

2. Design, Development & Re-Design!

Now that Requirements are understood and ideas have been brainstormed, the program will focus on the solution design. Once the team has agreed to a design, it will be implemented. Implementation is a time of discovery so changes are expected to the original design. Once the design is understood, re-design will help optimize the design.

Learning Points:

- You need to keep the Customer requirements in mind while working on the design so that you don't over-engineer the product.
- Although you have your initial design/schematic, as you start to refine and implement the design, it is still acceptable to make changes to the design.
- As you change your design, you need to make sure that you keep your engineering notebook and plans up to date. An engineering notebook is used by engineers to document notes, data, calculations, test results, etc.

Customer Deliverables:

- 🍏 Detailed design of the chosen solution for the Eggstraction activity.
- 🍏 Updated Team Organizational Chart
- 🍏 Role Assignments
- 🍏 Schedule
- 🍏 Plan Questions
- 🍏 Brainstorm Ideas
- 🍏 Risks
- 🍏 Prototype
- 🍏 Re-Design details

Leadership Skills

Innovation

Innovation is the introduction of something new; a new idea, method, or device.

- Innovation is the key to success. Fresh and unique ideas are important to solve problems.
- Do not be afraid of making a mistake. We all learn from mistakes. Some of the greatest inventions are the result of “mistakes.” (Penicillin, Chocolate chip cookies, potato chips, the microwave by Raytheon!)
- Diverse thought is important to innovation. Some of the best ideas result from playing off team ideas.
- There are different ways of getting the job done.
- Think outside the box!
- Be aware of what assumptions you have made and how they limit the solution space.
- Understand the Customer-driven **constraints**. Instead of making assumptions, ask questions.
- Don't be afraid and limit yourself!

A **constraint** is the state of being checked, restricted, or compelled to avoid or perform some action.

Innovation is key to the growth of a company and often stems from diverse thought. Typically, the final answer looks considerably different from the starting point.

Innovation stems from the ability to think outside the box! Thinking outside the box is the ability to analyze the assumptions and evaluate how they limit the solution. It is a way of looking at a situation or solution with a 360-degree viewpoint.

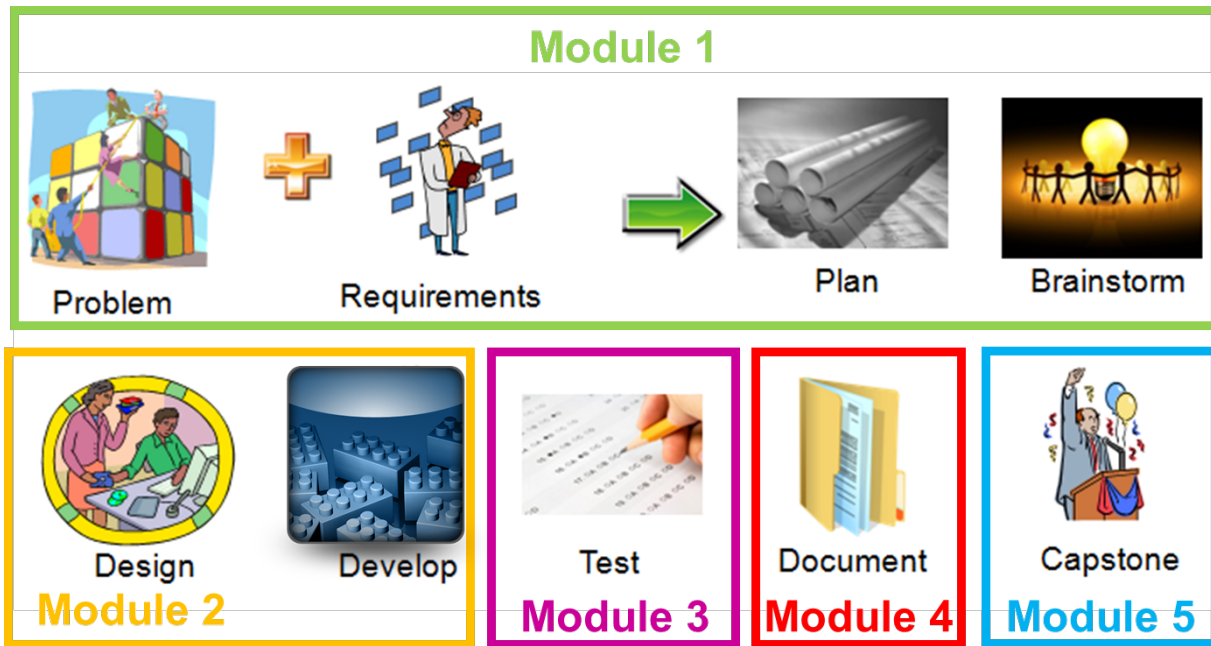
Goal Setting

- It is important to set the goal so you know the scope of the program and when you are finished.
- It is necessary for the team to understand and believe in the goal. This is how you obtain commitment.
- Goals are typically bound by cost, schedule, and requirements. In other words, the end product should not exceed the Customer's mission needs.

Goal setting is the key to understanding a program's scope. Without a well-defined scope, it is difficult to know when a program is complete. For leaders, team buy-in is critical because it can make accomplishing goals less challenging.

Engineering Lifecycle

In Module 2, the focus will be on design, development, and re-design. The design phase tackles the problem through a detailed definition for the technical solution. During development, the design will be implemented.



The Challenge

You have been assigned to your second project at Cogitate. The RACE (Rescue And reCon Enabler) team is challenged to re-design and build a second prototype of a device that can quickly extract people and vehicles from hazardous, remote areas inaccessible by normal means of travel. The Customer reviewed your work from the first phase of the program and saw real potential in your solution. Due to budget cuts, the Customer would like to see innovative ideas to decrease cost while improving upon technical aspects of the design. In the second phase of the program, the Customer is requesting a new prototype of the extraction design method. Safety and cost are still key Customer care-about.

Eggstraction Activity

Objective

To design a device operated by one person that will extract a Grade A Medium egg from the middle of a 4.25 meter radius circle while considering the new Customer requirements flowed down. The egg must not be broken or cracked.

Technical Terms

Circular motion is the movement of an object along the circumference of a circle or rotation along a circular path. Examples of circular motion include a satellite orbiting the Earth at constant height, a car turning through a curve at a race track, and a gear turning inside a mechanism.

Velocity is the rate of change of position along a straight line with respect to time: the derivative of position with respect to time.

Mass is a property that is a measure of the amount of material it contains and causes it to have weight in a gravitational field.

Accuracy is the freedom from mistake or error; conformity to truth or to a standard or model; degree of conformity of a measure to a standard or a true value.

Requirements

- 1) Each team will construct the device before the day of the competition.
- 2) Each team will be responsible for the secrecy of their design.
- 3) The eggs will be provided and they will be raw.
- 4) The device may be constructed of any kind of material.
- 5) Participants can use pulleys, motors, carts, remote control vehicles, etc. to move the egg outside of the circle.
- 6) The operator cannot touch the pavement within the 4.25 meter radius circle and cannot enter the space above the circle (an imaginary vertical cylinder).
- 7) The cost of the device shall be reduced by 30% compared to the original design.
- 8) The weight of the device shall be reduced by 20% compared to the original design.
- 9) The extraction time shall be reduced by 10% compared to the original design.
- 10) Extra consideration will be given by the Customer to the team that can extract two eggs while meeting all of the requirements.

Event

- 1) The circle will be outside on a rough concrete pavement in a street between two curbs, or, on a gym floor covered with plastic if it is raining outside.
- 2) The egg will be inspected by the judge within one minute of the extraction.
- 3) Only one extraction will be made for each team's device.
- 4) Each team will have 5 minutes to set up the device before the clock starts.
- 5) No part of the device may be inside the imaginary cylinder before the clock starts.
- 6) If the egg has not been extracted after 4 minutes, the clock will be stopped and the task considered incomplete.

Scores

Scoring will be based on time to complete the task and the cost of the device. The egg must not be cracked or broken. Tie-breakers will be based on creativity.

The team must report their Success Factor = time (seconds) x Cost (\$).

If two eggs are successfully extracted, then

Success Factor = [time (seconds) X Cost (\$)] / 2

Next Class

Prior to the next class:

If your program team members change, update the program org chart, roles and schedule plan.

Brainstorm ideas for the Crash Test Dummies activity.

Design and develop the solution so your team is ready for testing.

Module 2 Rubric

Due	Due Date	High School – Module 2 Rubric	Pts
Before Mod 2 LASER Class	Nov. 19, 2014	Updated Team Organizational Chart	5
Before Mod 2 LASER Class	Nov. 19, 2014	Role Assignments	5
Before Mod 2 LASER Class	Nov. 19, 2014	Schedule	10
Before Mod 2 LASER Class	Nov. 19, 2014	Plan Questions	10
Before Mod 2 LASER Class	Nov. 19, 2014	Brainstorm Ideas	10
Before Mod 2 LASER Class	Nov. 19, 2014	Risks	10
During Mod 2 LASER Class	Nov. 21, 2014	Detailed Design / Re-Design	20
During Mod 2 LASER Class	Nov. 21, 2014	Discussion and Career Questions	10
1 week after Mod 2 LASER class	Dec. 5, 2014	Re-Design Prototype	20
			100

Discussion

1. How did you ensure that you didn't over-engineer your product?
2. How did you decide what materials to use/change?
3. How many of the brainstorming ideas were used in the device's design?
4. How did you use communication skills to accomplish your goals? Was your communication effective?
5. How did you use other leadership skills on your team to address conflict?
6. How did the re-design help improve your prototype?
7. Show how your team met requirements 7 – 9. Show your work.

Outbrief Instructions

In the outbrief, each team will have the opportunity to discuss their answer to one of the discussion questions. Remember what you learned in the pre-work about presentations.

As time allows, feedback will be provided on the outbrief.

Real Life Applications

Skills

Communication, teaming, innovation, setting goals, critical thinking, decision-making, problem solving, schedule monitoring, product design & development, test planning, configuration management

Applications

Teacher, Manager, Program Manager, Systems Engineer, Mathematician, Physicist, Mechanical Engineer, Organizational Improvement Specialist, Politician, Concept Designer, Ship Builder, Aerospace Engineer, Astrophysicist, Statistician

Career–Summary Questions

1. I found that I have the following skills that helped me complete Module 2.
2. I discovered I have a gap in the following areas that can be a focus for future development.
3. List the aspects of Module 2 you enjoyed the most.
4. With the answer to Question 3 in mind, describe the types of career in which you might excel. **(Note, you are not limited to those listed above.)**

References

1. Reprinted with permission from IEEE at <http://tryengineering.org/> (The Sloan Career Cornerstone Center has provided engineering and engineering technology degree profiles to TryEngineering.)
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