FUTURA
MECHANICAL ENGINEERING

Force and Motion Engineering Internship:

Pods for Emergency Supplies

Copymaster Compilation

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Egg Drop Design

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Team Members _____ Date _____

INSTRUCTIONS

1. **Plan:** Choose the materials for your Egg Drop Model. Sketch and label your initial design in the space below.
2. **Build:** Make your design.
   - Before you test, record the mass of your Egg Drop Model in the Plan and Build section below. Be sure your egg is inside!
3. **Test:** Bring your Egg Drop Model to the test site. After you test, record the results.
4. **Analyze:** Reflect on your design in the Design 1 Analysis (on page 2).

PART 1: DESIGNING AN EGG DROP MODEL

Plan and Build: Draw your design. Record your Egg Drop Model's mass.

Mass of the Egg Drop Model (grams): _____

Describe your design:

_____

_____

Test Results: Record your results in the space below. Sketch or describe what happened to the pod and to the egg when it collided with the ground.

PART 2: ANALYZE YOUR EGG DROP MODEL

Design Successes: Which parts of your design worked? Why do you think they worked?

Design Failures: Which parts of your design did not work? Why do you think they did not work?

PLAN YOUR NEXT ITERATIVE TEST.

Draw and describe your revised design.

What would you change?

Why would you make these changes? Describe the science concepts that support your decisions.

Family After-Hours Experience: Exploring Force and Motion

Name: _____ Date: _____

When engineers and scientists are learning about new concepts, it often helps them to practice explaining those concepts to others. As part of your after-hours work, use this form to help you explain what you've been learning about to someone in your household.

Work with a member of your household to find examples of products that are designed to increase collision time and reduce impact forces.

- You may work with more than one member of your household.
- You might need to explain a little about forces and motion in order for the member of your household to be able to work with you.
- Try to answer any questions that person has about your explanation.
- Let them know that you have been investigating how different structures affect the function of reduced impact forces. Share about the design and analysis of your Egg Drop Challenge, and how this relates to your Mechanical Engineering Internship supply pod design problem.

Describe one item or structure you found that would be good for reducing impact forces, and one that would be less helpful, and why.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

SupplyDrop Data

FUTURA

Design Team _____ Date _____

PLAN

VERSION _____

BUILD
Design Details

Shell

Padding

% Air Bags

% Packing Peanuts

% Feathers

% Paper Pads

% Metal Foam

Add-On (Top)

Add-On (Bottom)

TEST
Test Results

Impact Force (N)

Mass (kg)

Velocity (m/s)

Shell Condition

Total Cost ($)

Cargo Damage (%)

ANALYZE

PLAN

VERSION _____

BUILD
Design Details

Shell

Padding

% Air Bags

% Packing Peanuts

% Feathers

% Paper Pads

% Metal Foam

Add-On (Top)

Add-On (Bottom)

TEST
Test Results

Impact Force (N)

Mass (kg)

Velocity (m/s)

Shell Condition

Total Cost ($)

Cargo Damage (%)

ANALYZE

Project Summary

Name: _____ Date: _____

Defining the Problem: Summarize your understanding of the project by answering the following questions. You may wish to review the Dossier to help you respond to the questions.

1. What is the engineering problem you are trying to solve?

2. Describe the first criterion—minimize cargo damage—and why it is important.

3. Describe the second criterion—maximize shell condition—and why it is important.

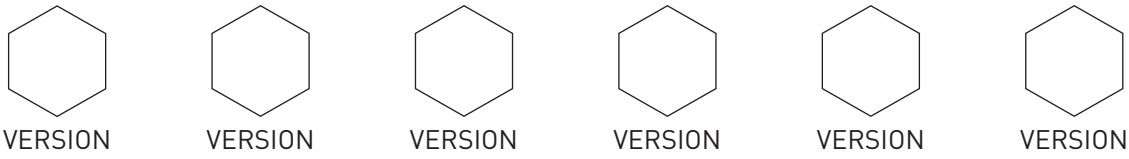
4. Describe the third criterion—keep costs low—and why it is important.

5. Based on your research so far, which criterion do you think is most important for a successful drop pod design? Why?

Results Analysis

FUTURA

Team Members: _____ Date _____



Force (N)						
Mass (kg)						
Velocity (m/s)						

SHELL CONDITION

Watertight Shelter						
Shade-Only Shelter						
Building materials						
Not reusable						

TOTAL POD COST

($)						
$3000						
$2000						
$1000						
$0						

CARGO DAMAGE

(%)						
60%						
50%						
40%						
30%						
20%						
10%						
0%						

Design Feedback Summary

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Name _____ Date _____

	CRITERIA		
	Cargo Damage (%)	Shell Condition	Total Pod Cost ($)
Submitted Version ☐ Test Results		☐ Watertight shelter ☐ Shade-only shelter ☐ Building materials ☐ Not reusable	
Feedback from project director			
Goal			
Redesign Strategy			

Trade-Offs Reflection

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Name _____ Date _____

A *trade-off* happens in a situation where a design has good results for one criterion but not for another. Look at your optimal supply pod design. Describe some of the trade-offs you noticed while designing your supply pod.

1. Which criterion did you prioritize?
   - ☐ minimize cargo damage
   - ☐ maximize shell condition
   - ☐ keep costs low

2. Why did you prioritize this criterion?

3. When you prioritized this criterion, what were some of the trade-offs? Describe what happened to the results of the other two criteria.

Proposal Rubric

	Needs Improvement	Developing	Proficient	Excels
Introduction	Introduction is incomplete; missing one or more criteria and no mention of the proposed design	Lists the criteria of the project but does not describe them; mentions the proposed design by listing the results or details but not both	Summarizes the design request and describes most criteria; describes the proposed design by listing the results or details but not both	Thoroughly summarizes the design request and describes the proposed design by listing the variables or details and the final results
Design Decisions (same for each criterion)	No evidence is provided to support the design decision; explanation is inadequate or missing	Uses minimal evidence to support the design decision and does not explain why the specific feature was selected over other options and/or how that feature of the design relates to the criterion	Uses some evidence to support design decision, mostly explaining why the specific feature was selected over other options and how that feature of the design relates to the criterion	Uses multiple pieces of strong evidence to support design decision, thoroughly explaining why the specific feature was selected over other options and how that feature of the design relates to the criterion
Conclusion: Considering Trade-offs	Two or more of the following need attention: design priorities, summary of trade-offs in the optimal design, or a closing statement	One of the following needs attention: design priorities, summary of trade-offs in the optimal design, or a closing statement	Includes all of the following, but may lack detail: design priorities, summary of trade-offs in the optimal design, and a closing statement	Description of design priorities is clear; summary of trade-offs in the optimal design is detailed and thorough; includes a strong closing statement
Scientific Communication	Lacks topic-specific vocabulary; uses informal style or language	Attempts to use topic-specific vocabulary and formal writing style, but needs improvement	Uses some topic-specific vocabulary; uses formal writing style somewhat successfully	Uses topic-specific vocabulary clearly and appropriately; uses formal writing style successfully

Proposal Outline

FUTURA

Name _____ Date _____

INSTRUCTIONS

For this outline, you need to list important information for the Design Decisions for each criterion. Refer to your SupplyDrop Data and the Dossier.

OPTIMAL DESIGN

List the design details of your proposed optimal design.

Version #: _____

Shell

Add-On (Top)

Padding

% Air Bags

% Packing Peanuts

% Feathers

% Paper Pads

% Metal Foam

Add-On (Bottom)

DESIGN DECISIONS

For each criterion, list the pieces of evidence from your data analysis and background research that support your optimal design.

Minimize Cargo Damage

DATA ANALYSIS

Final result (%):

Design goal (%):

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices (materials and features) affected the percentage of cargo damage. How did the choices you made affect the percentage of cargo damage?

Maximize Shell Condition

DATA ANALYSIS

Final result:

Design goal:

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices (materials and features) affected the shell condition. How did the choices you made affect the shell condition?

Keep Costs Low

DATA ANALYSIS

Final result ($):

Design goal ($):

Comparison to another design:

BACKGROUND RESEARCH

Think about how your design choices (materials and features) affected the supply pod cost. How did the choices you made affect the cost?

The Solutions Sequence

Guiding Question: What other projects, like creating supply pods, could a mechanical engineer who understands forces, motion, and collisions design a solution for?

Design Question: *Which constraints and criteria would make that solution the strongest?*

1. **Brainstorm 10–20 project ideas** and record them on the outside of your envelope.
2. **Choose and circle** one idea that is most interesting to your group. Pass your envelope to another group.
3. **Brainstorm constraints and criteria** for the idea circled on the new envelope you receive. Write **1-2 constraints** on one side of the blank paper, and **as many criteria as you can** on the other side of the piece of blank paper. Place your paper back inside the envelope and pass it to another group.
4. **Repeat Step 3 for two more project ideas.**
5. When you get your envelope back, **read all the constraints and criteria your peers brainstormed**. There might be some repeated ideas!
6. **Choose the one most important constraint and three most important criteria** that will make your design solution strong.
7. **Define your engineering problem.** Write your problem, the constraints, and the criteria you selected in a project statement.
8. **Share.**

fold

Define your engineering problem:

Circle the idea (above) that is most interesting to you.

Brainstorm project ideas:

Guiding Question: What other projects, like creating supply pods, could a mechanical engineer who understands forces, motion, and collisions design a solution for?

Team Names: _____