   

Project Compound Ballistics

Background

Mechanical systems often require a combination of mechanisms to complete a given task. Any time two or more machines are combined, the result is a compound machine. If many mechanisms are combined, the machine may even be referred to as a complex machine. Compound machines can range in complexity from a crane or automobile to a simple manual can opener. A bicycle is an example of a compound machine. The pedals, brakes, handle bars, and sprocket systems are just some of the mechanisms on most bicycles

Client:

Target Consumer:

Problem Statement

The Ratite Toys company is designing a large scale yard game similar to the classic board game of Battleship. In this game kids will build a machine that launches ping-pong balls using the power of a rubber band. Ratite would like the mechanism to be complex and integrate several simple machines and a gear system. The game will require players to launch the balls at the other teams "Ships" that will be distributed on a 10'x10' grid. The mechanisms must be able to launch the ball between 10 and 20 feet and adjusted to target different distances withinin the range.

Design Constraints

1. The applied effort Force must come from a single rubber band provided by Mr. Vezino.
2. Ping pong ball projectiles must be able to be launched a minimum of 10 ft and a max of 20 ft.
3. The final design must include a minimum of five different types of mechanisms including any of the simple machines or gear systems. You must include at least three types of simple machines and one gear system.
    - Simple Machines: Lever, inclined plane, wedge, screw, wheel/axle, pulley
    - Gear Systems: gear train, belt/pulley system, sprocket/chain system
4. Your compound machine must be made of various VEX® components, including gears (sprockets), chains, belts, pulleys, axles, and support pieces. Any non VEX parts must be approved by the Mr. Vezino.
5. Overall Mechanical Advantage cannot be equal to 1.

Procedure

- **Include each of the following sections in your engineering notebook with clear labels.**

1. **Design Brief:**
    a. Project Name:
    b. Client
    c. Target Consumer:
    d. Problem Statement: Describe the problem in detail including the purpose of the design and your specific task.
    e. Criteria: a bulleted list of the things your machine must do to be considered successful
    f. Constraints: a bulleted list of the limitations placed upon your design including time and materials.

2. **Generate Concepts:**
    a. Brainstorm: ideas for accomplishing the assigned task, and record at least two combinations of simple machines to create your compound machine. Both possible machines must be documented in your engineering notebook.
    b. Solution Choice: Write a short statement explaining how you chose your final solution including process and reasoning.
    c. Design Solution Diagram: Sketch and annotate a preliminary design solution in your engineering notebook. For each individual mechanism label its type and state whether it will have a mechanical advantage greater than, less than, or equal to 1.
    d. Have your instructor sign off on your brainstorm ideas and your preliminary sketch.

3. **Final Design Solution:**
    a. Build, test, and modify your compound machine design.
    b. Final Design Solution:
        i. Final Design Photographs: In your engineering notebook glue one or more photographs of your final compound machine. Be sure that your photographs include enough detail to show the function. Annotate the pictures with labels stating the type of machine and IMA or GR of each individual mechanism.

4. **Design Testing:**
    a. Individual Mechanisms Testing: Use the data table format shown below to document and illustrate the mechanical advantage and drive ratios of the individual mechanisms utilized within your final compound machine solution. Show work and units throughout.
    b. Overall Compound Machine Testing: In your engineering notebook calculate the overall gear ratio of the system, overall IMA, overall AMA, and overall Efficiency for the compound machine. Use the data table format provided.

Conclusion:

Answer the following conclusion questions in your engineering notebook. Write the question and your response.

c. For which mechanism was it the easiest to determine the mechanical advantage or drive ratio? Why was it the easiest?
d. For which mechanism was it the most difficult to determine the mechanical advantage or drive ratio? Why was it the most difficult?
e. Does your compound machine increase or decrease your input force? How do you know?
f. How efficient was your compound machine and what parts of the machine contributed to its inefficiencies?
g. What modifications could you make to your compound machine to make it more mechanically efficient?

5. **Submit your engineering notebook and demonstrate your compound machine to the class on**

DATE: ____

Individual Mechanisms Testing Data Table (one for each machine = 5)

Mechanism #______	**Type__________________________**	
Illustration: ***Include proper documentation such as force, distance, direction, and key mechanism features.***		
Ideal Mechanical Advantage / Gear Ratio Calculations		
Formula	**Substitute / Solve**	**Final Answer**

Overall Compound Machine Testing

Overall Gear Ratio of the System:		
Formula	**Substitute / Solve**	**Final Answer**

Overall Ideal Mechanical Advantage of the System:		
Formula	**Substitute / Solve**	**Final Answer**

Overall Actual Mechanical Advantage of the System:		
Formula	**Substitute / Solve**	**Final Answer**

Overall Efficiency of the System:		
Formula	**Substitute / Solve**	**Final Answer**