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| **Lesson 2.4 – Advanced Designs**  |

**Preface**

As time and technology have advanced, the process of designing products has become quicker, more precise, and efficient, which enables changes to be made when needed. The process from getting a concept to a marketable solution is also being completed with higher quality and in far less time.

The design of solutions to problems is sometimes completed in teams. These teams work together, constantly communicating with each other, to create the desired product needed. The team may receive a problem and then are expected to create a solution with very few constraints. This allows teams to think outside the box and use their imagination. The process of deriving solutions to these problems will vary from team to team. Designs are usually presented to supervisors or board members and a single solution is then chosen.

In this lesson, students will work in teams of two. They will choose a problem from a list of design briefs and create a solution to the problem. Each team will apply the design process steps in the development of their solution. Students will work as a product design team and together, create a solution to their chosen problem. Challenges they will encounter are written up in such a way that they will experience a design work environment, such as a design challenge for redesigning a fluid power system, or a challenge for designing a executive desk set, as well as others. Students will then make plans to market their solution to their company.

**Concepts**

1. Design solutions are created while working in teams and sometimes as an individual.

2. Engineers use design briefs to explain the problem, identify solution expectations, and establish project constraints.

3. Teamwork requires constant communication to achieve the goal at hand.

4. Engineers conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

5. Engineers use a design process to create solutions to existing problems.

6. Engineers use computer-aided design (CAD) modeling systems to quickly generate and annotate working drawings.

7. Fluid Power Concepts could be used to enhance design solutions.

8. The use of fluid power, hydraulics and pneumatics is used as an enhancement to solving problems with electrical control systems.

**Standards and Benchmarks Addressed**

***Standards for Technological Literacy***

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| **Standard 2:** | Students will develop an understanding of the core concepts of technology. |
| **BM AA:** | Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. |
| **Standard 3:** | Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study. |
| **BM A:** | The study of technology uses many of the same ideas and skills as other subjects. |
| **BM C:** | Various relationships exist between technology and other fields of study. |
| **BM F:** | Knowledge gained from other fields of study has a direct effect on the development of technological products and systems. |
| **Standard 6:** | Students will develop an understanding of the role of society in the development and use of technology. |
| **BM A:** | Products are made to meet individual needs and wants. |
| **Standard 8:** | Students will develop an understanding of the attributes of design. |
| **BM H:** | The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results. |
| **Standard 9:** | Students will develop an understanding of engineering design. |
| **BM A:** | The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others. |
| **BM B:** | Expressing ideas to others verbally and through sketches and models is an important part of the design process. |
| **BM D:** | When designing an object, it is important to be creative and consider all ideas. |
| **BM F:** | Design involves a set of steps, which can be performed in different sequences and repeated as needed. |
| **BM G:** | Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. |
| **BM J:** | Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. |
| **Standard 11** | Students will develop the abilities to apply the design process. |
| **BM E:** | The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many. |
| **BM I:** | Specify criteria and constraints for the design. |
| **BM J:** | Make two-dimensional and three-dimensional representations of the designed solution. |
| **BM R:** | Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. |
| **Standard 17** | Students will develop an understanding of and be able to select and use information and communication technologies. |
| **BM Q:** | Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli. |

***National Science Education Standards***

**Unifying Concepts and Processes Standard K-12:** As a result of activities in grades 9-12, all students should develop—

 **Change, constancy, and measurement**

 **Form and function**

**Science and Technology Standard E:** As a result of activities in grades 9-12, all students should develop—

 **Abilities of technological design**

***Principles and Standards for School Mathematics***

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| **Number Operations:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates. |
| **Algebra:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; and [**analyze change**](file:///D%3A%5CStandards%5Cdocument%5Cchapter3%5Calg.htm#bp4#bp4) in various contexts. |
| **Geometry:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems. |
| **Measurement:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements. |
| **Problem Solving**  | Instructional programs from pre-kindergarten through grade 12 should enable all students to solve problems that arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems. |
| **Communication:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; and communicate their mathematical thinking coherently and clearly to peers, teachers, and others. |
| **Connections:** | Instructional programs from pre-kindergarten through grade 12 should enable all students recognize and apply mathematics in contexts outside of mathematics. |

***Standards for English Language Arts***

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| **Standard 4:** | Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. |
| **Standard 5:** | Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes. |
| **Standard 8:** | Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge. |
| **Standard 12:** | Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information). |

**Performance Objectives**

*It is expected that students will:*

 Brainstorm and sketch possible solutions to an existing design problem.

 Create a decision making matrix.

 Select an approach that meets or satisfies the constraints given in a design brief.

 Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.

 Apply geometric numeric and parametric constraints to form CAD modeled parts.

 Generate dimensioned multiview drawings from simple CAD modeled parts.

 Assemble the product using the CAD modeling software.

 Explain what constraints are and why they are included in a design brief.

 Create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.

**Assessment**

*Explanation*

1. Students will explain why design options of a project are determined by criteria and constraints.

*Application*

2. Students will design an alternate solution to the same design brief completed in the lesson and adjust their solution to include a different material.

*Interpretation*

3. Students will illustrate their proposed solution and use their illustration to explain how it relates to what they have learned about engineering design.

4. Students will explain the advantages and disadvantages of working in teams answering questions, such as:

a. When I work with I team I find that I …

b. The hardest thing for me to do when working with a team is …

c. The easiest part of working on a team is …

**Essential Questions**

1. What is a design brief?

2. Why is a design process so important to follow when creating a solution to a problem?

3. What is the purpose of design constraints?

4. What is a decision matrix and why is it used?

5. What does consensus mean, and how do teams use it to make decisions?

6. How are visual design principles and elements used to capture a consumer’s attention?

7. How is the design of a consumer product different then the design of a product used to help a manufacturing process?

8. What is fluid power?

9. What is the difference between hydraulic and pneumatic power systems?

10. How does the use of fluid power aid the use of electronics or other power systems?

**Key Terms**

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| **Accuracy** | **Assembly** | **Assembly Drawing** |
| **Component** | **Consensus** | **Constraint** |
| **Decision Matrix** | **Design Brief** | **Design Process** |
| **Design Statement** | **Designer** | **Fluid Power** |
| **Hydraulics** | **Marketing** | **Multiview Drawing** |
| **Pneumatics** | **Problem Statement** | **Purpose** |
| **Solid Modeling** | **Target Consumer** | **Team** |

**Day-by-Day Plans**

*Time: 6 days*

**Day 1:**

 The teacher will present **Concepts**, **Key Terms**, and **Essential Questions** to provide a lesson overview.

 The teacher will distribute and introduce **Project 2.4.1 Design Challenge**and**Project 2.4.1 Design Challenge Rubric**.

 The teacher will divide the class into groups of two.

 The teacher will discuss constraints, requirements and design briefs for each project.

 The teacher will present **Teamwork.ppt**.

 Students will take notes in their journals.

 The teacher will review the design process using **Example Design Process** distributed in Lesson 1.1.

 Students will keep Example Design Process document available throughout this lesson.

 The teacher will distribute the graph paper located in the **Teacher Guidelines** at the end of this lesson.

 Students will begin work on Project 2.4.1 Design Challenge.

**Day2-6:**

 The teacher will distribute **Decision Matrix Template**

 The teacher will present the **Decision Making Matrix.ppt.**

 Students will take notes in their journals.

 Students will continue working on materials to be completed for Project 2.4.1 Design Challenge.

 The teacher will keep students on task and answer any questions during the process.

 Students will complete Project 2.4.1 Design Challenges.

 Students will present their design solution using their three-fold brochure and an oral report to the class.

**Instructional Resources**

PowerPoint Presentations

Teamwork

Decision Making Matrix

Word Documents

**Project 2.4.1 Design Challenge**