	_____	_____	_____	_____	_____
10. In general, the rationale and structure present an adequate solution to the problem of conceptualizing the structure of the body of knowledge from which industrial arts derives its subject matter.	_____	_____	_____	_____	_____

Appendix A (continued)

Comments:

APPENDIX B

INDUSTRIAL ARTS CURRICULUM PROJECT

Rating Scale Results

Please indicate the extent to which you agree or disagree with each of the following elements of the rationale and structure. Place an "x" in a selected blank after each item. If you wish to review a particular point, the numbers after each item refer to pertinent pages in the text.

	Strongly Agree	Agree	Un-decided	Dis-agree	Strongly Disagree
1. "Knowledge of practice" is a significant domain of man's knowledge. (8, 15)	35 / 92	14 / 123	1 / 11	0 / 2	0 / 1
2. A new term to mean <u>only</u> "the science of the application of knowledge to practical purposes" needs to be substituted for technology. (38)	13 / 27	12 / 91	15 / 64	6 / 42	3 / 5
3. The economic institution is the societal instrument which exists to satisfy man's wants for economic goods (material and non-material). (39, 72)	22 / 48	23 / 148	3 / 21	2 / 10	0 / 0
4. Industry is that subcategory of the economic system which substantially changes the form of materials; i.e., construction and manufacturing, to satisfy man's wants for goods. (40)	19 / 84	19 / 100	4 / 11	6 / 18	2 / 15

Peer Review = Above Line

Dissemination Lectures = Below Line

Appendix B (continued)

		Strongly Agree	Agree	Un-decided	Dis-agree	Strongly Disagree
5.	Industrial Arts is an "organized study of industry." (42)	21 / 92	22 / 85	5 / 21	2 / 19	0 / 9
6.	The body of knowledge of industry consists of the principles of industrial management and production practice which are used to affect humans and materials within the establishment, to produce industrial material goods. (146, 148)	17 / 38	24 / 141	2 / 25	6 / 17	0 / 6
7.	Industrial management practices consist of subcategories of planning, organizing, and controlling. (149, 160)	22 / 58	27 / 142	0 / 21	1 / 5	0 / 1
8.	Production practices consist of the subcategories of pre-processing, processing, and post-processing. (149, 162)	21 / 52	25 / 127	2 / 38	2 / 9	0 / 2
9.	Practices which affect humans in the industrial enterprise, and their major subcategories, may be separately classified for analytical purposes. (147, 150, 175)	14 / 48	30 / 134	5 / 49	0 / 9	0 / 1

Peer Review = Above Line

Dissemination Lectures = Below Line

Appendix B (continued)

	Strongly Agree	Agree	Un-decided	Dis-agree	Strongly Disagree
10. In general, the rationale and structure present an adequate solution to the problem of conceptualizing the structure of the body of knowledge from which industrial arts derives its subject matter.	11 / 24	26 / 113	6 / 56	5 / 26	2 / 4
TOTALS	195 / 558	222 / 1,191	43 / 316	30 / 157	7 / 44

Peer Review = Above Line

Dissemination Lectures = Below Line