A Compilation of Tasks for Competency-based Instruction in Fiberglass Technology for Industrial Arts Education

James Roy White
Old Dominion University

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A COMPILATION OF TASKS FOR COMPETENCY-BASED INSTRUCTION IN FIBERGLASS TECHNOLOGY FOR INDUSTRIAL ARTS EDUCATION

A Research Project
Presented to
the Faculty of the Graduate School
Old Dominion University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education

by
James Roy White
April 1979
This research paper was presented by James Roy White under the direction of the researcher's advisor in Education 536, Problems in Education. It was submitted as partial fulfillment of the requirements for the degree of Master of Science in Education.

Date: April 30, 1979

John M. Boy
Graduate Program Director

Approved by: David I. Joyner
Graduate Advisor
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CHAPTER I

INTRODUCTION

Providing the type of instruction necessary for the youth of today to be able to cope with a rapidly changing technology has become the responsibility of our modern educational systems. Basic manipulative skills previously taught at home by parents are no longer adequate to prepare children to cope with our rapidly changing society. Educators are now challenged with the ultimate objective of complete preparation of life.

Today, in all sections of the country, school administrators are meeting the need for well-rounded education by making industrial arts an important subject at all grade levels. If students are to receive an education that will be satisfying to them in their future living, educators must supply those subjects that will lend themselves to the all-round growth of the individual.

According to Newkirk and Johnson (1948) industrial arts includes a study of the fundamental manufacturing processes, the conditions under which these processes function, and the efficient selection, care, use, and enjoyment of the resulting products. A committee, appointed by the Commissioner of Education, U.S. Department of the Interior, Office of Education, in its report,
"Industrial Arts - Its Interpretation in American Schools," defined industrial arts in this manner.

"Industrial Arts is a phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contributions of those engaged in industry. The learning comes through the pupil's experiences with tools and materials and through his study of resultant conditions of life."

A student should understand his modern industrial environment and the direct bearing it has on his economic, social, and cultural life. Experiences taken from modern industry are being used to excellent advantage in the school shop or laboratory for educational purposes.

As the industrial arts researcher surveys the ever-changing world of technology for relevant concepts and techniques that need to be understood and mastered by today's students, parents and industry are crying out for an educational system that can realistically measure the students learning at the completion of a course or body of instruction.

Competency-based instruction, according to Ritz and Joyner (1978) is an educational system based upon the identification and attainment of prespecified outcomes. To be competent implies that the student will be well qualified within a particular content area of study.

The General Assembly in Virginia has approved legislation which require the local school divisions to establish
minimum competencies for all their students. The Vocational Education Amendments in 1976, P.L.94-482 emphasizes the importance of competencies being developed for all vocational and industrial arts areas.

**Purpose of the Study**

The purpose of this study is to identify the tasks needed to produce a fiberglass product from a preconstructed mold and list these tasks in a form that can be measured in behavioral terms.

**Significance of the Study**

What is fiberglass (fiberglass reinforced plastic-FRP)? According to Owens/Corning (1976) it is a boat hull, storage tank for a quarter of a million gallons of liquid, an automobile front end, or a room air conditioner. It's the gears and pinions in a clock, a fishing rod, an aircraft radome, a bathroom shower, or over 35,000 more engineered products of all kinds.

FRP has come of age as a family of basic engineering materials. With proven technology to support new developments, and a spectrum of production methods at their disposal, design engineers in every area of industry are turning to FRP.

It offers combinations of properties not found in any other material: high strength and dimensional stability with low weight, corrosion resistance and excellent
dielectric properties, opportunities for parts consolidation and design flexibility, low finishing cost, and moderate tooling cost.

Add to these basic benefits the relatively stable economics of FRP as compared to upward cost trends in metals. Sophisticated automated molding processes are now available to deliver parts at high production rates with low labor costs. One can clearly see why there is a growing level of confidence and a surging market in FRP.

Fiberglass technology has reached a level of sophistication and acceptance in industry warrenting its inclusion in the industrial arts curriculum.

FRP could easily be incorporated in a personal enrichment or pretechnical course on the high school level or under the area of orientation and exploration in junior high school. See Table 1

The techniques of fiberglassing could also be combined with existing traditional areas such as woodworking, metalworking as a modern finishing technique.

It is the desire of the research to provide competency based instruction in fiberglass technology that can be utilized in any existing or new compatible industrial arts course.
# The Industrial Arts Curriculum

<table>
<thead>
<tr>
<th>Level</th>
<th>Goal</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>Personal Enrichment</td>
<td>Mechanical Drawing, Electricity/Electronics, Graphic Arts, General Industrial Arts, Industrial Crafts, Metalworking, Woodworking, Power Mechanics</td>
</tr>
<tr>
<td></td>
<td>Pretechnical</td>
<td>Communications Technology, Power and Transportation Technology, Materials and Processes Technology</td>
</tr>
<tr>
<td>Middle or Junior High School</td>
<td>Orientation and Exploration</td>
<td>World of Manufacturing, World of Construction, Modern Industry and Technology, Exploring Technology</td>
</tr>
<tr>
<td>Elementary School</td>
<td>Learning Reinforcement</td>
<td>Industrial Arts activities integrated within the elementary curriculum</td>
</tr>
</tbody>
</table>
Limitations of the Study

The researcher used the task validation method established by Ritz and Joyner (1978). An advisory committee composed of eight members filled out a survey form designed to measure the suitability of the tasks. A vote of at least five positive responses validated a task as an important measure for attaining competency. Five negative votes invalidated the task and caused its removal.

Uncertain statements, those tasks that didn't receive enough positive or negative votes to be included or removed were not decided upon by dialogue as recommended.

Definitions

The writer chose to use Petrick's (1976) Beginner's Glossary for Polyester and Fiberglass in complete form.

General:

LAY-UP. A technique of molding the reinforcement (glass) and liquid plastic in a mold to produce an item. Also referred to as a laminate.

MIL. A measurement equal to one-thousandth of one inch. Generally used to measure the diameter of glass filaments or the thickness of an applied coating.

REINFORCED PLASTIC. A combination of plastic and reinforcement filaments to produce optimum strength—generally, but not limited to fiberglass and polyester resins.
REINFORCEMENT. Generally fiberglass filaments in either woven or matt form to provide high tensile strength when combined with plastics. Other materials such as asbestos, nylon, and sisal are also used.

THERMOPLASTIC. A solid material which liquefied by the application of heat and rehardens at room temperatures. Generally can be softened or formed by the application of mild heat.

THERMOSETTING PLASTIC. A liquid plastic that cures (or hardens) with the application of heat—either direct or through chemical reaction. Cannot be reliquefied.

Reinforcement:

BINDER. Generally used to hold fiberglass matt together in a compressed state similar to felt, for dry handling purposes. The binder is usually dissolved by the subsequent application of resin to allow it to configure to the mold surface during the molding process.

CHOPPED STRAND. Continuous glass roving chopped into uniform lengths, usually from 1/4" to 3" long. Lengths under 1/8" are called milled fibers.

CONTINUOUS FILAMENT STRAND. A single filament of glass with a small diameter.

END. A strand of roving consisting of a given number of filaments.

FIBERGLAS. Fibers made from glass; glass fiber forms include cloth, yarn, matt, milled fibers, chopped strands, roving, woven roving.
FILAMENT. A single thread of fiberglass in continuous form.

FINISHES. On woven fiberglass fabrics, various types of finishes (such as chrome and Volan) are available to promote better penetration of the resin into the cloth. These finishes cause the cloth to be shiny in appearance. Dull finished cloth should be avoided as it is inferior for "wetting out" purposes.

GLASS CONTENT. The amount of fiberglass, by weight, in proportion to the amount of resin in the finished piece. Example: A finished piece weighing 100 lbs., contains 40 lbs. of glass reinforcement and 60 lbs. of resin, has a glass content of 40%.

MATT. Randomly distributed strands of chopped fibers pressed together in felt form and held together by a binder.

ROVING (FILAMENT WINDING). Bundles of continuous filaments either as untwisted strands or as twisted yarns.

SPRAY UP. A method used to produce fiberglass reinforced items by simultaneously spraying chopped roving and resins onto the mold surface. The wetted fibers are then rolled into a compressed state and allowed to cure without external pressure. Laminates of 25-35% glass are produced resulting in weaker parts in comparison to woven fibers or roving laminates.

WOVEN CLOTH. A cloth woven from fiberglass filaments.
It is used where high strength is important and good drape is required.

WOVEN ROVING FABRIC. Heavy fabric woven from continuous strands of roving. It has good drape, wets out readily, is intermediately priced, and offers excellent tensile strength.

Plastic Resins:

ACETONE. One of the most efficient solvents used for tool and hand cleaning. It should not (contrary to some practices) be used to thin polyester because entrapment of this material within the cured polyester would degrade the general characteristics of the cured piece. It has a very low flash point and is extremely flammable.

AIR INHIBITION (sometimes SURFACE INHIBITION). A resin that cures throughout its thickness except for the uppermost surface which is exposed to air. During curing, the air in contact with this surface retards the surface cure causing the uppermost surface to remain "tacky." This permits a true molecular bond to take place between this surface and subsequent applications of polyester. Surface-inhibited resins cannot be readily sanded as they would clog the sandpaper.

BACK-UP COAT. A dark pigmented gel coat applied over the white gel coat to provide contrast so that air bubbles can be seen readily when making the fiberglass lay-up.
CABOSIL. An ultra lightweight filler commonly used to make a liquid plastic thixotropic. Generally added in proportions of 1% to 3% (by weight).

CATALYST (also called HARDENER). A peroxide material, usually a clear liquid, which is added to the promoted resin in small quantities (usually 1% by weight—roughly 1/2 oz. or 10cc. per qt. of resin) to effect a cure.

CHEMICAL INHIBITOR. A substance which slows down or prevents the polyester from curing. Oil, water, wood resin, and paint thinners are typical inhibitors which would retard or prevent the cure of general purpose polyesters.

CRAZING. Cracking generally due to excessive exotherm being developed in the piece while curing.

CURE TIME. The time it takes for the lay-up to achieve a hard cure suitable for removing the piece from the mold and for permitting subsequent handling.

EPOXY RESINS. Also liquid thermosetting plastics noted for their greater tensile strength and adhesion to nonporous substrates. They are considerably more expensive than polyesters and are consequently limited in boat use, where the lower priced polyesters do a satisfactory job. They are also generally more difficult to work with from a toxicity and curing standpoint.
EXOTHERM. The internal heat generated within the resin due to polymerization.

FILLERS. Powdered materials such as clays, talc, mica, marble dust, etc., which are mixed with the liquid polyesters to extend their bulk and thicken the material. Various filler compounds are used to produce seam fillers, auto body patching compounds, dent and nick fillers, casting compounds, etc.

GEL COAT. A semi-thixotropic, air-inhibited, usually pigmented resin which is applied to the mold surface (after parting agent) upon which the subsequent fiberglass lay-up is made. When the piece is removed from the mold, the gel coat represents the final outside finish of the article.

GEL TIME. The time it takes for the polyester to leave its liquid state and achieve a gelatinous consistency.

HIGH TEMPERATURE SURFACE INHIBITION. This occurs when surfacing resins are applied to hot surfaces (over 100°F.). Such high temperatures cause the surfacing additive to melt, rendering it ineffective and causing a tacky surface to exist in the presence of air. This does not affect the under-cure, but only the uppermost surface. Surfacing resins should be applied in the shade.

LAY-UP RESIN. A slightly thixotropic clear promoted resin designed for good fiberglass saturation. It is generally air-inhibited to permit a molecular bond to exist between coats, even if the resin cures between coats.
PIGMENTS. Pastes made from combining powdered color pigments with a liquid vehicle. The pigments themselves can be either organic or inorganic, with the inorganic pigments exhibiting superior light stability and permanence. Organic pigments have a tendency to fade and deteriorate in the sunlight. Only sufficient pigment should be added to the resin to accomplish opacity, as overpigmentation could cause total inhibition due to a superfluous amount of the vehicle involved.

POLYESTER RESINS. Liquid thermosetting plastics which cure into a solid mass by the application of physical heat and/or chemical heat. They are noted for their excellent penetration qualities, weathering resistance, and general chemical resistance. They are used primarily in conjunction with fiberglass reinforcement to manufacture such items as boat hulls, auto bodies, etc.

POLYMERIZATION. A process where the molecules of the resin cross-link to change from a liquid to a solid.

POST CURE. The time it takes for the piece to achieve its ultimate hardness and chemical resistance; usually two weeks at room temperature, although this time can be greatly reduced by the application of heat.

POT LIFE. The working time of a resin (while it is still liquid) after the catalyst has been added.

PREACCELERATED (also PREPROMOTED). Used to describe a polyester which has had the accelerator added by the manufacturer or processor.
PROMOTER. Also called accelerator. Usually a liquid metal compound added to the polyester in small quantities to react with the subsequently added catalyst causing a "chemical heat" to be generated, thereby causing the polyester to cure into a solid mass. The promoter can be added to the resin by the manufacturer and will not affect the shelf life of the resin. The most common type is a cobalt which is deep purple in color, and is generally added to the resin at a proportion of 1/2 of one percent by weight. Cobalts are available in various strength compounds for extremely fast cures.

STYRENE. One of the more common monomers used to thin (reduce the viscosity) of polyesters. This water-thin clear liquid is also 100% solids and cross-links with the polyester during curing, thereby maintaining the 100% solids integrity of the polyester resin.

SURFACE COATING RESINS (sometimes referred to as SURFACING GEL COATS or NON-AIR-INHIBITED RESINS). Resins which have a waxy additive which, when the resin is applied, prevents the air from inhibiting the uppermost surface. Such resins cure "tack-free" and can be readily sanded without clogging the sandpaper. They must be sanded to break the surface to insure a molecular bond if they are to be recoated.
SURFACING ADDITIVE. A clear liquid containing the waxy additives which are mixed with the liquid polyesters in small quantities (usually 1% by weight) to prevent air inhibition. Materials and mixing temperatures should exceed 70°F.

THIXOTROPIC. A resin which has been modified with ultra lightweight fillers to prevent running or sagging on vertical or inclined surfaces. Can be compared to whipped cream, which is a relative solid when not in motion and a relative fluid when in motion.

TOTAL INHIBITION. A resin which will not cure, or which achieves only a partial cure throughout its entire thickness due to improper mixing, low temperatures, or chemical contaminants.

TRIM TIME. The time it takes for the lay-up to achieve a rubbery consistency, which permits knife-trimming the excess material from the mold edges.

VISCOSITY. The term used to describe the thickness (flow rate) of a liquid. Can be compared to viscosities used in motor oils such as "high" ("STP"—about 80), versus "low" (#10 motor oil).

100% SOLIDS. A term applied to plastics indicating that they contain no evaporative solvents, as such, and will cure in thin films or mass without the evaporation of solvents. (Paints dry by the evaporation of solvents.)
15° RULE. For each 15°F. rise in temperature over the normal (considered at 75°F.) the pot life and cure time will be halved. Conversely for each 15° decrease in temperature, the pot life and cure time will be doubled. Ambient, materials, and surface temperatures must be taken into consideration.

Lay-up Terminology:

MOLD. This is the piece into which the fiberglass and polyester is laid up to produce the finished product. The mold is usually made of fiberglass and polyester and should have a perfect interior finish, as any flaw will be reproduced in all subsequent pieces.

MOLD RELEASE (sometimes called PARTING AGENT). A material applied to the mold surface to prevent sticking of the piece. It can be a paste type wax or a liquid release agent. On new molds a combination of the two can be used to insure good release.

PLUG. A model of the piece to be produced. Usually made of wood, wood and fiberglass, plaster, etc. It is from this plug that the fiberglass mold is made.

PRUNE SKINNING. An undesirable texture found in the gel coat after the piece is removed from the mold. It is generally due to the gel coat being applied too thin, or otherwise totally inhibited. The subsequent lay-up resins will swell the gel coat and cause it to prematurely release from the mold while the lay-up resin is still in liquid form.
UNDERCUT. Female depressions in the mold. Split molds are necessary when undercuts are present in order to remove the piece with its projections from the mold.
CHAPTER II

REVIEW OF THE LITERATURE

Introduction

It is the purpose of this chapter to review the literature that reflects the state of the art techniques used in the fiberglass industry. Many books and articles have been written on the subject but, certain common procedures and standards are clearly evident in all publications and must be meticulously followed to insure proper chemical reactions. The research done by the Owens-Corning Laboratories often times is the guide for many current publications.

General

Fiberglass is available in many different forms, but for the purpose of classroom projects we will concentrate on only three: fiberglass cloth, fiberglass matt, and fiberglass woven roving. The fiberglass content in a laminate determines the tensile strength of the laminate. For example, a laminate with a 50% fiberglass and 50% resin content by weight will be much stronger than a laminate consisting of 25% fiberglass and 75% resin. Fiberglass reinforcement acts similarly to tie rods in concrete. Without the fiberglass, the resin would be very brittle and have a tendency to crack or rupture.
Fiberglass cloth is a woven fabric made from twisted fiberglass filaments. Technically it usually weighs 10 oz. per sq. yd. and it has 16 strands per inch. When used with polyesters, it produces the strongest laminates—generally having a 45-50% glass to resin ratio.

Fiberglass fabric, unlike most other woven materials, has a slip weave which allows the 90 degree threads to slip or slide over one another. This capability allows the fiberglass fabric to be formed around compound curves without cutting.

Woven roving is generally made from 60 filament end continuous roving weighing 24 oz. per sq. yd. It is much thicker than boat cloth and therefore produces a thicker ply of laminate. With a 45% glass to resin ratio, very little strength is sacrificed. It is almost always used as an alternate layer with matt to yield the best adhesion and combination tensile strength and stiffness. In repair work, if woven roving is to be used, it is always best to begin and end with matt, with woven roving between each layer of matt.
Fiberglass matt is made from chopped strands of fiberglass filaments pre-set into a matt form and held together with a resin soluble binder. It is available in various thicknesses, generally ranging from $3/4$ oz. to $3$ oz. per sq. ft. One and two ounce are the most common and readily available. Matt yields the weakest laminate with a ratio of $25-35\%$ glass per resin. It does however, produce the stiffest laminate with a greater degree of bonding strength due to its nondirectional woven pattern. It is general practice to use alternate layers of matt and woven roving as this combination assures excellent interlaminate bond, sufficient stiffness, and sufficient tensile strength.

Polyester resins come in many different formulations. Four types which the author felt lend themselves to the industrial arts classroom projects are: air inhibited clear lay-up resin, clear non-air-inhibited coating resin, pigmented gel coat, and polyester putty.

Air inhibited resin means that when the resin cures the uppermost surface only remains tacky when exposed to air. This is an excellent quality when applying a laminate to previously cured coats. It is the only way to achieve a true molecular bond.

Non-air-inhibited resin, is also known as surfacing resin and is most readily available. It contains a waxy additive which floats to the surface when applied and
allows the laminate to dry to a hard tack-free sandable surface. When using a tack-free resin, it must be thoroughly sanded to assure a good intercoat bond if another coat is to be applied over it.

Pigmented gel coat is the finished coat that contains the color and gives the product a smooth glossy protective coat. It is applied first when using a female mold prior to the glass laminate, or last if a male mold is utilized. Gel coats should always be used as the final layer of construction—to avoid the unsuitable wicking action of the fiberglass strands. Gel coats are thixotropic in nature and are ideally applied by spraying with an externally mixing gun.

Polyester putty is simply a polyester resin to which fillers such as clay or talc are added to convert the liquid into a putty consistency. This putty can then be troweled or knifed into a void and will remain until cured.

Methyl ethyl ketone peroxide (MEK) is the catalyst used with polyester resin which causes it to change from a liquid to a solid. The catalyst is usually packaged in 1/2 oz. bottles which contain 10 cc. This quantity is sufficient to catalyze one quart of resin. Catalyst can be added in varying amounts from 1/2-5% to expedite the gel time (pot life). Table 2 is a table of small quantities and the catalyst necessary for a 1% mixture.
<table>
<thead>
<tr>
<th>POLYESTER RESIN</th>
<th>CATALYST FOR 1% SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tsp.</td>
<td>2 drops</td>
</tr>
<tr>
<td>1 Tbsp.</td>
<td>4 drops</td>
</tr>
<tr>
<td>1/2 pt. (8 oz.)</td>
<td>1/12 oz. or 2 1/2 cc. (100 drops)</td>
</tr>
<tr>
<td>1 pt. (16 oz.)</td>
<td>1/6 oz. or 5 cc. (200 drops)</td>
</tr>
<tr>
<td>1 qt. (32 oz.)</td>
<td>1/3 oz. or 10 cc. (400 drops)</td>
</tr>
</tbody>
</table>
When polyesters cure they undergo a gradual change from liquid to solid. Table 3 gives a general guide for elapsed time and stage of cure.

Temperature has a tremendous effect on the curing rate of polyesters. The average working temperature is about 75°F. There is a "Fifteen Degree Rule" according to Petrick (1976) that simply states that for each 15 degree increase in temperature over 75°F the pot life and cure rate is halved; and for each 15 degrees less in temperature, the pot life and cure rate is doubled. For example, if a typical polyester resin has a pot life of 30 minutes with 1% catalyst, then it will have a 15 minute pot life at 90°F, and a 7 1/2 minute pot life at 105°F.

Safety Precautions

Much of the following information has been prepared by the National Institute for Occupational Safety and Health (NIOSH) to provide safe working conditions for workers using polyester and epoxy resins. It should be noted that even though the author recommends the use of polyester resins in the basic project, epoxy resin may be substituted if desired. Epoxy has a more severe irritating effect on the skin and contact should be avoided. The following general rules should be observed:

1. Ventilate the room well.

2. Avoid contact with the skin.
Table 3.

<table>
<thead>
<tr>
<th>STAGE OF CURE</th>
<th>TIME ELAPSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot life with 1% catalyst (liquid state)</td>
<td>0-30 minutes</td>
</tr>
<tr>
<td>&quot;Rubber cement&quot; consistency (starting to gel)</td>
<td>31-32 minutes</td>
</tr>
<tr>
<td>&quot;Cheese&quot; consistency (trimming time)</td>
<td>33-40 minutes</td>
</tr>
<tr>
<td>&quot;Hard Rubber&quot; (time to start sanding)</td>
<td>41-59 minutes</td>
</tr>
<tr>
<td>Hard (hard enough to use)</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Final post use (ultimate hardness)</td>
<td>2 weeks</td>
</tr>
</tbody>
</table>
3. Ground large containers and avoid sparks and flames.

4. Wear protective clothing (respirator, safety glasses, gloves, coveralls, shoes & socks).

5. Use disposable containers for mixing solutions.

6. Never mix organic peroxides with promoters or accelerators.

7. Read manufacturers recommendations before use.

8. Clean all equipment with proper solvent before resin has set-up.

9. Store all products in manufacturers containers.

10. Clean containers and destroy after use.

11. Store organic peroxide apart from all other chemicals.

12. Destroy, do not discard, waste, spilled or outdated peroxides.

13. Soak up spilled peroxides with sand, clay, perlite, or vermiculite and then wet with water and sweep up with spark proof tools. Place wet waste in double polythene bags and dispose of immediately by slowly burning or slowly adding to 5% caustic solutions.

14. Change your clothing daily.

15. Use waterless handcleaners to remove resin from your skin, followed by soap and water washup.


17. Don't wear rings and watches on the job.

18. Always shower after working with resins.

19. Never eat or smoke where chemicals are used or stored.

20. Use the proper type of protective skin cream.

21. Use immediate water flush for skin or eye contact.
22. Always get medical aid if the skin is damaged or remains red, if you feel like vomiting, or have balance, vision or breathing problems.

**Recommended Supplies**

1. Fiberglass cloth, matt, woven roving

2. Abrasive paper in sheet and disc form.
   - 36 grit (open)
   - 80 grit
   - 150 grit
   - 240 grit wet-or-dry
   - 400 grit wet-or-dry
   - 600 grit wet-or-dry

3. Rubbing compound

4. Paste wax

5. Masking tape

6. Saran wrap (clear plastic food wrapping paper)

7. Small paper mixing cups

8. Stirring sticks

9. Eye dropper

10. Dust mask

11. Goggles

12. Inexpensive paint brush

13. Paper towels

**Recommended Tools**

1. Variable speed disc sander with flexible head

2. Saber saw with metal cutting blades

3. Variable speed electric drill

4. Lamb's wool buffing pad

5. Abrasive grinding burrs
6. Sanding block
7. Putty knife
8. Vibrator sander
9. Utility knife
10. Scissors
CHAPTER III

RESEARCH METHODS

There are ten basic elements common to a project oriented industrial arts course: 1) Introduction, 2) Safety, 3) Technology, 4) Tools, 5) Materials, 6) Working drawings, 7) Plan of procedure, 8) Quality control, 9) Industrial applications, and 10) Suggestions for further study.

Using these areas as a guide, information was compiled from existing texts, periodicals, technical bulletins, and direct contact with industrial representatives. Current FRP projects were evaluated and rewritten to reflect the state of the art technology.

This data was then reviewed by the author and basic tasks necessary to understand and build a FRP project were written and rated by industry using a task validation survey.

The validated information was then used to write competency-based material in the area of FRP for Industrial Arts.
CHAPTER IV
TASKS
TASK # 1

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Demonstrate proper lay-up techniques

CRITERION REFERENCED MEASURE: Construct a laminate on the mold provided by the instructor.

PERFORMANCE GUIDES:

1. Brush on gel coat .020" to .035" thick and allow to cure.
2. Sand cured resin lightly with 6/0 paper
3. Brush on resin (Do not let cure)
4. Wet out a piece of fiberglass matt.
5. Lay matt on wet mold.
7. Apply additional layers as instructed.
TASK # 2

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Quality Control

TASK: Measure fiberglass laminate in mils

CRITERION REFERENCED MEASURE: Measure the thickness of fiberglass laminates provided by the instructor.

PERFORMANCE GUIDES:

1. Obtain several laminates from the instructor.
2. Measure the thickness of the laminate with an Owens/Corning thickness gauge.
3. Record the laminate thickness in mils.
TASK # 3

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Define reinforced plastic

CRITERION REFERENCED MEASURE: Indicate your understanding of the term reinforced plastics.

PERFORMANCE GUIDES:

1. Read the definition of reinforced plastics in the glossary.
2. View an instructional film on FRP.
3. Write a definition of reinforced plastic.
TASK # 4

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Explain the properties of a thermoplastic

CRITERION REFERENCED MEASURE: Demonstrate your knowledge of the term thermoplastic.

PERFORMANCE GUIDES:

1. Read the definition of thermoplastic in the glossary.
2. View an instructional film on FRP.
3. Write the definition of thermoplastic.
4. List three thermoplastic items.
TASK # 5

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Explain the properties of a thermosetting plastic

CRITERION REFERENCED MEASURE: Demonstrate your knowledge of the term thermosetting plastic.

PERFORMANCE GUIDES:

1. Read the definition of thermosetting plastic in the glossary.
2. View an instructional film on FRP.
3. Write the definition of thermosetting plastic.
4. List three thermosetting plastic items.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Recall the properties of chopped strand

CRITERION REFERENCED MEASURE: Identify chopped strand lay-up on a laminate provided by the instructor.

PERFORMANCE GUIDES:

1. View a film on chopper gun method of lay-up.
2. Identify chopped strand from a variety of laminates.
3. Identify trace strands.
4. Check with instructor for proper consistency.
TASK # 7

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Material

TASK: List seven forms of fiberglass provided by the instructor

CRITERION REFERENCED MEASURE: Identify seven forms of fiberglass provided by the instructor.

PERFORMANCE GUIDES:

1. View a film on FRP.
2. Study samples of fiberglass.
3. Read the description of cloth, yarn, matt, milled fibers, chopped strands, roving, woven roving.
4. Label the fiberglass samples.
TASK # 8

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Material

TASK: Recognize fiberglass fabric finishes

CRITERION REFERENCED MEASURE: Select Volan fiberglass fabric provided by the instructor.

PERFORMANCE GUIDES:

1. View the two types of fabric.
2. Note which fabrics are shiny and dull.
3. Read the description of Volan.
TASK # 9

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Quality Control

TASK: Compute the glass content of a laminate

CRITERION REFERENCED MEASURE: Compute and evaluate the glass content of the laminate you are constructing.

PERFORMANCE GUIDES:

1. Weigh the fiberglass to be used in the laminate.
2. Wet out the fiberglass.
3. Construct laminate and let cure.
4. Weigh the laminate.
5. Subtract answer # 1 from answer # 4.
6. Determine the glass/resin ratio.
7. Determine if this is a satisfactory ratio.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Material

TASK: Compare the properties of matt, roving, and cloth

CRITERION REFERENCED MEASURE: Recall the unique qualities of fiberglass matt, roving, and cloth.

PERFORMANCE GUIDES:

1. Read the technical description.
2. View a film on FRP.
3. List one distinct advantage each has over the other.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Material

TASK: Identify acetone, styrene, polyester resin, methyl ethyl keytone peroxide

CRITERION REFERENCED MEASURE: Identify chemicals provided by the instructor visually and aromatically.

PERFORMANCE GUIDES:

1. Practice identifying chemicals by visual and aromatic inspection.

2. Attempt to label chemicals provided by instructor.
TASK # 12

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Safety

TASK: Store chemicals properly

CRITERION REFERENCED MEASURE: Store acetone, peroxide, resin, styrene properly.

PERFORMANCE GUIDES:
1. Read the manufacturer's guide for storage of each chemical.
2. Locate the storage area with the instructor.
3. Store the chemicals.
TASK # 13

AREA OF COMPETENCE:  Fiberglass Technology

CONTENT/CONCEPT:  Safety

TASK:  Destroy chemicals

CRITERION REFERENCED MEASURE:  Destroy left over and old chemicals with the aid of the instructor.

PERFORMANCE GUIDES:

1. Read the destruction guides for all stored chemicals provided by the manufacturer.
2. Locate an appropriate destruction site.
3. List safety precautions to be observed in destruction.
4. Destroy materials with aid of instructor.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Mix catalyst correctly

CRITERION REFERENCED MEASURE: Mix a 1% solution of polyester resin provided by the instructor.

PERFORMANCE GUIDES:

1. Read Table 2.

2. Determine the proper amount of catalyst needed for 1 qt. of resin.

3. Mix the catalyst and resin.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Understand the effect of temperature on cure time.

CRITERION REFERENCED MEASURE: Mix prescribed amounts of catalyst and resin, provided by the instructor, to determine the effect of temperature on cure time.

PERFORMANCE GUIDES:

1. Mix a 1% solution at 55°F.
2. Record the cure time.
3. Mix a 1% solution at 70°F.
4. Record the cure time.
5. Mix a 1% solution at 85°F.
6. Record the cure time.
7. Write the 15° rule.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Understand the use of chemical inhibitors

CRITERION REFERENCED MEASURE: Know the uses of chemical inhibitors provided by the instructor.

PERFORMANCE GUIDES:
1. Read the definition of chemical inhibitors.
2. View an instructional film on FRP.
3. List the primary use of chemical inhibitors.
TASK #17

AREA OF COMPETENCE:  Fiberglass Technology

CONTENT/CONCEPT:  Quality Control

TASK:  Troubleshoot crazing

CRITERION REFERENCED MEASURE:  Identify crazing on several fiberglass products provided by the instructor and remedy.

PERFORMANCE GUIDES:

1. View a film on FRP.
2. Circle crazed areas on the products.
3. Determine superstructural deficiencies.
4. Repair superstructure.
5. Sand off gel coat.
7. Sand and buff.
TASK # 18

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Know characteristics of epoxy resin

CRITERION REFERENCED MEASURE: Compare qualities of polyester and epoxy resin.

PERFORMANCE GUIDES:

1. Read technical bulletins on each resin.
2. Write a comparison of the resins.
TASK # 19

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Understand the term exotherm

CRITERION REFERENCED MEASURE: Recall the effect of heat during curing.

PERFORMANCE GUIDES:
1. Define exotherm.
2. View a film on FRP.
3. List two adverse effects excessive heat has on the laminate.
TASK # 20

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Display a working knowledge of fillers

CRITERION REFERENCED MEASURE: Repair a void in a laminate provided by the instructor.

PERFORMANCE GUIDES:

1. Grind the void.
2. Mix the filler with resin to proper consistency.
3. Apply the filler.
4. Sand and buff.
TASK # 21

AREA OF COMPETENCE:  Fiberglass Technology

CONTENT/CONCEPT:  General

TASK:  Define gel coat

CRITERION REFERENCED MEASURE:  Recall the properties of gel coat.

PERFORMANCE GUIDES:

1. Read the definition of gel coat in the glossary.
2. View a film on FRP.
3. Write the definition of gel coat.
4. List three reasons to use gel coat.
TASK # 22

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Lay-up

TASK: Mix pigment

CRITERION REFERENCED MEASURE: Mix pigment to match an existing color provided by the instructor.

PERFORMANCE GUIDES:

1. Choose a pigment that most nearly matches the existing color.

2. Using a mixing chart, change the basic pigment color to match the desired color.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Define preaccelerated

CRITERION REFERENCED MEASURE: Explain the meaning of preaccelerated.

PERFORMANCE GUIDES:

1. Read the definition of preaccelerated in the glossary.
2. Write a definition of preaccelerated.
3. Describe a technique for checking your resin for a preaccelerator.
TASK # 24

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Define styrene

CRITERION REFERENCED MEASURE: Recall the properties of styrene.

PERFORMANCE GUIDES:

1. Read the definition of styrene in the glossary.
2. Read the styrene container label.
3. Write the uses and properties of styrene.
TASK # 25

AREA OF COMPETENCE:  Fiberglass Technology

CONTENT/CONCEPT:  General

TASK:  Know the qualities of air-inhibited and non-air-inhibited resins.

CRITERION REFERENCED MEASURE:  Compare and contrast the properties of air-inhibited and non-air-inhibited resins.

PERFORMANCE GUIDES:

1. Read the definitions of the resins in the glossary.

2. Write a comparison of the properties of the resins.

3. List the type used for surface coating.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Quality Control

TASK: Understand total inhibition

CRITERION REFERENCED MEASURE: Troubleshoot various laminates, provided by the instructor, for total inhibition.

PERFORMANCE GUIDES:

1. Read the definition for total inhibition in the glossary.
2. Write three causes for total inhibition.
3. Identify the totally inhibited laminate.
TASK # 27

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Define viscosity

CRITERION REFERENCED MEASURE: Understand the properties of viscosity.

PERFORMANCE GUIDES:

1. Read the definition of viscosity in the glossary.
2. Write the definition of viscosity.
3. List three products that have listed viscosities.
TASK # 28

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Quality Control

TASK: Identify prune skinning

CRITERION REFERENCED MEASURE: Choose the laminate provided by the instructor that illustrates prune skinning.

PERFORMANCE GUIDES:

1. Read the definition of prune skinning in the glossary.
2. View a film on FRP.
3. Choose the laminate that reflects prune skinning.
4. Write a description of how prune skinning can be cured and avoided.
TASK # 29

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Quality Control

TASK: Identify oil canning

CRITERION REFERENCED MEASURE: Choose the laminate provided by the instructor that illustrates oil canning.

PERFORMANCE GUIDES:

1. Read the definition of oil canning in the glossary.
2. View a film on FRP.
3. Choose the laminate that reflects oil canning.
4. Write a description of how oil canning can be cured and avoided.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Explain undercuts

CRITERION REFERENCED MEASURE: Show the relationship between undercuts and female molds.

PERFORMANCE GUIDES:

1. Read the definition of undercuts and female molds in the glossary.

2. View a film on FRP.

3. Write the relationship between undercuts and female molds.

4. List two products that would be best made with female molds.
TASK # 31

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Tools

TASK: Recognize various grades of abrasive paper

CRITERION REFERENCED MEASURE: Select various grades of abrasive paper provided by the instructor.

PERFORMANCE GUIDES:

1. Review the grading system for abrasive paper in the text.
2. Observe the relationship of grit to grade.
3. Describe the grading system.
TASK # 32

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Safety

TASK: Use proper personal safety items

CRITERION REFERENCED MEASURE: Demonstrate the proper use of personal safety items.

PERFORMANCE GUIDES:

1. Fit a respirator correctly.
2. Wear safety goggles.
3. Wear protective cream.
4. Wear protective clothing.
5. Wear protective gloves.
AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Tools

TASK: Operate a variable speed disc sander

CRITERION REFERENCED MEASURE: Demonstrate the proper usage of a variable speed disc sander and accessories.

PERFORMANCE GUIDES:

1. Read the operator's manual.
2. Attach the proper grit abrasive paper.
3. Install the disc.
4. Sand a laminate with instructor supervising.
5. Install a buffing pad.
6. Apply buffing compound.
7. Buff a laminate with instructor supervising.
TASK # 34

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Tools

TASK: Operate a saber saw

CRITERION REFERENCED MEASURE: Demonstrate the proper usage of a saber saw and accessories.

PERFORMANCE GUIDES:

1. Read the operator's manual.
2. Select the proper blade.
3. Attach the blade.
4. Cut a laminate with the supervision of the instructor.
TASK # 35

AREA OF COMPETENCE:  Fiberglass Technology

CONTENT/CONCEPT:  Tools

TASK:  Operate a variable speed electric drill

CRITERION REFERENCED MEASURE:  Demonstrate the proper usage of a variable speed electric drill and accessories.

PERFORMANCE GUIDES:

1. Read the operator's manual.
2. Select the proper drill bit.
3. Drill a hole in a laminate with the supervision of the instructor.
TASK # 36

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Tools

TASK: Construct a sanding block

CRITERION REFERENCED MEASURE: Demonstrate the building and use of a sanding block.

PERFORMANCE GUIDES:

1. Cut a piece of wood 2 x 4 x 5.
2. Wrap the wood with abrasive paper.
3. Rub the block over the surface of the laminate.
4. Change the grade of abrasive paper to decrease the size of the scratches.
TASK # 37

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: Tools

TASK: Operate a vibrator sander correctly

CRITERION REFERENCED MEASURE: Demonstrate the proper use of a vibrator sander and accessories.

PERFORMANCE GUIDES:
1. Read the operator's manual.
2. Attach the proper abrasive paper.
3. Sand a laminate with the supervision of the instructor.
TASK # 38

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Determine the best type of mold

CRITERION REFERENCED MEASURE: Know four types of molds and their proper use.

PERFORMANCE GUIDES:

1. View a film on FRP.
2. Name four types of molds.
3. Write a list of two products made with each mold process.
TASK # 39

AREA OF COMPETENCE: Fiberglass Technology

CONTENT/CONCEPT: General

TASK: Outline assembly line jobs in the fiberglass industry

CRITERION REFERENCED MEASURE: Demonstrate a knowledge of the various factory jobs in the fiberglass industry.

PERFORMANCE GUIDES:

1. Read the text.
2. View a film on FRP.
3. Discuss ten jobs related to the fiberglass industry.
CHAPTER V

VALIDATION OF THE STUDY

Validation Survey of Fiberglass Technology Competencies

This study is aimed at validating competencies in the area of fiberglass technology needed by industrial arts students in the State of Virginia. Circle the one response which reflects your opinion of each statement. If you feel additional competencies are needed, please note them on the final page of the survey.

A-agree
U-uncertain
D-disagree

The Virginia Industrial Arts student will:

1. Demonstrate proper lay-up techniques. A
2. Measure fiberglass laminates in mils. A
3. Define reinforced plastic. A
4. Explain the properties of a thermoplastic. A
5. Explain the properties of a thermosetting plastic. A
6. Understand the function of a binder. A
7. Recall the properties and uses of chopped strand. A
8. Recall the properties and use of continuous filament strand. A
9. List 7 forms of fiberglass. A
10. Define filament. A
11. Recognize fiberglass fabric finishes. A
12. Compute the glass content. A
13. Quote a satisfactory glass content.
14. Fabricate a proper glass content laminate.
15. Define matt.
16. Critique the properties of matt.
17. Recognize matt.
18. Define roving.
19. Critique the properties of roving.
20. Recognize roving.
21. Describe spray-up.
22. Define woven cloth.
23. Critique the properties of woven cloth.
24. Recognize woven cloth.
28. Identify acetone visually and aromatically.
29. Mix acetone in proper proportions.
30. Store acetone properly.
31. Utilize proper destruction methods for acetone.
32. Recall safety regulations for acetone.
33. Comprehend air inhibition.
34. Understand the use of a back-up-coat.
35. Detect the need for cabosil.
36. Mix cabosil correctly.
37. Recognize a catalyst visually and aromatically.
38. Mix catalyst correctly.
AU D 39. Understand the effect of temperature on curing times.

AU D 40. Compute catalyst percentage to obtain various curing times.

AU D 41. Store catalysts correctly.

AU D 42. Utilize proper destruction techniques for catalysts.

AU D 43. Name a common catalyst.

AU D 44. Recall proper safety procedures for catalysts.

AU D 45. Recognize chemical inhibitors visually and aromatically.

AU D 46. Mix chemical inhibitors correctly.

AU D 47. Name three common chemical inhibitors.

AU D 48. Store chemical inhibitors properly.

AU D 49. Utilize proper destruction techniques for chemical inhibitors.

AU D 50. Recall proper safety procedures for chemical inhibitors.

AU D 51. Recognize crazing.

AU D 52. Troubleshoot crazing problems.

AU D 53. Redesign crazing problem areas.

AU D 54. Repair crazing areas.

AU D 55. Explain cure time.

AU D 56. Quote characteristics of epoxy resins.

AU D 57. Understand the implications of exotherm.

AU D 58. Name four fillers.

AU D 59. Recognize fillers.

AU D 60. Mix fillers properly.

AU D 61. Store fillers properly.
Recall safety precautions involving fillers.

Define gel coat.

Mix gel coat.

Apply gel coat.

Recall safety procedures using gel coat.

Define gel time.

Summarize high temperature surface inhibitor.

Define lay-up resin.

Recognize pigments.

Select pigment to obtain proper color.

Store pigments correctly.

Select correct pigment mixture percentages.

Recall safety requirements with pigments.

Understand the characteristics of polyester resin.

Recognize polyester resin visually and aromatically.

Mix polyester resin correctly.

Store polyester resin correctly.

Recall proper safety procedures for polyester resin.

Explain polymerization.

Define post cure.

Know post cure time for mixtures used.

Define pot life.

Control pot life.

Know ideal pot life of mixtures used.

Define preaccelerated.

Identify preaccelerated mixtures.
88. Explain promoters.

89. Identify styrene visually and aromatically.

90. Mix styrene correctly.

91. Store styrene properly.

92. Destroy styrene correctly.

93. Understand safety precautions for styrene.

94. Understand the use of surface coating resins.

95. Define surface additive.

96. Recognize surface additives.

97. Mix surface additives properly.

98. Store surface additives properly.

99. Define thixotropic.

100. Explain total inhibition.

101. Explain trim time.

102. Define viscosity.

103. Explain 100% solids.

104. Recite the 15° rule.

105. Define mold.

106. Recognize mold release.

107. Name two common mold release agents.

108. Apply mold release.

109. Define plug.

110. Identify prune skinning.

111. Understand the cause of prune skinning.

112. Identify oil canning.

113. Understand the cause of oil canning.
AU D 114. Explain undercuts.
AU D 115. Recognize various grits of abrasive paper.
AU D 116. Demonstrate proper use of various grits of abrasive paper.
AU D 117. Follow proper masking techniques.
AU D 118. Use proper personal safety items.
AU D 119. Recall general safety procedures for power tools.
AU D 120. Operate variable speed disc sander.
AU D 121. Determine proper speed for all variable speed tools.
AU D 122. Operate a saber saw.
AU D 123. Recognize variety of saber saw blades.
AU D 124. Determine the proper saber saw blade for the job.
AU D 125. Remove and replace a saber saw blade.
AU D 126. Remove and replace a sanding disc.
AU D 127. Operate an electric drill.
AU D 128. Recognize various size drill bits.
AU D 129. Determine proper size drill bit.
AU D 130. Remove and replace a drill bit.
AU D 131. Remove and replace a buffing pad on a disc sander.
AU D 132. Select a proper grinding burr.
AU D 133. Recognize a grinding burr.
AU D 134. Remove and replace a grinding burr in an electric drill.
AU D 135. Construct a sanding block.
AU D 136. Use a sanding block.
A U D 137. Recognize various size putty knives.
A U D 138. Use a putty knife properly.
A U D 139. Recognize a vibrator sander.
A U D 140. Use a vibrator sander correctly.
A U D 141. Remove and replace abrasive paper on a vibrator sander.
A U D 142. Detect proper working area ventilation.
A U D 143. Dress safely at work.
A U D 144. Use disposable bench covers.
A U D 145. Dispose of bench covers and mixing containers after work.
A U D 146. Protect all body parts when sanding.
A U D 147. Recall first aid techniques.
A U D 148. Determine the best molding techniques.
A U D 149. Build a mold.
A U D 150. Surface a mold.
A U D 151. Apply mold release.
A U D 152. Lay on glass cloth.
A U D 153. Saturate glass cloth with resin.
A U D 154. Construct laminate layers properly.
A U D 155. Squeegie laminate.
A U D 156. Wet trim laminate.
A U D 157. Dry trim edges.
A U D 158. Use proper filing techniques.
A U D 159. Buff laminate.
A U D 160. Display proper fiberglass patching techniques.
A U D 161. Describe three types of molds.
AU D 162. List ten common fiberglass consumer items.

AU D 163. Outline assembly line jobs in fiberglass industry.

AU D 164. Know employment potential for fiberglass industry.
CHAPTER V

VALIDATION OF THE STUDY

Validation Survey of Fiberglass Technology Competencies

This study is aimed at validating competencies in the area of fiberglass technology needed by industrial arts students in the State of Virginia. Circle the one response which reflects your opinion of each statement. If you feel additional competencies are needed, please note them on the final page of the survey.

A-agree
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D-disagree

The Virginia Industrial Arts student will:

1. Demonstrate proper lay-up techniques. [A] У D
2. Measure fiberglass laminates in mils. [A] У D
3. Define reinforced plastic. [A] У D
4. Explain the properties of a thermoplastic. [A] У D
5. Explain the properties of a thermosetting plastic. [A] У D
6. Understand the function of a binder. [A] У D
7. Recall the properties and uses of chopped strand. [A] У D
8. Recall the properties and use of continuous filament strand. [A] У D
9. List 7 forms of fiberglass. [A] У D
10. Define filament. [A] У D
12. Compute the glass content. [A] У D
13. Quote a satisfactory glass content.
14. Fabricate a proper glass content laminate.
15. Define matt.
16. Critique the properties of matt.
17. Recognize matt.
18. Define roving.
19. Critique the properties of roving.
20. Recognize roving.
21. Describe spray-up.
22. Define woven cloth.
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33. Comprehend air inhibition.
34. Understand the use of a back-up-coat.
35. Detect the need for cabosil.
36. Mix cabosil correctly.
37. Recognize a catalyst visually and aromatically.
38. Mix catalyst correctly.
Understand the effect of temperature on curing times.

Compute catalyst percentage to obtain various curing times.

Store catalysts correctly.

Utilize proper destruction techniques for catalysts.

Name a common catalyst.

Recall proper safety procedures for catalysts.

Recognize chemical inhibitors visually and aromatically.

Mix chemical inhibitors correctly.

Name three common chemical inhibitors.

Store chemical inhibitors properly.

Utilize proper destruction techniques for chemical inhibitors.

Recall proper safety procedures for chemical inhibitors.

Recognize crazing.

Troubleshoot crazing problems.

Redesign crazing problem areas.

Repair crazing areas.

Explain cure time.

Quote characteristics of epoxy resins.

Understand the implications of exotherm.

Name four fillers.

Recognize fillers.

Mix fillers properly.

Store fillers properly.
A U D 62. Recall safety precautions involving fillers.
A U D 63. Define gel coat.
A U D 64. Mix gel coat.
A U D 65. Apply gel coat.
A U D 66. Recall safety procedures using gel coat.
A U D 67. Define gel time.
A U D 68. Summarize high temperature surface inhibitor.
A U D 69. Define lay-up resin.
A U D 70. Recognize pigments.
A U D 71. Select pigment to obtain proper color.
A U D 72. Store pigments correctly.
A U D 73. Select correct pigment mixture percentages.
A U D 74. Recall safety requirements with pigments.
A U D 75. Understand the characteristics of polyester resin.
A U D 76. Recognize polyester resin visually and aromatically.
A U D 77. Mix polyester resin correctly.
A U D 78. Store polyester resin correctly.
A U D 79. Recall proper safety procedures for polyester resin.
A U D 80. Explain polymirization.
A U D 81. Define post cure.
A U D 82. Know post cure time for mixtures used.
A U D 83. Define pot life.
A U D 84. Control pot life.
A U D 85. Know ideal pot life of mixtures used.
A U D 86. Define preaccelerated.
A U D 87. Identify preaccelerated mixtures.
AU D 88. Explain promoters.
AU D 89. Identify styrene visually and aromatically.
AU D 90. Mix styrene correctly.
AU D 91. Store styrene properly.
AU D 92. Destroy styrene correctly.
AU D 93. Understand safety precautions for styrene.
AU D 94. Understand the use of surface coating resins.
AU D 95. Define surface additive.
AU D 96. Recognize surface additives.
AU D 97. Mix surface additives properly.
AU D 98. Store surface additives properly.
AU D 99. Define thixotropic.
AU D 100. Explain total inhibition.
AU D 101. Explain trim time.
AU D 102. Define viscosity.
AU D 103. Explain 100% solids.
AU D 104. Recite the 15° rule.
AU D 105. Define mold.
AU D 106. Recognize mold release.
AU D 107. Name two common mold release agents.
AU D 108. Apply mold release.
AU D 109. Define plug.
AU D 110. Identify prune skinning.
AU D 111. Understand the cause of prune skinning.
AU D 112. Identify oil canning.
AU D 113. Understand the cause of oil canning.
114. Explain undercuts.

115. Recognize various grits of abrasive paper.

116. Demonstrate proper use of various grits of abrasive paper.

117. Follow proper masking techniques.

118. Use proper personal safety items.

119. Recall general safety procedures for power tools.

120. Operate variable speed disc sander.

121. Determine proper speed for all variable speed tools.

122. Operate a saber saw.

123. Recognize variety of saber saw blades.

124. Determine the proper saber saw blade for the job.

125. Remove and replace a saber saw blade.

126. Remove and replace a sanding disc.

127. Operate an electric drill.

128. Recognize various size drill bits.

129. Determine proper size drill bit.

130. Remove and replace a drill bit.

131. Remove and replace a buffing pad on a disc sander.

132. Select a proper grinding burr.

133. Recognize a grinding burr.

134. Remove and replace a grinding burr in an electric drill.

135. Construct a sanding block.

136. Use a sanding block.
AUD 137. Recognize various size putty knives.

AUD 138. Use a putty knife properly.

AUD 139. Recognize a vibrator sander.

AUD 140. Use a vibrator sander correctly.

AUD 141. Remove and replace abrasive paper on a vibrator sander.

AUD 142. Detect proper working area ventilation.

AUD 143. Dress safely at work.

AUD 144. Use disposable bench covers.

AUD 145. Dispose of bench covers and mixing containers after work.

AUD 146. Protect all body parts when sanding.

AUD 147. Recall first aid techniques.

AUD 148. Determine the best molding techniques.

AUD 149. Build a mold.

AUD 150. Surface a mold.

AUD 151. Apply mold release.

AUD 152. Lay on glass cloth.

AUD 153. Saturate glass cloth with resin.

AUD 154. Construct laminate layers properly.

AUD 155. Squeegie laminate.

AUD 156. Wet trim laminate.

AUD 157. Dry trim edges.

AUD 158. Use proper filing techniques.

AUD 159. Buff laminate.

AUD 160. Display proper fiberglass patching techniques.

AUD 161. Describe three types of molds.
AUD 162. List ten common fiberglass consumer items.

AUD 163. Outline assembly line jobs in fiberglass industry.

AUD 164. Know employment potential for fiberglass industry.
CHAPTER V

VALIDATION OF THE STUDY

Validation Survey of Fiberglass Technology Competencies

This study is aimed at validating competencies in the area of fiberglass technology needed by industrial arts students in the State of Virginia. Circle the one response which reflects your opinion of each statement. If you feel additional competencies are needed, please note them on the final page of the survey.

A-agree
U-uncertain
D-disagree

The Virginia Industrial Arts student will:

1. Demonstrate proper lay-up techniques. A
2. Measure fiberglass laminates in mils. U
3. Define reinforced plastic. A
4. Explain the properties of a thermoplastic. A
5. Explain the properties of a thermosetting plastic. A
6. Understand the function of a binder. A
7. Recall the properties and uses of chopped strand. U
8. Recall the properties and use of continuous filament strand. D
9. List 7 forms of fiberglass. A
10. Define filament. A
11. Recognize fiberglass fabric finishes. A
12. Compute the glass content. A
AU D 13. Quote a satisfactory glass content.
AU D 14. Fabricate a proper glass content laminate.
AU D 15. Define matt.
AU D 16. Critique the properties of matt.
AU D 17. Recognize matt.
AU D 18. Define roving.
AU D 19. Critique the properties of roving.
AU D 20. Recognize roving.
AU D 22. Define woven cloth.
AU D 23. Critique the properties of woven cloth.
AU D 24. Recognize woven cloth.
AU D 28. Identify acetone visually and aromatically.
AU D 29. Mix acetone in proper proportions.
AU D 30. Store acetone properly.
AU D 31. Utilize proper destruction methods for acetone.
AU D 32. Recall safety regulations for acetone.
AU D 33. Comprehend air inhibition.
AU D 34. Understand the use of a back-up-coat.
AU D 35. Detect the need for cabosil.
AU D 36. Mix cabosil correctly.
AU D 37. Recognize a catalyst visually and aromatically.
AU D 38. Mix catalyst correctly.
39. Understand the effect of temperature on curing times.

40. Compute catalyst percentage to obtain various curing times.

41. Store catalysts correctly.

42. Utilize proper destruction techniques for catalysts.

43. Name a common catalyst.

44. Recall proper safety procedures for catalysts.

45. Recognize chemical inhibitors visually and aromatically.

46. Mix chemical inhibitors correctly.

47. Name three common chemical inhibitors.

48. Store chemical inhibitors properly.

49. Utilize proper destruction techniques for chemical inhibitors.

50. Recall proper safety procedures for chemical inhibitors.

51. Recognize crazing.

52. Troubleshoot crazing problems.

53. Redesign crazing problem areas.

54. Repair crazing areas.

55. Explain cure time.

56. Quote characteristics of epoxy resins.

57. Understand the implications of exotherm.

58. Name four fillers.

59. Recognize fillers.

60. Mix fillers properly.

61. Store fillers properly.
Recall safety precautions involving fillers.
Define gel coat.
Mix gel coat.
Apply gel coat.
Recall safety procedures using gel coat.
Define gel time.
Summarize high temperature surface inhibitor.
Define lay-up resin.
Recognize pigments.
Select pigment to obtain proper color.
Store pigments correctly.
Select correct pigment mixture percentages.
Recall safety requirements with pigments.
Understand the characteristics of polyester resin.
Recognize polyester resin visually and aromatically.
Mix polyester resin correctly.
Store polyester resin correctly.
Recall proper safety procedures for polyester resin.
Explain polymerization.
Define post cure.
Know post cure time for mixtures used.
Define pot life.
Control pot life.
Know ideal pot life of mixtures used.
Define preaccelerated.
Identify preaccelerated mixtures.
AUD 88. Explain promoters.
AUD 89. Identify styrene visually and aromatically.
AUD 90. Mix styrene correctly.
AUD 91. Store styrene properly.
AUD 92. Destroy styrene correctly.
AUD 93. Understand safety precautions for styrene.
AUD 94. Understand the use of surface coating resins.
AUD 95. Define surface additive.
AUD 96. Recognize surface additives.
AUD 97. Mix surface additives properly.
AUD 98. Store surface additives properly.
AUD 99. Define thixotropic.
AUD 100. Explain total inhibition.
AUD 101. Explain trim time.
AUD 102. Define viscosity.
AUD 103. Explain 100% solids.
AUD 104. Recite the 15° rule.
AUD 105. Define mold.
AUD 106. Recognize mold release.
AUD 107. Name two common mold release agents.
AUD 108. Apply mold release.
AUD 109. Define plug.
AUD 110. Identify prune skinning.
AUD 111. Understand the cause of prune skinning.
AUD 112. Identify oil canning.
AUD 113. Understand the cause of oil canning.
A U D 114. Explain undercuts.

A U D 115. Recognize various grits of abrasive paper.

A U D 116. Demonstrate proper use of various grits of abrasive paper.

A U D 117. Follow proper masking techniques.

A U D 118. Use proper personal safety items.

A U D 119. Recall general safety procedures for power tools.

A U D 120. Operate variable speed disc sander.

A U D 121. Determine proper speed for all variable speed tools.

A U D 122. Operate a saber saw.

A U D 123. Recognize variety of saber saw blades.

A U D 124. Determine the proper saber saw blade for the job.

A U D 125. Remove and replace a saber saw blade.

A U D 126. Remove and replace a sanding disc.

A U D 127. Operate an electric drill.

A U D 128. Recognize various size drill bits.

A U D 129. Determine proper size drill bit.

A U D 130. Remove and replace a drill bit.

A U D 131. Remove and replace a buffing pad on a disc sander.

A U D 132. Select a proper grinding burr.

A U D 133. Recognize a grinding burr.

A U D 134. Remove and replace a grinding burr in an electric drill.

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AU D 155. Squeegie laminate.
AU D 156. Wet trim laminate.
AU D 157. Dry trim edges.
AU D 158. Use proper filing techniques.
AU D 159. Buff laminate
AU D 160. Display proper fiberglass patching techniques.
AU D 161. Describe three types of molds.
AU D 162. List ten common fiberglass consumer items.

AU D 163. Outline assembly line jobs in fiberglass industry.

AU D 164. Know employment potential for fiberglass industry.
CHAPTER VI

SUMMARY AND CONCLUSION

The purpose of this research report was to show the need for the inclusion of an introductory fiber-glass technology course in the industrial arts curriculum and to provide validated tasks following State of Virginia guidelines for the implementation of future curriculum development.

An industrial arts teacher should be able to employ the tasks to expand his existing area of instruction or move in new directions.

The versatility of FRP lends itself to new finishing techniques for old established projects in wood or metal to complete fiberglass products. A complete package of industry reflecting knowledge and skills can be derived equally from a small, space saving, serving tray or from a large assembly line school shop produced boat. The challenge and need is there.
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