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Factors Involved in Establishing Power Mechanics in the Industrial Arts Curriculum at Morgan Junior High School, Ellensburg, Washington

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FACTORS INVOLVED IN ESTABLISHING POWER MECHANICS
IN THE INDUSTRIAL ARTS CURRICULUM AT
MORGAN JUNIOR HIGH SCHOOL,
ELLENSBURG, WASHINGTON

A Thesis
Presented to
the Graduate Faculty
Central Washington State College

In Partial Fulfillment
of the Requirements of the Degree
Master of Education

by
Donald Wallace McInnis
August 1964

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PREFACE

This study has been made in an effort to provide information necessary for an analytical approach to the problem of introducing power mechanics into the industrial arts program at Morgan Junior High, Ellensburg, Washington.

It is hoped that, as a result of this study, industrial arts instructors and administrative personnel in similar junior high school situations may be better informed, and will be cognizant of the problems involved in introducing this area of study.

TABLE OF CONTENTS

CHAPTER	PAGE
I. THE PROBLEM AND DEFINITIONS OF TERMS	1
The Problem	1
Definition of Terms	1
Power mechanics	1
Industrial arts	2
General shop	2
Unit shop	2
General education	2
Course outline	3
Laboratory experience	3
Mock-up	3
Cut-away	3
Tune-up	3
II. DEVELOPMENT OF POWER MECHANICS	4
III. VALUE AND PERTINENCE OF POWER MECHANICS	
IN LOCAL PROGRAM	6
IV. ADAPTABILITY OF POWER MECHANICS TO EXISTING	
PHYSICAL SITUATION	9
Class size and space needed	9
Investigation of existing facilities	10
V. ADAPTABILITY OF POWER MECHANICS TO EXISTING	
SCHEDULE	12
Investigation of Electives	12

CHAPTER	PAGE
Proposed Schedule Change	13
VI. COST OF PROGRAM	14
Equipment	14
List of tools on "Proto" tool panel	16
List of supplemental hand tools not found on the "Proto" panel	19
Tools on hand	20
Miscellaneous equipment	20
Testing equipment	21
Permanent Fixtures	21
Instructional Aids	22
Books	22
Wall charts and audio visual materials	23
Engines	23
Cost of Required Space	23
Cost of Instruction	23
Total Cost	24
VII. SUMMARY AND RECOMMENDATIONS	25
BIBLIOGRAPHY	26
APPENDIX	28

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS

In the teaching of industrial arts several problems are constantly encountered. Foremost of these is the necessary re-evaluation of the curriculum to provide a program which truly represents the rapidly changing industrial complex in our country.

I. THE PROBLEM

When a subject matter area is being considered in a local situation the following points must be investigated; (1) the value and pertinence of the offering to the total local industrial arts program, (2) the possibility of using the existing physical plant, (3) the possibility of modifying the existing schedule to include the new offering, and (4) the cost of the new offering.

The intent of this paper is to investigate the above factors as they apply to the introduction of power mechanics into the industrial arts curriculum at Morgan Junior High, Ellensburg, Washington.

II. DEFINITION OF TERMS

Power mechanics. A term given to the course of

study which in the broadest sense gives meaning by application to the basic principles of mechanical systems found on our commonly used machines, vehicles, and appliances. The subject is traditionally taught with the small gasoline engine as the basis of instruction.

Industrial arts. Industrial arts can be defined as those phases of general education which deal with industry--its organization, materials, occupations, processes, and products--and with problems resulting from the industrial and technological nature of society.

General shop. The term general shop has been given to a shop program which selects subject matter from a wide variety of industrial activities. The scope of subject matter will vary with the size of the school, size of the shop building, and location of the school. These activities are usually carried on in one room, under one teacher, and at the same time.

Unit shop. The unit shop is an instructional arrangement dealing with a single area of industry.

General education. General education has been defined as a broad type of education aimed at developing attitudes, abilities, and the behaviors considered desirable by society, but not necessarily preparing the learner for

specific types of vocational or avocational pursuit.

Course outline. A course outline is a brief description of the material to be presented, the method of presentation, the time sequence of the presentation, and the procedures used in the presentation.

Laboratory experience. This term is used to describe a shop or manipulative situation where the student is actually working with tools and materials.

Mock-up. A mock-up is a three dimensional representation of an actual object.

Cut-away. A cut-away is an actual object which has been cut or sectioned to reveal the internal area.

Tune-up. This term is given to the process of adjusting an engine until its best performance is obtained.

CHAPTER II

DEVELOPMENT OF POWER MECHANICS

The history of industrial arts in the public school systems has seen a gradual change in curricular emphasis to meet the needs of changing technology. The first primary field was woodworking, with drafting, metalworking, and electricity joining the curriculum later as major areas. To quote John Glenn, an experienced power mechanics teacher at Hughes Junior High School, Long Beach, California: "actually each new course is essentially a shift in emphasis, depending on the skill level to be achieved" (3-22). With this shift of emphasis in mind one can trace the beginning of power mechanics back to the 1940's.

During the years following World War II the need for instruction in power and transportation became apparent to educators. Dr. William E. Warner observed the areas of industrial arts instruction are much broader than in the past, and should included instruction in construction, power, transportation, and communication (7-141).

Gradually educators began to feel the need for an offering to closely parallel the auto mechanics programs then in existence. The new offering would be similar to auto mechanics, but limited in laboratory experience and broader in coverage. This new offering would make possible

the study of practical power situations in the small high school. In fact, as John W. Walgren, supervisor of Industrial Arts Education, Illinois Board of Vocational Education stated: "The small high school which cannot offer instruction in auto mechanics might find that a course in small engines would partially satisfy the desire of boys to participate in an auto mechanics course . . ." (8-19).

The new course, which became known simply as "power mechanics," offered not only instruction in the internal combustion engine, but all commonly known methods of power development. The course content has been successfully adapted to the junior high school, in fact one reference indicated success with a nine week offering (2-47).

Power mechanics is now included in state guides for industrial arts. From the direction our technology is moving it seems that power mechanics is a legitimate subject offering in industrial arts.

CHAPTER III

VALUE AND PERTINENCE OF POWER MECHANICS IN LOCAL PROGRAM

The industrial arts program at Morgan Junior High School is divided into elective and required areas. The elective classes consist of crafts at the seventh grade level and a woodworking and metalworking class at the ninth grade level. The required classes consist of a one semester seventh grade woodworking class and a one semester eighth grade mechanical drawing class.

Under present conditions, the only industrial arts offered at the eighth grade level is mechanical drawing. The lack of other eighth grade classes in industrial arts limits the students opportunity in this area.

With the present scheduling of the industrial arts classrooms there is much available space. The metal shop, for example, is scheduled for only one half the school day during one semester, and not at all the other semester of the year.

By definition the junior high school level industrial arts program is an exploratory experience. The Washington State Industrial Arts Curriculum Guide provides us with the following:

At the junior high school level, industrial arts provides exploratory experiences with tools and materials

of drawing, wood, metal, plastic, leather, ceramics, electricity, graphic arts, power mechanics and other fields. Industrial arts helps the junior high school student to discover his abilities, interests and capacities in as many areas as possible. The development of skills and the exploratory value of industrial arts at this level are most important (9-67).

To meet the full recommendation of the state curriculum guide would be possible only in a large junior high school with many general shop situations. In the smaller junior high school the full complement of course offering is not possible; thus a crucial decision rests with the industrial arts faculty and administration to provide the best possible course offering in the existing physical situation.

The present industrial arts program at Morgan Junior High School provides experiences in wood, metal, leather, copper tooling, enameling, and mechanical drawing. Of this selection only the wood and mechanical drawing experience are required of all boys.

More breadth in subject matter offering would be of benefit in the Morgan Junior High School program, however, this additional breadth of experience must not be made at the expense of valid subject matter. The new offering must not only satisfy the existing needs, but must be compatible with the existing schedule and shop space.

Power mechanics would be of benefit in the local situation. The use of small gas engines extends from the

poorest to the wealthiest family, and from the city dweller to the farmer. As we are involved in leisure activities a good share of the time, the use of outboard motors, small motor-cycles, tote-goats, and go-carts increases constantly. The basic knowledge of the operating principles and proper operation of engines is an essential part of making a living to a sizable portion of our population. The farmers in the local area are an example of this, and have many children in the public schools.

CHAPTER IV

ADAPTABILITY OF POWER MECHANICS TO EXISTING PHYSICAL SITUATION

The proposed program will consist of a laboratory and classroom phase, which need not be presented in the same room. The laboratory phase will include student work on disassembly and assembly of small gas engines, tune-up of practice engines and minor overhaul of the engines. The classroom phase will involve work in the text book, demonstrations, and discussion.

Class size and space needed. The class size for the proposed program has been set at twenty four students, a figure realistic from both a scheduling and instructional standpoint. This figure will probably vary with student interest and the number of class periods available. The space needed for such a class depends upon the number of boys at each work station. Four boys can work at each station, according to Charles E. Risher, a power mechanics teacher who has published many articles on the subject (5-48). Six work stations will be the minimum space requirement for the laboratory portion. These work stations should consist of durable benches with vises and storage space.

The classroom needs involve only adequate seating

space with a blackboard and demonstration table.

Investigation of existing facilities. The present metalworking shop is the most desirable location for power mechanics laboratory instruction. This room is sixty-six by twenty-eight feet with the majority of the area devoted to six benches. These benches are wooden with three inch tops and four by six legs. They measure thirty-two inches tall, twenty-six inches wide and ten feet long. Each is equipped with a four inch machinist's vise at each corner. The lower area is closed storage measuring twenty-nine cubic feet per bench. One disadvantage to the metal shop is the lack of extra storage space which could be used for power mechanics material.

For the classroom portion of the proposed program both the existing woodworking and crafts rooms are satisfactory. Both are near the metal working area and are well suited to industrial arts use.

The present industrial arts area seems readily adaptable to a power mechanics program, in terms of both laboratory and classroom needs.

CHAPTER V

ADAPTABILITY OF POWER MECHANICS TO EXISTING SCHEDULE

The addition of the proposed class to the eighth grade schedule necessitates the consideration of two approaches to altering the existing schedule, The first approach would be to offer power mechanics as an additional elective for boys only, while the second would involve the removal of an existing elective. In either case the girls would need to be assimilated into other electives, as power mechanics has traditionally been for boys only.

I. INVESTIGATION OF ELECTIVES

In the investigation of the eighth grade electives the following course descriptions have been used. The list is taken from the Morgan Junior High School enrollment material.

- A. Chorus (vocal) This is a special interest area and enrollment will be limited to qualified students as determined by a screening program by the music teacher.
- B. Band (instrumental) Student should already be able to play an instrument suited for use in a band. Enrollment will be limited to qualified students.

- C. Safety Education. This is a class in general safety, with units of work on safety in the home; safety in public buildings; safety for pedestrians; bicycle safety; safety with fire arms; safety in recreation; and a special unit on water safety at the Y.M.C.A. pool.
- D. Expression. Training in clear and accurate oral and written expression. Units of work in speech, radio, dramatics, creative writing and related activities will be included.
- E. American Historical Biography. This is an interesting and valuable academic class which will enrich both of the required offerings in American History and Literature. Good biographical literature of great American men and women and their contribution to the development of our nation will be studied. Students of average and above average ability in reading should find this class of interest and value.
- F. Spanish. Students who have taken Spanish in the 7th grade will have an opportunity to continue another semester of Spanish in the 8th grade, provided their work in the 7th grade indicates that they are qualified to do this.

Students who are enrolled in Spanish will have this class in place of the one semester of reading and literature.

II. PROPOSED SCHEDULE CHANGE

The most practical solution involves the removal of one co-educational elective to make room for the power mechanics class. This decision is based upon discussions with Mr. Lannes E. Purnell, principal of Morgan Junior High School.

Safety education has a history of being made up predominantly of boys, thus making it the logical choice for removal. In removing safety education the few girls displaced would be assimilated by the other classes. Also, it is not part of an established sequence as is the case of Spanish and expression. The proposed power mechanics class will stress safety in practical application, thus paralleling safety education.

From the above investigation there seems ample evidence that the present eighth grade schedule can be modified to include the proposed power mechanics program.

CHAPTER VI

COST OF PROGRAM

The intent of the proposed power mechanics program is to remain in the exploratory phase of learning, that is, to give the student an insight into the basic principles of gasoline engine operation and maintenance, without extending into the more complicated areas of major engine overhaul.

I. EQUIPMENT

There are several methods of making tools available to all students. As the students are divided into work station groups of four, one logical alternative would be to provide a complete set of hand tools for each work station. The second alternative would be to provide tools at a central tool panel for use of the entire class.

It is the opinion of Wendell Howard, who has successfully introduced power mechanics into a general shop situation, that the separate set of hand tools for each work station is the best approach. He felt that the continuity of the class work was not disturbed by needless trips to the tool panel when tools were provided at the immediate area (4-35).

A centrally located tool panel is better, according

to Charles G. Risher, author of the article, "Tools and Equipment for Power Mechanics." His argument was based upon the assumption that few school districts can afford a complete set of hand tools for every four students in a power mechanics class. He also felt that better security is possible with a centrally located locked panel, especially in the event that the power mechanics area is used for other class work (6-14).

With the lack of adequate tools on hand in the metalworking area, the second alternative of placing the power mechanics tools in locked panels is recommended.

The "Proto" tool company has foreseen this need and can supply a complete panel of tools for power mechanics use. "Proto" tools have a reputation of high quality and are widely accepted by industry. The tool panels are designed to be hung in a cabinet or exposed on a wall, and are of the type which has a striped shadow behind each tool for easy identification of missing tools. The tool panels are not complete in every respect, but provide a nucleus of good quality tools which are easy to store and are readily available.

For the proposed program one of these panels at each end of the working area would supply the essential hand tools for the entire class. Additional tools not found on

the panels could be stored on similar pegboard panels in the same storage cabinets. Testing equipment could be stored in these cabinets, or in a separate locked cabinet.

The above hand tool proposal is recommended for the following reasons:

- A. The tool panels are neat and businesslike in appearance and they tend to stress orderliness and proper care.
- B. Tool security is easy to maintain because of the ease of visual check from any position in the shop. Individual tool boxes placed at each bench would necessitate a check at the end of each class period, and could easily be overlooked.
- C. The tools on the "Proto" panels are selected specifically for power mechanics use and are of high quality.

List of tools found on "Proto" tool panel.

Quantity	Description	Price each
1	Ignition Gauge Set	\$ 1.35
1	Brake Gauge Set	1.35
1	Spark Plug Gauge Set	1.39
1	Offset Screwdriver 1/4" Bit	1.09
1	Cold Chisel, 5/16" Cut	.79

Quantity	Description	Price each
1	Cold Chisel, 7/16" Cut	\$.95
1	Cold Chisel, 5/8" Cut	1.19
1	Drift Punch	1.09
1	Lever Wrench Plier, 8"	2.89
1	Dinging Hammer	4.25
1	Pecking Hammer	4.19
1	All Purpose Dolly	6.55
1	Screw with 2 Tips	2.99
3	Reversible Jaws	2.15
1	Yoke for two Puller Jaws	2.55
1	Adjusting Nut	.89
3	Outside Jaw	2.45
1	Yoke for Three Jaws	3.55
1	Allen Wrench Set in Kit	2.15
1	Short Square Blade Screwdriver	1.99
1	Multi Plier, 7 3/4"	3.49
1	Utility Slip Joint Plier, 9 3/4"	3.59
1	Slip Joint Plier, 6 1/2"	1.57
1	Adjustable Wrench, 8"	3.29
1	Combination Wrench 5/16"	1.55
1	Combination Wrench 3/8"	1.65
1	Combination Wrench 7/16"	1.95
1	Combination Wrench 1/2"	2.06
1	Combination Wrench 9/16"	2.19

Quantity	Description	Price each
1	Combination Wrench 3/8"	\$ 2.39
1	Combination Wrench 3/16"	2.69
1	Combination Wrench 3/4"	2.79
1	Combination Wrench 13/16"	3.59
1	Combination Wrench 7/8"	3.89
1	Midget 1 3/4 x 15/64 Open end Wrench	1.15
1	Midget 7/32 x 1/4 Open End Wrench	1.15
1	Midget 9/32 x 5/16 Open End Wrench	1.15
1	Midget 11/32 x 3/8 Open End Wrench	1.15
1	Square 13/16" Spark Plug Socket	1.75
1	3/8" Square Drive, 6 point, 5/16 Socket	.95
1	3/8" Square Drive, 6 point, 3/8" Socket	.95
1	3/8" Square Drive, 12 point, 7/16" Socket	.95
1	3/8" Square Drive, 12 point, 1/2" Socket	.95
1	3/8" Square Drive, 12 point, 9/16" Socket	.95
1	3/8" Square Drive, 12 point, Socket	.99
1	3/8" Square Drive, 11/16" 12 point, Hexagon Socket	1.05
1	3/8" Square Drive, 3/4" point, Hexagon Socket	1.05
1	3/8" Square Drive, 13/16" 12 point, Hexagon Socket	1.09

Quantity	Description	Price each
1	3/8 Square Drive, 7/8" 12 point, Hexagon Socket	\$ 1.15
1	Square 1/4" Screwdriver Socket	1.85
1	3/8" Square Drive, Reversible Ratchet	6.19
1	3/8" Square Drive Extension 3 1/2"	1.55
1	No. 2 Phillips Screwdriver	1.59
1	1/4" Bit 8" Square Blade Screwdriver	1.29
1	5/16" Bit 10" Square Blade Screwdriver	1.69
1	3/8" Bit 13" Square Blade Screwdriver	2.05
1	3/8" Bit 6 1/4" Square Blade Screwdriver	.79
	Single Complete Panel Price	\$95.25

List of supplemental hand tools not found on the "Proto" panel. The following tools are necessary to complete the recommended complement of hand tools. The quoted prices are current catalog listings of high quality American made tools.

Quantity	Description	Price each	Total
2	6" Needle Nose Plier	\$ 3.80	\$ 7.60
1 dozen	Contact Point File	2.05 dozen	2.05
4	Soft Face Hammer	3.00	12.00
1	Piston Ring Compressor	1.98	1.98
1	Piston Ring Expander	1.67	1.67

Quantity	Description	Price each	Total
1	Piston Groove Cleaner	\$ 3.98	\$ 3.98
1	Valve Spring Compressor	5.72	5.72
1	Valve Seat Cutter and Grinder	11.85	11.85
1 set	Telescope Gauges	4.35	4.35
1 set	Outside Micrometer 9-3"	51.70	51.70
1	Torque Wrench 3/8" Drive	7.89	7.89
1	Cylinder Hone	9.69	9.69
1	Set Screw Extractor	2.50	2.50
1	Tubing Cutter and Flaring Tool	7.90	7.90
1	Wrist Pin Plier	2.65	2.65
1	Soldering Gun	9.60	9.60
	Total Cost of Supplemental Tools		\$144.13

Tools on hand. The following tools are on hand in the present industrial arts department.

Quantity	Description
1 set	Twist Drills 1/16-1/2"
1	Hand Drill, 1/4" Capacity, Electric
1 set	Tap and Die set 1/8-3/4" NF and NC
4	Hammer, Ball Peen 12 oz.

Miscellaneous equipment. Several items will be

necessary for the proposed program which are not easily classified under the previous equipment headings.

Quantity	Description	Cost
1	Oily Waste Can	\$ 9.45
1	Oil Storage Can	.50
1	Gasoline Storage Can	2.80
Total Miscellaneous Equipment Cost		\$ 12.75

Testing equipment. For the proposed program several items of basic test equipment will be necessary for instruction in modern methods of engine tune up. Following is a list of recommended testing equipment.

Quantity	Description	Price
1	Magneto Coil and Condenser Tester # 603	\$59.50
1	Compression Gauge #AG-32	5.35
1	RPM Indicator	12.70
Total Cost of Test Equipment		\$77.55

II. PERMANENT FIXTURES

The permanent fixture involved in the proposed program will include benches, vises, and storage facilities. The metalworking area contains six benches previously described in this study. Each bench is equipped with four machinist vises. Both the benches and vises are adequate for the proposed program.

Separate storage area must be provided, as other industrial arts classes are taught in the same room. As no adequate storage is available, cabinets must be either purchased or constructed. A satisfactory cabinet, advertised by Brodhead Garrett is as follows:

The cabinet is steel, measures thirty-six inches by twelve inches deep and eighty-seven inches high. The tool storage area is sixty inches high and is fitted with peg-board. It contains twelve bins and eight drawers for parts storage. The cost is \$102.00 unassembled.

Two cabinets similar to the one described above are necessary for complete tool security and classroom availability.

III. INSTRUCTIONAL AIDS

Books. The two books available for exploratory power mechanics are "Exploring Power Mechanics," by Harold T. Glenn, and "Power Mechanics," by Pat H. Atteberry. The book by Glenn is written for high school use, and is too advanced for the eighth grade level. The book by Atteberry is written for use in the junior high school, and is the more desirable of the two. This book is published by Goodheart-Willcox of Chicago, Illinois. The school price of the book is \$1.76 per copy. At this price an initial set of twenty-four books would cost \$42.24.

Wall charts and audio visual materials. Free wall charts and instructional pamphlets may be obtained by writing to either of the following: Briggs and Stratton Corporation, Milwaukee, Wisconsin or L. S. Starrett Company, Athol, Massachusetts. Film strips and educational films are available upon request from the film libraries of Central Washington State College, University of Washington, and Washington State University (9-68).

Engines. It is possible to obtain junk engines for demonstration purposes from the Triangle Auto Wrecking Company of Ellensburg or other wrecking yards for the regular junk price of five cents a pound. At this rate four small one cylinder engines could be obtained for approximately five dollars.

IV. COST OF REQUIRED SPACE

Due to the scheduling of the metalworking class on a one semester basis, and only for three class periods a day at the most, it is evident that the power mechanics class can be scheduled into this area without the need of new facilities. Therefore, no additional cost will be incurred.

V. COST OF INSTRUCTION

To determine the cost to the school district the

following formula has been used: The average salary received by teachers in the Ellensburg school district has been divided by six. The six represents the number of class periods in the junior high school day. The quotient represents the average yearly pay for one class period of instruction. By means of the above formula the cost has been found to be \$1001.00. This figure applies only if the power mechanics course doesn't replace an existing class. If the power mechanics class replaces an existing class, the instruction cost would remain the same.

VI. TOTAL COST

The overall cost of the program has been computed with power mechanics as an additional class.

Equipment

1. Tool panels	\$ 190.50
2. Supplemental tools	144.13
3. Miscellaneous equipment	12.75
4. Testing equipment	77.55
5. Cabinets	204.00

Instructional Aids

1. Books	42.24
2. Engines	5.00

Instruction 1001.00

Total Cost \$1607.07

CHAPTER VII

SUMMARY AND RECOMMENDATIONS

I. SUMMARY

Power mechanics, as an accepted offering in the contemporary industrial arts curriculum has been presented as a possible enrichment to the Morgan Junior High School subject offering. The emphasis of the study has been on the lack of laboratory experience at the eighth grade level, which can be rectified by the proposed addition.

Several possibilities for use of available space and time have been investigated to show the adaptability of the existing program to the addition of power mechanics. An investigation of cost involved has been presented to provide the local administration with information vital to making a decision on adoption of the proposed program.

II. RECOMMENDATIONS

The result of this study is a positive recommendation for the adoption of the proposed power mechanics program. This will involve modifying the existing class schedule, room schedule and industrial arts teacher schedules to accommodate the class in power mechanics. Storage must be provided in the metalworking area. Tools, books, and equipment as listed will need to be purchased.

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APPENDIX

COURSE OUTLINE

The following outline is offered as a suggested guide for the proposed power mechanics course of eighteen weeks duration at Morgan Junior High, and includes subject matter suitable to the eighth grade level. The units are arranged to correspond with the recommended text, "Power Mechanics," by Pat H. Atteberry, which closely parallels the recommendations of the Washington State Industrial Arts Curriculum Guide (8-67).

UNIT I

Title: Types of Engines

Time: One and one-half weeks

Information: A. Piston Engines

1. Four cycle

2. Two cycle

3. Diesel

B. Jet

C. Turboprop and turbojet

D. Rocket

E. Electric motors

Teacher Activities: A. Demonstrate difference between two cycle and four cycle engines.

B. Demonstrate steam pressure.

C. Demonstrate rocket power, using toy rocket.

D. Show film, "ABC of Automobile Engines."

Student Participation:

A. Disassemble four cycle and two cycle engines.

B. Prepare report on diesel engines.

C. Prepare list of uses of engines.

UNIT II

Title: The Piston Engine

Time: Two and one half weeks

Information: A. Measurement of size

1. Bore and stroke

2. Piston displacement

3. Compression ratio

4. Horsepower

B. Basic engine parts

1. Block

2. Cylinder head

3. Pistons

4. Valves

5. Crankshaft

Teacher Activities: A. Assign computation of piston displacement.

B. Assign comparison of compression ratio between new and older cars.

- C. Assign research on hydraulic valve lifters.
- Student participation:
- A. Measure shop engines and compute piston displacement.
 - B. Look up compression ratio of diesel engines.
 - C. Disassemble a hydraulic valve lifter.

UNIT III

Title: Fuel Systems

Time: Two weeks

- Information:
- A. Source of fuels
 - B. Carburetion
 - C. Fuel pumps

- Teacher Activities:
- A. Demonstrate Venturi effect with hand sprayer.
 - B. Show film "Gasoline Engine"
 - C. Adjust carburetor on running engine to show effect of needle valve and idle adjustments.

- Student Participation:
- A. Disassemble an automobile carburetor.
 - B. Obtain samples of unleaded and leaded gasoline and report the difference noted.
 - C. Write a report on the operation of an automatic choke.

UNIT IV

Title: Ignition Systems

Time: Two and one half weeks

- Information:
- A. Electric ignition
 - 1. Magneto
 - 2. Battery
 - B. Diesel ignition
 - C. Basic election theory
 - D. Electric circuits
 - 1. Lighting
 - 2. Service
 - 3. Starter
 - 4. Ignition
 - 5. Generator
 - E. Alternators
 - F. Spark plugs

- Teacher Activities:
- A. Demonstrate source of electrical current with magnets.
 - B. Demonstrate operation of storage batteries with cut-away battery.
 - C. Demonstrate setting spark plug gap.
 - D. Show film "Ignition and Spark Plugs"

- Student Participation:
- A. Disassemble magneto and locate magnets.
 - B. Disassemble and automobile generator.
 - C. Prepare a report on transistor ignition.

UNIT V

Title: Cooling Systems

Time: One and one half weeks

Information: A. Water cooled engines
B. Air cooled engines
C. Engine temperature
D. Cooling system components
 1. Radiator
 2. Thermostat
 3. Water pump
E. Antifreeze

Teacher Activities: A. Demonstrate thermostat opening and closing by heating thermostat in pan of water.
B. Explain principles involved in the radiation of heat from cast fins of air cooled engines.

Student Participation: A. Obtain a leaky radiator and repair with solder.
B. Test pressure of water system by applying air pressure to tank until cap spring lifts.

UNIT VI

Title: Engine Bearings and Lubrication

Time: Two and one half weeks

Information: A. Types of bearings

1. Ball
 2. Roller
 3. Needle
 4. Sleeve
- B. Oil clearance in bearings
- C. Types of engine lubrication
1. Splash
 2. Pressure
- D. Oil filters
1. By-pass flow
 2. Full flow
- E. Characteristics of oil
1. Viscosity
 2. Detergents

- Teacher Activities:
- A. Demonstrate use of various types of bearings.
 - B. Demonstrate shimming a connecting rod.
 - C. Demonstrate oil pump operation.
 - D. Demonstrate cut-away oil filter.
 - E. Assign reports on above topics.
 - F. Show film "Why of Automotive Lubrication."

- Student Participation:
- A. Disassemble an old engine and examine the bearings.
 - B. Obtain an old oil filter and cut it in half to determine the type.

- C. Obtain samples of various viscosity oil and report on the differences noted.

UNIT VII

Title: Power Transmission

Time: Two and one half weeks

Information: A. Power Train

1. Clutch

2. Transmission

3. Propeller shaft and universals

4. Differential

B. Belt drives

C. Friction drives

D. Chain drives

Teacher Activities: A. Demonstrate operation of gears by means of gearing mock-up or similar device.

B. Demonstrate fluid coupling by running one electric fan with another.

C. Demonstrate differential operation with cut-away of automobile differential.

Student Participation: A. Disassemble a junked automobile transmission.

B. Disassemble a motor scooter automatic clutch.

- C. Disassemble a universal joint and determine the type of bearings used.

UNIT VIII

Title: Service and Trouble-shooting

Time: Three weeks

- Information:
- A. Engine maintenance
 - B. Starting engines
 - C. Trouble-shooting engine problems
 - D. Engine storage

- Teacher Activities:
- A. Demonstrate the use of the timing light.
 - B. Demonstrate the step-by-step procedure of engine tune up.

- Student Participation:
- A. Practice correct tune-up procedure.
 - B. Check engine compression and valve timing.
 - C. Determine causes of malfunction of practice engines.

UNIT IX

Title: Control Devices

Time: One week

- Information:
- A. Governors
 - 1. Fly-ball
 - 2. Overload
 - B. Throttle and spark regulators

1. Hand throttle
2. Governor controlled throttle
3. Hand spark control

Teacher Activities: A. Demonstrate fly-ball governor principle with model.

B. Demonstrate retarding and advancing spark with tractor magneto.

Student Participation: A. Disassemble governor on small engine to determine the type and operation.

B. Observe action of governor on engine operating on an intermittent load.