These materials inform school administrators of the rationale of the Detroit Galaxy Plan and provide procedures for implementing the Plan. This program of occupational education for secondary Grades 7 through 12 is planned for students who intend to enter college, apprenticeships, or employment after high school. The Plan, developed by 24 experienced teachers who participated in a related fellowship program, involves laboratory programs in four major career clusters: (1) Industrial Materials and Processes, (2) Energy and Propulsion Systems, (3) Visual Communications, and (4) Personal Services. "Organizational Plan" gives the rationale, summarizes the Plan, and lists the career clusters. "Instructional Content" provides exemplary objectives, lesson plans, and unit outlines. "Instruments for Evaluation" gives an instructional material evaluation guide and a student safety test. "Facilities" provides laboratory floor plans and equipment lists. A bibliography lists teaching aids, films, and books. Also included are a list of the fellows. A related document is VT 008 186. (EM)
the galaxy plan
in
industrial education
experienced teacher fellowship program
wayne state university
1967-1968
THE GALAXY PLAN IN INDUSTRIAL EDUCATION

Experienced Teacher Fellowship Program
September, 1967 - June, 1968

Developed in the Experienced Teacher Fellowship Program under Title V of the Higher Education Act of 1965, in cooperation with the U.S. Office of Education.

Kenneth R. McLea, Robert Aronson, and Carl W. Butler, Experienced Teacher Fellows

G. Harold Silvius
Project Director

Wayne State University
July, 1968

Department of Industrial Education
Wayne State University
Detroit, Michigan 48228
WAYNE STATE UNIVERSITY

THE GALAXY PLAN

IN

INDUSTRIAL EDUCATION

1967 - 1968

by

Experienced Teacher Fellowship Program

Publishing and Editing Committee

Kenneth R. McLea, Chairman
Robert Aronson
Carl W. Butler
FOREWORD

The Detroit Galaxy Plan is one of several new curriculum approaches advocated for Industrial Education. This brochure was written to inform school administrators of the rationale of the Galaxy Plan as it supports the "World of Work" concept, and the procedures for implementing the Plan.

Two of the four clusters of the Galaxy Plan, Energy and Propulsion Systems and Industrial Materials and Processes, have been refined, developed, and field-tested by twenty-four participants of the Experienced Teacher Fellowship Program sponsored by the United States Office of Education and Wayne State University during 1967-68.

These experienced teachers received advanced technical preparation and professional courses so as to become more competent to teach in a particular cluster. Field-testing and evaluation of sample units through micro-teaching and classroom situations equipped each teacher with a nucleus of tested materials, and provided experiences in developing the techniques of planning, integrating, and evaluating such units.

The materials contained in this brochure are the product of these twenty-four experienced teachers, and represent their insights and experiences.

It is hoped that their ideas will be found useful in improving the Industrial Education program in your school.

William D. Wolansky
Associate Director
Experienced Teacher Fellowship Program
Department of Industrial Education
Wayne State University
PREFACE

THE GALAXY PLAN IN INDUSTRIAL EDUCATION

The Galaxy Plan is a broad-base approach for occupational education for grades seven through twelve in secondary schools. This type of program is planned so that it would be meaningful and beneficial for youths (1) going on to colleges to prepare for the professions in such areas as science, engineering, and industrial education; (2) going to a community college or technical institute to prepare as technicians; (3) entering an apprenticeship in the building trades or manufacturing industries; or (4) developing salable skills for entering the labor force directly from high school.

During the 1967-68 academic year at Wayne State University, twenty-four Fellows, representing the length and breadth of the United States, were brought together in Detroit to study and to experiment within the Galaxy Approach to industrial arts education. The purpose of this graduate program, leading to a master's degree, was to identify patterns of content, develop and field test instructional materials, and assist these selected teachers in developing technical and professional competence to organize instruction for, and to teach in, a broad-base approach to occupational education.

The Fellows have spent the past year in graduate courses at the University, attending industrial schools, and in developing and experimenting with the Galaxy Approach for occupational education in the Detroit Public Schools. During the year it has become apparent that industrial arts education could make a significant contribution to this broad-base approach to occupational education and keep abreast of economic, scientific, and technological changes taking place in the industrial world
of work. Equally important is that industrial arts education adapt itself to the needs of youth in a technological society.

The Galaxy Plan currently being promulgated by the Detroit Public Schools provides for laboratories in four major career clusters. They are: (1) Industrial Materials and Processes; (2) Energy and Propulsion Systems; (3) Visual Communications; and (4) Personal Services. Each of these clusters organized from typical entries from The Dictionary of Occupational Titles\(^1\) covers a wide range of careers for those (a) going into management and engineering, (b) planning to qualify as technicians, (c) hoping to enter an apprenticeship or, (d) developing a salable skill to go directly into the labor force. The program at Wayne State University for industrial arts teachers has focused on two of these occupational clusters, namely: (a) Industrial Materials and Processes and (b) Energy and Propulsion Systems. The job cluster in Industrial Materials and Processes (shown as Table 1 on Page vi) includes the study of metals, wood products, ceramics, and plastics. The occupational education cluster in Energy and Propulsion Systems (shown as Table 1A on Page vii) includes the study of electricity/electronics, power plants, instrumentation, and land, sea, and air propulsion systems.

It is suggested that this approach to occupational education be introduced by industrial arts teachers on an exploratory basis, in the 7th grade and expand into specialty concentrations by the 11th grade (as illustrated in Table 2 on Page viii). The work at WSU has been predicated

on the principle that students will have a wide spectrum of career objectives and should, therefore, study in a multiple activity program. As the student progresses, his objectives become more specific and hence, are directed into a meaningful occupational orientation.

This material in this report has been developed to help and to encourage industrial education teachers put into practice, a program that will help students take their place in the world of work.

by

Dr. G. Harold Silvius, Professor and Chairman, Department of Industrial Education at WSU, Detroit, Michigan 48202 and Director of the Experienced Teacher Fellowship Program.

and

Kenneth R. McLea, Teacher of Industrial Arts, Mission High School, San Francisco, California 94114 and one of the Fellows in the 1967-68 Experienced Teacher Fellowship Program at WSU.
## Table 1
### Career Preparation
An exploratory analysis of vocational education subject area galaxies showing instructional areas in depth for four learner ability/interest areas.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 10</strong></td>
<td><strong>Note:</strong> The job titles and DOT numbers are representative examples only</td>
<td><strong>MATERIALS AND PROCESSES</strong></td>
<td><strong>Landscape Architecture</strong></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td><strong>Cybernetics</strong></td>
<td>Machine Tool 606.150</td>
<td>Machinist 600.280</td>
</tr>
<tr>
<td></td>
<td><strong>Metalurgy and Microanalysis</strong></td>
<td>Fabrication Technician 619.380</td>
<td>Pattern Maker 693.281</td>
</tr>
<tr>
<td></td>
<td>011.081 Technician 619.380</td>
<td>Metallurgy Technician 011.281</td>
<td>Welder 810.884</td>
</tr>
<tr>
<td></td>
<td>010.081 Technician 011.281</td>
<td>Pipe Fitter 862.381</td>
<td>Sheet Metal 804.281</td>
</tr>
<tr>
<td></td>
<td>024.081 Technician 011.281</td>
<td><strong>Structures</strong></td>
<td>Carpenter 860.281</td>
</tr>
<tr>
<td></td>
<td>Concrete Tech. 570.532</td>
<td>Inspector 182.287</td>
<td>Lather 842.781</td>
</tr>
<tr>
<td></td>
<td>005.081</td>
<td>Wood Products</td>
<td>Carpenter 860.281</td>
</tr>
<tr>
<td></td>
<td>007.081 Technician 040.081</td>
<td>Concrete Tech. 570.532</td>
<td>Model Maker 661.281</td>
</tr>
<tr>
<td></td>
<td>019.081 Technician 040.081</td>
<td><strong>Landscape Architecture</strong></td>
<td>Roofer 804.281</td>
</tr>
<tr>
<td></td>
<td>Nurseryman 406.168</td>
<td>Vegetable 403.181</td>
<td>Gardener 407.181</td>
</tr>
<tr>
<td></td>
<td><strong>Landscape Architecture</strong></td>
<td>001.081</td>
<td>018.168 Technician 168.168</td>
</tr>
<tr>
<td></td>
<td>040.081 Planner 199.168</td>
<td><strong>Industrial Chemical Applications</strong></td>
<td><strong>Prototype Foreman</strong></td>
</tr>
<tr>
<td></td>
<td>059.086 Park Foreman 407.134</td>
<td>Plaster 754.137</td>
<td><strong>Prototype Foreman</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Industrial Chemical Applications</strong></td>
<td>022.081 Cermics Foreman 775.131</td>
<td>Plaster 754.137</td>
</tr>
<tr>
<td></td>
<td>006.081 Plastics Foreman 556.130</td>
<td>Plaster 754.137</td>
<td>Operator 844.884</td>
</tr>
<tr>
<td></td>
<td>010.081 Prototype Foreman 754.137</td>
<td>Plaster 754.137</td>
<td>Chemical Process 559.380</td>
</tr>
</tbody>
</table>

**Note:** The job titles and DOT numbers are representative examples only.
### Table 1A

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Propulsion</td>
<td>Ground and Water Systems 014.081 Power Systems 015.197</td>
<td>Automotive Technician 620.131</td>
<td>Locomotive Engineer 910.383</td>
<td>Assembler 806.887</td>
</tr>
<tr>
<td></td>
<td>187.198</td>
<td>Automobile Service Tech. 620.281</td>
<td>Auto. Mechanic Engineer 620.131</td>
<td>Gas Station Operator 915.867</td>
</tr>
<tr>
<td></td>
<td>Inspector 722.381</td>
<td>Instrument Technician 025.088</td>
<td>Outboard Engine Serviceman 625.281</td>
<td>892.883</td>
</tr>
<tr>
<td></td>
<td>Pilot 196.168</td>
<td>Note: The job titles and DOT numbers are representative examples only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerodynamic Systems 002.081</td>
<td>Air Frame Mechanic 621.281</td>
<td>Locomotive Engine 910.383</td>
<td>Assembler 806.381</td>
</tr>
<tr>
<td></td>
<td>Instrument Technician 003.281</td>
<td>Instrument Engineer 621.281</td>
<td>Office Machine Repairman 633.281</td>
<td>Counterman 289.358</td>
</tr>
<tr>
<td></td>
<td>Instrument Foreman 710.131</td>
<td>Instrument Repairman 710.281</td>
<td>Watch Repairman 715.281</td>
<td>Cleaner 919.887</td>
</tr>
<tr>
<td></td>
<td>Energy Source System 012.081</td>
<td>Stationary Engin. 950.782</td>
<td>Appliance Repairman 723.781</td>
<td>Helper 710.884</td>
</tr>
<tr>
<td></td>
<td>007.081, 015.081, 023.081</td>
<td>Refrigeration Mechanic 637.281</td>
<td>Air Conditioning Serviceman 637.381</td>
<td>Instrument 710.281</td>
</tr>
<tr>
<td></td>
<td>Power Plant Technician 638.281</td>
<td>187.168</td>
<td></td>
<td>Firetender 951.885</td>
</tr>
<tr>
<td></td>
<td>Stationary Engineering Technician 950.131</td>
<td>Electronic Technician 726.281</td>
<td>Electronic Repairman 828.281</td>
<td>Rigger 921.280</td>
</tr>
<tr>
<td></td>
<td>Electronic Systems Tech. 024.288</td>
<td>Electrician 821.381</td>
<td>T.V. Repairman 726.381</td>
<td>729.884</td>
</tr>
<tr>
<td></td>
<td>T.V.-Radio Technician 720.281</td>
<td>Industrial Electrician 825.281</td>
<td>Industrial 825.281</td>
<td>729.884</td>
</tr>
<tr>
<td></td>
<td>Electronic Repairman 828.281</td>
<td>Electronic 825.281</td>
<td>Frameman 822.884</td>
<td>729.884</td>
</tr>
<tr>
<td></td>
<td>T.V. Repairman 726.781</td>
<td>Manufacturing Worker 196.168</td>
<td>Assemblers 729.884</td>
<td>729.884</td>
</tr>
<tr>
<td></td>
<td>Radio Repairman 720.281</td>
<td></td>
<td></td>
<td>729.884</td>
</tr>
</tbody>
</table>

Note: The job titles and DOT numbers are representative examples only.
### C A R E E R P R E P A R A T I O N P L A N

<table>
<thead>
<tr>
<th>CLUSTER 1</th>
<th>CLUSTER 2</th>
<th>CLUSTER 3</th>
<th>CLUSTER 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIALS &amp; PROCESSES Laboratory</td>
<td>VISUAL COMMUNICATIONS LABORATORY</td>
<td>ENERGY &amp; PROPULSION LABORATORY</td>
<td>PERSONAL SERVICES LABORATORY</td>
</tr>
</tbody>
</table>

#### J U N I O R H I G H S C H O O L

<table>
<thead>
<tr>
<th>GRADE</th>
<th>7B</th>
<th>7A</th>
<th>8B</th>
<th>8A</th>
<th>9B</th>
<th>9A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 WEEKS</td>
<td>ONE PERIOD</td>
<td>20 WEEKS</td>
<td>ONE PERIOD</td>
<td>20 WEEKS</td>
<td>ONE PERIOD</td>
</tr>
<tr>
<td></td>
<td>20 WEEKS</td>
<td>ONE PERIOD</td>
<td>10 WEEKS</td>
<td>ONE PERIOD</td>
<td>10 WEEKS</td>
<td>ONE PERIOD</td>
</tr>
</tbody>
</table>

#### S E N I O R H I G H S C H O O L

STUDENT MAKES VALIDATED CHOICE OF TWO OF THE FOUR CLUSTERS

<table>
<thead>
<tr>
<th>GRADE</th>
<th>10B</th>
<th>10A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 WEEKS, TWO PERIODS, 1ST CHOICE OF TWO CLUSTERS</td>
<td>20 WEEKS, TWO PERIODS, 2ND CHOICE OF TWO CLUSTERS</td>
</tr>
</tbody>
</table>

#### D E P T H C A R E E R D E V E L O P M E N T

IN ONE GALAXY LABORATORY

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>80 WEEKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONE PERIOD/DAY</td>
<td>SCIENTIST, MANAGEMENT, ENGINEER/FURTHER EDUCATION NECESSARY</td>
</tr>
<tr>
<td>TWO PERIOD/DAY</td>
<td>TECHNICIAN/FURTHER EDUCATION NECESSARY</td>
</tr>
<tr>
<td>THREE PERIOD/DAY</td>
<td>SKILLED TRADES, SERVICE, SALES/FURTHER EDUCATION VALUABLE</td>
</tr>
<tr>
<td>FOUR PERIOD/DAY</td>
<td>SINGLE OPERATION OPERATOR/WORK EXPERIENCE VALUABLE</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

I ORGANIZATIONAL PLAN

1. The Galaxy Plan for Career Preparation Rationale - 1
   The Plan - 2 Families of Technologies - 5

II INSTRUCTIONAL CONTENT

2. Introduction - 6 Goals of the Galaxy Approach in Industrial Education - 8 Specific Objectives of the Materials and Processes Cluster - 9 Specific Objectives of the Energy and Propulsion Cluster - 9 Unit Outline (Energy and Propulsion) - 10 Lesson Plan (Energy and Propulsion) - 11 Unit Outline (Materials and Processes) - 13 Lesson Plan (Materials and Processes) - 14

III INSTRUMENTS FOR EVALUATION


IV FACILITIES


V BIBLIOGRAPHY

5. Energy and Propulsion Books and Booklets - 26 Films, Film Strips, Transparencies, Training Film Sources, Material and Processes Books - 27 Books (Con't.), Audio Visual Materials Indexes - 28 Experienced Teacher Fellowship Program List of Participants - 29 Location Map of Participants - 30
ORGANIZATIONAL PLAN

Committee:
Richard F. Hornchek
Orville C. Haan
Roger A. Vicroy
CHAPTER I

ORGANIZATIONAL PLAN

The Galaxy Plan For Career Preparation

RATIONALE

We are living in an industrialized world of work, at a time when occupational change is occurring at a rapid pace. New industries seem to spring up overnight, while others become obsolete. Associated with this industrial transformation, is an unprecedented search by business and industry to seek out potential employees with an ability to adjust to these dynamic employment conditions.

The educational systems, along with other institutions, have the challenge of preparing youngsters for gainful employment. In order to meet the needs of our society in this space age, education must also undergo planned change.

The Galaxy Plan for Career Preparation is a proposal by educators to help provide controlled experiences with a core of skills related to a cluster of occupations, rather than to one distinct specialization.

Many of the former types of entry level occupations sought by students, are no longer available to graduates upon entering the labor market today. They also will find their first job can no longer be viewed as a final career commitment, but in reality it will be the first of a series of job changes hopefully leading to a satisfying career.
Young people seeking a job today are required as employees to have a broad base of cognitive, communicative and social skills. The Galaxy Plan and its cluster approach will prepare the student with these required skills and allow for steady lateral movement within a comprehensive cluster of technologies.

THE PLAN

The Galaxy Plan for Career Preparation is concerned with a broad approach to occupational education. It is organized around four groupings of technologies which serve as a basis for families of occupations stemming from a technology or combination of technologies. These groups or clusters are identified as the Materials and Processes Cluster, the Energy and Propulsion Cluster, the Communication Cluster and the Personal Services Cluster. Using the cluster method of curriculum organization for occupational preparation, we should find that the necessary content will change less than previous curricula when it is related to the broad aspect of our overlapping technologies.

The Galaxy Plan must involve all the departments in the secondary schools that now are preparing students for the entry level occupation. The business education, distributive education, home economics, industrial arts and vocational education departments are examples of our secondary curricula that will have to work closely together. Cooperation between all other departments and professional services found within the school will, also, be needed to help carry out this career preparation plan.

The students' first experiences under the Plan with the "world of work" will occur during the seventh and eighth grades. Equal time will
be devoted by every student to each of the four clusters during these two years. The experiences within the four clusters will provide the students with a sound foundation on which to build his or her future career plans. Four appropriate activity rooms or laboratories must be provided to allow every student to explore the technologies of each cluster by using the project and creative investigation methods. These exploratory activities must be broad, enabling each child to discover a cluster challenging to him or her.

At the ninth grade level, every student will once again experience the four clusters through a ten week rotational plan. A major purpose of this final broad exposure, is to enable the student to make a wise choice of his or her planned high school curriculum. The student, before leaving the junior high school, will make a choice of two clusters most related to his or her personal interests and identified talents. The exercise method should be used at this level so the student can measure his or her tolerance of the disciplines necessary in each of the career preparation programs. By now the student will also have some manipulative knowledge in each of the four clusters.

The two clusters chosen by the student will be further explored at the tenth grade level. During this year the student will be required to decide on one cluster for in-depth career preparation during the eleventh and twelfth grade levels. This decision must be made only after careful advisement, utilization of all the school's guidance services and with the cooperation of the parents.

During the final two years of high school the student will be able to
specialize within the cluster of his choice. In addition to the chosen specialization, the school must provide a flexible or modular schedule so the degree of career preparation can be modified or tailored to the ability level of the student. Some students will become involved in cooperative work experience programs, which will possibly take as many as five periods out of the school day. Others will be preparing for college and possibly as little as one period per day or even per week will be devoted to the career preparation laboratory. The important point is that during the last two years, the career preparation programs must be tailored to the individuals needs and every student will still be allowed to elect a laboratory experience throughout his secondary education.
## Families of Technologies Related to Clusters

**Materials and Processes**
- Metals: Machining
- Plastics: Welding
- Woods: Forming
- Ceramics: Fabrication
- Glass: Foundry
- Textiles: Metallurgy, Coatings, Forging, Automation

**Energy and Propulsion**
- Engines & Motors
- Electricity & Electronics
- Atomic Energy & Fuel Cells
- Fluid Power
- Application
- Servicing
- Operation
- Installation
- Transmission
- Instrumentation

## Personal Services
- Food: Preparation
- Clothing: Maintenance
- Shelter: Repair
- Recreation: Sales
- Entertainment: Protection
- Health & Beauty: Distribution

## Visual Communications
- Publishing
- Advertising
- Commerce
- Clerical
- Printing
- Photography
- Drafting
- Writing
- Reporting
- Design
INSTRUCTIONAL CONTENT

Committee:

ENERGY AND PROPULSION

Robert Aronson, Chairman
Victor Bridges
Carl W. Butler

MATERIALS AND PROCESSES

William H. Carson, Chairman
Terry L. Davis
Edwin A. Gray
INTRODUCTION

Energy and Propulsion

One of the goals of education is to prepare people for gainful employment. Fortunately many of the manipulative skills and knowledge skills in one area are often transferable to other job classifications. This is the basic principle behind a cluster of occupations rather than a specific trade or job area. This cluster is structured toward energy and propulsion and is designed to develop interest in land vehicles, sea vehicles, air vehicles, power plants, instrumentation, electricity and electronics.

Materials and Processes

It would seem appropriate to utilize team teaching techniques as a means of involving the student in a variety of laboratory activities designed to accomplish the objectives of Materials and Processes. Team teaching would simplify the problem of organization, and provide an effective means for involving the student in the interrelated use of materials in a single product. Some products and construction activities may only involve the use of a single material, but to be more representative of industry and the Materials and Processes concepts, a variety of materials should be considered in relation to production associated with industry.

Whether team teaching is practical or not will depend on the school's philosophy. However, the objectives cannot be realized to the degree considered desirable in a traditional teaching-learning situation. In
order to bring about a greater understanding of our industrial society and to reach the desired objectives, students should become involved in activities centered around the management and production systems. To attain the objectives for the cluster of Industrial Materials and Processes, students should study the various functions of a typical industry, organize, and mass produce a product involving the use of several materials and many processes. The laboratory experiences must reflect our industrial society and prepare youth to think and solve problems associated with salable employment in the world of work.
CHAPTER II

INSTRUCTIONAL CONTENT

Goals of the Galaxy Approach in Industrial Education

1. To provide a curriculum to meet the needs of students with varying abilities, aptitudes, desires, and interests.

2. To cluster information and experiences relevant to related occupations.

3. To discover and encourage the occupational talents and abilities of students which are consistent with their interests.

4. To develop desirable habits, traits, and attitudes relative to the world of work.

5. To provide generous experience in each cluster to aid pupils in the selection of an occupation and develop skills pertinent to creative leisure.

6. To be able to identify and effectively use tools and equipment associated with the occupational clusters.

7. To develop an understanding of the relationship of each cluster to our industrial society.
Specific Objectives of the Materials and Processes Cluster of the Galaxy Approach to Industrial Education

1. To be able to identify various materials and select an appropriate material for a particular application.

2. To be able to identify and use machines and tools to form materials into useful products.

3. To identify the nature and status of industry in our society.

4. To be able to intelligently identify quality and design features as a consumer of industrial products.

5. To identify the role of industrial organization and planning for effective production.

6. To develop a desirable work attitude and promote an interest in productive work in the industrial complex.

Specific Objectives of the Energy and Propulsion Cluster of the Galaxy Approach to Industrial Education

1. To know the nature of energy in its various forms and its role in modern society.

2. To know the principles of operation on engines and their application.

3. To know the principles of electricity and electronics and their applications.

4. To develop skills in the use of instrumentation and the art of mensuration.

5. To provide opportunities for experiences in the field of Energy and Propulsion Systems.

6. To develop desirable work habits and attitudes for productive work in our industrial complex.
UNIT OUTLINE

I. Title: Energy and Propulsion

II. Unit Title: Fluid Power Fundamentals

III. Objectives:
   A. The student will be able to identify the common components of an hydraulic circuit.
   B. The student will be able to explain the function of each hydraulic component.
   C. The student will be able to "plumb" up a typical hydraulic circuit on the lab bench.
   D. Through visitations of local industries, the student will be able to identify several of the most important uses of fluid power in our economy.
   E. The student will become proficient in the use of tools used in fluid power.

IV. Outline of Unit Content
   A. There will be a presentation, discussion and review of the fundamentals of fluid power.
   B. A presentation and discussion of simple fluid power components as they are used in the typical circuits.
   C. A demonstration will be given using the various components and visual aids that are available for the course.
   D. The many simple hand tools necessary for the lab work will be presented and discussion of their use and safety will follow.
   E. The materials and resources necessary for the presentation are:
      1. Transparencies
      2. Cut-aways
      3. Movies
      4. Film strips
      5. Components of hydraulic circuits
      6. Fluid power bench
      7. Basic hand tools
   F. An evaluation of each session will be obtained by open questions and written tests or job sheets.
V. Suggested Activities
A. Students will "plumb" circuits of typical design on the lab benches.
B. Students will diagnose and repair "troubles" in fluid power circuits.
C. Students will disassemble and reassemble components of fluid power circuits such as:
   1. Power steering pumps
   2. Hydraulic brakes
   3. Hydraulic jacks
   4. Components of fluid power circuits
   5. Air wrenches
   6. Air lifts
   7. Presses
D. Field trips will be organized to visit local industries and construction companies that use fluid power machinery extensively.
E. An invitation will be extended to an instructor of fluid power in a local college to present a short session about their program.

VI. Textbooks and Resource Materials
A. Class textbook for fundamentals of fluid power
B. Resource materials
   1. Cut-aways of hydraulic components
   2. Cardboard slide rules from:
      Flick-Reedy Corporation
      Miller Products
      7N015 York Road
      Bensenville, Illinois 50106 (free)
   3. Hydraulic components drawing template from:
      Racine Hydraulics and Machinery
      Racine, Wisconsin (free)
   4. Movies and slides
      Double A Products
      Manchester, Michigan 48158
      Parker-Hannifin Corporation
      17325 Euclid Avenue
      Cleveland, Ohio 44112
VII. Evaluation materials
   A. Written tests and quizzes
      1. Tests will be given at the end of each session and will be of the true and false, multiple-choice, and word completion type.
      2. Class participation will be evaluated as part of the final grade. Oral questions and class discussion will generate class involvement.

   B. Lab work evaluation
      1. Job work sheets will be used as an aid by students to help them to learn the circuits and components.
      2. A chart will be posted listing the students names and all the required jobs. Each will be checked as they are completed.
      3. Notebooks will be used by each student for reference in class and lab. They will be filled out each day and used as a partial evaluation instrument.
METHOD OF INSTRUCTION
Lecture

UNIT TITLE
Hydraulics

TOPIC
Introduction to Pascal's Law

OBJECTIVES
1. To define Pascal's Law in simple terms.
2. To indicate, by drawing arrows, the direction of forces acting on a confined fluid given a drawing.

TOOLS, EQUIPMENT, AND MATERIALS
1. Transparencies
2. Chalk board

TEACHING AIDS AND DEVICES
Screen
Overhead projector
Overhead Transparency

TECHNIQUES
Refer to the diagram on the transparency as a means of illustrating Pascal's Law.

ASSIGNMENTS
Text: Pages 1 - 3

PROCEDURE
1. Greeting
2. Introduce topic
3. Purpose of topic
4. Statement of objectives
5. Explanation of topic and interaction of students
6. Question review
7. Closure

REFERENCES
UNIT OUTLINE

I. Title: Materials and Processes

II. Unit Title: "The Old and The New of Foundry Work"

III. Objectives:
   A. To learn to identify by name and function the tools, equipment, and operations basic to foundry practice.
   B. To compare wood pattern casting, wax pattern casting, and styrofoam casting.
   C. To determine the advantages and disadvantage of each method in relation to the item being cast.

IV. Outline of Unit Content
   A. Lesson I: Introduction. "What is foundry work?"
      1. Terminology
      2. Equipment
      3. Tools
      4. Materials
      5. Safety practice
   B. Lesson II: Casting with a wood pattern
   C. Lesson III: Casting with the "lost wax" pattern
   D. Lesson IV: Casting with a styrofoam pattern

V. Suggested Activities
   A. Teacher demonstrations with maximum student participation.
   B. Select students to make a wax and styrofoam pattern.
   C. Follow-up with student projects.

VI. Textbook and Resource Materials
   A. Textbook
   B. Resource materials
VII. Evaluation Materials
   A. Test: Final test on the four lessons
      1. Type: Take home: objective and short answer
      2. Purposes
         a) Student evaluation
         b) Evaluation of material presented
METHOD OF INSTRUCTION

Demonstration

UNIT TITLE

"The Old and The New of Foundry Work"

TOPIC

Casting with a Styrofoam Pattern

OBJECTIVES

1. To learn to make a styrofoam pattern.
2. To learn to cast from a styrofoam pattern.

TOOLS, EQUIPMENT, AND MATERIALS

1. Standard foundry tools
2. Large piece of casting styrofoam
3. Old knife for heat cutting
4. Flame heat source
5. Sandpaper and sanding block
6. Styrofoam drinking cup
7. Aluminum foil
8. Elmer's glue
9. Styrofoam heat cutter (if available)
10. Band saw (if available)

TEACHING AIDS AND DEVICES

A completed styrofoam pattern
A completed pattern with styrofoam gates, sprue, & pour cup
A completed raw casting
Handout: "Procedure and Making a Styrofoam Pattern and Casting"

PROCEDURE

1. Introduction: Relationship of styrofoam casting to investment and solid pattern casting.
2. Procedure for making the pattern.
3. Assembly of the pattern to the gates, sprue, and pouring cup.
4. Ramming of a styrofoam pattern.
5. Special safety precautions of styrofoam casting.
6. Pouring of the casting.
TECHNIQUES

Teacher guided demonstration. Select a student assistant to give the actual manipulative demonstration following your explanations.

ASSIGNMENTS

Read the handout: "Procedure for Making a Styrofoam Pattern and Casting"

REFERENCES

Swanson, Robert S., Plastics Technology (Bloomington) 1965, pp. 95 - 97 & 177 - 183.
INSTRUMENTS FOR EVALUATION

Committee:
William W. Davison, Chairman
Eugene J. Kirby
Edward R. Lee
Luther E. Saunders
INTRODUCTION

This chapter is devoted to Instruments for Evaluation. It consists of a series of tests and check sheets concerning the two Galaxies of Energy and Propulsion, and Materials and Processes. These are designed to help the teacher in selecting materials for instruction and as a reference for test samples involving fluid power, automotive mechanics, electricity, metalworking, woodworking, and plastics.
CHAPTER III

INSTRUMENTS FOR EVALUATION

Material Evaluation Guide

This evaluation guide is designed to be used by the teacher to assist him to get the most effective use of instructional materials.

Instructor ________________________ Subject ______________________ Date ______________________

low high

(not applicable) na 1 2 3 4 5
(circle one)

Organization

1. The class level was considered when selecting contents of material.

2. Clarity of objectives (purpose of lesson clear).

3. The individual parts of the lesson materials are clearly related to each other.

4. The material contributed an interesting and meaningful understanding of the lesson content.

5. The most effective material available was used.

Use of Materials

1. The information needed was available in the following media:
   (circle answer)

   Transparencies yes no
   Motion Pictures yes no
   Film Strips yes no
   Slides yes no
   Programmed Materials yes no
   Charts yes no
   Periodicals yes no
   Recordings yes no
2. Are other reference materials available in the classroom?  yes  no

3. Is this material available to other classes in the system?  yes  no

Quality of Audio and/or Visual Materials

1. Are contents in harmony with technological advancements and terminology?  na 1 2 3 4 5

2. Is the subject matter accurate?  na 1 2 3 4 5

3. Is the content of the material in proportion to the length of the instructional time allocated?  na 1 2 3 4 5

4. If the aid is one of a commercial nature, is the degree of advertising kept to a minimum?  na 1 2 3 4 5

5. Is it interesting to the student?  na 1 2 3 4 5

6. Are diagrams or charts clear and arranged for optimum instructional purposes?  na 1 2 3 4 5

7. Are titles, print, and notes large enough and arranged effectively so as to be easily read within the time available?  na 1 2 3 4 5

8. Are the visual materials attractive and in good condition?  na 1 2 3 4 5

9. Is the narrator's voice clear and easily understandable?  na 1 2 3 4 5

10. Sound effects (if any) are clear, sharp and representative of actual production.  na 1 2 3 4 5

11. Bulletin boards are attractive and kept up to date.  na 1 2 3 4 5

Tools and Equipment

1. Tools and equipment in good working order and is readily available for use in the class.  na 1 2 3 4 5

2. Safety precautions are posted clearly on machines.  na 1 2 3 4 5
3. Tools and equipment are attractively displayed and located so they can be found, used and replaced without difficulty.

4. Sufficient equipment and material is available for class to participate in class activity.

Comments:

Evaluated by ___________________
 Fluid Power Safety Questions

True-False (circle the correct answer)

T F 1. A machine operator should understand the function and operating principle of all the component parts of the machine.

T F 2. To safely operate a machine, one should understand the function and operation of the machine's control system.

T F 3. Loose fitting and comfortable clothing is necessary for the machine operator.

T F 4. When working with equipment using fluid power systems it is not necessary to wear safety glasses because of the fluid.

T F 5. Hasty emergency repairs may endanger life or damage the equipment.

T F 6. Preventive maintenance is costly and generally speaking it is seldom practiced in industrial applications.

T F 7. Contribute information to the safety and well-being of others.

T F 8. Hydraulic shock and damage to costly hydraulic components can be a result of operation of controls in a reckless manner.

T F 9. If the machine is equipped with an accumulator, be sure its pressure energy is released when preparing for shutdowns.

T F 10. A good method to temporarily stop a "pinhole" leak in a hydraulic circuit is to apply pressure over it with your finger. This is sometimes necessary to stop the leak while someone gets some plastic tape to permanently repair it.
FACILITIES

Committee:

ENERGY AND PROPULSION

John P. Novosad, Chairman
Lester Paige

MATERIALS AND PROCESSES

Orin L. Buchleither, Chairman
Edwin L. Munford
CHAPTER IV

FACILITIES

Introduction to Facilities

This chapter suggests ideal plans for Energy and Propulsion, and Materials and Processes laboratories. Both floor plans are designed for ninth and tenth grade level students. The Communications and the Personal Services Galaxies of the total Galaxy Plan have not been considered at this time, but it is imperative that all four Galaxies be considered in planning the total ideal facility.

The facilities for the Galaxy Plan can be adapted to the existing industrial education structure in a school. These ideal laboratories are designed to accommodate twenty-four students per teacher.

Each plan takes into consideration the maximum utilization of space by sharing equipment which may be common to various technologies within each Galaxy. The Materials and Processes facility is designed for study in materials testing, industrial woods, metals, plastics, and ceramics. The Energy and Propulsion plan includes facilities for engines, fluid power (hydraulics and pneumatics), electricity, and electronics.

All areas in each facility may be used simultaneously thus allowing for a greater variety of equipment and student experiences.
### CLASSROOM

1. 5-wheel polishing bench  
2. Bakelite mounting press  
3. Porcelain sink  
4. Brinell hardness tester  
5. Rockwell hardness tester  
6. Tensile tester  
7. Metallurgical microscope  
8. Book shelves  
9. Drafting tables  
10. Student desks  
11. Glass front display case  
12. Portable projector set  
13. Pull-down screen  
14. Overhead projector  
15. Demonstration bench  
16. Teacher's desk  
17. Chalk board  
18. Display board  
19. File

### INDUSTRIAL WOODS

20. Radial arm saw  
21. Table saw  
22. Jointer  
23. Band saw  
24. Scroll saw  
25. Pedestal grinder  
26. Drill press  
27. Tool storage  
28. Spindle shaper  
29. Disc sander  
30. Woodworking benches  
31. Planer  
32. Glue table  
33. Dust collector  
34. Wood lathe

### INDUSTRIAL PLASTICS

35. Extruding machine  
36. Injection molder  
37. Strip heater  
38. Plastic heating oven  
39. Refrigerator  
40. Pressure, vacuum, & mechanical forming machine  
41. Buffer  

### INDUSTRIAL CERAMICS

42. Ceramic kiln  
43. Wedging board  
44. Potter's wheel  
45. Clay cabinet

### INDUSTRIAL METALS

46. Stake plate bench  
47. Slip roll  
48. Box and pan brake  
49. Metal top bench  
50. Squaring shears  
51. Revolving machine stand  
52. Bar folder  
53. Bar and angle iron bender  
54. Gas welding unit, portable  
55. Gas welding unit, stationary  
56. Spot welder  
57. D. C. arc welder  
58. Welding booth  
59. A. C. arc welder  
60. Flexible shaft machine, portable, 1/2 hp

### FINISHING ROOM

61. Ventilation hood  
62. Crucible furnace  
63. Heat-treating furnace  
64. Furnace forge  
65. Molding bench  
66. Soldering bench  
67. Hydraulic bench  
68. Metal buffer  
69. Radial drill machine  
70. 20" drill press  
71. Metal cutting band saw  
72. Belt sander  
73. Power hack saw  
74. Vertical milling machine  
75. Horizontal milling machine  
76. Surface grinder  
77. Metal shaper  
78. 10" machine lathe  
79. 14" machine lathe  
80. Portable band saw  
81. Arbor press  
82. Bench grinder  
83. Machinists bench  
84. Machinists bench, vises  
85. Metal spinning lathe  
86. Surface plate  
87. Dust collector

### PROJECT STORAGE

95. Open shelves  
96. Student lockers

### MATERIAL STORAGE

97. Horizontal lumber rack  
98. Plywood stock rack  
99. Sheet metal rack  
100. Horizontal metal rack  
101. Short stock lumber rack  
102. Short stock metal rack

### GENERAL ITEMS

103. Portable work benches  
104. Portable tool panels  
105. Storage shelves  
106. Storage cabinet  
107. Loading dock  
108. Overhead roll-down door  
109. Water cooler  
110. First aid kit  
111. Half-round sink
BIBLIOGRAPHY

Committee:
John C. Ruppert
George T. Seriguchi
Joseph A. Wagner
BIBLIOGRAPHY

Energy and Propulsion

BOOKS


BOOKLETS

"Aids to Educators". Educational Relations Section, Public Relations Staff, General Motors Corporation.

"Curtiss-Wright's Experimental Rotating Combustion Engines". Wright Aeronautical Division, Curtiss-Wright Corporation.

"Hydraulic Fundamentals and Industrial Hydraulic Oils". Sun Oil Company, Industrial Products Department.


FILMS

"Application of Pascal's Law" Part I 15min/16mm. color. United World Films, Government Film Department.

"Automation Today" 15min/16mm. B&W. Supervisor, Training Department, Ford Motor Company.

"Basic Hydraulics" 15min/16mm. United World Films, Government Film Department.

FILM STRIPS

"Pneumatic Circuitry". Parker-Hannifin Corporation.

TRANSPARENCIES

Vega Hydraulic Power Training, Box 1006, Decatur, Illinois.

TRAINING FILM SOURCES

Film Library, Public Relations Section, General Motors Corporation
Modern Talking Pictures
School Assistance Department, Perfect Circle Corporation

Materials and Processes

BOOKS


AUDIO VISUAL MATERIALS INDEXES


Experienced Teacher Fellowship Program

Industrial Materials and Processes

Buchleiter, Orin, 4217 Douglas MacArthur, N.E., Albuquerque, New Mexico 87110
Carson, William H., 2223 Hurst Street, Columbia, South Carolina
Davis, Terry, 11803 North Lane, Apartment 5, Lakewood, Ohio 44107
Gray, Edwin A., 9149 Pinebrook Drive, Montague, Michigan 49437
Kirby, Eugene J., 172 Mt. Vernon Street, Arlington, Massachusetts 02174
McLea, Kenneth R., 123 Miramar Avenue, San Francisco, California 94112
Mose, Howard, 24903 South Sylvan Drive, Detroit, Michigan 48239
Munford, Edwin L., Box 26, Parowan, Utah 84761 (Please forward)
Olivo, Thomas P., 169 Rosemont Street, Albany, New York 12206
Saunders, Luther, 13637 Tuller Avenue, Detroit, Michigan 48238
Serenbetz, Robert L., 217 Delaware Rd., Kenmore, New York 14217
Vicroy, Roger, 235 E. Walnut Street, Westerville, Ohio

Energy and Propulsion

Aronson, Robert, 14944 Mark Twain, Detroit, Michigan 48277
Bridges, Victor, 468 East 1st Avenue, Chico, California 95926
Butler, Carl, P. O. Box 181, Howland, Maine 04448
Davison, William, 305 Jackson, Hugoton, Kansas 67951
Haan, Orville, 6723 12th Avenue, Jenison, Michigan
Hornchek, Richard, 406 McClellan Avenue, Trenton, New Jersey 08610
Lee, Edward R., 1217 Donald, Royal Oak, Michigan 48073
Novosad, John, 19325 Rock, Roseville, Michigan 48066
Paige, Lester, 1583 McCallie Boulevard N.W., Atlanta, Georgia 30318
Ruppert, John C., 2999 Riverside Drive, Pomona, California 91766
Seriguchi, George, 8045 Randy Drive, Westland, Michigan 48135
Wagner, Joseph, 717 East 2nd Street, Lima, Ohio 45804