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ABSTRACT

This curriculum guide provides topic outlines and objectives for 12 units of an industrial arts program in plastics at any grade level. Introductory material describes the scope and sequence of an Industrial Arts program, gives specific guidelines for Industrial Arts, and briefly discusses the nature of plastics. Unit titles include Orientation of Plastics Technology, Molding Processes, Thermoforming, Casting and Encapsulating, Foaming Processes, Bonding Processes, Laminating Processes, Coating Processes, Machining, Decorating, Moldmaking, and Ecology. Appendixes provide three sample lesson plans, a sample laboratory/shop learning activity, glossary of terms, listing of ideal equipment, sources of plastic information, sources for equipment and supplies, list of classroom textbooks, and reference list. (YLB)

INDUSTRIAL ARTS CURRICULUM GUIDE

FOR

PLASTICS

State Department of Education
Division of Vocational and Adult Education
May, 1981

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INTRODUCTION

The committee developed this curriculum to be used on any grade level in an industrial arts program. Many areas are covered in it and the teacher starting a program should investigate all the areas and determine what can be used in that particular laboratory. The equipment available can guide the teacher but through creativity and Yankee know how the various units can be taught with limited equipment.

Plastics is a rapidly growing industry and should be a part of every industrial arts program. This will provide the student with the knowledge and experience to work in this area.

With new developments in the plastics industry the teacher should also keep aware of developments. The list of periodicals in the appendix should provide this kind of information.

The reference list should be reviewed and the teacher should select the materials that seem to best fit into their program of industrial arts.

The list of equipment is basic but it is also what would be used to run an excellent plastics program.

CONNECTICUT STATE DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL AND ADULT EDUCATION
BUREAU OF VOCATIONAL SERVICES
HARTFORD

INDUSTRIAL ARTS

Scope and Sequence

Industrial Arts learning experiences are sequential, beginning in the lowest grades and continuing through adult and higher education. As an integral part of the total educational program, Industrial Arts is designed to meet student's needs as they relate to a modern technological society. Through manipulative and research experiences, with a variety of tools, machines, processes and products of industry, students develop an awareness of how industry and its many components function.

A comprehensive Industrial Arts program will provide for a sequence of courses in industrial areas. These include, but are not limited to:

drafting	industrial ceramics
electricity/electronics	metal technology
general lab	plastic technology
graphic arts	power technology

wood technology

The objectives of Industrial Arts are:

. . . . . To develop an insight and understanding of industry, its place in our society, and the free enterprise system.

. . . . . To develop problem solving skills related to the materials, tools, processes and products of industry.

. . . . . To provide for a degree of skill development through a series of sequential courses in common industrial areas with vocational emphasis at the advanced levels.

. . . . . To develop knowledge of the tools, machines, materials and processes of industry through their practical and safe use.

. . . . . To develop an appreciation of good design and craftsmanship.

. . . . . To develop an understanding of industrial and technological career opportunities and their requirements.

. . . . . To develop those traits which will help students obtain and maintain employment.

. . . . . To develop consumerism regarding the goods and services of industry.

. . . . . To discover avocational and recreational interests.

. . . . . To understand the affects of industry and civilization upon the environment.

The following sequential phases represent a range of Industrial Arts activities from kindergarten through adulthood. Reference is made to grade level to assist LEA's in planning. It is understood that a wide variety of grade organizations are employed based upon local situations.

I. Self-Awareness (grades K-6)

Industrial Arts at this level is designed to familiarize students with the many kinds of work people do and the tools and materials they use. It is at the elementary level that Industrial Arts activities are used to enhance basic skills and understandings in all curricular areas by providing relative hands-on experiences.

II. Industrial Arts Exploration (grades 7 & 8)

Industrial Arts at the middle school/jr. high school level is designed to foster the development of a strong foundation in the concepts, skills, knowledges and attitudes regarding not only the technical but also the related and social aspects of general education.

Industrial Arts experiences at this level are exploratory in nature. The program provides students with the opportunity to develop a better understanding of their interests, abilities and aspirations. Consumer knowledge as it relates to industrial products and processes is an inherent part of these activities. A broad exploratory Industrial Arts program at the middle school/jr. high school level allows individual student's interests to become more discernible for concentration at the senior high level.

III. Industrial Arts Occupational Orientation (grades 9 & 10)

Industrial Arts at this level emphasizes occupational orientation. It is here that the transition from middle school/jr. high school exploratory experiences to specialization at the upper levels is made. Students may explore in greater depth a wider variety of areas, evaluate their performance, aptitudes and interests and begin to formulate career plans.

IV. Industrial Arts Specialization (grades 11 & 12)

At this level students are provided the opportunity to specialize in one or more occupational areas and to develop pre-vocational skills. Training at this level should prepare students to maximize their career options after high school.

This level should also assist individuals in making informed and meaningful occupational choices and/or prepare them for entry into advanced trade and industrial or technical education programs.

V. Adult, Continuing and Higher education Industrial Arts programs are designed for adults and out of school youth. These programs are a-vocational, pre-vocational or vocational in nature depending upon the needs of the individual and the demands of society.

Specific Guidelines For Industrial Arts

Grade Level

7 – 12 and Adult

Selection of Students

Open to all students who can profit from instruction, and work safely in a Lab/Shop situation

Length of Program

Level One (Exploratory) grades seven (7) and eight (8) – Lab/Shop classes meet a minimum of 60 hours per year. Lab/Shop periods must be of at least 40 continuous minutes and should not exceed 60 minutes.

Level Two (Occupational Orientation) grades nine (9) through twelve (12), or grades ten (10) through twelve (12) – students electing Level Two Industrial Arts courses must have the opportunity to participate in a minimum of 225 minutes of Lab/Shop activities per week, per semester. Daily Lab/Shop periods must be of at least 45 continuous minutes and should not exceed 60 minutes.

Level Three & Four (Specialization and Pre-Vocational) grades eleven (11) and twelve (12). Students that elect Level III & IV Industrial Arts courses must have a minimum of 450 minutes per week, per year of Lab/Shop activities. Daily Lab/Shop periods must be of at least 90 continuous minutes.

The definition of a year is a minimum of 180-day school days. A semester is 90 continuous school days.

Pre-Requisites

Successful completion of Level Two course prior to participating in Level Three. Successful completion of Level Three course prior to Level Four.

Enrollments

Based on Lab/Shop size and facilities, 16 students per class maximum in Lab/Shop areas and 20 students per class in drafting. The recommended and minimum square footages are as follows:

Shop/Lab

	Recommended		Minimum	
Jr. & Sr. High School	s.f./pupil station	Net total s.f. area	s.f./pupil station	Net total s.f. area
Drafting (including storage	48 sf	1200 sf	40 sf	1000 sf
I.A. Jr. H.S. Level One (including storage)	100 sf	2500 sf	82 sf	2050 sf
I.A. Sr. HS (including Levels Two, Three & Four storage	144 sf	3600 sf	120 sf	3000 sf

A classroom should be made available for related study, adjacent to the Shop/Lab areas. All facilities must comply with OSHA regulations.

Teachers Schedule

Industrial Arts contact hours for a full-time instructor should comprise 70% to 80% of their school week, and 20% to 30% of their time in industrial arts related non-teaching duties, such as maintenance and preparation of I. A. materials.

Equipment

All equipment must be in safe operating condition and conform to all federal, state, and local standards. Equipment must be:

A. Applicable to the level being taught, i.e., size, capacity, quantity, and necessity.

B. Enhance the program level and be similar to that found in industry.

C. Take into consideration: occupational education, consumer competency, leisure time activity, and environmental awareness.

Evaluation

Continuous evaluation by students, teachers, school, vocational, advisory committee, and state. Evaluation results must become an integral part of program development and improvement.

School Credit

Equal to other academic credit granted for similar periods of time and activities.

Youth Organizations

It is recommended that the American Industrial Arts Student Association (AIASA) be an integral part of the curriculum.

Teacher Certification

Instructors shall meet the minimum standards for Industrial Arts teachers provisional certification as outlined in the "Rules and

Teacher Certification (cont.)

Regulations Concerning State Teacher Certification" section 10-146-21 and section 10-146-22.

Standard certification requires three (3) years of teaching under a provisional certificate, the last two (2) years consecutive and a master's degree or thirty (30) semester hours, consisting of a planned program at an approved institution of higher learning and an individual program, mutually determined and approved by teacher and supervising agent.

Teachers of Industrial Arts to be funded through the Vocational Education Acts must comply with section 10-146-22 above, have one (1) year of appropriate occupational experience and complete Principles of Vocational Education, a three (3) semester hour Vocational-Technical Education course.

Sex Stereotyping

Existing activities and future plans must show evidence of actions directed toward the elimination of sex stereotyping, including continual effort to attract females to elective industrial arts courses traditionally chosen by males. Industrial arts courses which are required for any students at a particular level must be required of all students, male and female.

THE NATURE OF PLASTICS

In quite simplified terms, a plastic is a material having three specific characteristics, namely:

1. The chemical elements of its composition are linked, or grouped and linked, bead-chain fashion, in very long strands which, in turn, may (or not) be chemically interconnected with each other in two- or three- dimensional networks.

2. Whether rigid or flexible in final form, it exhibits relatively little elastic recovery of shape after gross deformation.

3. The substance is, at some stage in its transformation into final form, able to be flowed into shape, yet when set will without load retain its shape, unsupported, at normal room temperature.

The first characteristic identifies plastics as a subgroup of materials called polymers, which differ in this fundamental manner from other chemical-process based materials such as glass, ceramics, metals, graphite, etc. The second characteristic distinguishes plastics from rubbers, and naturally occurring polymers such as gums. The third characteristic (with the second) separates plastics from other natural polymers such as cotton, wool and chitin, and from complex polymeric materials such as wood and leather.

A material need not be man-made to be a plastic, but the majority of plastics we commonly use are either entirely man-made or substantially altered chemically from their natural composition.

Since, historically, commercial uses of natural plastic polymers were developed by separate industries long before the chemical structures that relate them as a material family were recognized, we frequently overlook very large groups of materials which are, by definition, also plastics. We further obscure their nature by continuing to classify them together statistically according to historical uses in discussing their production. As examples of this we can cite textiles (rayon), ink and coating binders (alkyds) and glues/adhesives (phenolics). Plastics as such are not new, only the relatively widespread awareness by the general public regarding the extensiveness of plastics use is new.

The remarkable variety of properties that can be imparted to plastics by adding other materials to them such as reinforcements, softening and toughening agents and colorants, as well as changes that can be made in their inherent chemical structure cause considerable difficulty in distinguishing them from other classes of materials. Because of the economy of plastics use the differences between plastics and competing materials are deliberately being formulated away. An example of increasingly blurred boundries is shown by so-called thermoplastic-rubbers, which behave at room temperature much like stiffer grades of rubber but can (unlike rubber) be reshaped like many plastics at elevated temperatures.

Unit I ORIENTATION OF PLASTICS TECHNOLOGY

With this unit the student will have a knowledge of the technology of plastics, its history, an understanding of the industry, the chemistry of plastics, and basic terminology.

I. History of Plastics

   A. The early developments

   B. The world wars influence

   C. Recent developments

   D. The growth of plastics in the future

II. The plastics industry

   A. Careers in plastics

      1. Molding and extrusion

      2. Finishing

      3. Material

      4. Inspection

      5. Shipping and Receiving

      6. Maintenance

      7. Power Supply

      8. Tool Room

   B. The many uses of plastics

   C. Related industries

      1. Furniture

2. Construction

3. etc. (Plastics relates to all industries).

D. The future of the plastics industries

III. The families of plastic - chemistry

A. Thermoplastics

B. Thermosets

C. Product applications

D. The structure of plastics

IV. Safety

A. Safety should be taught under all units, see sample lesson plan in appendix.

V. Terminology

A. See terms in appendix.

Unit II MOLDING PROCESSES

The student will gain knowledge of some of the basic molding processes. The student will understand the processes, how to perform the process, perform maintenance on equipment and mold design.

I. Blow Molding

A. The Process

B. Mold Design

C. Maintenance

II. Compression Molding

A. The Process

B. Mold Design

C. Maintenance

III. Extrusion

A. The Process

B. Mold Design

C. Maintenance

IV. Injection Molding

A. The Process

B. Mold Design

C. Maintenance

V. Rotational Molding

A. The Process

B. Mold Design

C. Maintenance

VI. Slush Molding

A. The Process

B. Mold Design

C. Maintenance

VII. Transfer Molding

A. The Process

B. Mold Design

C. Maintenance

Unit III THERMOFORMING

Through this unit the student will understand the process of thermoforming. The student will be able to demonstrate skills in the process and also operate equipment used in thermoforming.

I. Drape Vacuum Forming

A. Operate equipment

B. Maintenance of equipment

C. Set up

II. Mechanical

A. Set up

B. Perform operation

III. Plug-assist Forming

A. Set up

B. Maintenance of equipment

IV. Straight Vacuum Forming

A. Set up

B. Perform operation

Unit IV CASTING AND ENCAPSULATING

The student will be able to prepare the materials needed for these processes. The student will be able to make a finished piece in each area.

I. Encapsulating

II. Epoxy Casting

III. Impregnation

IV. Polyester Casting

Unit V FOAMING PROCESSES

The student will demonstrate knowledge of the processes also the set up of operations as well as making a finished piece using the processes.

I. Flexible Polyurethane Foam

A. Set up

B. Knowledge of process

II. Polystyrene Bead

A. Pre-expanding

B. Molding

C. Knowledge of process

III. Rigid Polyurethane Foam

A. Knowledge of process

B. Set up of operations

Unit VI BONDING PROCESSES

With this unit the student will use bonding, the student will also demonstrate knowledge of the process, when to use the process, maintenance of equipment. The student will also be able to use each process correctly.

I. Adhesives

II. Bar Heat Sealing

III. Friction Welding

IV. Heat-shrink Packaging

V. Hot-air Welding

VI. Radio Frequency

VII. Solvent Welding

VIII. Ultra Sonic Welding

Unit VII LAMINATING PROCESSES

With this unit the student will work with plastics that will be laminated. The student will demonstrate skills in laminating and be able to maintain the equipment used. The student should know how to set up operations.

I. Adhesive Laminating

II. High Pressure Laminating

III. Low Pressure Laminating

IV. Reinforced Plastics

V. Thermoplastic Lamination

Unit VIII COATING PROCESSES

The student will work with coating of objects and will understand the processes that are being used.

I. Cold Dipping

A. Set up and preparation

B. Knowledge of the process

II. Fluidized Bed Coating

A. Set up and preparation

B. Knowledge of process

III. Vinyl Dispersions (hot dipping)

A. Set up and preparation

B. Knowledge of process

C. Tool Coating

Unit IX MACHINING

The student will work on various plastics and using machines to perform a number of operations. The student should set up the machines, perform maintenance on them, and run the machine for the operation.

I. Cutting

   A. Drilling

   B. Lathe

   C. Milling

   D. Routing

   E. Saws

   F. Shaping

   G. Any machine tool can be applicable to plastics

II. Finishing

   A. Buffing

   B. Polishing

   C. Types of Abrasives

III. Internal Carving

   A. Set up of operations

   B. Knowledge of process

IV. Engraving

A. Set up of operations

B. Maintenance of equipment

C. Knowledge of process

V. Die Cutting and Blanking

VI. Threading

Unit X DECORATING

The student will demonstrate skills in the processes of decorating and will be able to set up and perform the operations.

I. Silk Screen

   A. Set up

   B. Knowledge of process

   C. Perform process

II. Painting

   A. Brush

   B. Spray

   C. Dip

III. Hot Stamping

   A. Set up

   B. Knowledge of process

   C. Perform process

IV. Heat Transfer

Unit XI MOLDMAKING

With this unit the student will understand the construction of molds used in the plastics industry.

I. Mold Materials

A. Polyethylene molds (thermoformed)

B. Flexible

C. Plaster

D. Wax

E. Clay

F. Metals - steel, aluminum, brass, etc.

G. Cast - epoxy, polyester

H. Wood

II. Types of molds

A. Vacuum molds

B. Plate molds

Unit XII ECOLOGY

The student through this unit will develop an understanding of plastics and its effect on the ecology.

I. Effects of plastics on natural life cycle

II. Disposal of plastics waste

III. Contributions to the environment

SAFETY

OBJECTIVES:

- To develop a knowledge and an awareness for safety
- To develop safe working habits
- To promote and maintain a safe working environment

LESSON OUTLINE:

The plastics industry recognizes safety as an important aspect of training because of the dangers which exist if these conditions are not recognized. The industry utilizes resins, materials and equipment which require knowledgeable persons for handling, processing and testing.

I. Areas to be knowledgeable of:

A. Flammable and explosive volatile resins

B. Materials handling and storage

C. Tool and mold handling and storage

D. Machine and equipment safety locks and safe setup and operation procedures

E. How to purge a machine

F. High and low voltage circuits

G. High pneumatic and hydraulic pressures

H. Electrical heater bands with high temperatures

I. Steam, hot water and hot oils

J. Mechanical toggles and other clamping actions

K. Hot plastic resins under high pressure

L. Dangers in feed hoppers of machines:
(personal injury & machine damage)

M. Danger in recycling and granulating of resins

N. Dangers in processing hygroscopic and heat sensitive resins

O. Toxic and corrosive fumes from some resins

P. Danger in using catalyst and peroxides

II. Teaching methods and activities:

A. Emphasize safety and safe working procedures during demonstrations for setting up and operation of machines

B. Show audio visuals which present safety precautions and the correct methods for set up and operation of machine tools.

C. Display safety posters in the shop areas

D. Develop student progress charts which promote good working habits and identify violations of safety precautions

E. Develop a continual maintenance program for machines and equipment which will correct hazardous conditions and develop attentive safe work habits

F. Encourage students to be alert for their own safety as well as the safety of others

G. Have a monthly safety inspection by the class and implement a class maintenance program to correct any hazards

H. Designate a student Safety Personnel Officer to assist supervision of possible violations by students

I. Post safety regulations where students can read them and be aware of them

J. Require students to wear safety glasses and protective clothing where required by law, or where danger exists

References:

Books

The OSHA Compliance Manual, Donald Peterson, 1974
Plastics Industry Safety Handbook, Society of the Plastics Industry, 1973
American National Standard Safety Requirements for the Construction, Care and Use of Horizontal Injection Molding Machines, American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 (ANSI B151. -1976)

*Polyvinyl Chloride Informational Booklet, SPI 1975 $.50.
*Epoxy Wise is Health Wise, Dept. of Health, 1976, $.50.

* the above as well as other materials may be purchased from:

Plastics Education Foundation
1913 Central Avenue
Albany, New York 12205

AUDIO-VISUALS

The following may be purchased or loaned from the PEF

Zero-Base Accidents, 16 MM sound film and workbooks. (injection molding)
Safe At Work In Plastics Extrusion, 16 MM film and workbooks.

HISTORY AND GROWTH OF THE PLASTICS INDUSTRY

OBJECTIVES:

- To develop a knowledge of the history and growth of the plastics industry.
- To develop a knowledge of the relationship between plastics and the consumer.

LESSON OUTLINE:

I. Natural Resins

A. Rubber

B. Shellac

C. Gutta percha

D. Keratin

II. Early Commercial Plastics used in the USA

A. 18th Century Horners or Hornsmiths used keratin (a natural plastic found in animal horns, hoofs, etc.) for lantern windows and as a fabricating material.

B. In 1852, Samuel Peck, of New Haven, Connecticut was a pioneer molder of shellac. The plastics industry was a growing industry making checkers, buttons, picture frames, combs, etc.

C. The extruder invented by Bewley in 1845 for processing gutta percha, facilitated the manufacture of newly developed plastic resins and products.

D. The first synthetic plastics material "Celluloid". John W. Hyatt, a New York printer, discovered the effects of camphor on cellulose nitrate in 1868, which developed the start of synthetic plastics product-making in the United States.

E. In 1909, Dr. Leo Henrik Bakeland discovered phenolic resin while searching for a synthetic resin to replace shellac.

III. The Growth of Plastics in the 20th Century

A. Cold Modling of Phenolics in 1909

B. Casein from cows milk discovered in 1919

C. The first American injection molder, Grotelite Company, (after Hyatt) imported 12 Bucholz machines in 1922

D. Cellulose acetate 1927

E. First continuous plastics blow-molding machine was designed by James Bailey in the late thirties

F. During World War II the need for new materials and for substitute materials due to a shortage promoted the rapid growth for plastics. Polyethylene 1942, made radar and television possible (flexible electrical insulator) and Polyester made fiberglass reinforced plastics possible.

G. After WW II, the production of plastics declined, only to experience a rapid growth during the 50's from the discovery of new plastic materials, processes and product applications.

IV. The Growth of Plastics Production in the United States

A. As estimated by the Society of Plastics Industry:

1942 - less than ½ billion pounds
1952 - approximately 2.4 billion pounds
1963 - 9 billion pounds
1980 - 60 billion pounds

B. Future of the Plastics Industry

By mid 1980, world wide production of plastics may reach 273 million tons, and increase over six times again by the year 2000. This means that plastics materials may dominate nearly three-quarters of the total materials market by that time.

SUMMARY:

In approximately 100 years, the plastics industry has grown from discovery to a production of nearly 60 billion pounds per year. Basically, there are three big plastics markets, construction, transportation and packaging. The total of all other "smaller" markets may equal or surpass the larger ones in total production. An important factor in the growth of the plastics industry is that plastics have not only replaced materials traditionally used, but have actually created entirely new markets and product applications never before possible.

References:

Cope, Cope's Plastics Book, The Goodheart-Willcox Co., Inc., 1973
DuBois and John, Plastics, 6th Edition, Van Nostrand Reinhold, 1980
Frados, Plastics Engineering Handbook, SPI, 4th Edition, Van Nostrand Reinhold, 1976
Richardson, Modern Industrial Plastics
Swanson, Plastics Technology, McKnight & McKnight
DuBois, Plastics History - USA, Van Nostrand Reinhold

Table 1 Some commercial polymers and approximate year of introduction

Date	Material	Typical applications
1868	Cellulose nitrate	Mirror frames
1909	Phenol-formaldehyde	Electrical insulators
1926	Alkyds	Electrical insulators
1927	Cellulose acetate	Packaging films
1927	Polyvinyl chloride	Flooring
1929	Urea-formaldehyde	Electrical switches & parts
1935	Ethyl cellulose	Moldings
1936	Polymethyl methacrylate	Display signs
1936	Polyvinyl acetate	Adhesives
1938	Cellulose acetate Butyrate	Sheets
1938	Polystyrene	Kitchenware, toys
1938	Polyamides (nylons)	Fibers, films
1939	Melamine-formaldehyde	Tableware
1939	Polyvinylidene chloride	Films, paper coatings
1942	Polyesters (cross-linkable)	Boat hulls
1942	Polyethylene (low density)	Squeeze bottle, films
1943	Silicone	Rubber goods
1943	Fluoropolymers	Industrial gaskets, slip coatings
1943	Polyurethane	Foam products
1947	Epoxies	Molds
1948	Acrylonitrile-butadiene-styrene Copolymer	Radio cabinets, luggage
1955	Linear high density polyethylene	Detergent bottles
1956	Acetal resin	Auto parts
1957	Polypropylene	Carpet fiber, moldings
1957	Polycarbonate	Appliance parts
1962	Phenoxy resin	Adhesive coatings
1964	Ionomer	Moldings
1964	Polyphenylene oxide	High temperature moldings
1965	Polyimides	High temperature films & wire coatings
1965	Polybutene	Films
1965	Polysulfone	High temperature thermoplasti
1965	Poly (4-methyl-1-pentene)	Clear moldings
1968	Phenylene ether sulfone	High temperature films & molding
1970	Ethylene-tetrafluoroethylene Copolymer	Wire insulation
1970	Ethylene-chlorotrifluoroethylene Copolymer	Wire insulation
1970	Moldable elastomers	Molded rubber products

Date	Material	Typical applications
1971	Hydrogels (hydroxy acrylates)	Contact lenses
1972	Acrylonitrile copolymers	Soft drink bottles
1972	Moldable polyesters	Engineering thermoplastics
1974	Aromatic polyamides	High strength tire cord

ECOLOGY AND PLASTICS

OBJECTIVES:

- To develop the effects of plastics on the environment
- To promote effective and efficient methods for disposing and recycling plastics
- To develop insight into plastics contributions to mankind

LESSON OUTLINE:

I. History of the ecological effects (past 20 years)

A. Changes in the natural life cycle
ex. (effect of synthetic fibers on the moth)

B. Introduction of new materials and their effects
ex. (plastics packaging of fresh foods and the effects on food spoiling microbes

C. Design & Manufacturing of plastics products and their effects
ex. (product contribution or detriments toward human improvements, medical technology, electronics, etc.)

II. Study of numerous types of polymers wastes and their sources

A. Raw Material Manufacturer, Product Manufacturer, and Consumer

B. Types of Polymer wastes: Chemical, liquid, gas, solid, etc.

C. Methods of plastics wastes controls:

1. Recycling
2. Degrading (biodegradable, chemical, additives)
3. Sanitary Landfills
4. Incinerating
5. Possible long term use and reuse of product

D. Engineering Design to Control Plastics Wastes. (functional, long term of permanent use items, etc.)

III. Plastics Contribution to the Environment & Mankind

A. Efficient use of natural materials

B. Energy efficient

C. Increase in Economic Productivity and Use of Labor

D. Contribution to Society in Terms of Technological Advancements ex. (medical technology, water purification, emission controls and filtration, electronic applications, space, transportation, consumer, etc.)

IV. Activities:

Classroom

1. Various plastics may be discussed as to how they relate to accumulated = solid wastes.

2. What can the community or industry do to improve the above situation?

3. Recycle plastics to make interesting and useful projects.

4. Testing or identifying plastics to determine recycling possibilities.

V. Resources:

1. PEF - 35 MM slide presentation "Ecology of Plastics"

2. "Resource Recovery Education Program Kit", NCRR 1974

INTERNAL CARVING – 4 weeks

PURPOSE: To illustrate the basic procedures for Internal Carving of an acrylic block.

PROJECT: Paperweight with flower inside, pen desk set, jewelry, etc.

MATERIALS: Block of acrylic
Internal Carving Dye
Plaster of Paris
Flexible shaft drill and bit
Eye dropper
Fine abrasive paper
Very fine abrasive paper
Buffing and polishing compounds for plastic
  a. Tripoli buffing compound
  b. Nuwhite polishing compound

PROCEDURE:
1. Sand, buff and polish plastic cube to a clear cube.
2. Check internal carver, make sure bit is 3 fluted.
3. Start drilling, slow in one area (make starting bore).
4. Drill design in circular motion, turning both block and drill.
5. Clean inside of cavity.
6. Dye (dyeing can be done before putting plaster of paris in cavity). Use eye dropper.
7. Clean base block and polish of paper weight only.
8. For pen sets, etc. continue operation as follows:
   a. Make base
   b. Drill for pen holder
   c. Glue base and block
   d. After waiting 24 hours, polish both and add pen holder
   e. Wipe completely with light cloth.

GLOSSARY OF TERMS

ACETONE – An organic solvent used to clean up uncured polyester resin.

AIR INHIBITED – The phenomena which causes the final molecular layer on a casting to not cure properly thereby causing tackiness.

CASTING RESIN – A clear, water-white polyester used extensively in the craft field. Noted for its sparkle and brilliance.

CASTING RESIN PASTE – A casting resin with high percentage of thixotropic agent.

CATALYST – A chemical agent which promotes a chemical change while remaining unchanged itself.

COLORANT – Dye, pigment or tinting medium.

CURE – Completion of chemical reaction. In casting work this is generally associated with a "dry" or "hard" casting.

DAMS – Slight elevated ridges in a poly mold which enables the applicator to separate colors.

DEHYDRATION – Removal of all moisture.

DESSICCATOR – Chamber for drying specimens.

DRAFT – Degree of slant.

DYE – A soluble colorant generally associated with transparent colors.

ELASTOMER – Rubber-like compound.

ETHYLENE GLYCOL – Non-volatile organic solvent.

EVISERATE – Removal of specimen innards.

EXOTHERM – Heat generated by a chemical reaction.

FINISHING RESIN – A polyester resin specially formulated to dry tack-free. Employed primarily for surface coating where finish properties are of primary consideration (e.g. tack free). Is not necessarily water clear when cured.

FLUORESCENT – The power by which some substances, when illuminated, give off a light of a color differing from their own.

FORMALDEHYDE – Organic chemical extensively used for preservation of biological specimens.

GEL – A stage in polyester curing evidenced by a gelatin-like appearance.

HARDENER – Same as catalyst.

IRIDESCENT – Exhibiting changing rainbow colors.

LAMINATE – The act of bonding one material to another or several other materials.

LAMINATING RESIN – A polyester resin used primarily as a binder of fiber-glass laminates.

LATEX – Organic compound often referred to as synthetic rubber.

MONOMER – Chemical building block, a molecular structure.

MULTIPLE POUR – A casting where a layering technique is used.

MYLAR* – Trademark of E.I. DuPont and Nemours for polyester film.

NARCOTIZATION – Preparation of biological specimens having to do with preserving prior to dehydration and casting.

OPAQUE – Non-transparent.
PEARLESCENT – Resembling pearl.
PERMA-GLAZE – A high-gloss, tack-free polyester surfacing resin. Cures clear.
PIGMENT – A non-soluble colorant generally associated with opaque colors.
PLASTISOL – Organic compound consisting of polyvinyl chloride and non-volatile vehicle.
POLYETHYLENE – Plastic material with waxy feel.
POLYMERIZE – Organic chemical reaction by which monomer(s) are converted into a new chemical compound with higher molecular weight.
PROPYLENE GLYCOL – Non-volatile organic solvent.
PVC – Polyvinyl chloride.
PYREX – Trademark of specially treated heat-resistant glass.
REAGENT – Chemical compound.
RTV – Refers to room temperature vulcanization type of silicone rubber.
SET-UP – Stage in resin cure where the liquid resin will no longer pour.
SINGLE POUR – A casting where only one pour is made.
STYRENE – An aromatic-type organic solvent. Used to thin polyester resins.
TACK-FREE – A surface which may be touched by hand without leaving finger-prints.
THERMOPLASTIC – Term applied to organic plastic materials that can be heated, pressed into a shape, cooled and then re-heated and returned to original shape.
THERMOSETTING – Term applied to organic plastic materials that when once polymerized through heat, cannot be returned to original shape.
THIXOTROPIC – Liquid which cannot flow but which can be made to move by use of a brush, roller or spatula.
TRANSLUCENT – Allowing the passage of some light, but not a clear view of any object.
TRANSPARENT – See-through – admitting the passage of light and a clear view of objects beyond.
UNDERCUT – A design angle which does not permit a casting to drop out of a mold.
VISCOSITY – Term to describe mobility or pourability of a liquid. The lower the viscosity, the easier a liquid will flow.
WEP – Water-extended polyester resin.

IDEAL EQUIPMENT TO HAVE

MAJOR	MINOR
Injection molder	Heat gun
Thermoformer	Belt sander
Blow molder	Router
Rotational molder	Benches, woodworking
Hot plate	Saber saw
Oven	Disc sander, portable
Vacuum pumps	Electric drill
Bandsaw	Vises
Engraver	Balance
Table saw	Spray painting outfit
Disc sander	Timer
Oscillating sander	Natural gas torch
Buffer	Circular saw
Shears, squaring	Assorted hand tools
Jig saw	
Drill press	
Granulator	
Refrigerator	
Grinder	
Heat sealer	
Masonite bench	

SOURCES OF PLASTICS INFORMATION

Business Consulting Groups and Publishers

Business Communications Co., Inc. – 9 Viaduct Rd., Box 2070C, Stamford, CT 06906 – 203-325-2208

Chem Systems Inc. – 747 Third Ave., New York, NY 10016 – 212-421-9460

The Conference Board – 845 Third Ave., New York, NY 10022 – 212-759-0900

Frost & Sullivan, Inc. – 106 Fulton St., New York, NY 10038 – 212-233-1080

Hull & Co. – 77 Pondfield Road, Bronxville, NY 10708 – 914-779-8300

Charles H. Kline & Co. – 330 Passaic Ave., Fairfield, NJ 07006 – 201-227-6262

Arthur D. Little, Inc. – 35 Acorn Park, Cambridge, MA 02140 – 617-864-5770

Morton Research Corporation – 1745 Merrick Avenue, Merrick, NY 11566 516-378-1066

Noyes Data Corp. – Mill Road at Grand Ave., Park Ridge, NJ 07656 201-391-8484

Predicasts, Inc. – 200 University Circle Research Center, 11001 Cedar Ave., Cleveland, Ohio 44106 – 216-795-3000

Peter Sherwood Associates, Inc. – 60 East 42nd St., New York, NY 10017 212-687-3653

Skeist Laboratories, Inc. – 112 Naylon Ave., Livingston, NJ 07039 201-994-1050

Springborn Laboratories – P.O. Box J, Hazardville Station, Enfield, CT 06082 203-749-8371

SRI International – Menlo Park, Cal. 94025 – 415-326-6200

Technomic Publishing Co. – 265 W. State St., Westport, CT 06880 – 203-226-203-226-6356

Technomic Research Associates, Inc. – 1 North Wacker Drive, Chicago, IL 60606 312-346-5901

Roger Williams Technical & Economic Services, Inc. – 34 Washington Road, P.O. Box 426, Princeton, NJ 08540 – 609-799-1200

Government Publications

Annual Survey of Manufactures – Bureau of the Census

Census of Manufactures – Bureau of the Census

Current Industrial Reports – Bureau of the Census

Foreign Trade Reports: FT 135 (imports), FT 410 (exports) – Bureau of the Census

Guide to Census Bureau Data Files and Special Tabulations – Bureau of the Census

Guide to Foreign Trade Statistics – Bureau of the Census

Mineral Industry Surveys – Bureau of Mines

Standard Industrial Classification Manual – Office of Management and Budget

Statistical Abstract of the U.S. – Department of Commerce

Statistical Services of the U.S. Government – Office of Management and Budget

Synthetic Organic Chemicals – International Trade Commission

U. S. Industrial Outlook – Department of Commerce

Wholesale Price Index – Bureau of Labor Statistics

Newspapers

Chemical Marketing Reporter – 100 Church St., New York, NY 10007
212-732-9820

Journal of Commerce – 110 Wall St., New York, NY 10005 – 212-425-1616

Rubber & Plastics News – 1 Cascade Plaza, Suite 1302, Akron, Ohio 44308
216-253-2183

Trade Publications and Periodicals

Canadian Plastics – 1450 Don Mills Road, Don Mills, Ontario M3B2X7, Canada – 416-445-6641

Chemical Engineering – 1221 Ave. of the Americas, New York, NY 10020 212-997-2464

Chemical & Engineering News – 733 Third Ave., New York, NY 10017 212-679-6210

Chemical Week – 1221 Ave. of the Americas, New York, NY 10020 212-997-2922

European Chemical News – 33/39 Bowling Green Lane, London ECIR One, England

Market Search, Inc. – P.O. Box 2112, Asheville, NC 28802

Materials Engineering – 600 Summer Ave., Stamford, CT 06904 – 203-348-7531

Modern Packaging – 205 East 42nd St., New York, NY 10017 – 212-573-8107

Modern Plastics – 1221 Ave. of the Americas, New York, NY 10020 – 212-997-1221

Plastics Design Forum – 1129 East 17th Ave., Denver, Colorado 80218 303-832-1022

Plastics Design & Processing – 700 Peterson Rd., Libertyville, IL 60048 312-362-8711

Plastics Engineering – 656 W. Putnam Ave., Greenwich, CT 06830 – 203-661-4770

Plastics Focus – 30 E. 42nd St., Suite 1722, New York, NY 10017 – 212-724-4039

Plastics Industry News – Institute of Polymer Industry Central – P.O. Box 1176, Tokyo, Japan

Plastics Machinery & Equipment – 1129 East 17th Ave., Denver, Colorado 80218 303-832-1022

Plastics Technology – 633 Third Ave., New York, NY 10017 – 212-986-4800

Plastics World – 221 Columbus Ave., Boston, MA 02116 – 617-536-7780

Trade Associations & Professional Organizations

American Chemical Society - 1155 16th St., NW, Washington, D.C. 20036
202-872-4600

Chemical Coaters Assn. - Hitchcock Bldg., Wheaton, IL 60187 - 312-665-1000

Chemical Fabrics & Film Assn. - 453 Route 211 East, Middletown, NY 10940
914-342-5895

Chemical Marketing Research Assn. - 139 Chestnut Ave., Staten Island, NY 10305
212-727-0550

Chemical Specialties Manufacturers Assn. - 1001 Connecticut Ave., NW,
Washington, D. C. 20036 - 202-872-8110

Composite Can & Tube Institute - 1800 M St. NW, Washington, D.C. - 202-223-4840

Drug, Chemical & Allied Trades Assn. - 4240 Bell Blvd., Suite 204,
Bayside, NY 11361 - 212-229-8891

Dry Color Manufacturers Assn. - 561 Franklin Ave., Nutley, NJ 07110
201-667-3011

INDA - 10 East 40th St., New York, NY 10016 - 212-686-9170

International Institute of Synthetic Rubber Producers - 2077 S. Gessner Rd.,
Suite 133, Houston, Texas 77063 - 713-783-7511

Manufacturing Chemists Assn. - 1052 Connecticut Ave. NW, Washington,
D.C. 20009 - 202-483-6126

National Flexible Packaging Assn. - 12025 Shaker Blvd., Cleveland, Ohio 44120
216-229-6373

National Paint and Coatings Assn. - 1500 Rhode Island Ave., NW,
Washington, D.C. 20005 - 202-462-6272

Polyurethane Manufacturers Assn. - 600 S. Michigan Ave., Chicago, IL 60505
312-427-2487

Rubber Manufacturers Assn. - 1901 Pennsylvania Ave., NW, Washington,
D.C. 20006 - 202-785-2602

Single Service Institute - 250 Park Ave., New York, NY 10017 - 212-697-4545

Society of Plastics Engineers - 14 Fairfield Dr., Brookfield, CT 06805
203-775-0471

Society of the Plastics Industry, Inc. - 355 Lexington Ave., New York, NY 10017
212-573-9400

Society of the Plastics Industry - Canada - 1262 Don Mills Road, Don Mills, Ontario M3B2W7 - 416-449-3444

Synthetic Organic Chemical Manufacturers Assn. - 1075 Central Park Ave., Scarsdale, NY 10583 - 914-725-1492

PARTIAL LIST FOR EQUIPMENT AND SUPPLIES

AIN Plastics Inc.
160 Macquesten Parkway So.
Mt. Vernon, NY 10550

Allied Chemical Corporation
Specialty Chemical Division
P.O. Box 1057R
Morristown, NJ 07960

ALMAC Plastics
8 Thompson Road
E. Windsor, CT 06088

Besseler Corporation
8 Fernwood Road
Florham Park, NJ 07932

Broadhead-Garrett Co.
4560 East 71st Street
Cleveland, OH 44105

Cadilac Plastic and Chemical Co.
P.O. Box 810
Detroit, Mich. 48232

Clamco Corporation
11350 Brookpark Road
Cleveland, Ohio 44130

Cope Plastics, Inc.
4441 Industrial Drive
Godfrey, IL 62035

Delvies Plastics Inc.
2320 South West Temple
P.O. Box 1415
Salt Lake City, Utah 84110

Errich International Corp.
Errich Packaging Machine Div.
721 Broadway
New York, NY 10003

Graves-Humphreys, Inc.
P.O. Box 13407
1948 Franklin Road
Roanoke, Virginia 24033

Industrial Arts Supply Co.
5724 West 36th Street
Minneapolis, Minn. 55416

Industrial Plastics and Supply
574 New Park Ave.
W. Hartford, CT 06110

McKilligan Industrial Co.
494 Chenago Street
Binghamton, NY 13901

Paxton/Patterson
5719 West 65th Street
Chicago, IL 60638

Plastic Manufacturers, Inc.
4041 Ridge Ave.
Philadelphia, PA 19129

Weldotron Corporation
1532 S. Washington Ave.
Piscataway, NJ 08854

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