GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

ENGINEERING & TECHNOLOGY

COURSE: Technological Systems

UNIT 4: Fluid Power – Syringe Crane

INTRODUCTION

Annotation:

In this unit students will define components of fluid power systems and apply basic fluid power concepts in the construction of a crane using syringes as fluid power actuators.

Grade(s):

	6th
	7th
X	8th

Time:

7 hours

Author:

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Students with Disabilities:

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided appropriately. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation. Many students (both with and without disabilities) who struggle with reading may benefit from the use of text reading software or other technological aids to provide access to printed materials. Many of these are available at little or no cost on the internet.

FOCUS STANDARDS

GPS Focus Standards:

ENGR-TS-2- The students will develop an understanding of how the design process is used to develop a technological system.

a) Identify the steps of the design process

b) Identify how systems are used in a variety of settings

c) Illustrate how the systems model is utilized in the production of goods

d) Construct and work with a variety of systems, including Engineering, Electronics, Manufacturing, and Energy

ENGR-TS-3- The students will develop an understanding of how humans interact with systems.

a) Operate technological systems

b) Maintain technological systems

c) Constructing technological systems

d) Design technological systems

ENGR-TS-7- Students will develop leadership skills and work ethics.

a) Demonstrate work ethics within the classroom and lab environment

GPS Academic Standards:

M8A1 Students will use algebra to represent, analyze, and solve problems.

M8A3 Students will understand relations and linear functions.

UNDERSTANDING & GOALS

Enduring Understandings:

Students will identify basic fluid power components used in pneumatic and hydraulic systems and then apply that knowledge in their design and construction of a crane powered by syringes and built using K'nex blocks, or any other suitable building materials.

Essential Questions:

- What is a fluid power system?
- What are hydraulic and pneumatic systems?
- How can we apply fluid power to the construction of a lift?
- How are mathematics used to evaluate fluid power systems?

Knowledge from this Unit:

Students will…

- Be able to define fluid power.
- Understand the basic concepts of hydraulics and pneumatic systems.
- Utilize the engineering design process to construct a crane powered by syringes.
- Use mathematical skills to calculate the area of an actuator, and the force and pressure of fluid power

Skills from this Unit:

Students will…

- Define fluid and fluid power.
- Analyze the impact of fluid power systems on our economy and careers.
- List the basic parts used in a fluid power system.
- Compare the hydraulic and pneumatic systems.
- Design and construct a fluid powered syringe crane.
- Evaluate fluid power systems using basic mathematical skills.

ASSESSMENTS

Assessment Method Type:

____ Pre-test
X Objective assessment - multiple-choice, true- false, etc.
  X Quizzes/Tests
  __ Unit test
X Group project
____ Individual project
X Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
  __ Self-check rubrics
  __ Self-check during writing/planning process
  __ Journal reflections on concepts, personal experiences and impact on one's life
  __ Reflect on evaluations of work from teachers, business partners, and competition judges
  __ Academic prompts
  X Practice quizzes/tests
X Subjective assessment/Informal observations
  __ Essay tests
  X Observe students working with partners
  __ Observe students role playing
____ Peer-assessment
  __ Peer editing and commentary of products/projects/presentations using rubrics
  __ Peer editing and/or critiquing
X Dialogue and Discussion
  __ Student/teacher conferences

__ Partner and small group discussions
X_ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners

X Constructed Responses
__ Chart good reading/writing/listening/speaking habits
X_ Application of skills to real-life situations/scenarios

X Post-test

Assessment(s) Description/Directions:

Use the attached PowerPoints to lead class discussions. Unit is broken down into four areas; Introduction to Fluid Power, Hydraulic and Pneumatic Systems, Syringe Crane Challenge, and Using Mathematics to Evaluate Fluid Power Systems.

Attachments for Assessment(s):

ENGR 8-4 Syringe Crane Challenge Rubric
ENGR 8-4 Deal or No Deal - Fluid Power
ENGR 8-4 Fluid Power Quiz

LESSON PLANS

• LESSON 1: INTRODUCTION TO MANUFACTURING (Use PowerPoint and Issue Note-taking Guides)

1. Identify the Standards. Standards should be posted in the classroom for each lesson.

ENGR-TS-2- The students will develop an understanding of how the design process is used to develop a technological system.

a) Identify the steps of the design process

b) Identify how systems are used in a variety of settings

c) Illustrate how the systems model is utilized in the production of goods

d) Construct and work with a variety of systems, including Engineering, Electronics, Manufacturing, and Energy

ENGR-TS-3- The students will develop an understanding of how humans interact with systems.

a) Operate technological systems

b) Maintain technological systems

c) Constructing technological systems

d) Design technological systems

ENGR-TS-7- Students will develop leadership skills and work ethics.

a) Demonstrate work ethics within the classroom and lab environment

2. Review Essential Question. Essential Questions should be posted in the classroom for each lesson.

- What is fluid power?

3. Identify and review the unit vocabulary. Word Wall should be posted in the classroom for unit.

Fluid	Pascal's Principle
Fluid Power	Pressure
Hydraulic	Compressor
Pneumatic	Actuator
Boyle's Law	Mechanical Advantage

Word introduced in lesson: **Fluid and Fluid Power**

4. Give overview of video "Discovering Fluid Power".

5. Have students list at least 10 uses of fluid powered systems discussed in the following video. Examples of fluid power use might be: artificial limbs, earthquake testers, robots, cars, buses, assembly lines, trucks, tractors, airplanes, cranes, lifts.

6. Students will watch a video explaining fluid power and its uses at the following link (a free copy of the DVD can be ordered at the link at the bottom of the website): http://www.ccefp.org/highlights/videos

7. After the video, discuss with students their interpretation of "What is fluid power". Have students copy the following definitions on their note-taking guide:

Fluid Power: The use of liquids or gases under pressure to move heavy objects and perform many other tasks.
Fluid: Any substance that flows.

8. Discuss "Where fluid power is used?", and "How will fluid power be applied in new and transformational ways?" as seen in the video. Briefly discuss hydraulics and pneumatics (they will be discussed in the next lesson in detail along with their definitions.

9. Review Essential Question and summarize.

- What is fluid power?

• LESSON 2: Hydraulics and Pneumatics

1. Identify the Standards. Standards should be posted in the classroom for each lesson.

ENGR-TS-3- The students will develop an understanding of how humans interact with systems.

a) Operate technological systems

b) Maintain technological systems

c) Constructing technological systems

d) Design technological systems

2. Review Essential Question. Essential Questions should be posted in the classroom for each lesson.

- What are hydraulic and pneumatic systems?

3. Identify and review the unit vocabulary. Word Wall should be posted in the classroom for unit.

Fluid	**Pascal's Principle**
Fluid Power	**Pressure**
Hydraulic	**Compressor**
Pneumatic	**Actuator**
Boyle's Law	**Mechanical Advantage**

Words introduced in lesson: **Hydraulic, Pneumatic, Boyle's Law, Pascal's Principle, Pressure, Compressor, Actuator, and Mechanical Advantage.**

4. Review terms Fluid Power and Fluid, discussed in previous lesson.

5. Begin discussion on how fluid power systems work. Fluid power systems work by force being applied to a fluid (gas or liquid), then the energy of the fluid, under pressure, transfers its energy to a mechanically device to perform work.

6. Explain and have students copy the definition of **Pressure** on their note taking guide:
Pressure: The amount of force distributed over a unit of area, usually expressed in pounds per square inch. Explain the formula for calculating pressure.

7. Explain and have students copy the definition of **Boyle's Law** on their note taking guide: **Boyle's Law:** The volume of gas varies as the pressure increases, whereas a liquid's volume remains the same under pressure, provided the temperature remains constant.

8. Explain and have students copy the definition of **Pascal's Principle** on their note taking guide: **Pascal's Principle:** A pressure applied to a confined fluid at rest is transmitted with equal intensity throughout the fluid.

9. Explain and have students copy the definition of **Mechanical Advantage** on their note taking guide:
Mechanical Advantage: The increase in force gained by using a machine.

10. Students will watch a short 6 minute video explaining hydraulic systems and its uses at the following link (you may want to use a video download software or a site that stores Youtube videos): http://www.youtube.com/watch?v=YlmRa-9zDF8 . As you watch the video, have students write down their definition of hydraulic systems, and make a list of as many of the different uses of hydraulics as you can as described in the video.

11. Review video, explain and have students copy the definition of **Hydraulic System** on their note taking guide: **Hydraulic System:** Fluid power systems that use oil or another liquid.
Discuss the components of a hydraulic system.

12. Students will watch a short 6 minute video explaining pneumatic systems and its uses at the following link (you may want to use a video download software or a site that stores Youtube videos):

http://www.youtube.com/watch?v=UuK3ESGgbqk . As you watch the video, have students write down their definition of pneumatic systems, and make a list of as many of the different uses of pneumatics as you can as described in the video.

13. Review video, explain and have students copy the definition of **Pneumatic System** on their note taking guide: **Pneumatic System:** Fluid power systems based on the use of air or another gas. Discuss the components of a pneumatic system and compare it to the components of a hydraulic system.

14. Explain and have students copy the definition of **Compressor** on their note taking guide: **Compressor:** A device that converts mechanical force and motion into pneumatic fluid power.

15. Explain and have students copy the definition of **Actuator** on their note taking guide: **Actuator:** A device that converts fluid power into mechanical force and motion.

16. Review Essential Question and summarize.

- What is fluid power?

• LESSON 3: Syringe Crane Challenge

1. Identify the Standards. Standards should be posted in the classroom for each lesson.

ENGR-TS-2- The students will develop an understanding of how the design process is used to develop a technological system.
a) Identify the steps of the design process
b) Identify how systems are used in a variety of settings
c) Illustrate how the systems model is utilized in the production of goods
d) Construct and work with a variety of systems, including Engineering, Electronics, Manufacturing, and Energy

ENGR-TS-7- Students will develop leadership skills and work ethics.
a) Demonstrate work ethics within the classroom and lab environment

2. Review Essential Question. Essential Questions should be posted in the classroom for each lesson.

- How do we use the Engineering Design Process to design a fluid powered system?

3. Identify and review the unit vocabulary. Word Wall should be posted in the classroom for unit.

Fluid	**Pascal's Principle**
Fluid Power	**Pressure**
Hydraulic	**Compressor**
Pneumatic	**Actuator**
Boyle's Law	**Mechanical Advantage**

No new words introduced in lesson.

4. Review the steps in the engineering design process.

5. Explain the syringe crane challenge. Have 2 to 4 students working together. (See where to acquire materials and substitutions in Notes & Reflections Section.)

Context

Using design and fabrication processes used by industry, you will construct a fluid powered crane. Certain specifications and limitations will be followed, and you may only use the tools and materials provided.

Challenge

You are to design and construct a crane that is propelled by syringes that will lift the largest payload and set it down the farthest distance from the base of the crane.

Procedure

1. First you will design your crane.
2. Next you will explain you design to the instructor prior to beginning construction.
3. You will then build your crane according to your plans.
4. Lastly, you will demonstrate your crane's abilities. Your crane must lift the minimum payload.

Materials and Equipment

- Syringes
- plastic tubing
- K'nex blocks
- masking tape
- ruler

Evaluation

Your crane should be built according to the plans you created and will meet the requirements listed in the "Limitations" and "Instructions".

Grading rubric for your project will be as follows:

100 Project was completed in accordance to instructions.
90 Project was completed with minor errors.
80 Project was completed with errors.
70 Project was completed with major errors.
60 Project was not completed.
50 Project was not attempted according to procedures.
0 Project was not attempted.

LIMITATIONS

1. Crane must have a base allowing it to stand unassisted. Crane can may be held and aligned at its base when lifting its payload.
2. Crane must be power by remote syringes (fluid power) only.
3. You may not utilize rubber bands, springs, mouse traps, etc... to assist your crane. Masking tape can only be used to hold and attach syringes.
4. You may not assist your crane in any way.

INSTRUCTIONS

1. Crane will be placed on a flat surface, 12 inches from the payload.
2. Crane must be able to lift the minimum designated payload.
3. Crane lifting the most weight will win.

For the competition, the crane that lifts the most weight will be the winner. In case of a tie, the winner will be determined by the crane with the longest reach from the crane's base to the payload.

6. Allow sufficient time for students to construct their syringe crane.

7. Have competition to see whose crane can lift the most weight.

8. Discuss the syringe cranes and determine a winning group.

9. Assess student performance/participation using Syringe Crane Challenge Rubric.

10. Review Essential Question and summarize.
    - How do we use the Engineering Design Process to design a fluid powered system?

• LESSON 4: USING MATHMATICS IN FLUID POWER (OPTIONAL LESSON)

(This lesson is optional and you may wish to include worksheet as part of Lesson 2)

1. Identify the Standards. Standards should be posted in the classroom for each lesson.

ENGR-TS-3- The students will develop an understanding of how humans interact with systems.

a) Operate technological systems

d) Design technological systems

M8A1. Students will use algebra to represent, analyze, and solve problems.
M8A3. Students will understand relations and linear functions.

2. Review Essential Question. Essential Questions should be posted in the classroom for each lesson.

- How are mathematics used to evaluate fluid power systems?

3. Identify and review the unit vocabulary. Word Wall should be posted in the classroom for unit.

Fluid	**Pascal's Principle**
Fluid Power	**Pressure**
Hydraulic	**Compressor**
Pneumatic	**Actuator**
Boyle's Law	**Mechanical Advantage**

No new words introduced in lesson. (You may want to introduce Area, Diameter, Radius and Pi as words on your word wall).

4. Review what an actuator is and how it works.

5. How to find the area of a circle.

6. Explain how we use the formula to find the area of a circle to find the area of the piston in an actuator.

7. Review Pascal's law and pressure. Introduce the formula to find pressure:
   Pressure = Force / Area

Complete an example to fine the pressure (psi).

8. Review mechanical advantage. Demonstrate how we can use the formula for pressure to calculate the mechanical advantage of using fluid power.

9. Give students a copy of the Fluid Power Mathematics Worksheet.

10. Explain that students will now use their mathematical skills to evaluate force and mechanical advantage of a fluid power system. Allow student sufficient time to complete worksheet and review answers.

11. Review Essential Question and summarize.

- How are mathematics used to evaluate fluid power systems?

Review & Vocabulary Test

1. Use attached **ENGR 8-4 Deal or No Deal - Fluid Power** file. If you wish to change questions or convert information in this file, simply use PowerPoint to open file and edit.

2. After review, ensure students have completed their note taking guides.

3. Give vocabulary test.

• ATTACHMENTS FOR LESSON PLANS May be listed by lesson.

PowerPoints:

ENGR 8-4 Lesson 1-Fluid Power
ENGR 8-4 Lesson 2-Hydraulics and Pneumatics
ENGR 8-4 Lesson 3-Pneumatic Crane
ENGR 8-4 Lesson 4-Using Mathematics in Fluid Power

Word Documents:

ENGR 8-4 UNIT PLAN Fluid Power Syringe crane (This document)
ENGR 8-4 GPS
ENGR 8-4 ESSENTIAL QUESTION
ENGR 8-4 Word Wall
ENGR 8-4 Note Taking
ENGR 8-4 Fluid Power Design Brief Syringe Crane
ENGR 8-4 Fluid powered crane engineering design process worksheet
ENGR 8-4 Syringe Crane Challenge Rubric
ENGR 8-4 Fluid Power Mathematics Worksheet
ENGR 8-4 Fluid Power Quiz

Games:

ENGR 8-4 Deal or No Deal - Fluid Power

• NOTES & REFLECTION:

To play Deal or No Deal, split the class into groups of 3 to 4 students. Have a team choose a brief case. If they are correct, ask them if they want a deal or not deal. Some of the dollar values are positive and some are negative. If a team is wrong, go to next group of students and have them to answer the question and offer them the deal. Click on the brief case to get the question, the Deal or No Deal logo above the question to get the answer and dollar amount, and the brief case on the bottom right side to return to the game board. You must keep scores manually. The group with the most money at the end wins. You may want to substitute some of the questions in the game with information from your previous classes.

Syringe Crane Challenge: Syringes area available at Tractor Supply or online. Hose is available at most pet shops or online. You may substitute K'nex with any other build block system you may have available in your lab or use wood, Styrofoam, or cardboard as a building material.

You may want to also use the ITEA Standards-Based Technology Systems Curriculum for addition information on Fluid Power.

UNIT RESOURCES

Web Resources:

http://www.ccefp.org/highlights/videos

http://www.ccefp.org/education-outreach/fluid-power-demonstrator/middle-school-lesson-plan

http://www.nfpa.com/Education/Edu_NFPA-FP-TVprogram.asp

http://www.iteaconnect.org/EbD/CATTSresources/StateSiteAgreements/GeorgiaSiteAgreement.htm

http://www.metalwebnews.org/ftp/fluid-power.pdf

Materials & Equipment:

- Handouts
- PowerPoint projector/screen
- Internet
- Assortment of k'nex blocks or equivalent building materials
- 4 assorted sized syringes per group
- 2 – 18" lengths of aquarium hose per group
- Metal weights
- Masking tape

What 21st Century Technology was used in this unit?

X	Slide Show Software		Graphing Software		Audio File(s)
	Interactive Whiteboard		Calculator		Graphic Organizer
	Student Response System		Desktop Publishing		Image File(s)
	Web Design Software		Blog	X	Video
	Animation Software		Wiki	X	Electronic Game or Puzzle Maker
	Email	X	Website		