**Vaccine Container Design Project**

**Background Information:** Google, Amazon, and other delivery companies have been experimenting with the use of drones to deliver small items quickly. While drones are not in use for these tasks yet, the companies are working out the regulations and approvals. Meanwhile, people who provide medical needs to undeveloped communities are considering the use of drones to deliver medicine and vaccines to remote areas. The issue in many remote islands and villages within jungles and rainforests is that the drones would not be able to fly through the thick canopy of trees to land. These locations are ecologically clean and the medical personnel do not want to introduce non-biodegradable materials that will pollute their environment.

**Assignment:** Working in groups of 2 or 3, you will follow the Engineering Design Process to plan, engineer and construct a container from biodegradable materials that will absorb the energy from a fall of 9 meters and protect glass vials of vaccines. In place of glass vials of vaccines, the container will be tested using raw eggs. Containers will be tested by dropping the containers with eggs aboard over the rail in the back staircase of the school. Your plan must include a labeled diagram, list of materials used, and an explanation of what will happen to the kinetic energy that the container has as it hits the floor.

**Engineering Design Process:**

1. Determine the problem; review the criteria and constraints.
2. With your partner(s), brainstorm possible designs. Choose the best one.
3. Draw a preliminary diagram and gather materials.
4. Build a prototype and complete preliminary testing.
5. Examine the testing results and optimize to the design; repeat steps (or entire process) as needed until you have the best design.

**Container Construction:**

Criteria:

* Container must be made of biodegradable materials
* Container’s mass should be within mass limit that a drone can lift (400 g plus the egg)
* Container will be droppable from a height of 9 meters, simulating a drop from a drone
* The structure of the container must protect the contents from breaking
* The container must allow the kinetic energy to convert to energy that does not affect the condition of the egg shell

Constraints:

* Size of the container should be no larger than 30 cm on any side.
* Mass of container should not exceed 0.4 kg (400g). Egg’s mass will be additional to this.
* Any parachutes must be folded when the container is released, and the folded parachute must fit inside the 30 cm dimension
* Egg must be able to be removed from container without damage to shell.

**ASSESSMENT:**

**Final Grade on the project will be based on:**

* Meeting constraints and criteria for container construction (40%)
* Answers to analysis questions (40%)
* Condition of egg after drop (20%)
* *If any points are lost due to egg condition, those points can be recovered by completing reflection questions.*

**Analysis Questions:** **Individual students submit their own work.**

* *Address each prompt clearly using correct grammar, spelling, and mechanics.*
* *Support ideas with evidence from your observations and include reasoning that connects your ideas to scientific principles.*
1. List all materials used in the structure of the container. How does each material in the structure contribute to the container’s function to protect the contents?
2. What amount of energy did the container and egg have as you held it over the stairwell? *The distance from the stair rail on A3 to the floor on A1 is 9 meters.*
3. What happened to the energy as the container and egg fell and hit the floor? Support your answer with evidence.
4. When the container hit the floor, what happened to the energy it had? Explain how your design’s structure reduced the amount of energy transferred to the egg. Be sure to review your diagram and revise the ideas based on what happened to the container when it fell.

**Condition of egg after drop**

*20 pts = eggshell has no cracks whatsoever*

*17 pts = hairline fracture cracks in egg, no egg leakage*

*14 pts = small or larger cracks in egg, with leakage of small amount of egg white only*

*11 pts = leakage of a large amount of egg white*

 *8 pts = destruction of egg, with yolk exposed and shards of shell separated from egg*

 *0 pts = projectile yolk streams at time of impact; explosive impact*

**Reflection Questions: Only complete if you lost points on the condition of your egg!!**

* *Address each prompt clearly using correct grammar, spelling, and mechanics.*
* *Support ideas with evidence from your observations and reasoning to connect your ideas to scientific principles.*
1. What structural part(s) of your design did not function properly? (be specific)
2. How could your container design be improved to be successful?