DOCUMENT RESUME

ED 237 648 CE 037 479

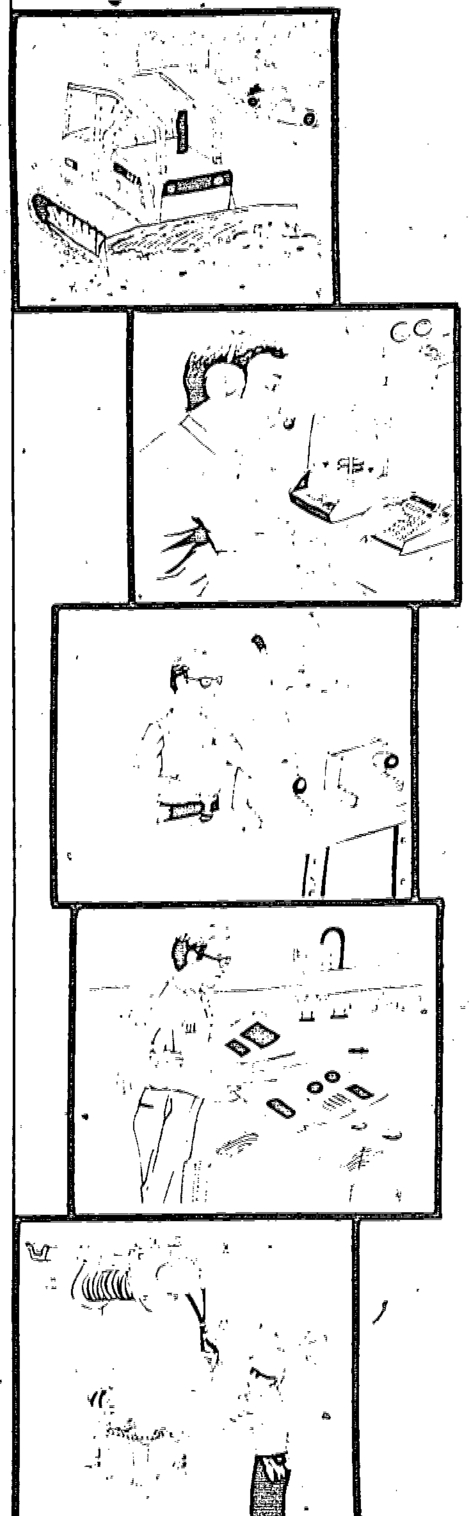
AUTHOR Wright, Thomas, Ed.
TITLE Symposium III Proceedings (Muncie, Indiana, October 23, 1981).
INSTITUTION Ball State Univ., Muncie, Ind.; Technical Foundation of America, Lansing, IL.
PUB DATE May 82
NOTE 66p.; For a related document, see ED 206 915.
PUB TYPE Collected Works - Conference Proceedings (021) -- Viewpoints (120)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Classroom Techniques; Communication (Thought Transfer); Communications; Construction (Process); Construction Industry; *Curriculum Development; Energy; *Industrial Arts; Instructional Materials; Manufacturing; Power Technology; Secondary Education; *Teaching Methods; *Technological Advancement; Transportation

ABSTRACT

Symposium III, a continuation of a series of meetings, was designed for exchanging ideas and structures for contemporary industrial arts curriculum development. The meeting provided practical classroom-oriented suggestions for teaching industry/technology-based industrial arts. The design of the symposium provided a keynote address, which gave a rationale for teaching technology, followed by two program interest sessions. At each session, two leaders in their area of expertise presented an answer to "What should be taught and how could it be organized?" The interest sessions concentrated on five major curriculum areas: communications, construction, manufacturing (enterprise and material processing), and transportation power and energy. The transcripts of the proceedings in this document give suggestions for teachers to improve their teaching in each of the five areas. Articles are illustrated with line drawings. (KC)

SYMPOSIUM III PROCEEDINGS



BALL STATE UNIVERSITY
Muncie, Indiana

In Cooperation With

TECHNICAL FOUNDATION OF AMERICA

Edited by:
THOMAS WRIGHT

October 23, 1981

Published May, 1982

Additional copies are available from:

Technical Foundation of America
1951 Bernice Road
Lansing, Illinois 60438

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PREFACE

Symposium III was a continuation of a series of meetings designed for exchanging ideas and structures for contemporary industrail arts curriculum development. The first meeting, Syumposium 80, was held at Eastern Illinois University followed by Symposium II at University of Wisconsin—Stout.

Each symposia had its own theme and goals. Symposium 80 set the stage for the series by emphasizing Technology Education. Symposium II adopted a "Technological Literacy" program theme. Symposium III was designed to provide practical classroom-oriented suggestions for teaching Industry/Technology Based Industrial Arts.

The design of Symposium provided a Keynote Address followed by two Program Interest Sessions. At each interest session two leaders in their area of expertise presented an answer to "What Should Be Taught and How Could It Be Organized". The interest sessions concentrated on five major curriculum areas: communication, construction, manufacturing—enterprise, manufacturing—material processing, and transportation—power/energy.

Symposium III provided a vehicle for exchanging ideas and, hopefully, created a desire to improve and change industrial arts programs in the public schools and industrial arts teacher education programs.

Symposium III was the result of the concern of a number of individuals and groups dedicated to curriculum development in industrial arts. Special recognition goes to the Technical Foundation of America for underwriting the major cost for Symposium III. Without TFA support it would have been impossible to assemble the team of outstanding speakers or cover the cost of attendance for a number of classroom teachers.

Additional financial support was provided by the College of Fine and Applied Arts and the Department of Industrial Education and Technology, Ball State University.

Many individuals gave of themselves to insure that Symposium III and these proceeding came to pass. A list of these contributors may be found on page 76.

The continued cooperation between educators, educational institutions, and philanthropic foundations promises to be an essential mix for promoting and implementing change. It can only be hoped that this cooperation will grow and flourish.

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Challenges Facing Industrial Arts

Thomas Wright

Over the years industrial arts, and its predecessors, manual training and manual arts, has meant many things to many people. Even today the meaning of industrial arts seems foggy and illusive. Confusion about industrial arts has become more pronounced as times have changed. The society has moved from a time which was characterized in the *Kaiser Aluminum News* (1966) as one of rapid change to a period of radical change. Each individual is facing changes wrought by technology that mystify the mind. These changes, coming at an ever accelerated pace, are exerting pressures on all of society's institutions including education. Society, in general, no longer seems willing to allow education to stand on the solid rock of tradition. The majority of citizens want educators to drive the educational vehicle in a path dictated by a clear forward looking vision of the future, rather than steering a path rooted in a rearview mirror panorama of the past. This call demands changes in attitude and action.

Industrial arts, like other school subjects, has long suffered from the rearview mirror syndrome. The field remains rooted in the subjects of Woodward's Manual Training High School—those of woodworking, metalworking and drawing. Plastics, power, graphic arts and electricity have been added only after they were fully established in our culture and came into view in the rearview mirror. However, as the society knocks on the door of the 21st century, these tradition-based programs are wholly inadequate. These programs, as depicted by Brown (1977, p. 5) as ones (1) rooted in the vocational lineage, (2) deriving content from the mechanical trades, (3) oriented to the past and (4) having tool skills and job peformance as a central theme, have long outlived their usefulness.

Citizens of the 21st century will need a different type of education dealing with the industrial-technological aspect of our culture.

Figure 1—CRISIS

They will need educational experiences which provide a basis for facing a radically changing society full of new and novel situations. This calls for a new type of industrial arts which has been espoused by numerous theorists but implemented by few practitioners. This program change causes many individuals to face a personal crisis—a need to abandon or modify old ideas and chart new directions and goals. But as in the Chinese ideogram for crises, shown in Figure 1, two important features are present. The first is **danger** and the second is **opportunity.** All crises have these elements present and the crisis of inadequate programs facing industrial arts is no exception.

This crisis has been brought about by a number of factors; however four are of prime importance. These are (1) a foggy mission, (2) a shaky content base, (3) narrow programs, and (4) limited teaching strategies. Each of these will be described in terms of dangerous practices now in vogue and opportunities for improvement.

A Foggy Mission

Industrial arts faces danger because a clearly defined mission upon which to build contemporary programs has never been established. Some members of the profession have suggested that a study of industry and its associated technologies is the primary goal of industrial arts or at least such an assertion causes little heated debate. However, a cursory glance at existing programs would suggest that either the concept of industry and technology is unclear or our interpretation has been faulty. The literature abounds with catchy phrases such as "back to basics" (back to Woodward's woodworking, metalworking and drawing, etc.) and confusing and often contradictory aims such as: — craftsmanship — skill — hobby interests — career — exploration — Industry — home maintenance — technology — self discovery — prevocational. Many of the above are secondary outcomes of a good industrial arts program but are neither central nor unique goals.

Industrial arts cannot be all things to all people. Its practitioners must decide, and decide soon, on a central mission. They must zero in on a

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primary target, and start shooting for the bullseye. And, like the expert marksman, each individual must be unwavering in his or her attention: unyielding to the distractions of personal interests, tradition, the easy way, Federal dollars, and pressures from vocational education colleagues. A mission that is truly broad in scope and provides worthwhile educational experiences about industry and technology to significant numbers of students in our school must be established. Failure to accomplish this task will produce still greater numbers of high school graduates who do not possess even rudimentary understanding of basic economics and the impact of the industrial complex on their lives.

The field must, therefore come to agreement that the mission of industrial arts lies in the sphere of general education with extensions into specialized education based on students' intensity of interest. Industrial arts, like mathematics,

A study of industry and its associated technologies.

science, social studies, and *language arts, is responsible to provide* the threshold knowledge, skills, and attitudes necessary to make wise citizen, career, and consumer choices.

Early industrial arts experiences should provide the student with broad understandings of **industry** and its **associated technologies** while advanced courses may provide more specific information as preoccupational education. However, it must be kept in mind that these occupations are not limited to the skilled trades taught in the area career centers but also include occupations requiring two and four-year collegiate or technical school training. These advanced courses are to the future skilled worker, technician, and industrial supervisor and manager as trigonometry and calculus are to the future mathematician, scientist, and engineer. They must be foundational in nature and broad in scope.

Shaky Content Base

Once the mission to provide general and pre-occupational experiences about industry and its associated technologies is accepted, the content base must be addressed. For years industrial arts professional have failed to establish a logical base for their offerings. Present-day programs are as varied as the shapes of Joshua trees on the desert. Woods, metals, and drawing are offered in one school; manufacturing and construction in another; photography is added in another; woods is dropped from another; ad infinitum.

This shaky content base must be solved. Agreement on the important question, "On what basis are curricular decisions related to content going to be made?", must be found. This agreement must be based on a scientific view of our society—a view which establishes the universals of our highly industrialized culture and then selects those universals which "belong" to industrial arts. The rear-view mirror must not be used to view the experiences provided during ones undergraduate preparation or in previous public school industrial arts programs. The eyes of the profession must be fixed on the 21st century, and the curriculum base chosen must have the potential for projection into that time frame.

A promising content base is one which uses as the basic universal **Human Productive Activity**—the activities engaged in by people to transform materials, information, and energy into more usable forms (Figure 2). These activities involve changing materials into manufactured or constructed products; information into media messages; energy into power. Each major transformation activity involves the major steps of (1) designing, (2) preparing to produce or transform, (3) producing or transforming, (4) marketing the output, (5) financing the activity, and (6) developing people to perform essential tasks.

These major steps encompass the **technology**—the efficient and appropriate action—of human productive activity. They involve the processing of inputs into usable outputs and are carried out in a societal context by manufacturing, construction, communication, and transportation

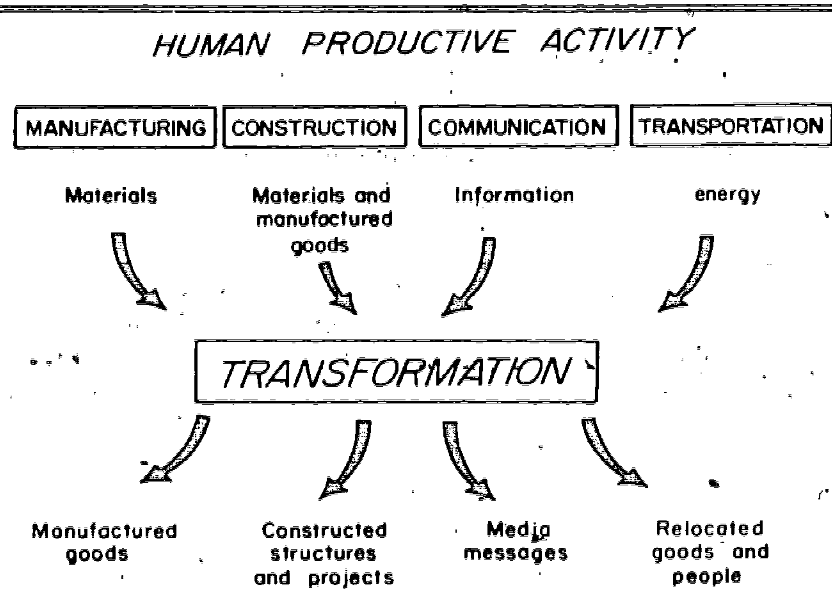

Figure 2—HUMAN PRODUCTIVE ACTIVITY

Industries. As can be seen in Figure 3, these industrial structures and technological activities have a history—they contributed to our past achievements; function in today's society, and will help shape our future.

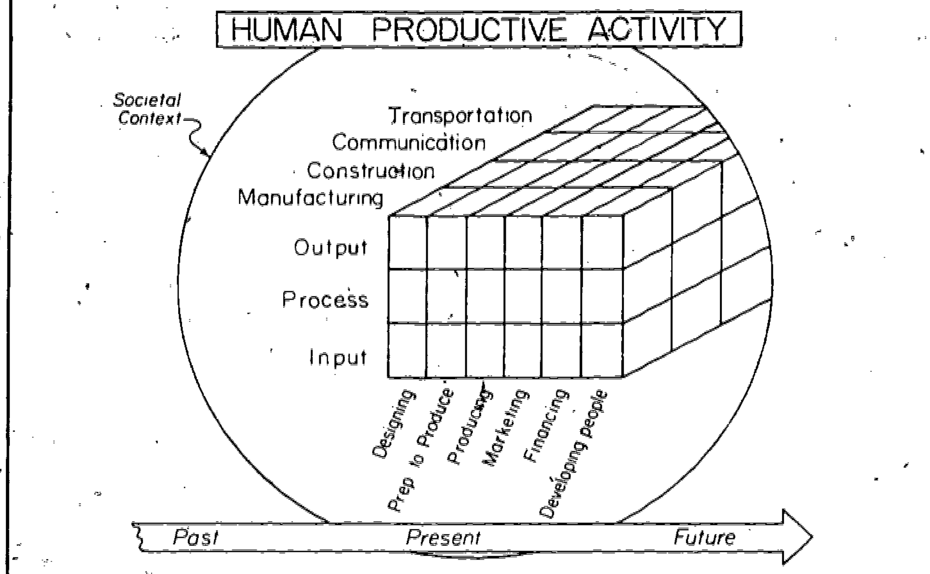

Figure 3—HUMAN PRODUCTIVE ACTIVITY

A closer view of these human productive activities suggests that each major system—manufacturing, construction, communication and power—may be categorized into management processes and managed productivity activities (Figure 4).

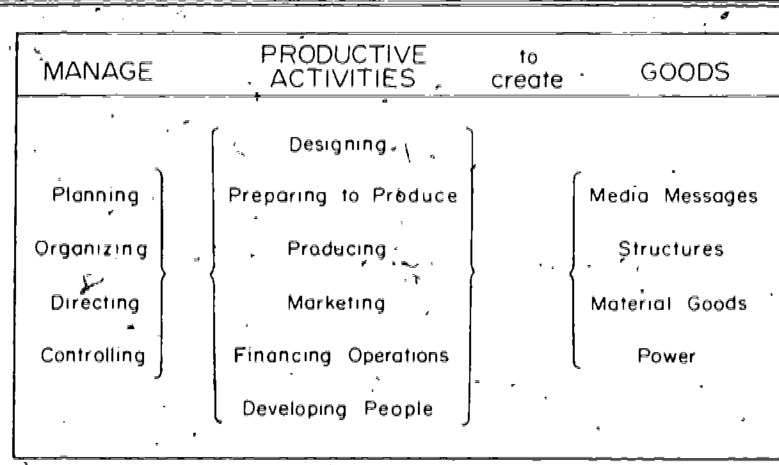

Figure 4—MANAGEMENT AND PRODUCTION TECHNOLOGY

An industrial arts program built on the above logic base and extended using the basic rules of classification, (Ray and Streichler, 1975) will be able to be described truly as study of industry and its associated technologies. Examples of the extended classification systems may be found in ACME, 1957; Lux and Ray 1971; Hauenstein and Bachmeyer, 1974 ad 1975; Wright and Jensen, 1976; and Wright, 1977. Such systems will help move the field toward a solid defensible content base.

Narrow Programs

Using a sound content base the third danger facing industrial arts may be addressed—the danger created by narrow programs. Many industrial arts programs are narrowly conceived and fail to address the wide range of interests and abilities of today's youth. Industrial arts' love-affair with the required project (or limited selection) does not meet the needs of all youth. The single levels of expected cognitive and psychomotor performance often used to evaluate individuals is unjust to many students. Programs resembling a funnel with its restricted freedom of movement fail to meet the needs of the slow learner, the uncoordinated, the high achiever, the inquisitive, and many other special groups.

Conceptually based programs which provide central learnings with abundant opportunities for students to move in several directions from the base need to be developed. The use of time as a central criteria for achieving goals, must be limited and activities of varying levels of difficulty and challenge need to be provided. In short, industrial arts programs need to be moved out of the tunnel and onto the plain where it is possible to travel varied paths to achieve stated goals.

The broadening of opportunities will allow all students to find a measure of success in the industrial arts laboratory. Industrial arts, probably more than any other area, is capable of providing genuine success—oriented learning experiences for all ability levels. Each student can be allowed "to become a somebody" in his or her own eyes. Every individual in a well-designed industrial arts program can find an area where he or she can succeed. Maley (1973) describes this type of program as having vertical and horizontal articulation. He described many of our programs as one-square programs in which all students perform similar activities and are judged in accordance to a single and limited range of divergence.

A better program, as shown in Figure 5, would be one which resembles a checkerboard with numerous vertical activity squares to accommodate varying student abilities and many horizontal activity squares to take advantage of student interests. With this course structure students are encouraged to complete activities which meet individual interests and abilities. But like a checkerboard, the program would have boundaries within which the students must operate. These boundaries are established by viewing the mission and content base for each class or program.

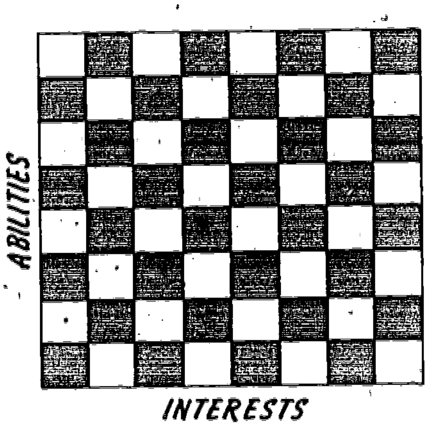

Figure 5—BALANCED PROGRAM

Limited Teaching Strategies

The fourth danger facing industrial arts arises out of a failure to use the myriad of teaching methods or strategies available to enhance the interest and effectiveness of the programs. The two-horse team of lecture and demonstration has been used until, like horses with blinders on, no other alternatives can be seen. It must be realized that no single method or pair of strategies can develop all the human abilities needed by citizens of the 21st century; or the 20th for that matter.

Reliance on the lectures, and demonstrations and on the individual-project has in effect provided activities designed to give the same opportunity to all members of the group and therefore reduces group variance and individual uniqueness. They involved the individual and his or her assigned work with little concern for group interaction. These methods are basically "I'm going to tell YOU something," or "I'm going to show YOU something," and now "I want YOU to do what I showed you on your own." How diametrically opposed this is to life which revolves around group interaction and cooperation (Combs, 1979, p. 15-22).

Additional teaching strategies must be added to the repertoire of each industrial arts teacher. Included in these new methods should be those that are group centered so students can develop group interaction skills and learn group roles. The group project where all members work together to build a single item or line production where the group organizes itself to produce a product in quantity can provide these types of group development experiences. Role-playing and simulations should also be investigated and implemented where they enhance learning. The industrial arts classrooms and laboratories should be the home of a balance of methods—some which develop individual abilities and others which develop group interaction abilities.

. . . provide knowledge skills and attitudes necessary to make wise citizen, career and consumer choices.

Conclusion

Dark days may well be ahead for industrial arts if programs are not carefully analyzed to identify and eliminate questionable practices and outmoded idea. Hope for the future lies in:

1. Accepting the mission of interpreting industry and its associated technologies of the future citizens of the 21st century;
2. Developing a content base from a careful analysis of human productive activity;
3. Broadening our programs to accommodate a wider range of student interests and abilities;
4. Using a mixture of group and individual centered methods to promote personal growth and group interaction and cooperative skills.

Industrial arts may well be at the crossroads. Its future lies in marching toward new challenges; remembering the past but seeking direction from a forward-looking interpretation of the needs of today's students.

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Keynote Message . . .

Invention / Innovation / Diffusion A Look At Technology Education

M. James Bensen

A Frame of Reference

Bringing about technological change through research and development requires a three stage process involving invention, innovation and diffusion. The invention stage is when a new and original solution is conceived for an identifiable problem. The invention then becomes an innovation when it is introduced and utilized by "early users" as a changed way of doing something. The innovation stage ceases being such when it becomes diffused (adopted) and eventually becomes the convention mode of operation.

When we draw a parallel between the process of bringing about technological change and that of changing our curriculum to one emphasizing technology education we see some interesting developments. The heritage of the inclusion of the study of technical subject matter in our schools is only a little over a century old. From its manual training, manual arts and industrial arts beginnings, the study of technology was "invented" by our leaders in the 1930's and 1940's. With proposals from such people as William Warner, Delmar Olson and others, the idea was conceived. Later, scholars such as Paul DeVore, spearheaded a more refined analysis of the discipline and the possibilities became more crystalized and manageable. A host of new approached were brought forth in the 1960's and 1970's as programs for the study of the social institution of industry, technology, and industrial technology evolved. This period was the "innovation" stage of change as people throughout the nation were using these ideas to design and implement tremendously exciting and relevant programs. At what stage of technology education are we presently in? Have we completed the innovation process necessary to move on to the diffusion stage? Most would readily agree that technology education has evolved where it is being implemented by many professional educators across the country, yet most feel that a dramatic movement would have to be experienced before it could be considered as "diffused" or implemented.

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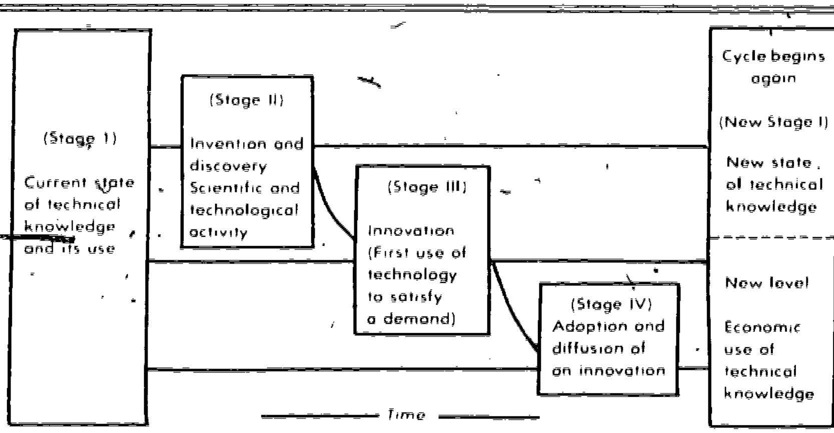
Sharpening Our Viewpoints

Technology, a force that has had an awesome influence on our culture, is defined as: "the 'know-how' and creative process that may utilize tools, resources and systems to solve problems to enhance control over the natural and man-made environment to alter the human conditions" (Gebhart, et. al.)

To teach technology more effectively in our schools we must have greater access in the time allocation of the school curriculum. Just as science is taught throughout the elementary and secondary curriculum, with a high percentage of required courses, so should the study of technology. Technology can be structured much like science if multiple offerings are to be provided on several levels. Experiences would run from the general to the specific in a parallel fashion. At what points we propose to require or offer electives is an educational decision that would have to be made.

Why Teach Technology?

The cultures of the world are shaped in a pervasive way by the technology they have developed or



Technical Advance is defined as an increase in the level of technical knowledge and or an increase in the economic uses of technical knowledge

Greber and Marquis, "The Human Factor" **Factors In the Transfer of Knowledge**

Figure 1—FOUR STAGE PROCESS OF TECHNICAL ADVANCE

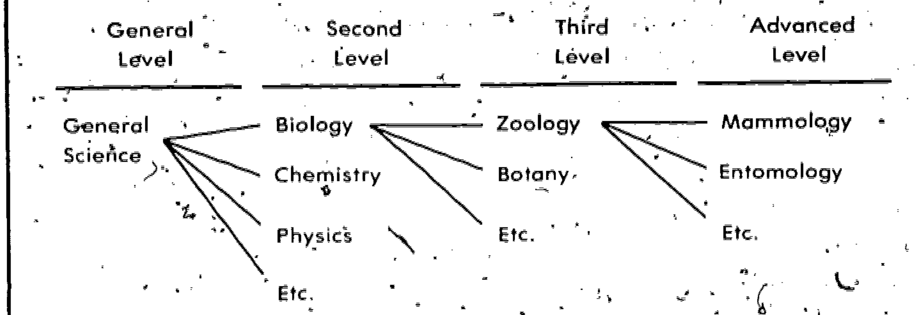


Figure 2—COURSE SEQUENCE IN A TYPICAL SCIENCE PROGRAM

transferred from others. This "snowballing" phenomenon creates an environment that has far reaching ramifications for the whole world. If we are going to be in control and direct technology for the good of all, then we must better understand it as a part of our culture. Hence, it is imperative that we have a technologically literate society.

General And Specialized Education

The study of technology as a part of general education naturally takes on a different form than if we study technology for a "specialized" function. The design of the portion of the curriculum for general education purposes must address the most generalizable concepts and focus on the elements that are central to an understanding of it. Specialized education in the field of technology, however, can take on more narrow goals and even address a single type of technology. Thus, we come to the issue of whether to teach technology (in its singular sense) or one or more technologies (in the plural sense).

To teach technology, its universals and process is a difficult task. However, if successful, the study of technology has the promise to yield one of the most powerful educational experiences that we can provide our society. If the outcome is truly a broad understanding of technology with a realization of its many ramifications learners are well on their way to being technologically literate.

To teach technologies, in the plural sense, we are providing a more specialized education and quite possibly be moving toward career competency attainment. This is especially so when the experience has the necessary depth and duration to provide the acquisition of these intended outcomes.

How Early Can We Begin?

The question is often raised by the traditional industrial educator as to

The study of Technology has the promise to yield on to the most powerful educational experiences that we can provide our society.

the earliest point we can commence teaching technical subject matter to young people. At what age can students safely use the table saw? When is it prudent to introduce power hand tools? These types of questions are perennial in nature, yet they address the issue in an awkward way.

If we begin our curriculum questions regarding young learners we should start with the issues of readiness and developmental tasks. These, along with the "Bruner Principle" that "we begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development," (Bruner) give us a point of departure. For example, we can take a technological problem, such as packaging and teach it at the kindergarten level for one or two short lessons and have a very excellent educational experience. Likewise, we can teach packaging in a four year university level program leading to a B.S. degree and provide experiences that meets the needs of a huge industry. Both educational endeavors addressed the technology of packaging and, yet, both were intellectually honest and valuable. The difference was one of degree and expected outcomes, not of one being more valuable or better than the other. The study of technology should be offered to students at all levels in the school. The introduction of the safe use of tools in the laboratory activities as concepts are being learned and problems being solved would then be governed by the principles of learner readiness.

Process As Content

One of the most interesting and dynamic approaches to the study of "technical means" is to teach the "process of technology". The processes are more durable and universal than facts and techniques and

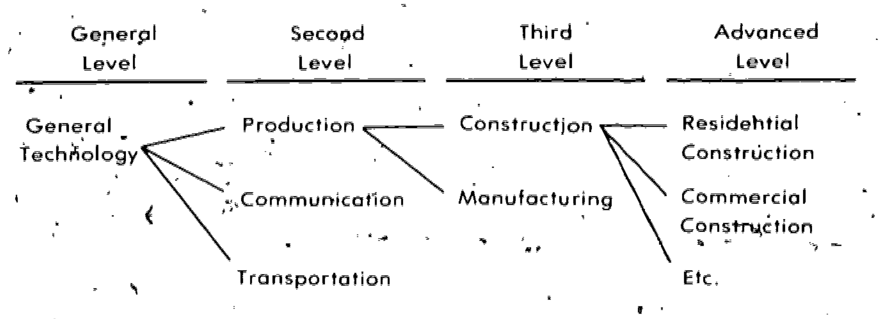


Figure 3—POSSIBLE COURSE SEQUENCE IN A TECHNOLOGY PROGRAM

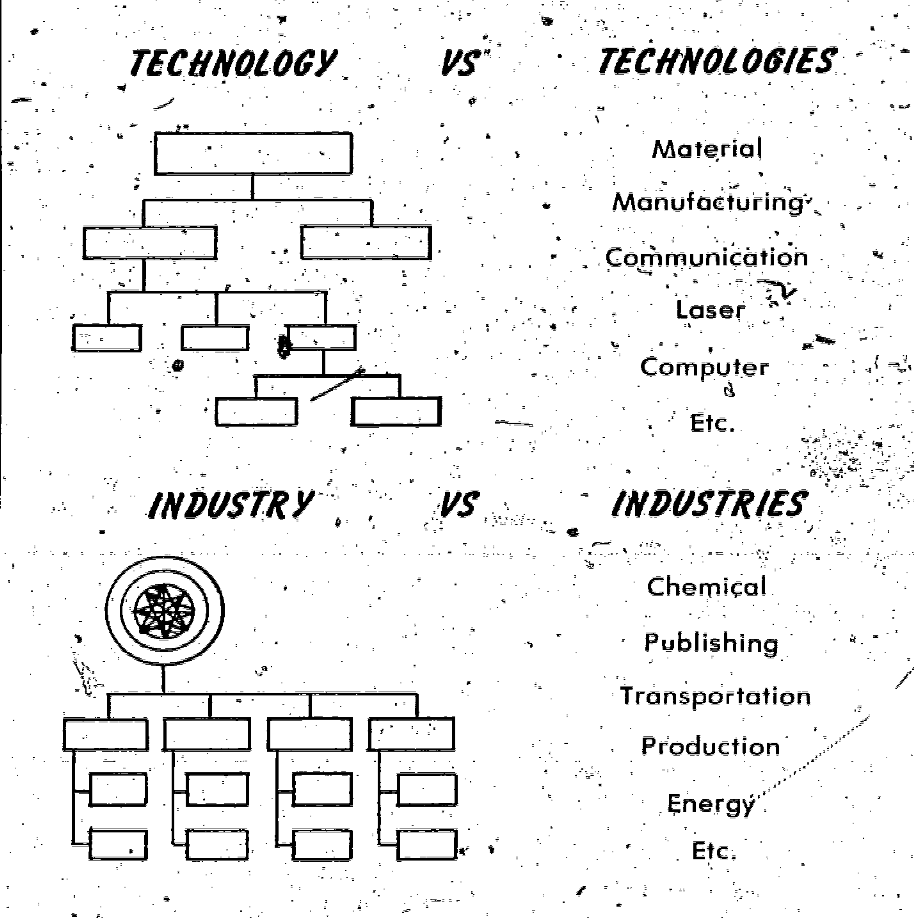


Figure 4—THE STUDY OF TECHNOLOGY VS TECHNOLOGIES

thus provide a more useful education that will help people to cope with the future. Halfin identified the following seventeen processes that are readily transferable to any application of technology:

1. Defining the problem or opportunity operationally
2. Observing
3. Analyzing
4. Visualizing
5. Computing
6. Communicating
7. Measuring
8. Predicting
9. Questioning and hypothesizing
10. Interpreting data
11. Constructing models
12. Experimenting
13. Testing
14. Designing
15. Modeling
16. Creating
17. Managing (Halfin, 1973)

To teach the process of technology requires the organization of the learning environment to be in a problem solving format. Students would be required to work on problems that would get them into design, research, development and engineering activities.

The Laboratory Approach To Learning

Industrial arts programs, since their inception, have had a rich and well developed process for providing a learning environment where students had an opportunity to apply the theory that they were learning. The laboratory was a natural evolution from the roots of approaches being used in apprenticeships, manual training exercises, projects from the manual arts and industrial arts eras. The strengths of these early programs capitalized on the inherent motivation that comes with making "smoke, sparks and chips".

It is absolutely essential that as technology education programs are developed that we utilize the laboratory to its fullest potential. The activities that are used will take on a variety of modes such as mass production, design, prototypes, "tryout" experiences (exercises used for exploring rather than skill building) diagnostic experiences (trouble shooting, etc.), construction, simulations, educational games, research and development and "engineering", just to name a few. These laboratory experiences should be a careful blend of individual, team and group activities as they are designed to meet all of the objectives of the particular courses.

Some Other Elements of Technology

There are several other elements of technology that will contribute to the content of programs as they are developed. In addition to the suggested technical categories of communications, construction, manufacturing and transportation the following elements are infused and are actually a part of all of these categories. They are:

- Technology assessment
- Appropriate technology
- Technology levels (high, intermediate and low)
- History of technology
- Systems of technology
- Development of technology (the inventing R&D process)
- Technology futures
- Impacts of technology
- Technology futures

All of these elements play a significant role in any study of technical means and should be brought into focus where appropriate.

Technology education must utilize the laboratory to its fullest extent.

A Parting Perspective

All fields of human endeavor are under constant change and development. The dynamics of our field present awesome challenges to us in the content aspect alone, to say nothing about how we design this education or how we deliver it. What we are teaching must be contemporary and future oriented as our learners are going to need an education that will be useful and relevant to them as they step into the 21st Century.

The study of Technology should be offered to students at all levels in the school.

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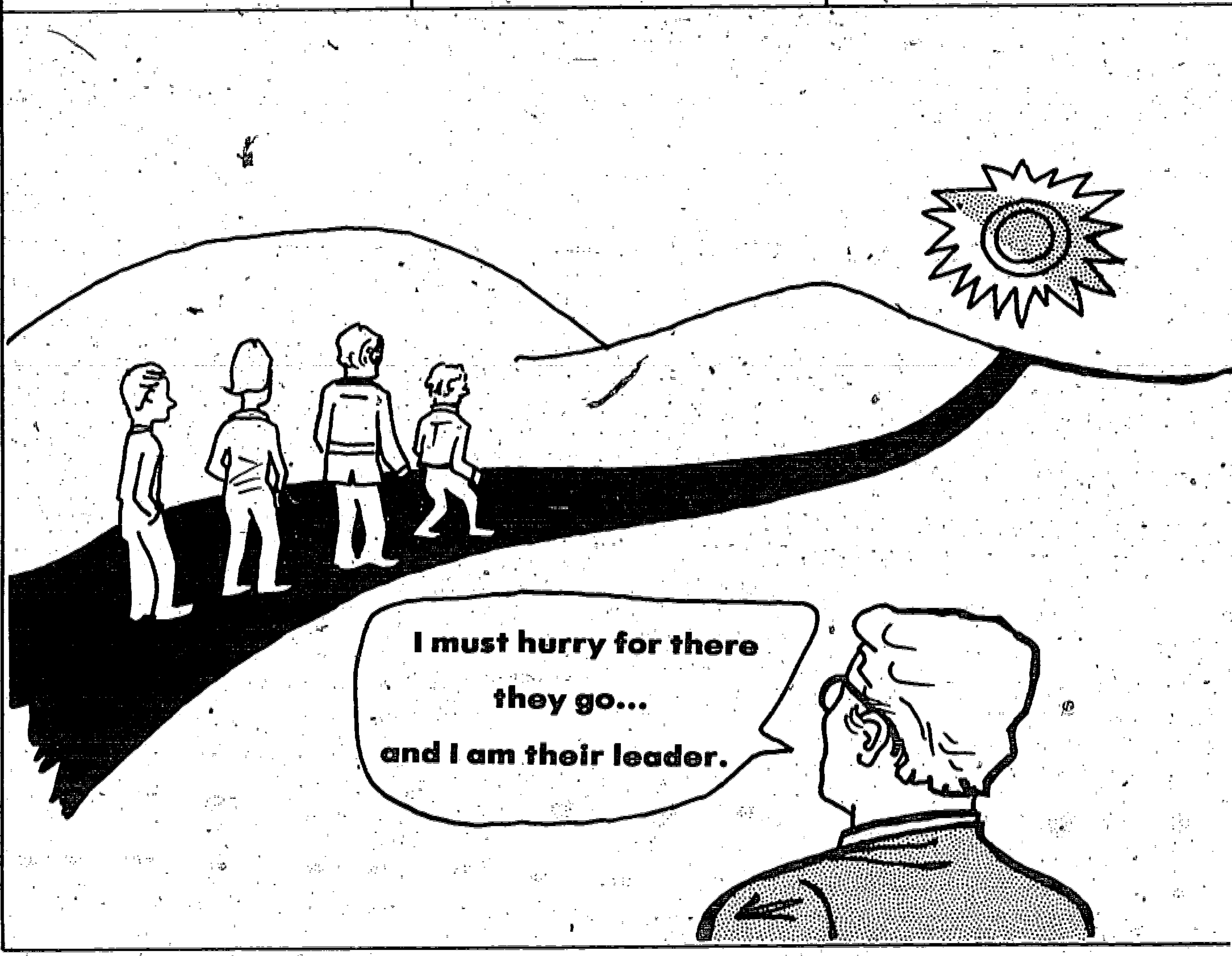

COMMUNICATIONS

Communication Technology In The Classroom

John M. Ritz

The reason for many of us gathering at conferences like this is to interact and attempt to find ways of implementing a concept known as technology education. Technology is one form of industrial arts education which has been around since the late sixties, and it is an option for those who feel industrial arts should be much more than the transfer of outdated industrial skills to our youth. One of the major problems confronting our field of study is the identity crises which exists among industrial arts teachers and teacher educators in general. Many who profess they are industrial arts teachers are rather trade and industrial education teachers. Whereas the mission of industrial arts education, from a technology base, is to help students develop an understanding of all aspects of industry and technology, trade and industrial education has a mission to develop manipulative skills . . . which prepare individuals for initial employment. Until this identity crisis is resolved, some will continue to develop new and exciting programs which will prepare youth and society for the future, but the majority of our programs (woods, metals and drafting) will continue to train individuals in the practices of the crafts. This may be called second rate trade and industrial education.

Although the above problem exists and will undoubtedly persist within our profession, there are individuals who are trying to make sense of what is being done in technology education. The Jackson's Mill Industrial Arts Curriculum Theory is proof of the interaction and compromise that is taking place in the profession. This compromise suggests that programs for industrial arts education should be developed within the major systems of technology. These include communication, transportation, manufacturing, and construction (Snyder and Hales, 1981, p. 20).

This presentation will focus on the area of communications technology. It will be done from the view of a curriculum developer, not from the view of a technologist.

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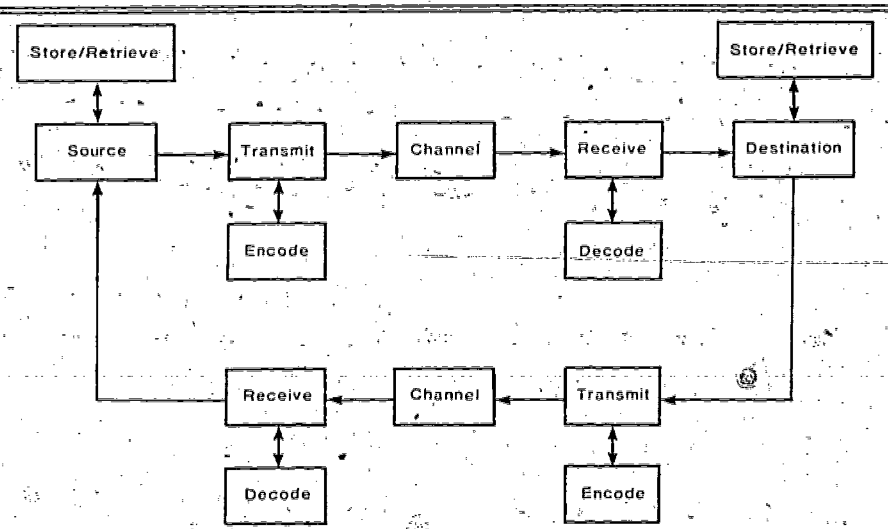

Figure 1—COMMUNICATION PROCESS.

Communication Technology

Communication is a technical system utilized to transfer information to extend human potential. The extension is made so that the human senses can function beyond their natural state. Through development in such technical areas as writing, drafting, graphic arts, photography, microforms, telegraphs, recordings, telephones, television, films, computers, radios, and satellites, new inventions have been born that assisted society in transferring information (Gore And Robb, 1981).

The heart of a communication system is controlled by a network of information processing known as the communication process. For individuals to understand communication technology, they must become aware of the process, know how it is utilized in various technical systems, and realize the impacts the communication process has had or can have on individuals and societies.

The simplest version of the communication process is illustrated in Figure 1. It shows the process that information must transcend so communications can occur. The terms identified in the illustration are defined as follows:

1. The SOURCE is the system (human, machine, etc.) desiring to transmit a message (information).

2. The ENCODER is the technical means used to put the message into a code form so it may be transmitted with the use of the transmitter.
3. The TRANSMITTER is the technical means (machine) used to transform the information into the channels.
4. The CHANNEL is the pathway (wires, waves, fluids, paper, gears, etc.) that the message travels from the source to the destination.
5. The DECODER is the technical means used to put the messge back into a usable form.
6. The RECEIVER is an apparatus or device that composes incoming decoded information for use by the destination.
7. The DESTINATION is the system to whom the message (information) was directed.
8. The STORAGE/RETRIEVER component is an element in the process where information can be placed until needed.

Three ways to illustrate the cycle of the communications process are illustrated in Figure 2. These include examples of ideas focusing on the communication process through the technical areas of radio, graphic arts, and drafting.

Implementation Methods

Although many in the field understand and accept the definition and process model for communication technology, little is done with this information in the classroom after it is briefly introduced early in the school year. Usually what is done is that the definition, process, and history of communication technology are discussed and then teachers move into a study of drafting, graphic art, photography, and electronics. This later study focuses on skill development and/or production procedures. The communication process is ignored and the potential impacts of communication are forgotten.

This is a mistake. We are again teaching trade and industrial education under a new name—Technology Education? We must rethink what the purpose of Technology Education is and focus the study on the technical systems of communication, manufacturing, transportation, and construction and their impact on society.

In the area of communication technology, we should analyze each of the following technical areas as identified by Gore and Robb (1981): writing, drafting, graphic arts, photography, microforms, telegraphs, recordings, radios, telephones, televisions, film, com-

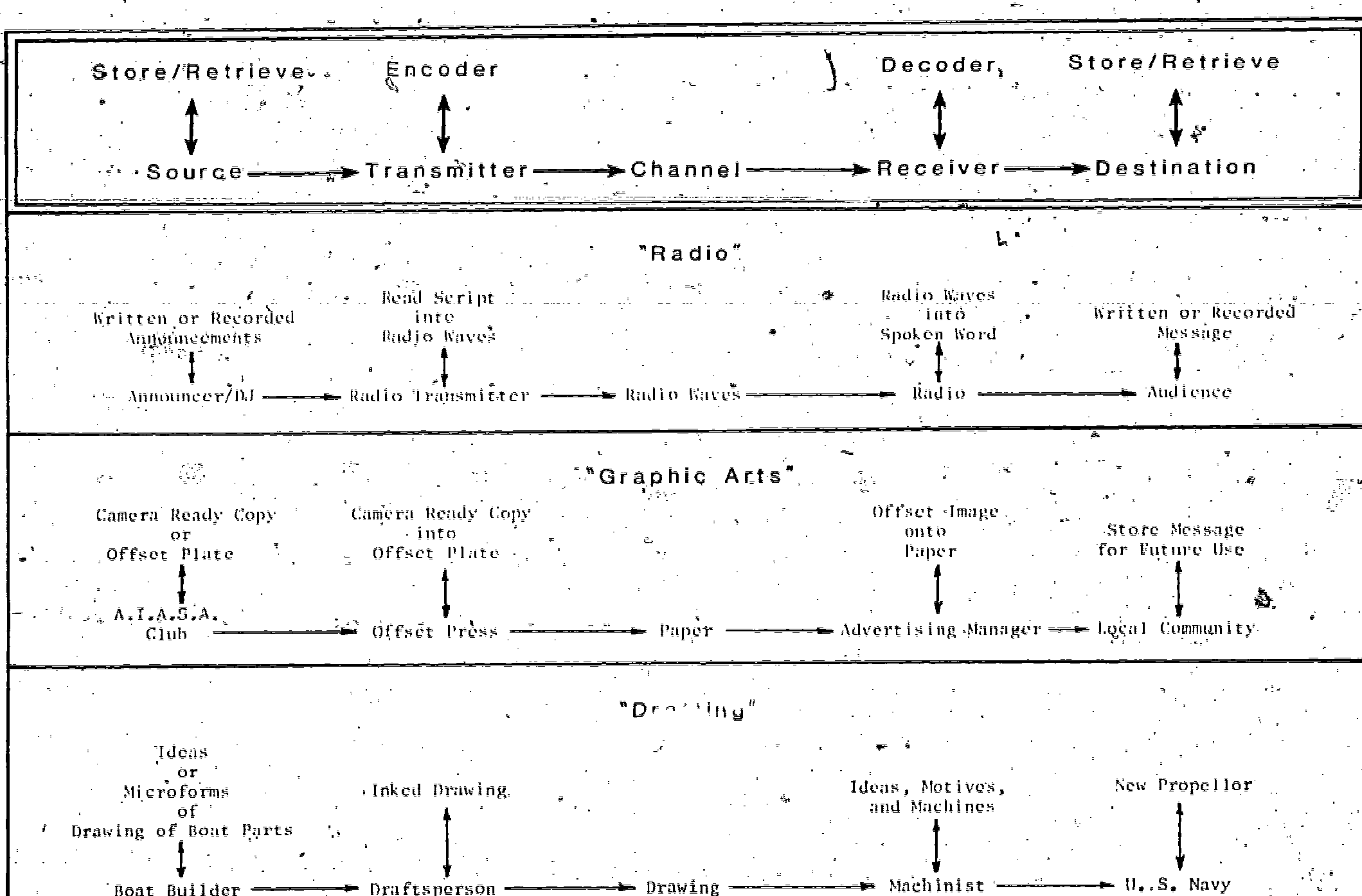

Figure 2—ILLUSTRATIONS OF THE COMMUNICATION PROCESS

puters, and satellites. In this analysis attention must be directed **equally** on the following content focusers: Their history, their significant technical developments, their use and operation, and their potential impacts on individuals and society.

The classroom study must focus on all of the above items. We need to constantly review the communication machines and their consequent processes in an evolutionary process from contemporary, as well as, past and future perspectives. However, is it not necessary to dwell on all technical means in a given area of communications. Be selective and select only those that have been most useful to society. Introduce technical skills to students where they are needed to keep the study interesting. This would be

"industrial arts should be more than the transfer of outdated industrial skills to our youth."

similar to the training of students to work on the assembly line in the technical system of manufacturing. However, concentration should be place on what needs to happen for the particular communications process to take place. Also, the most important factor is to have students evaluate various means of communication and how they have affected populations throughout history.

Typical examples of how this study could take place in the classroom are described in the following dialogue. First, if you choose to study the technical area of graphic arts, you might wish to start with screen process printing. This is an intriguing area for most students. You could begin the school year by having students hand cut stencil film of some logo and title. The students could print these on felt squares or T-shirts. However, as an instructor you should focus discussion and instruction on the technical uses of screen printing and the operations which must be followed for this communication to occur successfully. After you have performed the activity, discuss with the class the impacts that screen process printing (communications) have had on society and the age group of the students. Discuss made-to-order T-shirts, tapestry prints, posters, beverage containers, etc. Also discuss the significance of this given communications technology, such as, individuality, advertising, and aesthetics. From screen process printing move on to earlier graphic arts technical processes and more contemporary processes. Review as many processes and technical developments as possible. However only venture into student printing activities that are of high interest to the students.

Examples of activity areas could include printing of stationary with linoleum block cuts and hot type as a past era of graphic areas and the printing of iron-on transfers with offset lithography. Be as broad based as possible but remember to focus on the significance of the technical processes and the overall contributions and impacts the processes have had on society. Students should evaluate the technical means to determine when and why they are or should be used. A good example for this analysis would be electrostatic printing.

Another technical communications area to illustrate this instructional flow would be in the area of radio. You may wish to begin instruction in this technical area by focusing on the "CB" broadcasts and discuss their use to the community and individuals. Broadcast some messages from the class to local residents or truckers who may pass by the school. This also would undoubtedly provide some good public relations for the school and class. Finally review the significance and impact the "CB" radio has had upon the American society and economy.

From the "CB" experience you could move into other telecommunications areas related to the radio. Why not look at the use of the communications satellites and how they have made it possible to communicate over longer distances. Discuss the impacts of satellites and possible development in the future for radio communications. This should be of interest to the student and provide a springboard to work back through the development of radio communications.

A high motivational area could be the transistor radio. Discuss the historical development of the radio from Marconi to the transistor. How

"communication technology is oriented to an understanding of industry and technology and their significance and impact on individuals and society."

does the radio operate and how does it relate to the communication process. What has been its significance to world communications, entertainment, and the family? What impacts has the radio had on society? After the students become aware of the implications the radio has had on society, the family, and the individual, allow them to construct a transistor radio. Do this using either standard parts or purchase kits for assembly. Following the assembly by the class review the process used by American industry today and the production in the Orient. These discussions and activities should assist the student to better understand the significance and impact of the radio to the system of communication technology.

A final example will come from the technical area of recorded communications. You could begin this unit by reviewing and listening to different types of music boxes. How did this technical means influence societies of the past and present. How does this mechanical means produce music? How does the communications process flow?

From this development move onto the historical progression of recorded communications. You could discuss such technical means as the player pianos, record players, wire recorder, marine depth recorder, and various tape recorder devices. Students could collect materials for information recording such as records, paper tapes for numerical control, computer cards, magnetic tape, etc. They could also practice making tape recordings and experience the skills that must go into good recording. However, do not overlook tracing through the network of the communications process, the significance and uses of the differing technical means, and the impacts that these devices have had upon individuals and societies.

Although the above examples of case studies for graphic arts, radio, and recordings are limited, they do provide methods for implementing programs in communication technology that are oriented to an understanding of industry and technology and their significance and impact upon individuals and society. This is in contrast to industrial arts programs which are skill development focused and lean toward trade and industrial programs, i.e., printing, electronics, drafting, and photography.

When planning programs in communication technology, we must remember to study as many technical areas, i.e., writing, drafting, photography, television, microforms, film, etc., as possible and review the major technical developments (inventions or machines) within these areas. However we must focus our study on the history of the communication technical areas (past through contemporary and future times), the significant developments within the area, their use and operation (including the communications process), and their potential impacts on individuals and societies. We should continue to make our programs activity based, however it is not necessary to spend the majority of time working on the development of technical skills. Technical skills should be introduced where required to compliment the conceptual and affective information. They should be built where appropriate.

Scope and Sequence

A final point which must be treated in this analysis is a scope and sequence for a secondary school communication technology program. I can foresee a structure as depicted in Figure 3. The program planners should begin with an introduction into the area of technology, progress into the technical systems of manufacturing, communication, construction and transportation, then depart (with the students making the selection) into the knowledge associated with communication technology. This analysis can become more specific and technical as the instructor and students progress in grade levels. The end might be a specialization by the student into a particular vocation. This illustrates the progression that can occur from general in-

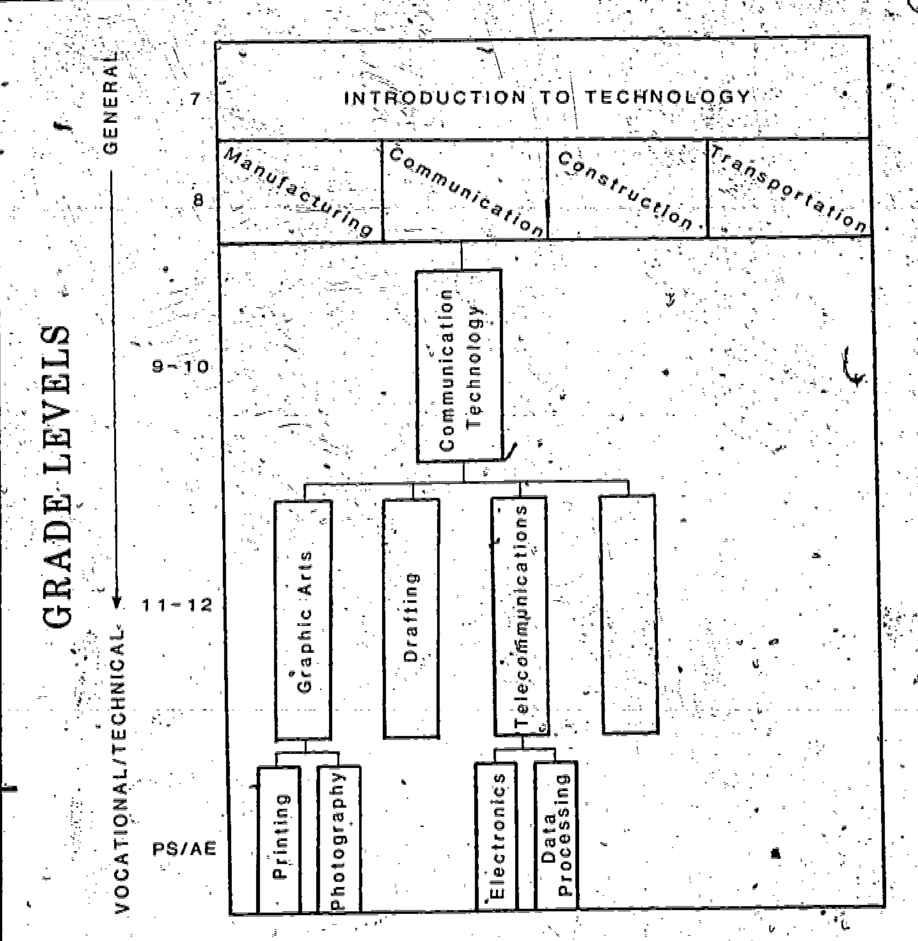

Figure 3—COMMUNICATION TECHNOLOGY SCOPE AND SEQUENCE

dustrial arts education into a specialized vocational trade and industrial education program.

Summary

The above discussion had as its thesis the implementation of a communication technology program that would assist the learner and teacher to understand our communication systems in a technological society. It focused on the technical areas of communication from a sociocultural perspective. Activities where included but technical skills were not the raison d'etre. With programs developed using this rationale, we might someday educate our students about the technology in their environments and truly gain an image for our profession that is other than job training.

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Communication As An Industrial Arts Area

Mike Steczak

Industrial arts has been undergoing an evolutionary change from a skill-based study of the work of craftsmen to one based on major industries and their associated technologies. Significant progress has been made in developing programs for the study of manufacturing and construction. However, these programs do not encompass the wide range of industries found in the American economy. Those industries which specialize in producing communication messages have either been ignored or given limited attention.

A view of the future indicates that information processing and communication are going to continue to increase their significance in everyday life. Students must be given a foundation for understanding, using and controlling this expanding technology if they are to be fully educated. This seems to be part of basic education which is in the scope of industrial arts.

What Is Communication?

Communication is a basic phenomenon of the culture and involves the exchange of ideas and information by any means. For the purposes of identifying content for industrial arts the communication's industries are those enterprises which convert information into messages. These enterprises may be grouped. The one grouping that seems to have the most utility, breaks communications into publishing, filmmaking, broadcasting and data processing. Each of these four elements have a basic technology—efficient practices and a group of companies which use these technologies in a managed production system. For example the publishing group includes book manufacturers, commercial printers, newspapers and magazine publishers, greeting card manufacturers, and so forth. Likewise, Broadcasting includes enterprises which deliver messages by radio and television media.

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How Do We Communicate?

Whenever communication is accomplished a basic procedure is followed. Every message is first conceived as an idea or information in the mind of the source. The information is then converted into messages through a four-step process which is as follows:

1. Encoding — designing the message using standard symbols
2. Transmitting - preparing the message for production and producing the message
3. Receiving — delivering the message to the intended receiver
4. Decoding — the receivers act of receiving, interpreting, synthesizing and reaction to the message

A model of the communication process which better helps one to understand what takes place in communication is shown in Figure 1.

One cannot fully understand the communication process unless you look at the production activities associated with the production of a message. Figure 2 shows the basic production activities needed to produce a message.

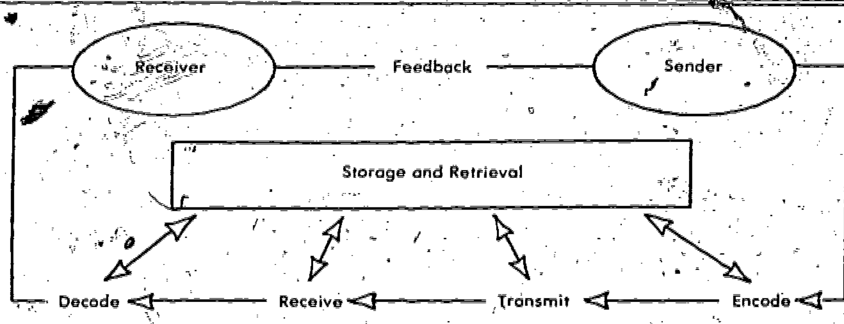


Figure 1—COMMUNICATION PROCESS

An expansion of the Production Activities will show the major steps encountered in producing a message in any one of the four fields previously stated that makeup the communication media, Figure 3.

How Do We Teach About Communication

Models and definitions serve a definite purpose but become useful to industrial arts teachers and their students only when they are transformed into a curriculum, course or unit of study. The remainder of this discussion will center on a proposed structure for

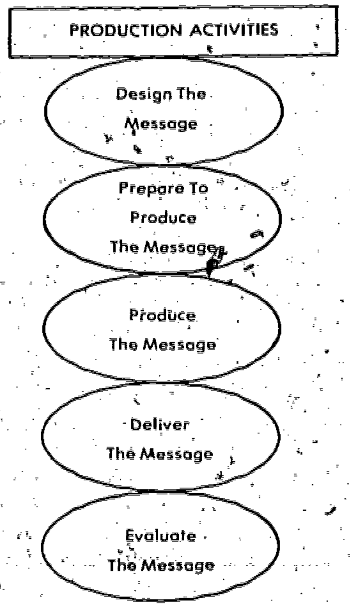


Figure 2—COMMUNICATION PRODUCTION ACTIVITIES

an introductory communication course and a presentation of selected student activities.

The major decision which must be made involves the structure of the course. At least two alternatives present themselves. The first would be to study the four production activities shown in Figure 2 as the major units in the course. The other, and seemingly more functional approach, would be to use the four basic industries—publishing, filmmaking, broadcasting and data processing as the vehicle to study the conversion of information into messages. This approach allows the teacher to concentrate on the major activities of (1) designing the message, (2) preparing to produce the message, (3) producing the message, and (4) delivering the message. Within the course the teacher may present the practices common to all four industries during an in-depth view of one selected industry and the unique practices while studying the other industries. For example an in-depth study of the practices of designing the message might be studied during the publishing industry unit and the design practices unique to broadcasting, data processing and filmmaking would be presented during the study of those areas. This approach allows the teacher to avoid redundant discussion of design principles and delivery practices and therefore provides an opportunity to enlarge the section on preparing for production and production where the major differences among the industries seem to lie. For example publishing, filmmaking and broadcasting messages all follow a similar design process but use uniquely different production techniques. Also, delivery is much more visible in the study of broadcast activities than other communication grouping (see Figure 3).

With these concepts in mind the following skeleton course structure and selected student activities are presented as a point of departure for further discussion, development and refinement.

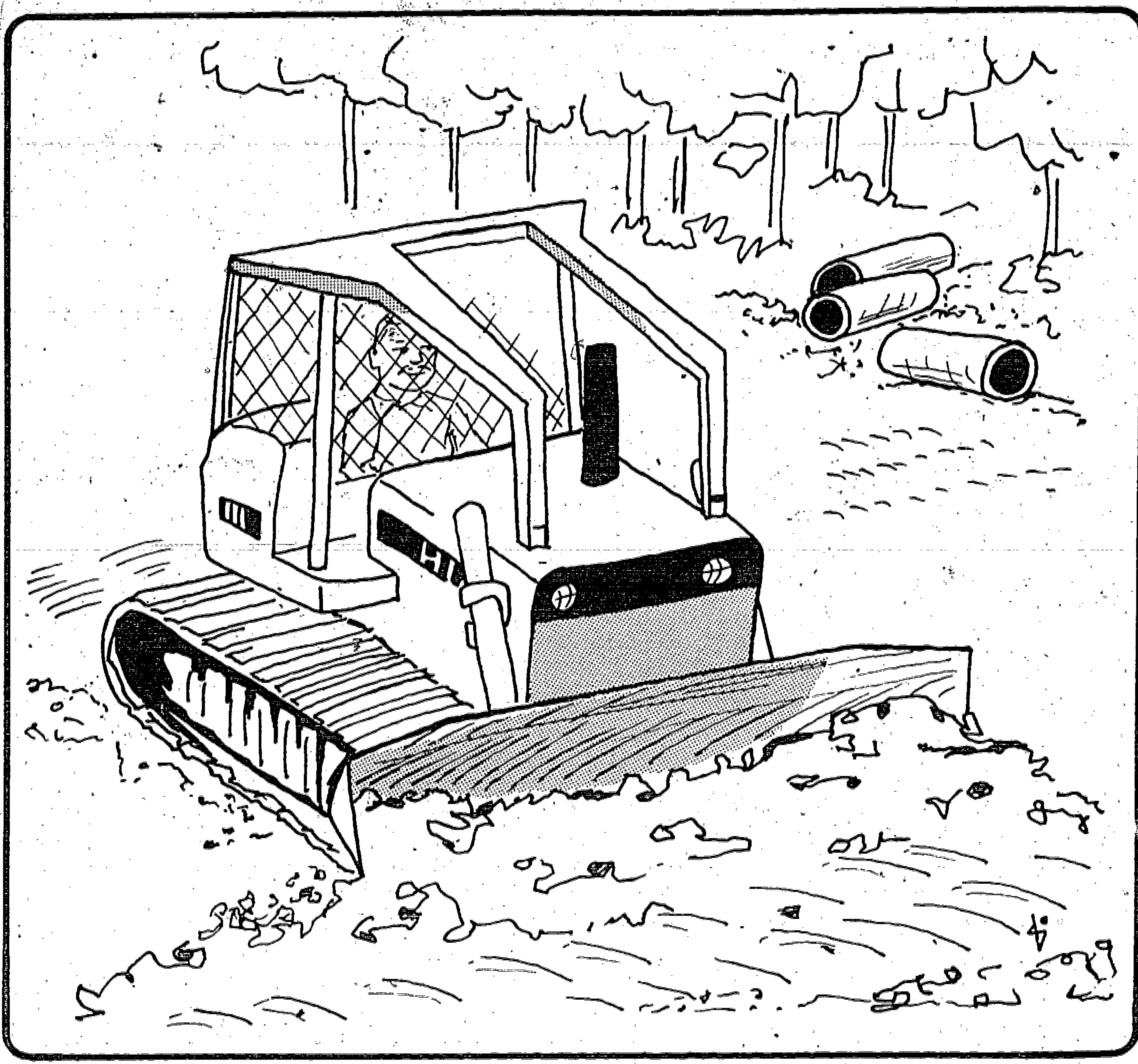
	PUBLISHING	FILMMAKING	BROADCASTING	DATA PROCESSING
DESIGN THE MESSASGE	Assess Market Establish Format Gather Information Write Copy Design Graphics Edit	Prepare Scripts		
PREPARE TO PRODUCE THE MESSAGE	Prepare Layout Generate Copy Generate Graphics Prepare Pasteups	Schedule Production Cast Stage Rehearse		Draw Flowchart Write Program
PRODUCE THE MESSAGE	Produce Image Carrier Transfer Image Finish Product	Film Scenes Develop Film Edit Film Produce Master Reproduce Masters	Record Scenes Edit Recording	Encode Information Process Information Store Information Decode Information
DELIVER THE MESSAGE	Pack Product Ship Product		Encode Signal Transmit Signal Decode Signal	

Figure 3—PRODUCTION ACTIVITIES AS THEY RELATE TO DIFFERENT COMMUNICATION MEDIA

Possible Course Outline for Communications

CONTENT	STUDENT ACTIVITIES	LENGTH (Day) 9 Wk	LENGTH (Day) 18 Wk
What Is Communication?	Discussion	1	1
Evolution of Communication	Discussion	1	1
Introduction To Design and Technical Drawing —Principles of Design —Types of Drawings —Computer Graphics	Rough Sketching Refined Sketching —one view —multiview —Tour of manufacturing facility that uses computer graphics	5-7	8-10
Publishing Industry —Types of Image Carriers —Audience Analysis —Image Generation —Pasteups —Image Transfer —Finishing Processes	Design and Produce A Greeting Card Processes that could be used Offset printing Spirit duplicator Screen printing	10-14	17-20
Filmmaking Industry —Types of Products —Preparing A Storyboard —Staging Shots —Exposing Film —Processing Film	Design and Produce A Photographic Story Using One Of The Following: Slides, Filmstrips, Prints	9-12	17-20
Broadcasting Industry —Types of Products —Writing And Editing Scripts —Staging And Rehearsing —Recording Programs —Transmitting Programs —Receiving Programs	Design And Produce An Advertisement, A Public Service Message or An Instructional Program Using Radio Or Television As A Media.	9-12	15-18
Data Processing Industry —What Is Data Processing? —How Is Data Processing Used?	View A Film On Data Processing Or Tour A Data Processing Center Some laboratory experience using one of the many microcomputers available in your school system (Radio Shack TRS-80, Apple II, Commodore PET, or Atari)	3	9
Synthesis	Given information to communicate and identified audience select a media then design and produce an appropriate message.	0	12-14

CONSTRUCTION



Construction Technology

E. Keith Blankenbaker

Providing educators with a framework for identifying the content of construction technology and suggesting guidelines for the development of classroom activities which will effectively communicate this knowledge are the major purposes of this paper. The information is organized into three segments. First, the fundamental practices of construction technology are identified. This outline of practice provides educators with a means of identifying the concepts which should be included in a construction curriculum. Secondly, the construction industry will be described in terms of the quantity of the various types of projects which are being built in the U.S. This information will assist the educator select examples to present to their students which truly reflect the nature of this diverse industry. Finally, generalizations will be presented to guide educators in the development of activities appropriate for the student being taught.

The Content of Construction Technology

Construction technology is defined as the practices mankind utilizes to build structures or other constructed works on a site. This definition includes the management practices necessary to initiate, design, engineer, finance, erect, transfer, and service constructed works. Construction technology encompasses the production practices necessary to clear the site, build the structure, landscape the site, and service the finished project. This definition also includes personnel practices which enable people to work together to produce the desired construction product. Note that the definition limits construction technology to those practices utilized to produce a project **on a site,** thus distinguishing construction from manufacturing. The production of constructed works tends to be unique for each project and the practices required are frequently very different from those utilized in manufacturing products. In fact, the differences are so great that studying either one provides only limited understanding of the other.

The above definitions and description serves to establish the scope of construction technology but it is an insufficient guide for educators as they design curricula. Educators must have a complete, detailed description of construction practices before they can make adequate decisions about what should be included or excluded from a curricula or course. The abridged taxonomy of construction practices presented herein was originally developed by Hauenstein, then refined by the Industrial Arts Curriculum Project, and later reviewed by the Construction Education Curriculum Project. Because all three of these efforts included extensive work with a variety of experts from construction, it is believed that the taxonomy is complete and accurate.

As the reader studies the taxonomy it is important that the following characteristics be kept in mind:

1. Each practice is identified by words in the gerund form ("ing" words) to denote action.
2. The structure orders parts into wholes. Each of the detailed practices are categorized within a more generalizable high level category.
3. The taxonomy is comprehensive because it identified the practices of construction beginning with the initiation of a project through the building and servicing of constructed works.
4. The taxonomy identifies practices without specifying methods or specific tools. This insures that the taxonomy will remain resistant to obsolescence. This characteristic also enables new methods, tools, and materials to be added to accumulated knowledge of construction technology.
5. This taxonomy avoids the confusion and overlap caused by content identification schemes which begin by identifying job titles and proceeding to describe the work performed by employees in each job category. The focus of this taxonomy is on the practices employed regardless of the job title of the person who performs the work.
6. The construction taxonomy has a "story telling" quality in that the identified practices tend to be employed sequentially as projects are designed and built.

The taxonomy of construction technology is comprised of three major sub-categories of practices. The integration of management, production, and personnel practices enables the construction field to accomplish its mission. By studying these practices systematically and providing opportunites for the integration of the knowledge, students are able to comprehend the breadth of the field and develop specific skills related to each of the practices selected for study.

The following segment presents an abridged version of the taxonomy of construction practices. The

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reader who is interested in studying the complete taxonomy is directed to reference three in the bibliography.

Construction Technology

CONSTRUCTION MANAGEMENT TECHNOLOGY

1. Initiating the Project
   1.1 Formulating
      1.1.1 Determining Objectives
      1.1.2 Researching
   1.2 Administrating the Project
      1.2.2 Authorizing
   1.3 Project Programming
      1.3.1 Evaluating
      1.3.2 Selecting
      1.3.3 Presenting
   1.4 Financing the Project
      1.4.1 Appraising Property
      1.4.2 Estimating Probable Costs (land plus construction)
      1.2.3 Funding
      1.4.4 Documenting
      1.4.5 Budgeting
2. Developing the Project
   2.1 Designing
      2.1.1 Evaluating Concepts
      2.1.2 Postulating Solutions
      2.1.3 Selecting a Solution
   2.2 Engineering
      2.2.1 Interpreting Drawings and Reports
      2.2.2 Establishing Detail Design Criteria and Standards
      2.2.3 Analyzing Problems—Proposal
      2.2.4 Estimating Sizes—Capacities
      2.2.5 Detail Designing
      2.2.6 Specifying
3. Implementing
   3.1 Contracting
      3.1.1 Advertising the Bid(s)
      3.1.2 Preparing Bid(s)
      3.1.3 Accepting Bid(s)
   3.2 Construction Programming
      3.2.1 Scheduling
      3.2.2 Routing
   3.3 Procuring
      3.3.1 Subcontracting
      3.3.2 Employing
      3.3.3 Purchasing
      3.3.4 Leasing
      3.3.5 Obtaining Licenses, Permits, and Authorizations
   3.4 Supervising Construction
      3.4.1 Directing
      3.4.2 Authorizing

CONSTRUCTION PRODUCTION TECHNOLOGY

1. Preparing the Site
   1.1 Clearing the Site
      1.1.1 Providing Temporary Access and Protection
      1.1.2 Reducing Obstacles
      1.1.3 Handling Materials
   1.2 Setting Up Temporary Facilities
      1.2.1 Establishing Temporary Shelters
      1.2.2 Providing Temporary Utilities
   1.3 Surveying for Construction
      1.3.1 Referencing to Existing Features
      1.3.2 Laying Out The Structure
   1.4 Earthworking
      1.4.1 Mobilizing Equipment
      1.4.2 Earthmoving
      1.4.3 Protecting Existing Utilities and Structures
      1.4.4 Shaping and Stabilizing Earthworks
2. Building the Structure
   2.1 Setting Foundations
      2.1.1 Making and Placing Forms
      2.1.2 Setting Reinforcement
      2.1.3 Preparing Foundation Materials
      2.1.4 Handling Materials
      2.1.5 Bonding
      2.1.6 Curing
      2.1.7 Removing Forms
      2.1.8 Finishing Foundations
   2.2 Building the Major Structural Elements
      2.2.1 Preparing Materials
      2.2.2 Fabricating Components and Temporary Forms
      2.2.3 Setting Reinforcement
      2.2.4 Handling Materials and Components
      2.2.5 Treating
      2.2.6 Removing Temporary Forms
      2.2.7 Finishing
   2.3 Installing Circulatory Systems
      2.3.1 Installing Permanent Utilities and Mechanical Plant
      2.3.2 Providing Temporary Equipment
   2.4 Completing the Structure
      2.4.1 Enclosing the Structure (rough finishing)
      2.4.2 Finishing the Structure (fine finishing)
   2.5 Completing the Site
      2.5.1 Removing Temporary Plant and Facilities
      2.5.2 Landscaping
      2.5.3 Building Features
      2.5.4 Shaping and Finishing Earth
      2.5.5 Removing Landscaping Equipment and Debris

CONSTRUCTION PERSONNEL TECHNOLOGY

1. Hiring
   1.1 Recruiting
   1.2 Selecting
   1.3 Inducting
2. Training
   2.1 On the Job Training
   2.2 Other Training
3. Working
   3.1 Providing Economic Rewards
   3.2 Providing Physical Setting
   3.3 Providing Social Environment
4. Advancing
   4.1 Promoting
   4.2 Demoting
   4.3 Discharging
5. Retiring
   5.1 Counseling
   5.2 Pre-Retirement Job Engineering
   5.3 Recognizing Service
   5.4 Awarding Retirement Benefits

This taxonomy is the first tool the educator requires in the effort to develop appropriate instruction related to the field of construction technology. It must be remembered that any educator who proports to teach construction technology is responsible to present a comprehensive view of construction which includes **all** of the higher level generalization identified in the taxonomy. Anything **less** is only a part of construction and is therefore inadequate to meet the general education goals of industrial arts.

The Nature of The Construction Industry in the U.S.

The second input educators need to prepare instructional materials adequate to teach construction is an understanding of the nature of the industry in terms of the types and quantities of various types of construction projects which are completed annually. If this information is coupled with realistic projections of the trends in the industry, educators can choose examples and activities for inclusion in a course or curricula which are truly representative of construction. One relatively simple way to characterize construction is to utilize U.S. Department of Commerce data for the value of new construction put in place annually, Table 1.

Table 1
VALUE OF NEW CONSTRUCTION PUT IN PLACE IN THE U.S. in 1980

Type of Construction	Current Dollar Value (in millions)
Total New Construction	230,273
Residential Buildings	88,909
Single family	45,662
Multi-family	17,476
Non-housekeeping	2,996
Additions and alterations	21.125
Public housing	1,648
Non-Residential Buildings	69,650
Industrial	15,625
Office	13,318
Other Commercial	16,627
Religious	1,637
Educational	9,225
Hospital and Institutional	5,831
Other Non-Residential	7,387
Farm Non-Residentail	5,274
Public Utilities	45,683
Telephone and Telegraph	6,733
Gas	2,643
Electric Light and Power	17,340
Railroads	1,153
Petroleum Pipelines	809
Sewer Systems	7,171
Water Supply Facilities	3,266
Miscellaneous	6,568
Highways and Streets	13,785
Military Facilities	1,880
Conservation and Development	5,090

From these data it is clearly evident that any curricula which proports to teach construction technology in total must include examples and activities from residential, non-residential, public utility, and highway construction. Anything less will result in students having a myopic understanding of construction technology. By including examples and activities which are representative of the major types of construction, the principles which the educator seeks to teach can be generalized by the student.

Educators who combine the taxonomy of construction practices with an understanding of the types of construction projects which are being built is able to create a curricula or course which adequately portrays the concepts and generalization of construction. The actual design and development of such a curricula or course requires the application of educational expertise to insure an efficient, effective instructional program.

Developing Appropriate Activities

The first decision which the educator must make is to determine the goals of the curricula. If for example, a complete construction curricula is to be developed for grades 6-12 it would be essential that **all** practices identified in the taxonomy be included somewhere in the curricula. It would also be necessary that the basic types of construction projects be included in the examples and activities which become the instructional program. If one further assumes that only one construction course will be required for all students, it will be important that this course include **all** of the higher level practices from the taxonomy. Also, representative examples and activities must be included to help the student form appropriate generalizations about the application of these practices to the various types of construction projects.

Given a set of goals for a course and some idea of how a representative sample of the various types of construction will be presented, it becomes the responsibility of the industrial arts educator to design or select activities which will serve as vehicles for the students to learn the desired content. The concept of the activity being a "vehicle" which promotes learning can not be over emphasized. Any physical product which results from the activity is secondary. The responsibility of the educator is to increase the students knowledge and understanding of the world in which we live. Therefore, designing activities which effectively and efficiently impart the desired knowledge, skills, and attitudes is the only critical measure of the worth of an activity.

When selecting or designing activities it is important to understand the development, experience, and interest of the students being taught. One of the major strengths of industrial arts continues to be the active physical involvement of students in the learning process. By knowing the developmental level of the students in both a physical and cognitive sense, it is possible to develop activities which maximize the student's opportunities for success in the learning environment. The interests of students are important to the selection of activities because interests directly effect the level of motivation students bring to the learning activity.

All learning activites must produce growth on the part of the student. This may be achieved by extending and enhancing the knowledge and skill already possessed by the student or by introducing the student to new concepts and generalizations. In either case, the expectation exists that a change will take place within the student as a direct result of the activity.

For the purpose of facilitating learning it is frequently necessary that some activities focus on a single construction practice, e.g. hiring construction workers. However, some activities must be included which enable students to experience the integration of construction practices as they will be experienced in the adult world. For example, designing a new school building may include many of the construction management practices. Simulation and role playing are instructional strategies which provide excellent opportunities for integration on the part of students. It should be noted that integration activities may extend over relatively long periods of time even for young students provided that new challenges and the accompanying opportunities for learning are introduced frequently. In fact, the activity tends to increase interest and motivation for each new demonstration or discussion.

To maintain interest and provide opportunities for all students to excel, it is essential that a variety of different types of activities be included in any course. When designing a course, educators should include a balanced variety of instructional strategies. The instructional strategies which have been found particularly appropriate for construction technology include group projects, simulation, role playing, individual investigation, research and development, and field trips. These activities must be supplemented at the appropriate time by teacher lead lecture/discussion, demonstrations, and audio-visual presentation if the instructional programs is to be successful.

It is recognized that the suggestions for selecting or designing activities to teach construction technology presented herein are incomplete in that they do not include all of the factors which educators must consider. However, the generalizations identified are believed to be the most significant because they focus on maximizing the learning which will result from the experiences in which the students engage.

Summary

The first step in developing any curricula or course is to identify what is to be taught. The taxomony of construction practices and the decription of the construction industry in terms of the types of construction put in place annually provides a basis for completing this step in the curricula/course development process. The second major task is to select or develop activities which will serve as vehicles to promote student learning of the practices which one seeks to teach. Maximization of the results of this step depends upon ones ability to couple an understanding of students with the need to teach the content identified in the first step. The additional ingredient which the educator must include in the design of the course is a balanced variety of instructional strategies which will enable all students to excel in at least some of the activities.

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Construction Technology Education

Franzie L. Loepp

Introduction

Construction Technology Education as presented in this paper, originates in the context of the Illinois plan for Industrial Education. This Plan evolved over the period of several years, through the involvement of many different groups. After an extensive review of the literature, advisory committee were formed to review the state of the art, and to make suggestions for industrial education in the State of Illinois. In addition to the advisory committees, teacher educators from all institutions that prepare industrial arts teachers, and the state curriculum consultants for industrial education also had extensive input into the development of the Illinois Plan for Industrial Education (see model, next page).

Within this model, Construction Technology Units appear in the section designated as "Exploring Industry and its Technologies". These units are scheduled to be taught in the middle or junior high school program. Some of them appear again in the Production Systems course that is designated for the ninth or tenth grade. After the Production Systems course a student may elect to take a construction oriented vocational program. However, Construction Technology, as referred to in this paper is a general education offering that proposes to orient the student to the entire area of construction.

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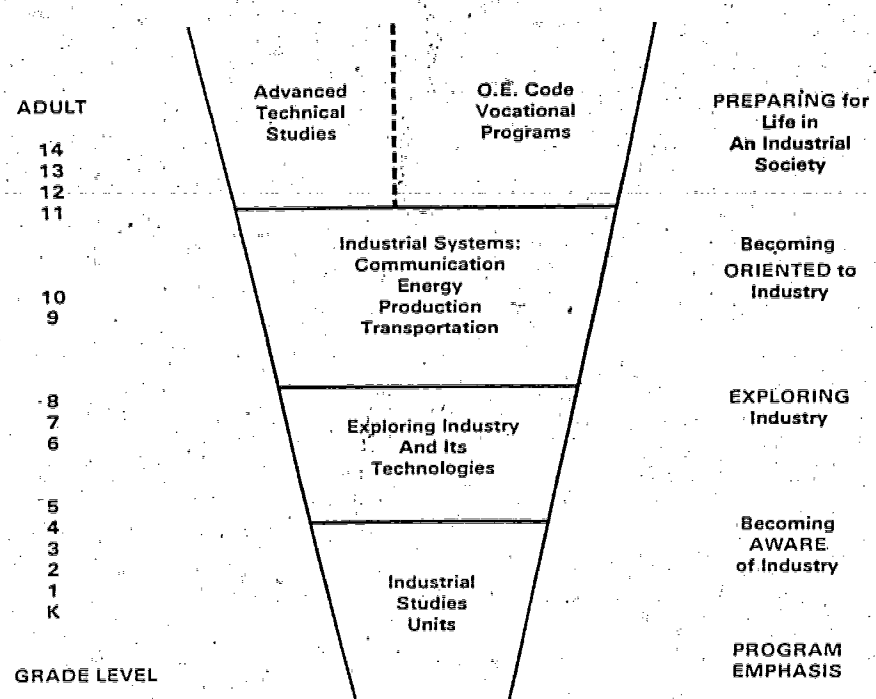
The Construction Curriculum Model

For purposes of curriculum development, the following model is presented to assist the teacher in determining the units of instruction that are appropriate to be included in a Construction Technology offering. In order to conserve space the taxonomy is only taken to the third level. This is sufficient to determine units of instruction although for topics within units a further breakdown would be beneficial.

Curriculum Model

I. Construction Technology
  A. Resources
    1. Personnel
    2. Tools
    3. Materials
    4. Capital
    5. Energy
  B. Technical Processes
    1. Managing (POC)
      a. managing people
      b. managing resources
    2. Processing (SFC)
      a. preparing to build
      b. setting foundations
      c. building superstructures
      d. installing utilities
      e. enclosing superstructures
      f. finishing the project
  C. Industrial Applications
    1. Structures
      a. residential

The Illinois Plan for Industrial Education



b. commercial
c. heavy/highway
2. Services
a. install
b. maintain
c. repair
D. Technological Impact
1. Environment
a. conservation
b. aesthetics
c. population density
2. Society
a. employment
b. life cycle
c. economics
d. education

Implementing The Curriculum Model

In order to implement the model presented, the following suggestions are presented:

1. All units must include aspects from the four main areas within the model (resources, technical processes, industrial application, and technological impact).
2. A unit may originate from any of the four main parts of the model.
3. A unit may vary in length, just as long as each unit has content from each of the four main areas.
4. The teacher of the unit should develop the details of the unit.
5. Learning activities should be selected that involve students. Hands-on experiences should be extensive.

These suggestions for implementation offer a number of advantages. The first is that of flexibility. This is very important in junior high programs because of the wide variance in facilities, and the amount of time students are in industrial arts courses. Secondly, each unit will have content from all four major areas and, thus, have breadth—an important feature of an exploratory program. And finally, the teachers have the opportunity the make the units their own by filling in the details and deciding which learning activities will be most effective in teaching the content. These aspects often depend on localized conditions such as facilities, length of course, resources available, developmental level of the students, and the expertise of the teacher. The following Unit Plan is provided to further assist in describing how the model can be implemented.

SAMPLE UNIT PLAN FOR A ONE SEMESTER CONSTRUCTION COURSE

UNITS	CONTENT	ACTIVITIES
UNIT I	Introduction to the course Assignment of lockers General laboratory procedures Emergency procedures Jobs in construction Construction processes Types of structures Impact of construction on community	Teacher directed Illustrated presentation using slides taken locally to show people working in construction, various construction activities, and different types of structures. Discussion of the impact of the construction industry on the community.
	The major learning activity for the succeeding unit will be the construction of a play house to be used by smaller children. The child care program in the high school, private nursery schools and families with small children are potential customers. It is suggested that the cost of materials be paid for by the recipient of the house.	
UNIT II **MANAGING PEOPLE**	Researching Designing Engineering Scheduling	Divide class into groups of four or five students. Each group gathers pertinent data such as zoning requirements, sizes of material and uses of building, customer's desires, etc. Each of the groups designs and engineers the building. Teacher will need to teach sketching skills as well as how structures are layed out and assembled. Once designs have been sketched and models built of paper and/or styrofoam, the customer selects the design to be built. Each group makes detailed drawings of various parts of the building. Through a carefully guided class discussion, the work is scheduled.

	Being Employed as Architects Engineers, Etc.	Using the "yellow pages" determine the architectural services available in the community. Call at least one firm to determine education needed, supply/demand, offering programs, pay, etc.
UNIT III **MANAGING RESOURCES**	Selecting Materials Estimating quantities and costs Preparing bidding documents Procuring	Each group gathers information in relation to the parts drawn in an earlier assignment. Also, assign such things as paint, electrical items, hardware, etc. to groups. Each group estimates quantities of items needed and the costs. Develop specifications and select vendors. Receive bids from vendors. Arrange for purchase and delivery of materials.
UNIT IV **BUILDING SUPER — STRUCTURES**	Preparing materials Laying out Cutting Treating Assembling Being employed as laborers, carpenters, roofers, etc.	Demonstrate layout procedures, use of measuring tools, saws, hammers, etc. Each group should make the component they designed and estimated i.e. trusses, windows, doors. Treat all wood that comes in contact with the ground. Frame up the building. Use work sheet, the DOT and information from counselors office to determine characteristics of various jobs.
UNIT V **INSTALLING UTILITIES**	Installing electrical systems Being employed as electricians, plumbers, heating/cooling installers, etc.	Install a low voltage circuit for a door bell and a light or two with at least two switches. Perhaps a parent could talk to the students about some of the occupations.
UNIT VI **ENCLOSING SUPER — STRUCTURES**	Insulating Drywalling, paneling Trimming Being employed as drywallers, insulators, etc.	Teacher demonstration. Have group insulate. Teacher demonstration. Have a group install interior wall materials. Teacher demonstration. Have a group trim out the building. Use handouts to help students understand the characteristics of these occupations.
UNIT VII **FINISHING THE PROJECT**	Preparing subsurfaces Painting Preparing the site Locating the building on the site Advertising Being employed as painters, carpet layers, landscapers, etc.	Teacher demonstration. Teacher demonstration. One group paints. Arrange to have building moved. Take pictures of students around building— get in the newspaper—may bring a customer for the next class.
UNIT VIII **OVERVIEW OF CONSTRUCTION INDUSTRY**	Resources Technical processes Industrial Applications Technological Impact	Show curriculum model to students. Have students gather information from periodicals concerning construction in their community. Emphasis should be on topics not yet covered in the course.

Summary

A meaningful orientation to construction technology can be gained by learning about the resources and processes used in construction, as well as their industrial application; and their impact on the environment and society. The major components of the construction industry can be portrayed through a curriculum which in turn can be used in planning units of instruction. By following a sound implementation plan the students can be assured of a broad orientation to the construction industry.

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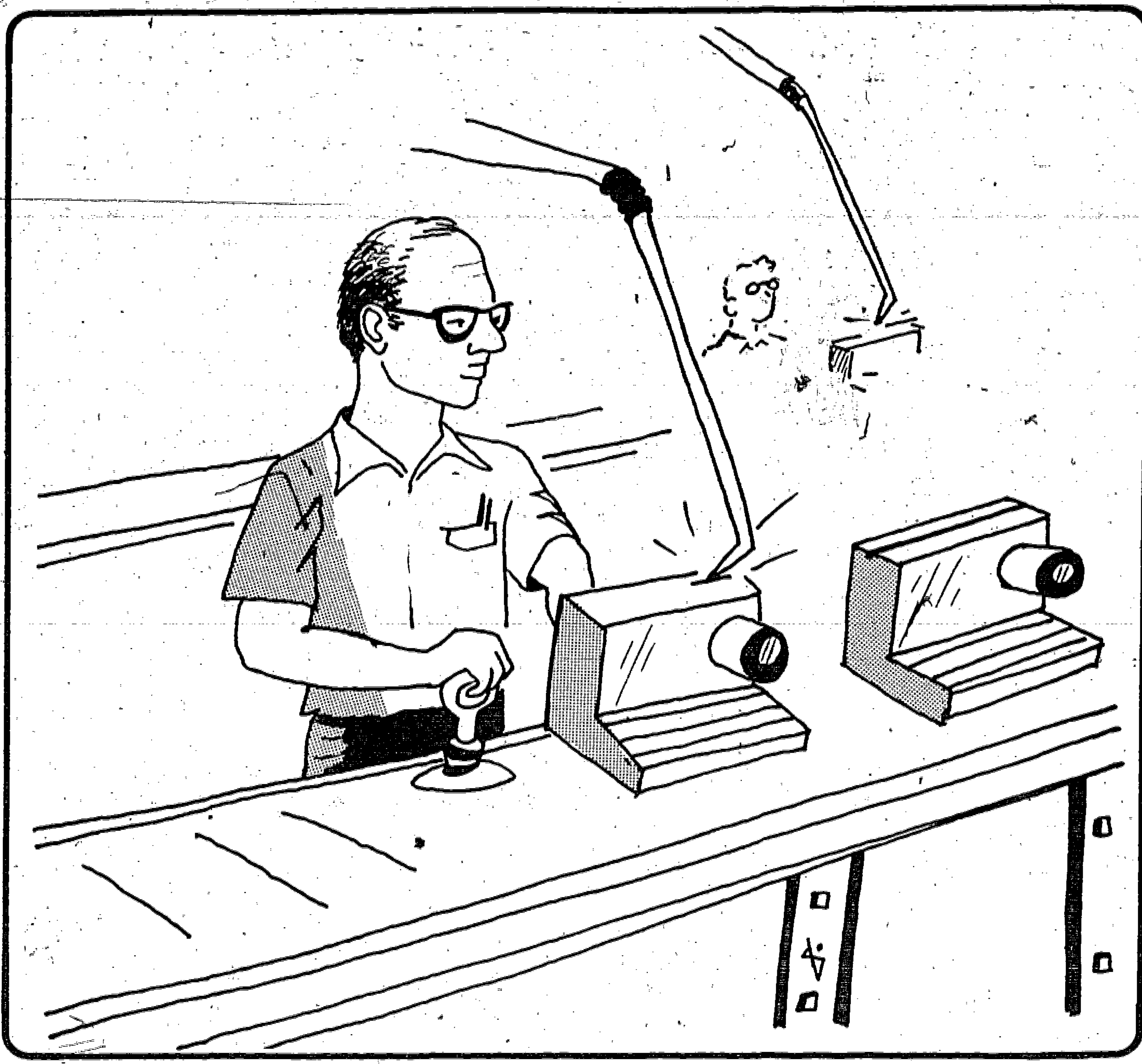
MANUFACTURING
—ENTERPRISE—



Manufacturing Enterprise A Component of Technology Education

John R. Wright

This is the third meeting in a series of symposia designed to investigate the merits and promise of Technology Education. At Jackson's Mill in West Virginia, another group of recognized nationally active industrial arts leaders also held a symposium (not a part of this series) to discuss curriculum theory for industrial arts (Hales and Snyder, 1981). The report from Jackson's Mill are uniquely supportive of the discussions which have been held in this technology education series of symposia. In a likeness to the topics which make up the agenda for Symposium III, the Jackson's Mill group also considers four unique areas of study and have called them the adaptive technical systems (see Figure 1).

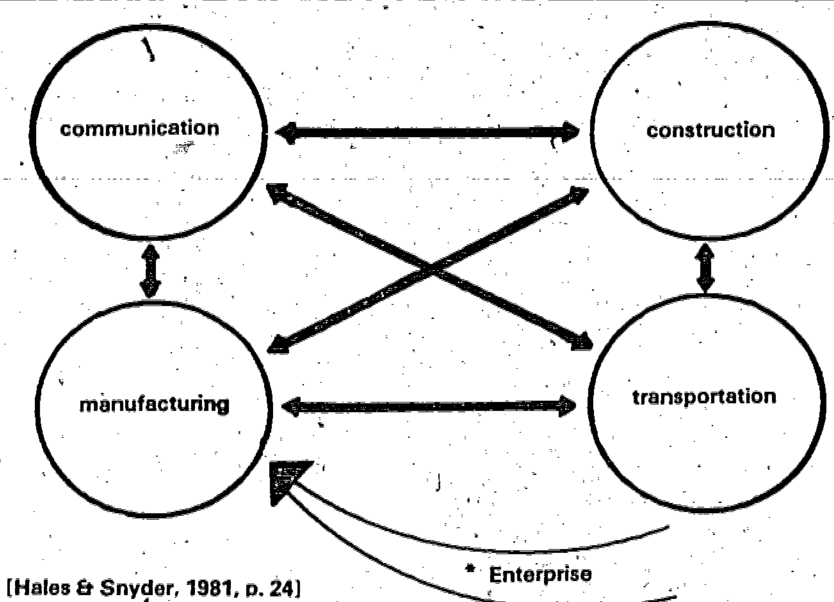
The above systems have been recognized by some industrial arts professionals as an integral part of a contemporary technology-based approach for industrial arts, sometimes referred to as technology education. For the purposes of this paper, technology education is defined as:

> The study of technology and its history, growth, and future development as they relate to industrial organization, materials, tools, processes, occupations, products and problems. It includes multi-and interdisciplinary academic and laboratory endeavors that help students explore their technological world, realize their responsibility therein, and better cope with the cultural change caused by technological advance. (Wright, 1981, p. 19-20).

Manuacturing is one of the adaptive technical systems we have used to show how materials are processed using an organized master plan. It does that well and has been doing so in many of our industrial arts laboratories for over thirty years. Converting materials through the use of machines and tools organized as a line production may help students understanding of the important concepts identified in the definition of technology education. For some of those goals, we need to add the term enterprise and create a role playing simulation that can bring in the human relationships to the varied processes.

By organizing an enterprise, we can create unique problem solving experiences in the technical, human and social areas that are not possible in traditional industrial arts curriculum fare. Enterprise can also be used with the other three adaptive technical systems or together as a capstone experience. Enterprise has even been used by distributive education programs simply as a way to organize a (risk taking) company which sells products for a profit. We sometimes call this a junior achievement program.

Combining the enterprise and manufacturing segments together can be a powerful curriculum design that has the potential to help students gain unique experiences, opportunities for responsibility and leadership, problem solving exper-



[Hales & Snyder, 1981, p. 24]

*arrow added by author

Figure 1—TECHNICAL ADAPTIVE SYSTEMS.

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tise and improvement in their overall level of technological literacy. However, the manufacturing enterprise conception raises three important questions that have not been addressed in the past.

1. Should the manufacturing enterprise be student centered or teacher centered?
2. What are the disadvantages of using the manufacturing enterprise at the junior high school level?
3. How does a manufacturing enterprise work as a last experience capstone course which applies all of the adaptive systems collectively into a common effort?

These questions are rather open ended and may not have a clear cut group of answers. They do, however, provide an introduction for discussion about several different ways to view the manufacturing enterprise experience and how it can make its contribution to technology education.

Student Centered vs Teacher Centered

Our obvious reaction to the first question is to answer "student centered of course." But do we in practice follow through with that idea? Most of the public school emphasis in manufacturing (I.A.C.P., Maryland Plan, American Industry Project) have focused at the junior high school curriculum. They have been well organized, activity centered with some very interesting role playing situations. They were, however, for the most part teacher centered. The teacher (or workbook) selected the product, organizational format, maintained control of supplies and money, conducted the testing, did the teaching, graded the work, assigned roles and solved tooling problems. The students acted out the roles, filled in the data for the worksheets, operated the jig or fixture, sold stock, bought the product and received a grade for the course.

The reason for the highly structured teacher centered approach is really quite simple. One cannot teach all of the necessary machine, material and tool skills at this level and still have time to concentrate on the enterprise part of the course. That is, its more of a time/readiness problem than one which is based on philosophical issues.

Technology Education: "The study of technology and its history, growth, and future development as they relate to industrial organization, materials, tools, processes, occupations, product and problems."

Disadvantages of the Junior High Enterprise

It is very difficult, if not impossible, to teach tool and machine skills, organizational and management skills to seventh and eighth grade students and also allow them the necessary time to develop problem solving and decision making skills. Technology and the social/cultural aspects of evaluating products, ecological problems, worker alienation, new materials and alternative management designs cannot be covered at this level because the basic concepts of material processing consume most of the time. This is a normal situation and should be expected. Since we usually begin the industrial arts experience at grade seven, it may be that we are asking for too much too soon. We can run the enterprise (its done every day) at this level, but are we really maximizing the potential for an enterprise and are the students really the decision makers?

Recognizing the problems with teacher centered manufacturing, some teachers began to split up the enterprise and spread it over a number of years. By using a scope and sequence pattern, each class is designed to look into specific areas such as design, research, testing and tooling. When the class gets into manufacturing, they may or may not be producing the same product they had designed or tested in other classes. That, of course, is not important, but problems do arise when students miss one of the courses in the series and then tend to loose sight of the total manufacuring process. This curriculum design has been critized by some who claim Manufacturing I, II, III, and IV is not much different than Woodworking I, II, III, and IV. That may be an unfair assessment because the enterprise is much more complicated than woodworking and lends itself to natural curriculum units which can be organized sequentially over a period of time.

Advantages of High School Enterprise

Perhaps the most obvious advantage of the high school level enterprise is the experience that the students have gained from previous classes. Because high school students are older, and have more education (including hands-on laboratory experiences) and tend to be more career oriented, they are able to successfully assume more responsibility for the management of the enterprise. They still role play well (this author has continued successful role playing experiences with college level seniors) and can solve some very complex material, finishing and tooling problems. In fact, if the enterprsie is offered towards the latter part of the high school curriculum, (in some states grade 10, in others grade 12) it can serve as a capstone experience and tie the Technology Education curriculum together.

Capstoning with Production Systems

The student centered approach can provide more opportunities for students to experience and discover the concepts and goals of technology education. Traditionally we have used manufacturing with the enterprise concept. It is possible to run an enterprise in communication, transportation and construction also but we have not moved in that direction.

The adaptive technical systems are tied together in many ways. By looking at them in a broad sense, one could call them part of a production system. That is, they seem to make major contributions to the success of an enterprise which either produces a product or service. That is the basic idea of capstoning with production systems. Organize an enterprise, select a product, have the materials and processes students work with the product, communications students work with public relations and transportation students design the product transportation system and flow pattern. Combined, these are the production systems.

Combining the enterprise and manufacturing segments can be a powerful curriculum design.

Production Systems:

All production enterprises use a variety of interrelated systems to make the company or corporation successful. The product is developed and produced using a materials processing system. Ideas and important messages are exchanged using a communications system. Product flow in the plant and distribution outside the plant depends on a transportation system. Each of these systems are interrelated and interdependent on each other in an enterprise and thus can be called the production systems. These systems are unique because they also represent broad classifications for the types of courses we offer in industrial arts programs. (See Figure 2.)

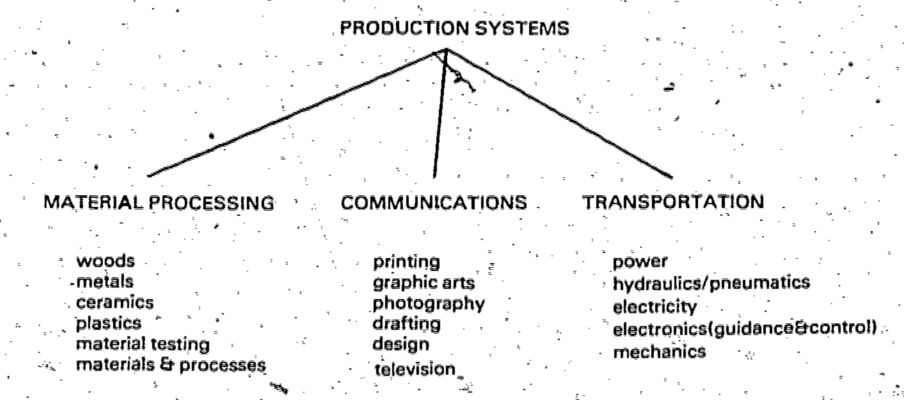

Figure 2—PRODUCTION SYSTEMS

Organizing the Capstone

The Production Systems enterprise can be divided into three major organized phases:

A. Launching
B. Conducting
C. Summarizing

Because the enterprise is a capstone, the use of tools, machines, and materials will not need to be emphasized as much in the class. Instead, enterprise organization, product development, tooling and manufacturing techniques make up the core of the learning content. The enterprise is student oriented and the teacher serves as an industrial advisor (Figure 2).

Launching the Enterprise

The most important part of a student centered enterprise is getting the organization off the ground. During the first class the idea of a capstone production is explained by the teacher. Examples of past products are displayed and the high points and low points (each production always has a number of these to laugh at once they are over) are brought out and the class begins a dialogue on some possibilities. To help the enthusiasm along, a video training tape is shown from the previous year. Being a student centered approach, the tapes are unedited by the instructor and have positive and negative comments. By the time the tape is over, the class is ready to get going. Using a very simple organizational structure, the instructor explains the major responsibility of each position (Figure 3).

Contract performance grading is used and the instructor explains how the president will write the management contracts and the department heads will write the worker contracts. Because a union is required, the class will also write a

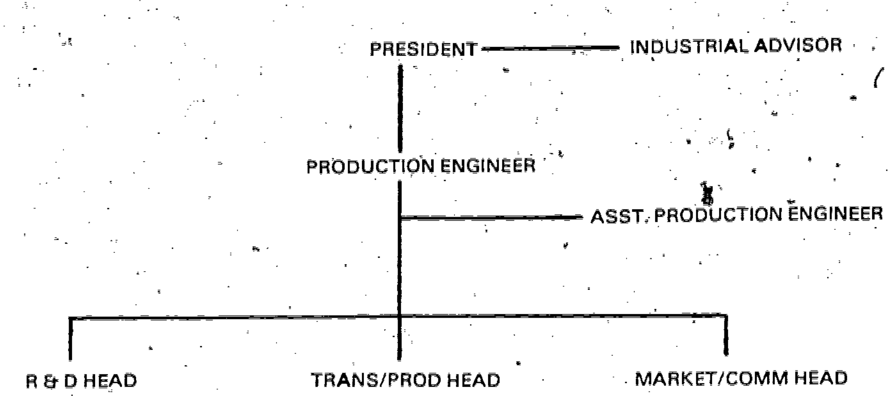

Figure 3—ENTERPRISE STRUCTURE

work agreement which will be approved by management/labor and guide the content and spirit of the contracts.

During the second class period, the class will elect its management group while the instructor conducts the union elections and outlines how they should proceed to become recognized. Once this is done, the instructor becomes the industrial advisor and assumes a regular seat in the class. The president runs the class for the rest of the semester.

Selecting the Product

The second week of class is usually pretty hectic with management/union trying to get a work agreement and the communications/marketing head trying to get concensus on product ideas. Once three ideas have been agreed on by the class, a market analysis/survey is conducted at three local food chain stores. Prototypes are constructed by the research and development group and the product engineers begin identifying potential manufacturing bottlenecks. When all the data and prototypes are in (usually one to two weeks) decisions are made on which product to produce and the exact price of the stock which will be sold to cover class costs.

Conducting the Enterprise

The production systems capstone class uses a continuous manufacturing line system. The class will spend the entire semester getting ready to run the production in one single day. This approach can create unique problem solving experiences. As the class gets ready for the production run, they will work in groups which are related to their expertise in one of the adaptive systems.

Research and Development

The research and development group is made up of materials and processes majors. They build the prototypes, jigs, fixtures and other types of special tooling. They test and measure different types of materials, processes, finishes and designs. Once the jigs and fixtures are complete, they work with the production engineer conducting time-studies and making adjustments according to the C.P.M. data. The R & D group also sets the standards for quality control and devises a scheme to check the product during the run.

Tranportation/Production

Setting up the laboratory to get a good product flow is very important for a continuous processing production. The power/energy majors make up this group and work with a variety of mechanical/electrical equipment which is used to transport the product. They develop flow plans, conveyer belts, and power systems for the production. Overhead conveyer belts are set up, tested and dropped into place for the day of the run. This group also collects time and motion data, develops a P.E.R.T., runs it on the microcomputer and provides the production engineer with the C.P.M. They also build specialized tooling such as heat booths, finish kilns and storage system.

The student centered approach can provide more apportunities for students to experience and discover the concepts and goals of technology education.

Communications/Marketing

This group is made up of drafting and graphic arts majors. They convert R & D thumbnail sketches into plans and blueprints. They conduct the market survey, print and issue stock, keep financial records and distribute the product. In addition, they keep a photographic documentation of the class, design and film a training video tape for next year's class and design the packaging for the product. During the early phase of the class, they also set up a display window with eight forms of relative advertising for the seleceted product.

Summarizing the Enterprise

Because the class is set up as a continuous manufacturing process, the summary occurs on the next to the last day of class. Each student except the president and production engineer assumes a new job on the manufacturing line. The president greets the people who come to the gallery to view the production and explains what the class is doing. The production engineer runs the production and is in charge of the class.

Fifty products are manufactured and generally "time in" at about ten minutes each. The average length of the production run is about eight hours including lunch.

During the last day of class, the enterprsie is closed,. stocks are redeemed for products and the class reviews the video tape of the run. Evaluation is completed by the department heads and the president and turned over to the instructor. These grades based on the contracts and along with tests and notebooks are used to determine the final grade. Reports and drawings are put together in a notebook and are kept by the instructor as a historical record of the class.

Conclusion

The enterprise format for production systems as a capstone will work quite well at the high school level. It can help students apply their knowledge and skills learned in each adaptive technical system for a common problem-solving effort. Because skills have been learned previously, concentration on the use and effects of technology, management and people can help students understand our economic social institution of industry in a broader sense. Technological literacy is increased as students understand the interrelatedness of the technological systems and their role in a technological society.

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Manufacturing—Enterprise

James F. Fales

Historically, that school subject that dealt with "making things", be it manual training, manual arts, industrial arts, technology education or **whatever,** has clearly emphasizd manufacturing more than anything else. The production of material goods, the changing of materials in form to increase utility has always seemed to be one of the most important parts of "our contribution" to general education.

But along with the material processing comes the very reason for production—to satisfy wants and needs. With that in mind, the study of material processing assumes a multifaceted shape inextricably intertwined with such concepts as productivity, supply and demand, profit and the economic like.

In today's world there seems to be much concern for economics. The news reports are full of economic news, mostly bad. Economists of all persuasions propose their solutions, and like industrial educators, never really come to agreement.

Concern For Economic Education

That economic concepts should be a part of general education is a notion that appears to be generally accepted. Consider the following bit of evidence collected by this writer in recent months.

Since I can't afford to self insure my automobiles, I buy liability insurance from an insurance company. They sell insurance in order to make an economic gain (profit). With part of their money, they print and send me a magazine (I suppose this is to make me feel better about paying them all that money).

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Anyway, as I was casually thumbing through this magazine a particular article caught my eye: "Educating Tomorrows Entrepreneurship". Now this magazine is not a scholarly journal but since my business is education, I began reading the article. I read of five teachers who have been awarded prizes of $5000 each for their creative teaching of economics in the secondary schools. These teachers have been honored for their creative approaches in making the dry subject of economics an exciting experience. Close analysis of the article indicates that these teachers have been selected for much of what an industrial arts teacher, teaching a manufacturing enterprise, does. So why weren't any of the honored teachers Industrial Arts teachers? I ponder that article and I say to myself—somebody out there must think that this stuff about economics/enterprise/entrepreneurship is important. More evidence:

- The U. S. Department of Commerce wants us to know our "EQ" (economics quotient) so they offer a free booklet entitled *The American Economic System . . . and Your Part In It.* Consider this quote from the forward: "This booklet was prepared following a nationwide survey involving Americans from all walks of life.

  "The survey revealed a basic faith in our economic system. It also revealed that most of those interviewed had difficulty in describing how our American Economic system works and how they were involved in it.

  "This booklet has been prepared to provide a quick and simple description of the American economic system. It can serve as one step in a journey to better economic understanding—a journey which should be a continuing one for all of us."
- Some state legistatures, in their collective wisdom, are mandating that some form of economic education occur in the public secondary schools. For example, Act 83 of the 1976 Louisiana Legislature mandates a one-half credit in the Free Enterprise system as a prerequisite for students graduating from public high schools during or after the 1977-78 school term. The Board of Elementary and Secondary Education of that state has ruled that the course is required of students graduating from public high schools during or after the 1977-78 school year. It has also ruled that teachers certified in *social studies, business education and distributive education* will be allowed to teach the course.
- Consider the Youth Enterprise Project of the Ameican Vocational Association. Funded partially by the Department of Commerce, the project allocated $25,000 to each of four local education agencies, to be matched by local CETA funds, to provide entrepreneurship training (vocational) for youth in secondary schools. Average delivery cost was $100,000 per LEA for approximately 10-40 students. While vocational in nature, this still indicates general concern for economic education.

- Junior Achievement is perhaps the most widely known and accepted vehicle for providing economic understanding to our youth. The basic problem however is that Junior Achievement serves only a select group of students in an extra school setting. Strongly supported by business and industry, Junior Achievement enjoys much publicity. Consider these statements made by educators about Junior Achievement:

By an area superintendent of a large school district—

"Presently, there are no other courses that provide for as realistic an experience in as many activities of small business operations than those included in the Junior Achievement program."

By a top official of the National Association of Secondary School Principals—

"The concept of 'learning-by-doing' has been endorsed by educators for many years. Yet too few opportunities are afforded our younger citizens. Junior Achievement stands out as a beacon light in providing them with unparalleled opportunities and we commend the program to adults and young people alike."

By a state superintendent of education—

"Junior Achievement is virtually a laboratory course in economics. More schools, states, and universities should recognize a year in JA as equivalent to a semester course and as an exceptional educational opportunity for thousands of high school students."

The Classic Definitions

Perhaps at this point some definitions are in order. If you consult any standard dictionary, you will find the following definitions or minor variations thereof:

MANUFACTURING: to make into a product suitable for use, to make from raw materials by hand or by machinery, to produce according to an organized plan and with division of labor.

ENTERPRISE: one who organizes, manages, and assumes the risk of a busines or enterprise.

ECONOMICS: concerned chiefly with description and analysis of the production, distribution, and consumption of goods and services.

Based upon the foregoing, the following definition of manufacturing enterprise can be derived:

—Manufacturing enterprise: a managed, risk-taking unit of economic organization to make goods (products suitable for use) from raw materials by hand or, machinery according to a plan and with division of labor.

Some Questions

Now where does all this economic concern leave us? To what extent does economic education belong in the Manufacturing Enterprise class? Are we solely responsible for teaching economic subject matter?

It strongly appears that we who claim to be teaching manufactuirng should be rightly accused of teaching economics. Not in a dull dry way, as seems to be the typical approach,—rather, let us use the special motivator, the "project or product", as the vehicle to really help students investigate productivity and the paycheck. By now, you may be saying "Ok, Ok, I'll do it, but I'm not sure how".

Some Answers

First, keep on teaching manufacturing—including tools, materials, and processes. Remember, our students must understand something about these phenomena before we can expect to teach the concepts of enterprise.

Secondly, increase your knowledge of economics. Get a basic business textbook for your own use. Find out what business books are used in you school. Start reading *Business Week*. Order copies of free annual reports through the service that *Business Week* offers.

In most states there exists an industry funded economic educational council. Contact them for assistance and school/public relations. Get a copy of the Junior Achievement Company Manual.

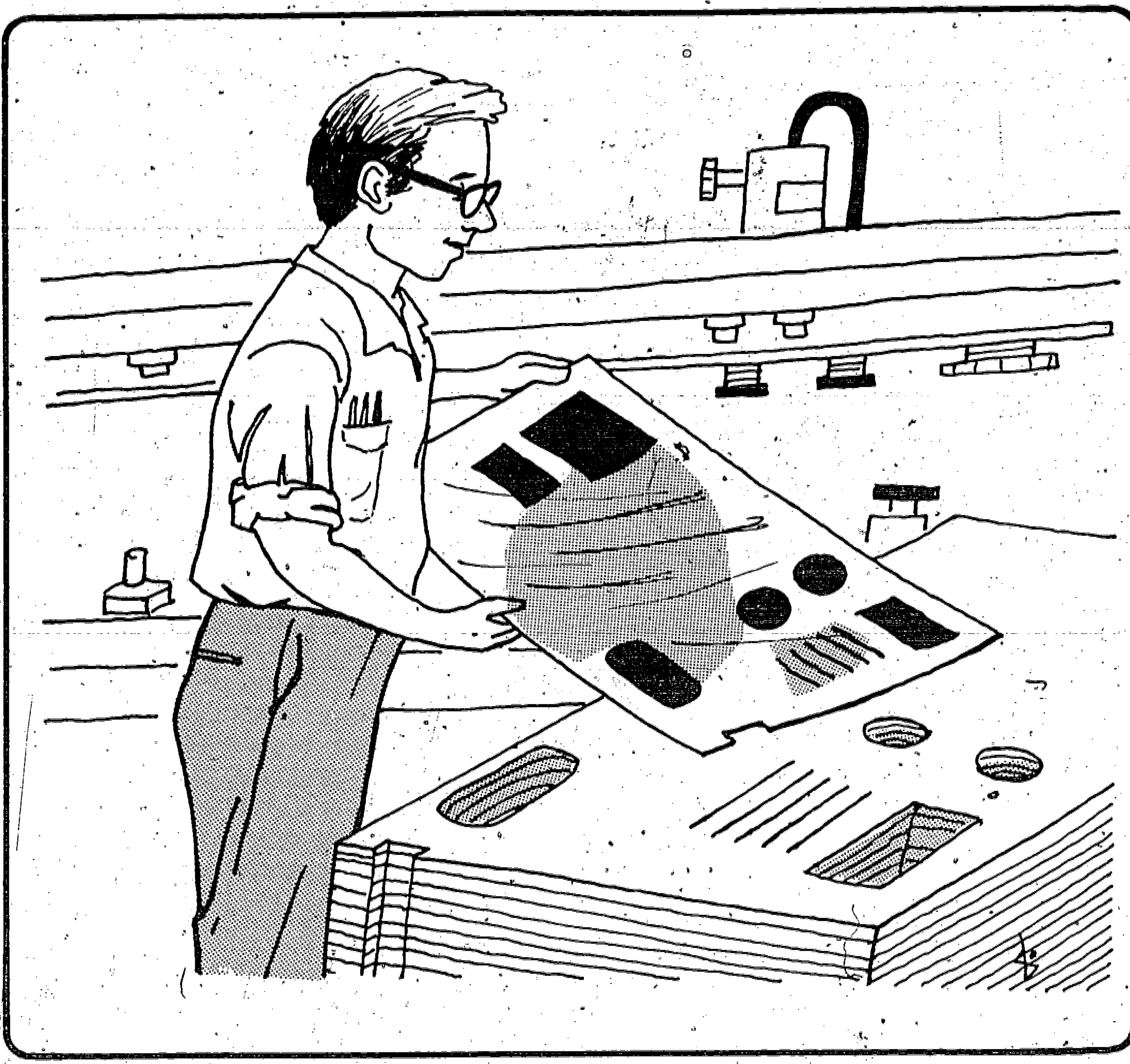
Next, make sure you spread the word about the economic nature of your manufacturing enterprise. Get interdisciplinary; social studies, math, business teachers need to know what you are doing.

Make sure your students have a good manufacturing textbook, one that includes the basics of economics as applied to manufacturing.

Conclusion

Manufacturing enterprise in one form or another has been and will continue to be taught in industrial arts classes. Let's make sure we can say we are contributing to a students economic education. If that's what you're doing, let others know. Good press never hurt anyone's program. Let's see some industrial arts teachers being honored for "teaching economics".

MANUFACTURING
—MATERIAL PROCESSING—



Material Processing A Conceptual Approach

Douglas T. Pine

Introduction

Since a concept is nothing more than an abstract or generic idea generalized from particular instances, it would seem to be almost impossible to teach any course without dealing with concepts in one form or another. If one accepts this conclusion, then how might an industrial arts teacher organize ideas about materials processing technology when dealing with a multi-material approach to the subject? As one answer to this question, the writer will discuss an approach that is being used at the University of Northern Iowa in a team-taught, six semester-hour course in materials processing technology. Content is structured via a conceptual model which accommodates the material areas of woods, metals, and plastics. It constitutes the first laboratory-oriented course that industrial arts and technology majors receive in the production area.

Why Conceptual Models?

The organization of content under the traditional project approach often starts with the project itself. The project is selected for its function, cost, interest to the student, and other similar reasons. The student then turns her/his attention to determining what operations are required to produce the item. Within the operations, certain unit processes such as milling, turning and boring may be evident to the student. If sufficient study is given to these unit processes, some generalized ideas (concepts) may be forthcoming to the student. If the student is in fact this fortunate, he/she may actually see the relevance of these concepts in other material areas or production situations; but, don't count on it. The sequence of events through which concepts are dealt with under the traditional approach appear in Figure 1.

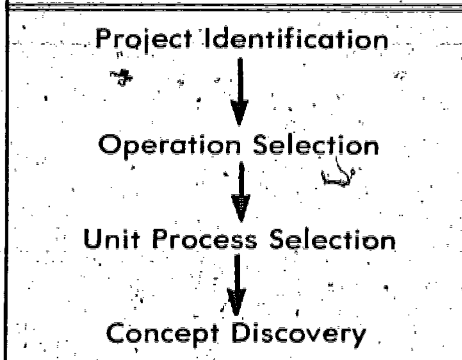


FIGURE 1: Traditional Approach

The writer proposes that the sequence of events should be reversed. The concepts which the instructor deems to be most important in fulfilling the goals and objectives of the course should be identified in step one. This will lead to the selection of certain unit processes with which the student should become familiar. Once the list of unit processes is established, the instructor should decide how each unit process can be most effectively demonstrated in his laboratory. This activity will lead to a "laundry-list" of operations which indicate the types of tools and machines to which the student should be exposed. Finally, laboratory activities are developed to encompass the selected concepts, unit processes, and operations. These activities may involve take-home type products or simply exercise pieces if that is considered to be the most efficient way to treat certain conceptual areas.* The sequence of events under the conceptual approach are summarized in Figure 2.

The conceptual approach is considered to be advantageous for the following reasons:

1. Conceptual models are **universal.** If properly developed, the models should be applicable in any material area.
2. Conceptual models are **stable.** The basic models do not change even though techniques are continually changing.
3. Conceptual models uncover all **alternatives.**
4. Conceptual models **simplify** the complex. Thus, they should also simplify learning.
5. Conceptual models can be explored at any **level of specificity.**

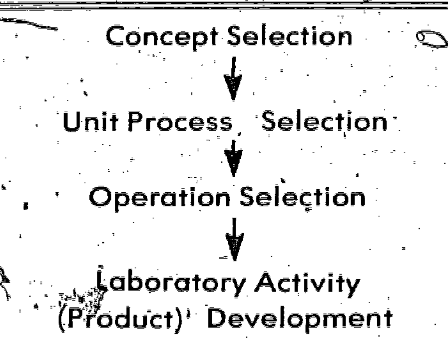


FIGURE 2: Conceptual Approach

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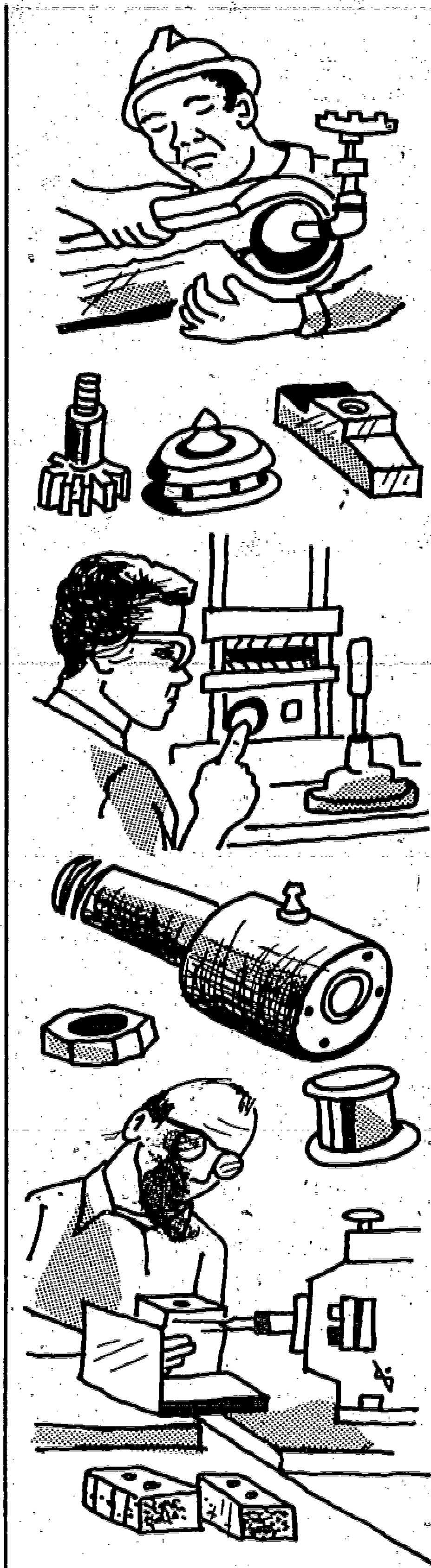
*NOTE: The presentation at the symposium was supplemented with several examples of laboratory activity.

A Conceptual Model for Materials Processing Technology

The basic conceptual model as used in the materials processing course at the University of Northern Iowa is shown in the following outline. Examples of **some** of the activity areas under each concept are also given.

Material Processing Technology

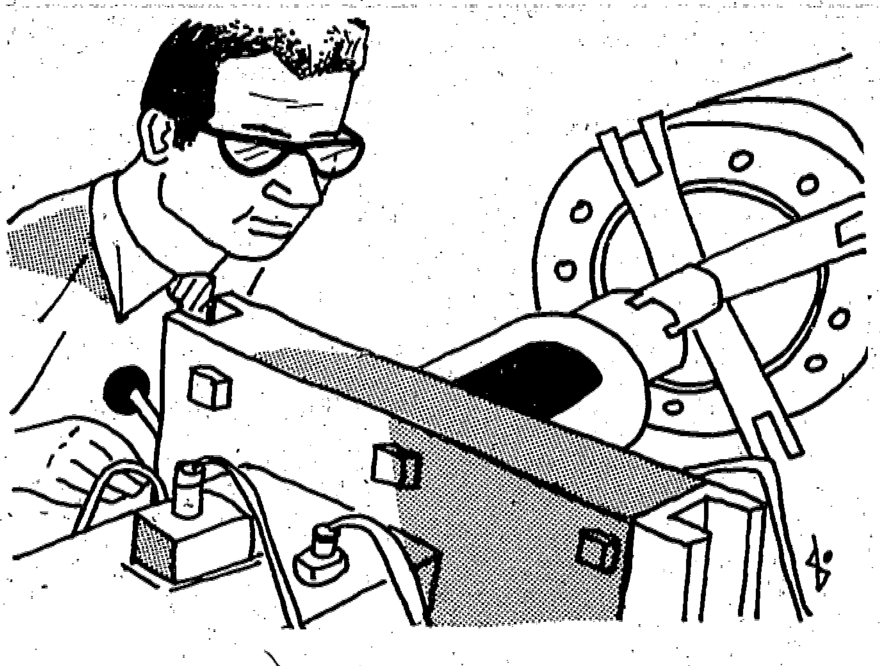
Conceptual Outline	**Lab Activities**
1.0 Separating Processes	
1.1 Non-chip removal	Shearing; punching
1.2 Chip removal	
1.2.1 Multiple-edge (point) cutting tools	Circular, band, jig, and saber sawing; multiple tooth wood and metal cutting hand tools; milling; wood shaping; routing; grinding; sanding; drilling
1.2.2 Single-edge cutting tools	Metal and wood turning; metal shaping
1.2.3 Knife-edged tools	Hand planing, jointing; surfacing
1.2.4 Other (non-traditional) processed	Electrial discharge machining; flamecutting; hot wire cutting
2.0 Forming Processes	
2.1 Hot forming	Metal casting; injection, compression, blow, and rotational molding; thermoforming; forging; wood steam bending
2.2 Cold forming	Metal spinning; bench metal and sheet metal forming
3.0 Combining Processes	
3.1 Cohesion	Oxyacetylene, arc, and spot welding; solvent cementing
3.2 Adhesion	Brazing; soldering; glueing
3.3 Mechanical fastening	Various fasteners related to assembling various materials
3.4 Mixing/blending	(Example: food processing industries)
4.0 Conditioning Processes	Heat treating; wood drying; stress relieving
5.0 Finishing Processes	
5.1 Surface treatments	Brushing; buffing; polishing; abrasive blasting; distressing; etching; anodizing
5.2 Sub-surface treatments	Staining; finishes for penetrating
5.3 Surface coatings	Liquid coatings; plating



The following related topics are interspersed throughout the treatment of the material processing concepts as appropriate:

1. Layout techniqes and precision measurement
2. Metric system
3. Speeds and feeds
4. Cutting tool geometry
5. Wood identification and properties
6. Metal identification and properties
7. Plastics identification and properties

The model can be expanded to provide a higher level of specificity. An example is shown below starting with the area of multiple-edge (point) cutting tools. The subcategories are not totally inclusive of all possible concepts.



- 1.2.1 Multiple-edge (point) cutting tools
  - 1.2.1.1 Milling
  - 1.2.1.2 Drilling
  - 1.2.1.3 Abrading
  - 1.2.1.4 Routing
  - 1.2.1.5 Broaching
  - 1.2.1.6 Filing
  - 1.2.1.7 Sawing
    - 1.2.1.7.1 Crosscut sawing
    - 1.2.1.7.2 Rip sawing
    - 1.2.1.7.3 Irregular sawing
    - 1.2.1.7.4 Resawing sawing
    - 1.2.1.7.5 Angular sawing
    - 1.2.1.7.6 Channel sawing
      - 1.2.1.7.6.1 Rabbet sawing
      - 1.2.1.7.6.2 Dado sawing
      - 1.2.1.7.6.3 Groove Sawing

Summary

The traditional project approach can lead to a hit or miss treatment of important concepts in the identified area of study. The writer has attempted to depict an approach which puts the primary focus on the concepts to be studied with products and laboratory activities becoming simply a means to an end.

The development of courses around conceptual models has some definite instructional and educational advantages. If used properly, this approach can result in more effective learning with conceptual transfer to other areas of study.

Manufacturing Processes

Ray Shackelford

Introduction

The primary purpose of Symposium III is to provide industrial arts content structures and teacher/learner activities related to the industrial arts instructional areas of Communications, Construction, Manufacturing-Enterprise, Manufacturing-Material Processes, and Transportation/Power.

In keeping with the theme, this paper will address the following questions as they relate to an introductory course in Manufacturing Processes:

1. What is a Manufacturing Process?
2. What assumptions and/or limitations should be used in the selection of the course content?
3. What manufacturing classifications and concepts can be used to support the study of Manufacturing Processes?
4. What laboratory activities can be used to reinforce classroom activity?

What Is A Manufacturing Process?

A process may be viewed and defined in many ways. For this presentation Todd's (1975) explicit and operational definitions will be used. These definitions are as follows:

EXPLICIT: "the conversion or transmission of materials, energy, and/or information; or the transporting of materials, humans, and/or machines from one physical location to another."

OPERATIONAL: "Identify all materials that are being changed in shape, appearance, structure, or location and isolate what is causing that change. Identify whether any material is being changed to generate a form of energy, such as the burning of natural gas to generate heat. Identify any energy form that is being changed into another form of energy, i.e., mechanical energy into electricity in a hand-crank generator, or the movement of a magnetized iron rod in a wire coil. Identify if any energy is being converted into an information form, i.e., moving a telegraph key to generate dots and dashes, or converting the sound of a voice into electrical wave patterns in a telephone. Identify any change of information to another form of information, i.e., the translation of the symbols of a trigonometric solution to the setting on the dials of a metal lathe. The changes taking place are the processes." (pp 29-33).

As the reader considers and analyzes the explicit and operational definitions, it may be useful to use the following statements to show the interrelationships of the elements included in the definitions. A manufacturing process utilizes materials, energy, information, machines and/or humans during or prior to a manufacturing activity. During that activity (process) there are three primary inputs into a manufacturing process: materials, energy, and information. The outputs of a process are a change in material, energy, and/or information. The change brought about by the conversion, transmission, and/or transportation of the inputs potentially results in the conversion of materials, energy, or information; transmission of energy or information, and/or the transportation of materials, humans, or machines.

Assumptions And Limitations

Two courses in Manufacturing-Material Processes ae currently being offered at Ball State University. One is a required course for all two- and four-year Industrial Technology majors, and the other is required of all Industrial Arts Teaching majors. Both courses are introductory in nature and are prerequisites for all courses in material processing. The selection of content for these courses was based upon the following assumptions and limitations:

Assumptions

1. It was assumed that the categories, concepts, and classifications of manufacturing processes utilized in these courses are correct.
2. It was assumed that the study of selected material conversion processes, guided by the application of manufacturing processes categories, classifications, and concepts to that study, would improve the transfer of underlying processing principles to new and unfamiliar processes.
3. It was assumed that the successful completion of these courses would improve student performance in the material conversion courses that follow.
4. It was assumed that the performance and analysis of selected material conversion processes would reinforce course content.

Limitations

1. The manufacturing processes studied in these courses are limited to those processes utilizing solid engineering materials: metallic, polymeric, and ceramic.
2. The manufacturing processes studied in these courses are

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limited to those processes converting materials.

3. The manufacturing processes studied in these course are limited to secondary processes which transform standard stock into goods.

Classification And Concepts Useful In The Study of Manufacturing Processes

As indicated, manufacturing processes either convert, transmit, or transport. However, to remain consistent with the stated assumptions and limitations, only classifications and concepts dealing with material conversion will be discussed in this section.

A large number and wide variety of material conversion processes are practiced by industry. These might include: drilling, welding, sawing, heat treating, printing, cutting, stapling, bending, pouring, etc. But this unending list and diversity of material conversion processes presents a problem when trying to study and understand manufacturing processes. Which conversion processes should be studied since it would be impossible to study all existing processes? Also, how do we prepare ourselves and others to understand and comprehend the new processes that will be developed in the future?

The study of individual isolated material conversion processes is sometimes difficult and less rewarding, because it tends to emphasize the differences among individual material conversion processes and fails to point out the many similarities that exist between processes. By placing the emphasis on the learning of facts the process is endless, many times non-transferrable, and the rewards less than fulfilling.

A more promising method for the study of material conversion processes is in the study of the categories, classifications and/or concepts of material conversion. Manufacturing processes, as shown in Figure 1, fall into two general categories of operations: (1) primary, and (2) secondary.

Primary operations are those processes which remove the material from its natural state. Examples include: reduction of iron ore into iron, sea water into magnesium, and synthetic chemicals into plastics. Such operations supply the raw or basic materials used in the manufacture of other products.

Secondary operations are those processes which relate to the actual manufacturing material coversion processes applied to basic materials. Examples include; milling, case hardening, die-forming, investment casting, riveting, etc.

Manufacturing Material Conversion Classifications

A useful tool in the study of manufacturing secondary processes is the use of material processing classifications. These classifications are useful in that they provide a system or means of grouping for studying the many diverse manufacturing material conversion processes. The classification system utilized at Ball State University classifies various materials processes into the following areas:

1. **Casting,** the process whereby the desired material is prepared in the form of a liquid and then introduced into a previously prepared cavity of proper design. The material is solidified in the cavity before being extracted.
2. **Molding,** the process of changing the size and/or shape of a material by forcing a pliable, semi-solid, and/or powdered material into a prepared cavity.

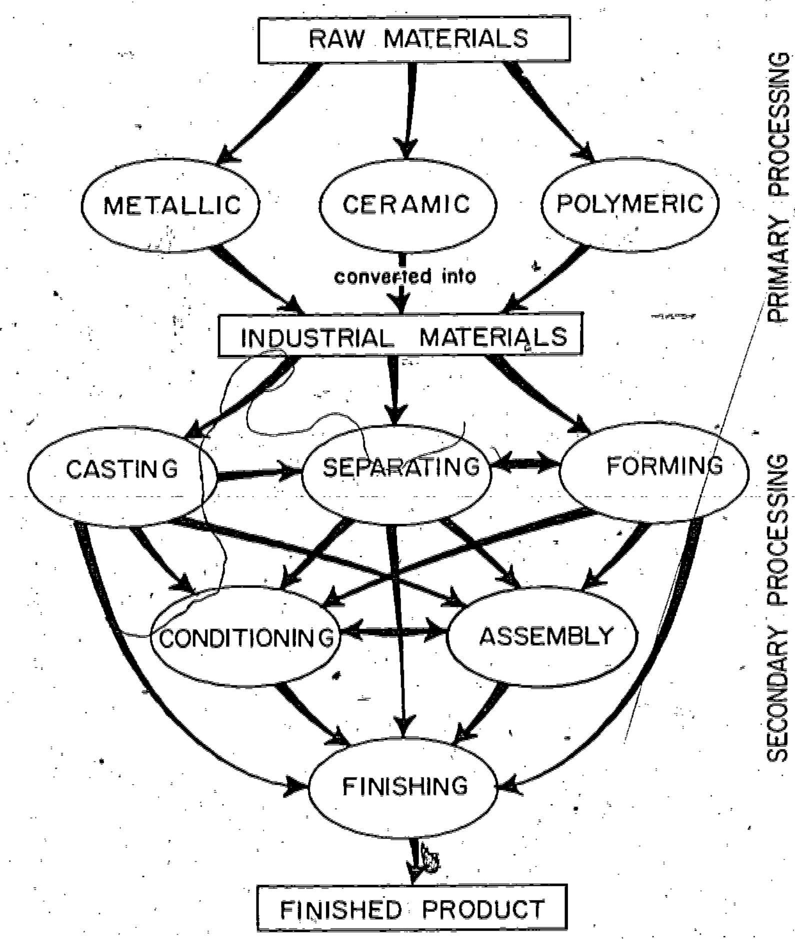

Figure 1—MATERIAL PROCESSING MODEL

3. **Forming,** the process of changing the size and/or shape, but not the material volume, of a material (part) by the application of a force between the yield point and the fracture point.
4. **Separating,** the process of removing material from a base material for the purpose of changing the size, shape, and/or surface finish of the base material.
5. **Conditioning,** the process of changing the mechanical and/or physical properties of a material usually by the application of heat, mechanical stress, and/or chemical or electro-magnetic action.
6. **Assembly,** the process of semi-permanently and/or permanently fastening two or more materials and/or parts together.
7. **Finishing,** the process of treating a base material for the purpose of protecting and/or beautifying that base material. (Wright and Jensen, 1976, pp 28-86)

The function and application of each of these manufacturing classification will be discussed in more detail later in this paper.

Conversion Concepts

The use of concepts to identify and decribe the many similarities existing in all material conversion processes is helpful when examining individual processes and/or comparing processes from different material conversion classifications. The material conversion concept chosen for this purpose consists of four sub-categories. These sub-categories can be used to describe the material conversion processes applied to a raw material as it moves towards becoming a finished product. These identified material conversion sub-categories include: (1) separation of materials, (2) addition of materials, (3) contour change of materials, and (4) internal change of materials. (Todd et.al., 1967)

The application of this concept as an underlying principle to the study of manufacturing processes is important because of the proven ability of concepts to support the transfer of learning. (Travie, 1967, p 260) But, before the reader passes judgment as to whether or not these four sub-categories are conceptual in nature or to their ability to support the study of manufacturing processes, the author would ask the reader to first consider the following definitions of each sub-category:

1. Separation of Materials
   Separation processes changes a material by removing material from a base or parent material for the purpose of changing the size, shape, material, volume, and/or surface finish of the base material by:
   a. the removal of material by a wedge cutting action with no loss of material: shearing, slicing, dicing, etc.,
   b. the removal of material by a wedge cutting action resulting in a chip (chip having no immediate production value): sawing, milling, jointing, etc.
   c. the removal of material without using conventional machining forces (wedge): etching, EDM, electron beam, etc.
2. Addition of Materials
   Addition processes change materials by combining materials semi-permanently and/or permanently by bonding (adhesion or cohesion), mechanical fastening, mixing, magnetism, and/or co-curing (ex. fiberglass).
3. Contour Change of Materials
   Contour processes change a base material's shape but not the material's volume. Examples of contour processes include: casting concrete or jello into a form or mold, forming steel or pie dough by rolling or molding plastics.
4. Internal Change of Materials
   Internal processes change a material's molecular and/or chemical structure for the purpose of changing the material's characteristics (ex. physical, mechanical, etc.). There are four general types of internal material conversion:
   a. Thermal: heat treating, cooking, etc.
   b. Chemical: alloying, adding baking soda to a cake mix, etc.
   c. Electromagmetic: magnetism, induction heating, etc.
   d. Mechanical: all types of work hardening.

As the reader will note, many of the examples used in the sub-category definitions were home cooking processes. This was done intentionally to emphasize the potential strength of the concept. For if the concept is valid, it should be applicable to any material conversion process whether it be in industry, home cooking, medicine, or hair styling.

The application of the material conversion concept and classifications to the study of manufacturing-material processing may be best described by giving a brief description of the course organization at Ball State University.

The course is designed to include units on all major classifications of material conversion. Each unit as seen in Figure 2, is made up of three components: an introduction, a period of process application and a review. The introduction is designed to acquaint the learner with:

1. The process classification,
2. The material conversion concepts and major components which make up the process classification, and
3. The procedures and practices used in selected manufacturing processes or operations in that classification.

The application phase is designed to provide "hands-on" experiences in as many practical applications of the process classification under study as possible.

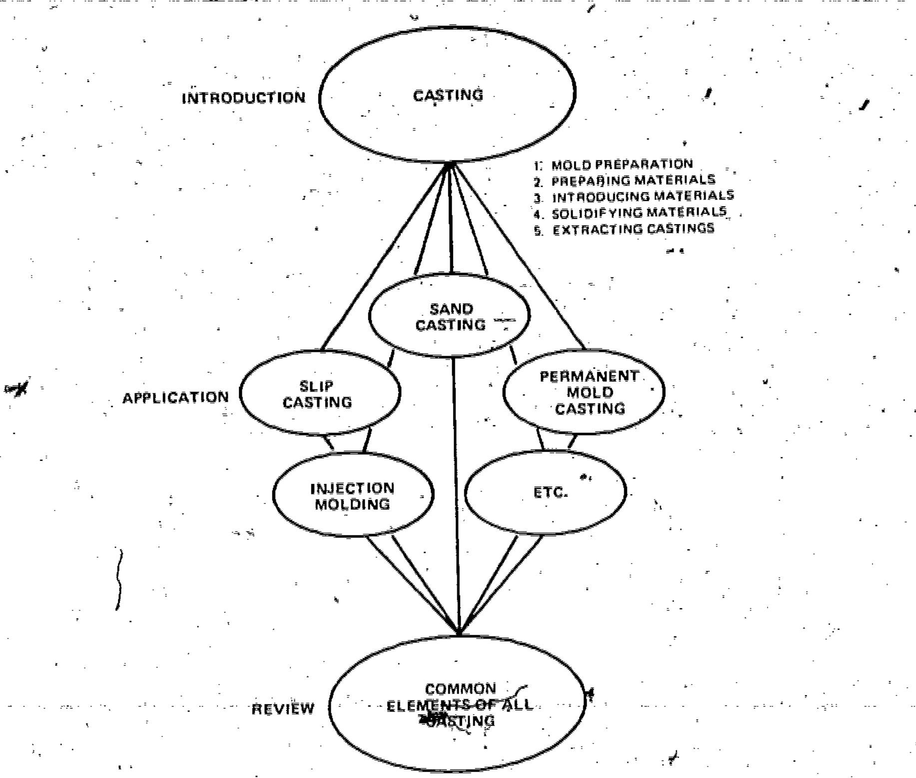

Figure 2—TEACHING MODEL

The review phase summarizes the similarities and differences among the processes which make up the classifications under study. Students are encouraged to share and compare experiences and understandings gained during the application phase.

The increased learner awareness and understanding of the application processes (laboratory activities) and to reinforce the introduction content, the learner completes a laboratory observation sheet for each applicaiton activity performed. Each laboratory observation sheet, (see Figures 3-6) contains four major sections.

The first section requires the learner to identify the process and the major industrial, social, and economic advantages and disadvantages of the identified process. The first section also requires the student to identify and describe the material(s) being converted. The second section requires the learner to identify and describe the major components of each process. The third section, (see Figure 7) requires the learner to list and describe the overall conceptual processes (separation, addition, contouring, and/or internal changes) that took place during the material's conversion. The fourth and last section of the laboratory observation sheet asks the learner to identify, describe, and explain any possible defects that may be evident in the product produced during the identified application process.

Application processes are selected to maximize and reinforce the concepts and classification components discussed during the introduction and review stages. However, many material conversion processes are not compatible with a facility design capable of supporting multi-function and innovative Manufacturing Materials and Processes Laboratory. Therefore, laboratory activities should be selected to support the study of material conversion by using the following criteria:

1. Usable—the identified process can be successfully performed by the identified population with minimal lecture/demonstration time related solely to that particular process.
2. Flexible—the identified process can have its variables (components and/or procedures) easily altered, thus allowing the alternative outcomes to the studied.
3. Comprehensive—the identified process reinforces the material conversion concepts and components, and is representative of the material conversion processes selected for study.

The material conversion processes to be discussed in the next section meets these criteria and will help answer the fourth and final question of, "What laboratory activities can be used to reinforce classroom acitivity?"

Selection of Laboratory Activities

The selection of usable, flexible, and comprehensive laboratory activities to support the study of material conversion is an important step in the curriculum development process. However, if the primary objective or goal is the teaching of material conversion concepts, then almost any available process can be utilized. Some processes will of course be more powerful in their ability to be used to reinforce the similarities and underlying prinicples of material conversion, but in this instance these similarities and underlying principles are the important factors; not the teaching of the related facts and skills of one isolated process. Thus, if a given teaching/learning environment is limited in size and/or available processes, this does not necessarily have to limit the success of the course or program.

During curriculum planning and

Casting, Forming,

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NOTE: When answering the following questions, be careful to describe the specific processes that took place during the material's conversion and **NOTE** the steps you followed in performing the process. This can **best** be accomplished by **describing how the process affects the material, (how the process works)** and/or **what the process does to the material.**

8. List and describe all of the **ADDITION** processes that took place during the material's conversion.
9. List and describe all of the **CONTOUR** processes that took place during the material's conversion.
10. List and describe all of the **SEPARATION** processes that took place during the material's conversion.
11. List and describe all of the **INTERNAL** processes that took place during the material's conversion.

12. Describe and explain any possible defects in your processed material.

Figure 7—DESCRIPTION OF CONCEPTS AND PROCESSED MATERIAL (These questions are included with each Analysis Sheet)

the design of the Materials and Processes Laboratory at Ball State University, it was determined that the addition of "limited size" to the process selection criteria would facilitate and improve the laboratory comprehensiveness. The criteria also greatly increased the overall flexibility of the Materials and Processes Laboratory, and created what we refer to as table-top processing. In this instance, table top processing having the connotation that all application processes be capable of being performed on standard laboratory table tops. Then, upon completion of the activity, the necessary equipment and supplies are capable of being store ocessing tables.

Some of the table-top application processes selected for use include: sand casting, shell mold casting, forging, permanent mold casting, blanking, spinning, flexible die forming, shearing, abrading, mechanical and adhesion fastening, explosion forming, injection molding, dip finishing, slip casting, drilling, hydroforming, punching, heat treating, and chemical conditioning. Although some of these activities have been developed by the instructors involved in these courses, many others were purchased from various suppliers as complete self-contained instructional units. Three such suppliers include:

1. Parke's Adventurous Projects, Springfield, MO.
2. Tech-Aide, Grand Forks, ND.
3. Pitsco, Pittsburg, KS.

Although other suppliers of similar table-top processes do exist, the author has found these three to be very helpful and reliable suppliers.

Conclusion

The intent of this article has been to provide information in the form of content structure and teacher/learner activities that will be an aid in planning a new or improving an existing course in manufacturing processes. It may or may not have been successful, but the road to an improved curriculum is easily paved by improved communications and the exchanging of ideas. This was and will be the purpose of the Symposium Series.

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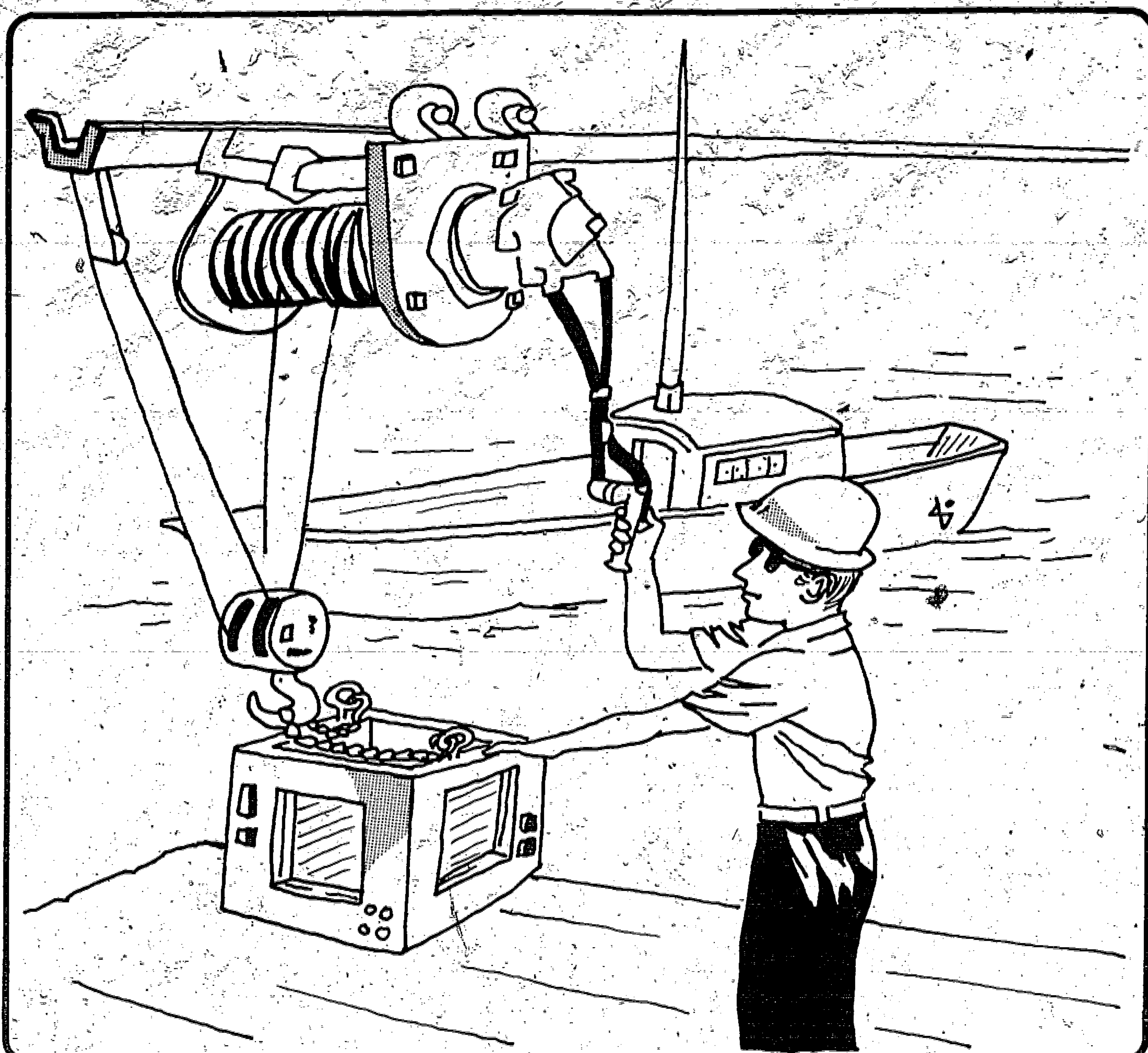
TRANSPORTATION POWER-ENERGY



Energy Utilization Technology

Dennis R. Mueller

An essential area of Technology Education is the study of how industry utilizes energy to produce goods and services. There are many approaches which may be taken to organize a curriculum to instruct students about the applications of energy utilization in our industrial society. These approaches must include several common elements:

1. how energy is harnessed, converted and utilized,
2. the industrial applications of this harnessing of energy, and,
3. the impact that the use of energy has upon our society.

This instruction must be presented through hands-on laboratory experiences in which students become directly involved in the learning process, have an opportunity to explore technology, and grow in their comprehension of our industrial society.

THE STUDY OF ENERGY ULITIZATION

Curriculum for the study of industrial technology may be organized in a number of ways depending on the needs of the school and the students, the time allocated to the study, and the educational experiences preceding and following this study. The essential elements of industrial technology may be taught under the organizational structure of a course titled Production, which may be either a one semester or a one year offering. At that time, all elements of industrial production: technical processes, industrial applications, societal impact, managerial organization, and personnel requirements, are presented in organized laboratory experiences. Often it is feasible and desirable to divide the study of industrial production into at least two elements. Often, the common divisions of Manufacturing and Construction are used to provide a workable organizational scheme for this instruction. When industrial technology is taught, whether in a single Production course, or in differentiated Manufacturing and Construction courses, it is assumed that a number of supportive areas are included. These supportive areas are Communication Technology, Transportation Technology, and Energy Utilization Technology.

There have been proposals for Technology Education which isolate the service technologies of Communications, Transportation and Energy Utilization, and teach them as separate course—almost in a vacuum. This is not only a disservice to the students, but violates the assumption that Technolgy Education provides opportunities for students to comprehend and interact with our entire industrial society. When Communications, Transportation, and Energy Utilization are taught, they must always be referenced to their applications within industry—both Manufacturing and Construction.

This is not to say that separate semester, or year long, courses in

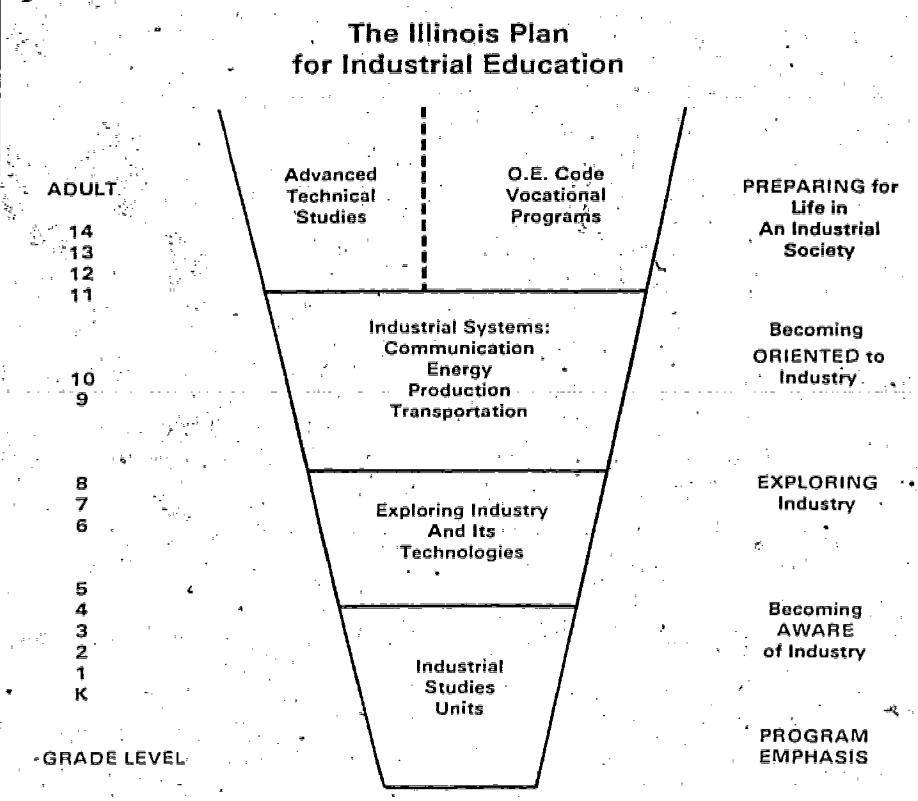


Figure 1—ILLINOIS PLAN FOR INDUSTRIAL EDUCATION

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Communications, Energy Utilization, and Transporatation may not be taught. On the contrary, as we provide extensive, in depth learning experiences in Technology Education, it is essential that the element of Production be divided into manageable units. Only on the most basic level, can all the factors involved in industrial production be offered in one or two course (Manufacturing and Construction). A point is quickly reached in student's learning experience where very detailed specific instruction about certain areas of Industrial Technology must be provided. At this level, the curriculum is usually divided into three or four courses. One Course is often titled Production, or Production Technology. Here the emphasis is not on the overall, global, Gestaldt view of technology, but emphasis is placed primarily upon the tools and materials which are used in industrial production, and the managerial organizational schemes which allow people to partake in the production process. Other courses offered at this level include Communications Technology, Transportation Technology, and often, Energy Utilization Technology.

The term Energy Utilization, is proposed to include all instruction about how energy is harnessed, converted, and utilized in industrial applications. This term is more appropriate and descriptive of the area of study than such terms as energy, power, or energy and power; and will be used in place of these other terms.

Some authors argue that Energy Utilization, being a supportive area of industrial production, be subsumed under Production, and that Technology Education consist of courses in Production, Communications, and Transportation. Energy Utilization is often excluded as being a separate curriculum entity. An example of this is the work done in the Jackson's Mill Industrial Arts Curriculum Theory (Snyder and Hales, no date). Here we see Energy Utilization excluded as a separate course of study, but the essential elements of Energy Utilization are presented throughout the study of Industrial Technology, through Production, Comunications, and Transportation.

An example of curriculum development which includes the study of Energy Utilization as essential element is the Illinois Plan for Industrial Education (Loepp, Jones, Mueller, White, 1981). This plan provides an organizational scheme for instrúction in industrial technology for the Kindergarten through adult levels. Figure 1 describes the organization of the Illinois Plan for Industrial Education. On the elementary school level, units of varying length are incorporated into the standard curriculum of a self-contained classroom. At the junior high school level, courses under the broad category, Exploring Industries and its Technologies, will be offered. At the lower senior high school level, four Industrial Systems courses are proposed. These include Communications Systems, Energy Utilization System., Production System, and Transportation System. Here we see Energy Utilization presented as a one-semester course providing opportunities for students to learn about this essential area of industry. At the advanced high school/adult level, students may take offerings in Advanced Technical Studies, and/or traditional industrial vocational courses.

The Illinois Plan for Industrial Education provides an example of how a course in Energy Utilization may be incorporated into a Technology Education program which provides not only an overview of industry, but also opportunities for students to study critical elements of industrial technology in great detail.

It is essential that a study of industrial technology include Energy Utilization as a self-contained course with equal emphasis with the other elements of Transportation, Communication, and Production.

ENERGY UTILIZATION MODELS

Now that the term Energy Utilization has been defined, and its application described, it is necessary to look at how curriculum can be organized in the study of how industry utilizes energy to produce goods and services. There are a number of different organizational schemes, each with significant variability. One area in which there are many proposals is the taxomony of the forms of energy which are to be studied in this curriculum.

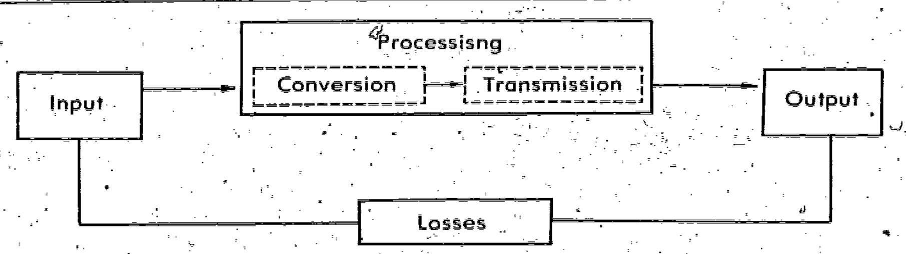

Figure 2—IOWA ENERGY MODEL

Johnson (1980, p. 123) suggests six forms of energy. They are: hydro, gravitational, geothermo, solar, nuclear, and fossil. On the other hand, Schwaller (1980, p.p. 9-10) identifies 10 forms of energy for study. Schwaller's forms of energy are: chemical, fossil, thermo, kinetic, potential, gravitational, nuclear, sound, radiant, and electrical. He later combined kinetic, potential and gravitational forms of energy under the category of mechanical. In the Illinois Plan for Industrial Education (Loepp, Jones, Mueller, White, 1981) four forms of energy are proposed. These forms

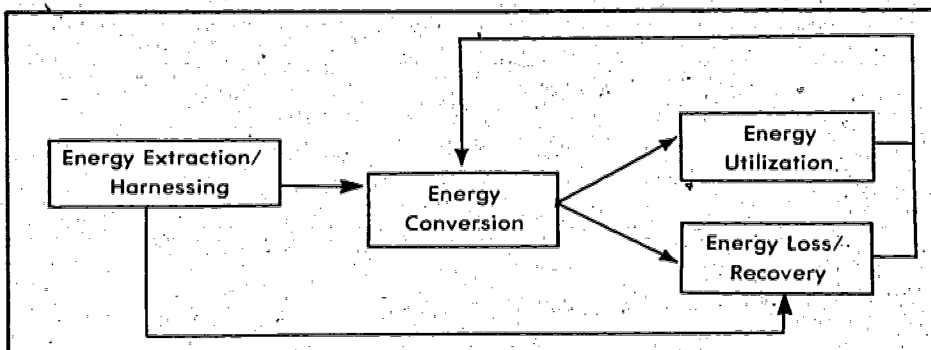

Figure 3—ILLINOIS ENERGY UTILIZATION FLOW CHART

are: nuclear, chemical, mechanical, and heat/light.

There are a number of organizational models which can be used to describe the industrial utilization of energy. Two of these models will be selected for presentation here. The first model was developed by Bro for the Iowa Industrial Arts Handbook, in 1978 (p.13). This model is presented in Figure 2. Here we see the major divisions: input, processing, output, and loss. Processing, in this Generalized Basic Power System is further divided into conversion and transmission. In this flow chart, energy input is processed through the steps of conversion and transmission and appears in the output. Bro has accounted for energy losses at every step in this flow chart.

The Illinois Plan for Industrial Education (Loepp, Jones, Mueller, White, 1981) identifies the first step in the Energy Utilization flow chart as being energy extraction/harnessing. After the energy has been harnessed it is converted. After conversion, energy is either utilized, lost, and/or recovered. Feedback loops identify the loss that can occur through the model and the fact that energy which is recovered can be recycled through the conversion process. This model is a closed loop system, showing that energy is neither created nor destroyed (the law of conservation of energy) and that the form of energy can be changed as it cycles through this flow chart.

The Illinois Plan provides a workable definition of the term Energy Utilization, and a flow chart describing the changes that take place in the processing of energy.

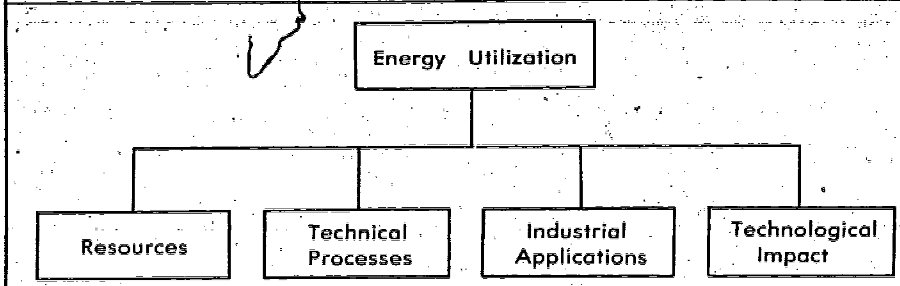

Figure 4—ENERGY UTILIZATION MODEL

ENERGY UTILIZATION CURRICULUM DEVELOPMENT

It is now important to present a method by which Energy Utilization curricular materials may be organized. Figure 4 shows the Energy Utilization model for the Illinois Plan for Industrial Education (Loepp, Jones, Mueller, White, 1981). The four major divisions of this curriculum development model are Resources, Technical Processes, Industrial Application, and Technological Impact. Each of these major divisions are further divided as follows:

RESOURCES is organized into the four forms of energy: nuclear, chemical, mechanical, and heat/light.

TECHNICAL PROCESSES is divided into conversion/control, transmission, and storage.

INDUSTRIAL APPLICATION consists of warming/cooling, lighting, and propelling.

TECHNOLOGICAL IMPACT includes two types of impacts: social and environmental.

By organizing curriculum around these major divisions students will gain an understanding of the inputs into Energy Utilization, the methods

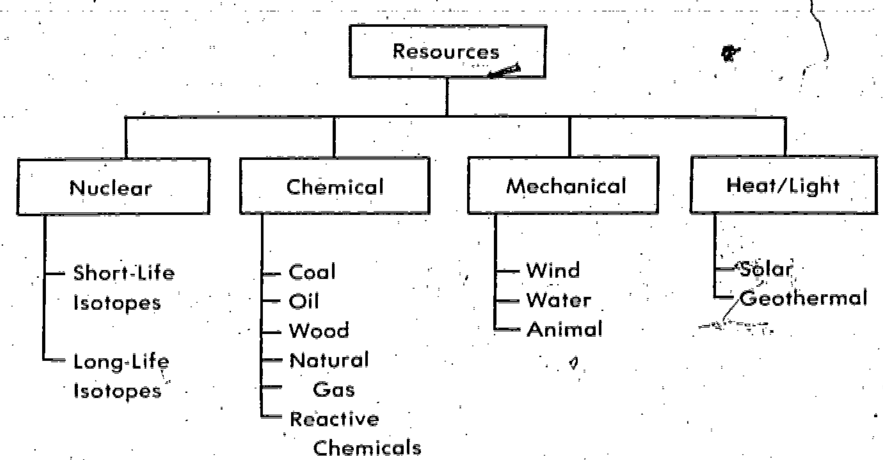

Figure 5—RESOURCE MODEL

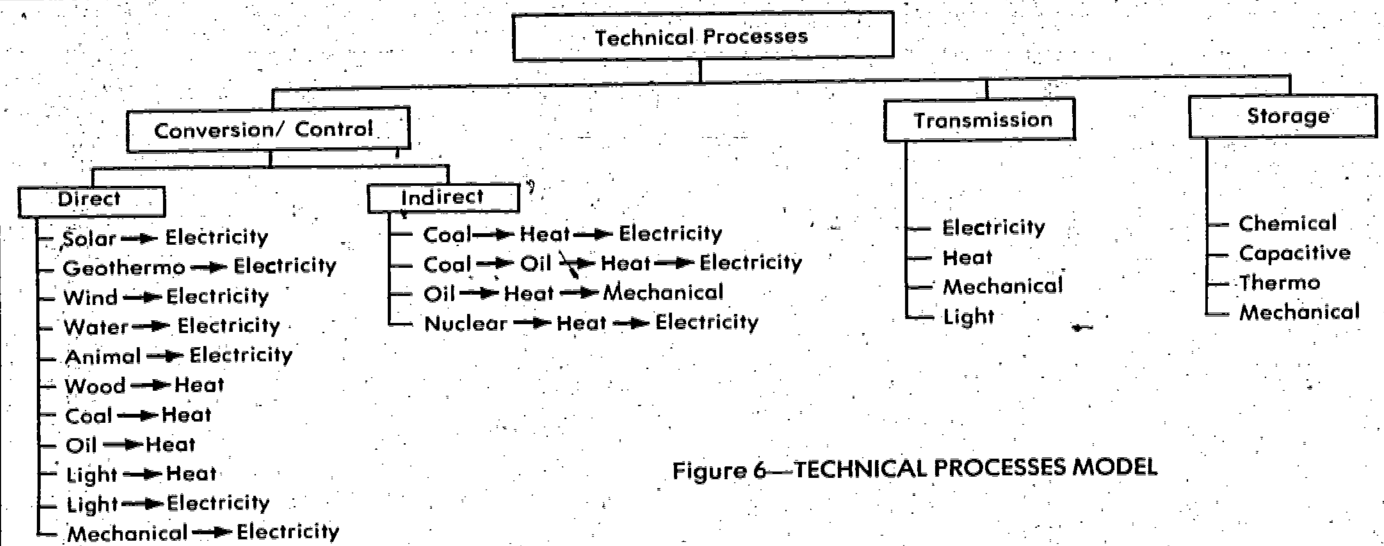

Figure 6—TECHNICAL PROCESSES MODEL

of Energy Utilization, and the applications and the impact of Energy Utilization.

Figure 5 gives a more detailed subdivision of the Resources section of the Energy Utilization Model. Here we see that nuclear is divided into short life and long life isotopes. Chemical is further divided into the sources of coal, oil, wood, natural gas and reactive chemicals. Mechanical energy can be subdivided into wind, water, and animal. The two divisions of heat/light are solar and geothermo.

The three subdivisions of technical processes can be further refined. Conversion/control can be divided into direct and indirect methods. As Figure 6 shows, the direct and indirect methods describe conversion techniques from one form of energy to another. The last form of energy described are the ones that can be used in industrial application. Transmission of energy is achieved through the media of electricity, heat, light and mechanical. Energy may be stored in forms of chemical, capacitive, thermo or mechanical.

There are three organizers for industrial application of energy. These are described in Figure 7. They include warming/cooling which may be further divided into airconditioning/refrigeration and heating. The three forms of lighting are incandescent, gaseous, and arc. Finally, the applications of propelling are in the field of transportation and mechanical motion.

Figure 8 describes societal and environmental technological impact brought about by the industrtial use of energy. Several societal impacts are in the areas of Transportation, Communication, Production, Conservation, and Invention. The environmental consideration includes: conservation of expendable natural resources, the efficient conservation of energy, the control of hazards and the effect upon pollution, both with the environment on earth and in space.

This model gives a complete detailed overview of Energy Utilization and permits extensive curriculum development in this field. The more specific divisions of the model are not intended to be viewed as being totally inclusive and representative of all possible topics. They are rather, suggested areas which may be presented to the students and investigated in this study.

By using this curriculum model, the field of Energy Utilization may be organized in a logical manner and curriculum materials may be developed which will provide meaningful experiences for the student.

Procedures

Now that the curriculum development model has been presented, it is necessary to decribe how this model may be used in developing instructional material for the study of Energy Utilization. There are two rules which must be followed in applying this model to curriculum development. They are:

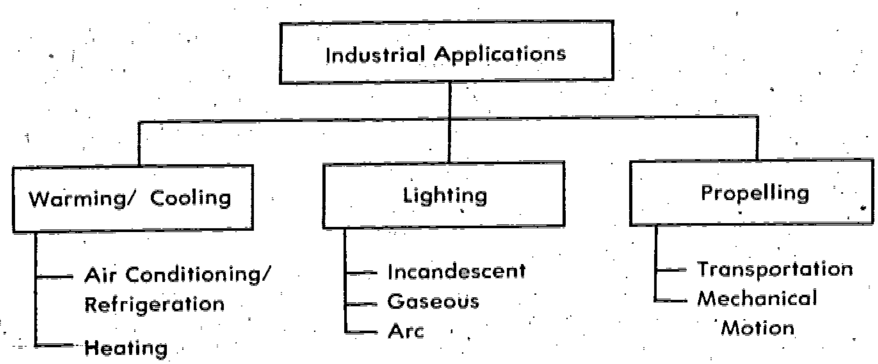

Figure 7—INDUSTRIAL APPLICATION MODEL

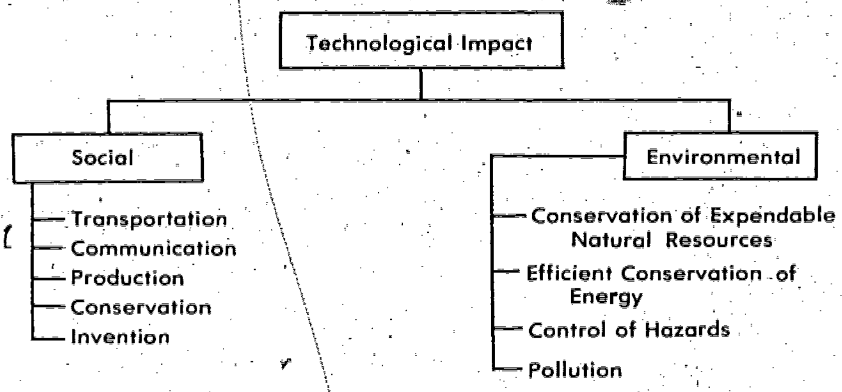

Figure 8—TECHNOLOGICAL IMPACT MODE

1. the developer may start anywhere in the model when selecting materials for instruction,
2. all four divisions of the model (Resources, Technical Processes, Industrial Application, and Technological Impact) must be included in every unit of instruction.

It is critical that these two rules be followed. The first gives flexibility to the curriculum developer, and the second ensures that the students receive instruction which include all of the pertinent areas found in study of Energy Utilization.

The study of Energy Utilization as a separate curricular offering in Technology Education is of vital importance to the understanding of how energy is harnessed, converted, and used. Materials for use in the classroom can be developed by using the curriculum model proposed by the Illinois Plan and following the procedural rules associated with this model. The end result will be meaningful educational experiences for the students, which actively reflect the role of Energy Utilization in our industrial society.

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Transportation 2000 For Industrial Educators

Robert Cooksey

In recent years our professional literature has been filled with many fine suggestions dealing with curriculum analysis. With the coming of the energy crisis much has been said about energy technology. The literature in industrial education indicates a continued interest in all broad aspects of technology including transportation. But over the past ten years very little in the literature deals with content in transportation.

This writing is an attempt to update information in transportation technology, and specifically deal with transportation as related to industrial technology rather than technology in general.

A number of activites are possible in the areas of land, sea, and air transportation. Many of these activities appeared in our literature of the early 1970's and before the energy crisis of 1973. Therefore, the purpose of this paper is to fill in the voids of the last few years and make suggestions concerning some specific applications to industry.

Three categories were addressed. First, transportation in industry, and secondly, the modes of transportation related both to industry as well as the private sector of society. Last, details of the mass transit problems are presented.

Transportation In Industry

The National Council of Physical Distribution Management (1978) defines physical distribution as follows: "Physical distribution management is the term describing the integration of two or more activities for the purpose of planning, implementing and controlling the efficient flow of raw materials, in-process inventory, and finished goods from point of origin to point of consumption" (Boxersox, 1978, p 6). Activities may include, but are not be limited to customer service, demand forecasting, parts and service support, plant and warehouse site selection, procurement, packaging, return goods handling, salvage and scrap disposal, traffic and transportation, and warehousing and storage (Boxersox, 1978, p 6).

Logistics

The basic objective of logistics seems to be that of delivering finished inventory and material assortments, in correct quantities, when required, in usable condition, to the location where needed, at the lowest possible total cost. Logistical management provides time and place utility.

While the integration of all functions is necessary to carry out logistical operations, Bowersox suggests three basic categories of: "(1) physical distribution, (2) materials management, and (3) internal inventory transfer (Boxersox, 1978, p 121). Physical distribution is concerned with movement of product to consumers. Materials management is concerned with procurement and movement of materials, parts, and finished inventory from points of purchase to manufacturing or assembly plants, warehouse, or retail stores. Internal inventory transfer concerns those activities necessary to control the flow between stages of manufacturing and the initial movement of finished product to warehouses or retail sales outlets."

Logistical coordination has grown through the 1970's to a high level of sophistication. In large part this was brought about by the recessions we have experienced during the last eight years. The inability to retain a large work force in industry, and the energy shortages of 1973 pointed out the serious need to integrate and control all functions necessary to plan, purchase materials, store materials, handle, package, warehouse, ship, and service products. Many computer programs have been developed to help solve the management problems to provide proper coordination of all these activities.

Although the management of these activities is much more advanced, the process still involves transportation, both internal and external. The process of transportation as applied to industry is concerned with those functions requiring movement. Movement in the industrial setting applies to the general category of internal, and external, meaning the function "inside" the plant that moves raw materials from receiving point to shipping point. External transportation is concerned with these functions outside the plant from point of storage or shipping to retail marketing, as shown in Figure 1.

Warehousing

In so far as logistics are concerned, most industries are basically concerned with only activities centered around warehousing and order selecting processes. Internal plant transport is a function of manufacturing management. Since

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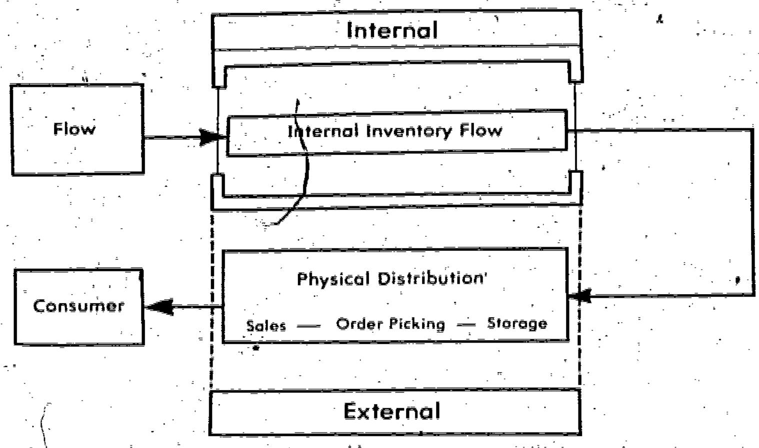


Figure 1—INTERNAL AND EXTERNAL INDUSTRIAL TRANSPORTATION

the flow of raw materials must be accommodated by technical transport equipment, it is appropriate to deal with both elements where the equipment is common to both.

Regarding the raw material flow, it may be necessary to accommodate such functions as:

1. Input to storage, and from storage to—
2. Preliminary fabrication, to—
3. First production, to—
4. First machinery (if applicable) to—
5. Second machinery, third, etc., to—
6. Parts inspection to—
7. Sub assembly to—
8. Final inspection to—
9. Packaging, to—
10. Warehouse, to—
11. Shipping platform, to—
12. Vehicle loading. (Hurdle, 1981, p 258)

Material Handling

Most handling systems are classified as mechanized or automated. A combination of labor and handling equipment is utilized in mechanized systems. In contast, automated systems attempt to minimize the labor involved as much as possible by substituting capital investment in equipment (Boxersox, 1978, p 185).

For equipment used whether in handling raw materials flow or finished goods, there are common types of mechanized equipment with which industrial education students should become familiar. Conveyors are quite common and take several forms such as either rollers, wheels, belts or hooks. The wheel type is most often used in circular or curved plant layouts, while rollers are applicable in straight line functions. These two systems require input force for operation. Belts provide flat surfaces for materials or parts and usually are motor driven at a constant speed. Chain hooks are used to convey heavy or odd shape part and are motor driven. Chain hooks usually operate from overhead.

It is not difficult for students to build such equipment from standard materials found in most school laboratories. Students should be allowed to design a handling system, build and operate the system and measure its efficiency. If the industrial education program includes equipment where a simple product may be manufactured, students could build a system to fit that manufacturing operation. If such activity is not available, simulate a process by disassembling some available product and permit the students to design and operate a system of handling the sub parts for the purpose of assembly.

The students should consider the following design aspects:

1. Nature of item needing transported.
2. Shortest possible travel distance.
3. Increase of decrease speed possibilities.
4. Physical dimensions of space available.
5. Location of raw material, subparts, and final storage.
6. Safety of handling with minimum of waste or spoilage.

In the design of such a system, students should deal with the type of motive force required, mechanical parts needed, and specify maintenance required. Much learning may take place regarding mechanisms. The students should then be permitted to evaluate the process by observing how well the system works. Observe such conditions as:

1. Traffic flow and bottlenecks.
2. Number of labor motions required to load and unload.
3. Any maintenance problems.
4. Direction and distance of travel
5. Quantity of parts handled per minute.
6. Consider multiple loading or stocking to increase speed.

Additional equipment should be studied. Special materials such as food products and powders need special handling. Chutes and tubes or pipelines are used in industry to move products and materials that could be hazardous or could be spoiled if not enclosed. Such items as powders or sand can cause a special problem because of their abrasive qualities and their tendency to clog up mechanical equipment. Let students study alternative ways to move these products, such as with screw type conveyors. Wherever possible, let gravity provide the motive force. Chutes, pipelines and tubes accommodate this action very well.

For material handling to accommodate physical distribution, other common types of equipment are necessary. Many types of fork lifts are available. While most fork lifts used in industry operate on electric power or propane gas, a small, wheeled, hand operated type device could be built in a school lab. Fork lifts for industry may have dual forks that only go up or down, or they may rotate or with a back stop, be used to push off their load. Some are capable of heights of 20 feet or more. Special features may be adapted such as roll grabs, crane forks or shovels.

Trucks of various types are often used. These include platform, pallet lifts, bin trucks, dollies and two wheeled hand trucks. A small tractor with trailer is often used. Often towlines mounted in the floor with drag hooks are employed to move four wheel trailer at a continuous speed.

Most school laboratories use materials that involve storage. Student activities should include storage design for both raw materials and completed items. A complete system of storage racks and handling truck could be designed. Students could calculate loads and design movement system efficient to the laboratory operation. Studies should be made of types of warehouses and storage systems.

Most storage systems are sized to accommodate both efficient plant load sizes and shipping vehicles. Products must be packaged individually or placed together and are moved on some kind of base. Usually a pallet or slip sheet is used on which products are placed. Single face or double faced pallets are used, skids are, also, often employed. Slip sheets are now coming into use, but require the modification of grippers to fork lift trucks costing about $4000. Not all storage warehouses would have these available. A slip sheet is a strong but thin paper board the same size as a pallet which is 48" x 40". A flat plate instead of forks are used on lift trucks with a gripper bar used to pull or push the slip sheet on or off the platform. Slip sheets take up much less space and cost much less than pallets.

In most warehouses, storage racks are designed on which pallets or slip sheets may be placed. Racks may have decks or be open so trucks may be driven through. Bins are cabinets that have closed backs and usually shallow front and back dimensions. Flow through racks accommodate pushing products in at one side and removal at opposite side. Vertical racks store long pieces upright and A-frame racks store long pieces horizontally.

1. Input-output flow of products in storage.
2. Route of truck with appropriate aisle and intersection space.
3. Racks to accommodate load and flow of product.
4. Package system that permits protection, communication and transporting. Also consider how package accommodates order picking to send to retailer.

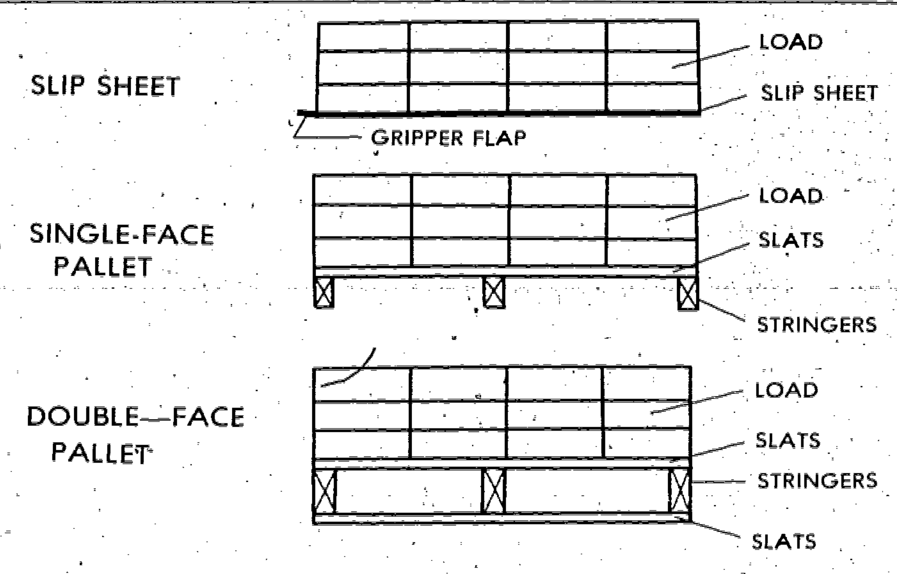


Figure 2—PALLETS AND SLIP SHEETS

Automated warehouses have great appeal, but require large capital investments. It is less labor intensive, and is faster. Such systems are computerized for operation and counting of pieces moved. Cartons are used with code markings that are sensed electronically. Large stoker cranes can be used and warehouse architecture can be greatly changed as a result. High-Rise type architecture is usually used.

In addition to student field trips to warehouses, terminals, etc., it is possible to have student perform many of the actions and use a smaller scale if necessary. Hand operated trucks can be built and storage facilities can be built to scale and be made to simulate design problems in industry such as:

Packaging

Packaging must accommodate the product by preparing it for shipment, protecting it, and providing communication to those who handle it. Packing the products in proper quantity is a necessary part of the physical distribution system. Student activities should involve those steps necessary to provide for the product. Packing and packaging material can be of paperboard, corrugated or wood easily located as used material. Have students build a prototype package and test it. A test should be devised to determine stacking height strength of multiple packages. Drop tests can help determine product safety. Local packaging industries have data that can be used to determine how much crush can be applied to different products and from how high products of different weights can be dropped. Communication on the package should tell quantity as well as identify products and give destination. Other information such as safety and handling instruction should be given. This information is usually a code placed on a specific place on the package. Visit a local warehouse and observe stacking methods as well as methods of communication. Note the proportion used in terms of dock space, aisle space and rack space. Most local libraries have text materials of business logistics which cover details of sizes of material handling equipment and storage space. These dimensions can be scaled down for simulation in the laboratory.

Transportation Modes

Tranasportation infrastructure is the term applied to the legal variety and characteristics of individual modes of external transportation (Boxersox, 1978, p 204). These modes of transportation include rail, highway, water, pipeline and air. Much of our shipping is done today in multimodal systems made possible by the use of containers that fit several types of vehicle systems.

When student activities include physical distribution systems in their lab projects, research should be done for a given system to determine the size of truck trailer and/or box cars, or cargo bays on aircraft to determine size and weight of package that would provide a full load. Knowing this information will permit students to decide on package design and handling systems so as to accommodate geographic shipping vehicles.

The railroad is able to handle the largest tonnage and is our main mode of transport for raw materials. The plight of our railroads is of great concern at this time. Roadways are in poor repair and poor operations have caused lost revenue.

Government backed corporations have been formed to help improve the system. For passenger service the National Railroad Passenger Corporation was formed known as AMTRACK. In 1976 the Consolidated Rail Corporation was formed for freight service and is known as CONRAIL.

Rail transportaton was our first long haul made for both passengers and freight. Cars were cheap to build in the 1920's and the railraods had many built. But by World War II air travel had started. To offset this, the railroads developed limited and improved locomotives for higher speed. During World War II trains were necessary, but after the war, air travel and private automobile were more popular. The railroads still were active in hauling freight but they had not developed passenger cars for modern times.

War torn Europe concentrated on rebuilding rail transportation as the cheapest way to move the population as well as provide for hauling freight. Therefore, it is understandable why Europe leads the world in rail transport technology (Collins, 1978, p 8). France specifically has developed modern high speed technology which includes new energy systems and tracks. Electric and diesel power are the most efficient. The French are working on an air cushion single center concrete rail for a train that can go 256 mph. Grumman in the U.S. has developed a 258 mph. train, but no track bed will permit its use (Collins, 1978, p 85).

France is ready to start service from Paris to Lyon this winter (1981-82) by using new mile long rails with tapered joints mounted on concrete ties placed on ballast made from heavier broken stone filled with crushed stone which permits the T6V (Train-Grand Vista) to travel at 160 mph. Electric motors drive each axle of each car thus eliminating the need for a heavy locomotive. Also, mounting half of each wheel truck on the end of each car permits higher speed turns.

The U.S. is also working on streamlining locomotives and cars. Reshaping the frontal area and redesigning skirts to prevent undercarriage turbulence helps produce speed.

The electric trains are starting to use 25000 V A.C. grids for power systems, but new developments are underway. The hovertrain based on air cushions read speeds of 250 mph, but both linear induction and magnetic levitation have promise for high speeds.

Linear induction systems use electro magnets mounted in the vehicle and metal conductors of steel or aluminum plates fixed on the track. The passing of electrical current on the fixed conductors creates magnetic field which sweeps from front to back of each car. This interacts with the magnetic field created by the electromagnet mounted on the vehicle.

Magnetic levitation vehicles work with fixed magnets which move over sheets of steel that induces a current in the steel creating a magnetic field. In turn, the magnetic field reacts against the magnetic field of the vehicle causing it to lift. Ford Motor Company and Stanford University are working on the development of such a system.

Other modes of transportation have been greatly developed, but earlier than the more recent development of the railroads.

Highway transport developed rapidly since World War II. How the private automobile is used today is generally well known. But highway development did much to increase the ability of motor carriers to deliver door to door. While fuel was inexpensive, trucks could go almost anywhere at any time. But with fuel cost of today, it is more difficult to provide the same flow of service.

Since 1975, fuel economy has risen due to improved aerodynamics and lower speeds. But truck transport is more costly, not only due to fuel costs, but the labor required to load and unload. Since 1976 over 50 percent of all truck transport was handled by private shippers.

Water transport is still the oldest

form of transport and ships over 23 percent of intercity tonnage. The main advantage is the ability to haul extremely large shipments. However, the U.S. as well as a few other countries do not have the deep water ports to accommodate the new super tankers.

In marine transport most developments have been previously publicized, such as hovercraft and hydrofoils. Both these type of vessels are seeing service for passengers in Britain and Europe. Both are interesting to many students who study marine vessel design. Water transport on the inland waterway of the U.S. is important due to its low cost.

Pipeline transportation is the cheapest form of transport for material. Pipelines have been used since 1865 and hauls 19 percent of our intecity tonnage (McDonnell, 1980, p 117). It has the advantage of climate control and 24 hour service. Liquids are easily shipped by pipeline, but it is also easy to make a slurry of many dry products and place them in the pipe. Boost pressure pumps are located about 150 miles apart. By knowing the rate of flow engineers can determine what product is flowing in the pipe.

Recently, more use has been made of the capsule pipeline carrier. An eight inch capsule with wheels to reduce friction is used inside a pipe for high speed, low friction operation. These systems can move more freight than 20 train loads per day.

Research is still progressing on a passenger "tube flight" train. Passengers enter a cylinder shaped car in an underground tube and closed in. Air pressure is lowered ahead of the car to keep it moving at high speed.

Air transportation may be able to gain more growth in the near future but it is still the most expensive methods of transport and accounts for only 0.2 percent of intercity tonnage. Except for small freight aircraft specifically for specialized hauling, not much has changed in recent years. An aircraft cargo container does make it possible to pack at point of manufacture and deliver a full container to the aircraft. The aircraft industry has received a boost more recently due to some activities in our space program and the need to modernize our fleet of aircraft. New space and aircraft designs are highly publicized so will not be treated here in this writing, but should be considered for student activities.

One new little known development is that of an airfoil highway vehicle being tested by the developer, James T. Amick. Amick, a consultant in aerospace, is testing a one passenger wing sail vehicle shown in Figure 3.

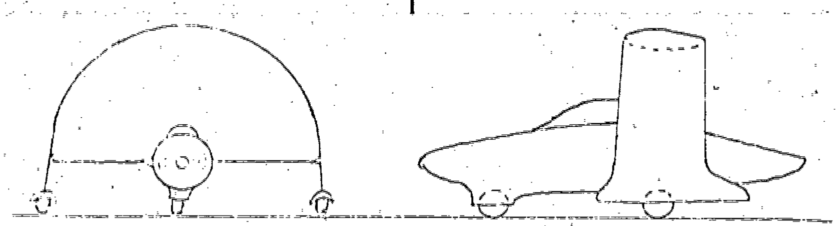


Figure 3—SAIL VEHICLE

The vehicle uses a combination of battery power and sailing power. When following a circular path to the wind, cruising distance is 90 miles at 45 mph with continuous wind direction, this distance is increased to 220 miles. The vehicle is 11.5 feet long, 8 feet high and 8 feet wide and weight 750 pounds. Basically it designed to operate at 55 mph. This style vehicle can easily be built in model form stimulating students to consider new vehicle design.

MASS TRANSPORTATION

People today seem more ready to accept a different type of transport system, perhaps prompted by high fuel costs, but more likely due to having reached the saturation point on our highways. According to Tabor Stone, (1971) states: "We are facing a transportation crisis, one that becomes more critical as time goes on, a crisis which threatens to overwhelm us while we are standing around seeking solutions. Concurrently we are facing a land-usage crisis as we face the task of accommodating an additional half-million people by the year 2000 in a landscape that has been shaped more to fit the needs of the automobile than to fit the needs of man. (p 2).

Perhaps advanced communications systems will replace the need for so much business travel. But the telephone only served to expand man's scope of operation—not limit it.

While the new systems hardware is now coming onto the scene, sales people say it expands their in-office contacts requiring very extensive routes with little additional sales and therefore, no reduction in travel.

Stone (1971) believes that transportation must be discussed on a dual level—functional and environmental. Our present transportation techniques are failing to serve us properly in both areas" (p. 3).

Labor goes on to point out the myth regarding use of leisure time. The average American work week has increased from 40.6 to 41.8 in 1970, and is expected to go to 42.5 by 1985 (Stone, 1971, p 5).

Two types of surface, urban transport exist known as random route and fixed route systems. Random routes transfer cars from point of origin to point of destination over a random route and require a park-

Carrying Capacities of Single Lane.

Passengers in autos on surface streets	1575
Passengers in autos on elevated or express highways	2025
Passengers in buses on surface streets	9000
Passengers in streetcars on surface streets	13500
Passengers in subways	20000 to 40000
Express subway trains	60000

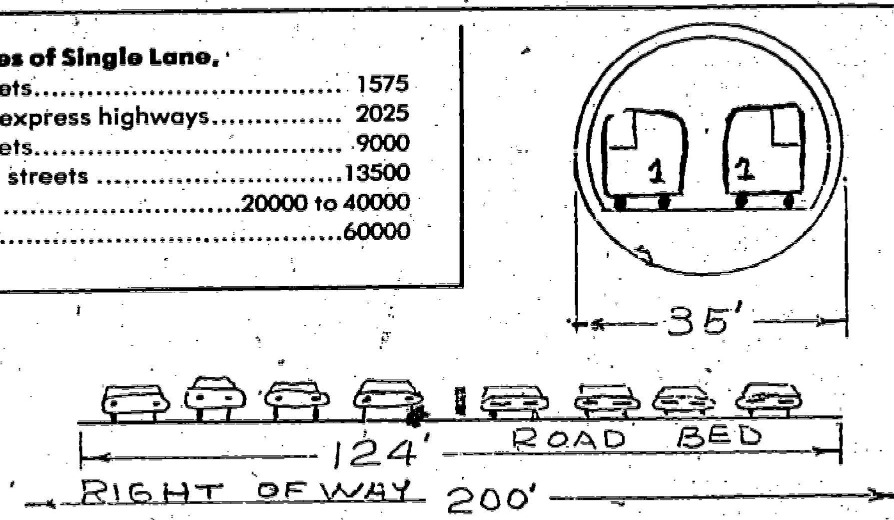


Figure 5—CONTRAST OF TWO LANE SUBWAY TO EIGHT LANES OF CARS

ing place at destination. City buses act like random route vehicles but have characteristics of fixed system. See Figure 4.

Random systems are expensive in terms of landspace, and support system such as gas stations, parking garages which are a greater burden on landspace than railyards and terminal space.

The chart below shows a comparison of different vehicles for single highway lane, per each hour of travel.

In selecting a mass transit system, many comparisons can be made between modes. Because our rapid rail systems lack connecting links at destination, they have not proven desirable. (U.S. News) Yet the landspace for highways is massive and fails to carry rush hour loads as shown in Figure 5.

The subway can handle 40,000 people while the expressway handles 2625 people.

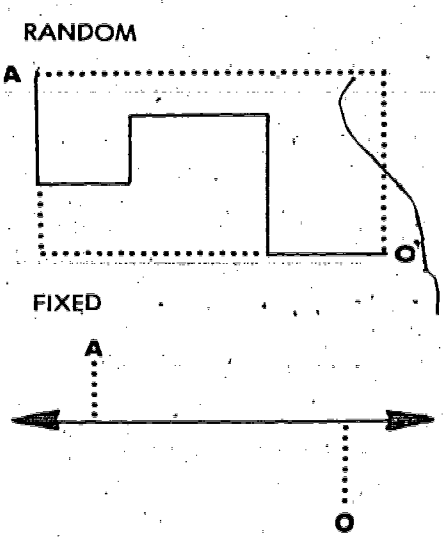


Figure 4—RANDOM AND FIXED TRANSPORT SYSTEMS

Fixed route systems require hardware of a more simple nature than random systems and require very little space. Fixed systems can maintain total control when automated and computerized systems are applied. These systems operate from a central point using a master board keyed with an extensive route desire notification system activated by ticket purchase, token deposit, or turnstile action. This permits weighting of train size and schedules to fit demand (Beardsley, 1981 p. 11).

Random systems accommodate widely spread, non-centralized activity areas on door to door basis better than other systems. But many independent costly controls are needed. Random system are a source of noise and exhaust pollution. With high density traffic we are reaching a point beyond human capability no matter how well trained or physically fit the driver. In 1980, 70 percent of all our law enforcement dealt with traffic (McDonnell, 1980, p 23).

What is needed is better integration of systems and a system for intermediate transport to act as a feeder system to make rapid transit work. Each time a new freeway opens, it provides a corridor for more business expansion thus creating more traffic.

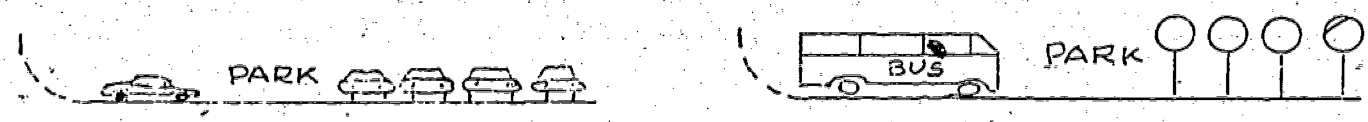
Dulles Airport near Washington, D.C. is an excellent facility but is too far from D.C. without intermediate transportation. The highway to it is in danger of being over developed. More airports take too much land and creates noise.

Several experts on transportation support the proposal of rapid rail transit into our large cities with short haul buses or small automaticlly controlled cars on a small single rail system to carry people to their individual destination.

In revewing the possibilities for student activity, much remains to be researched in technical equipment and social-cultural desires. Privacy and comfort seem to be necessasry for our culture but these are hard to achieve in mass transit.

As students deal with activites designed to acquaint them with transport vehicle system, it might be well to develop interdisciplinary studies with social science and science. Students need to develop attitudes that can only be developed by understanding the problems of mass transit. Working on projects that bring students into contact with community leaders of transportation would serve well.

With the space shuttle success, much attention may return to space travel. Because ample literature is available on space program, it is not



A park full of trees is better than a park full of cars.

detailed here. In addition to the many needed testing activities that are listed in the past literature it might be wise to add the activity of vehicle design.

The use of homemade devices for drag and airflow can be used to study new vehicle configurations. Mounting reasonsably accurate scale model cars and trucks on pivot mounts attached to springs measuring drag created by moving air with a fan past the vehicle, is still an interesting way to study the new streamlining of cars, trucks and trains. Boat hulls can be tested by using a paint roller tray, allowing water to enter at the top and flow down the slope past a model hull attached to the tray. A grid sheet painted on the base permits observations of the pattern of water deflection and turbulence.

Because transportation takes on several different dimensions, it may not appear to be associated with energy lab activities. But in addition to the motive energy relationship, power mechanics labs are well suited to transportation activities due to tools and equipment on hand. Only the addition of a few different supplies might be necessary, such as perforated angle iron for construction of support frames for material handling activities.

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