Standards Based Learning: An Introduction to the Engineering Design Process Using a Paper Drop Competition

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Outline

- Design process
- Design exercise – paper drop competition
- Link to Illinois standards
- Hands-on design work
- The paper drop competition
- Variations on the competition
- Summary

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Design Process

- Determine the problem to be solved
  - Not as easy as it sounds!!!
- Determine possible solutions
  - Brainstorming
- Evaluate potential solutions
  - Choose a solution to implement
- Design the solution
- Test, revise, test…
  - May require several iterations

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Design Exercise – Paper Drop Competition

- Goal: Design a "flying" device
- Criteria:
  - The device must stay in the air as long as possible (70%)
  - The device must land as close to a target as possible (30%)
- Criteria are proxies for performance metrics specified in engineering design tasks

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Design Exercise – Paper Drop Competition

You may use the following items to construct your flying device

- Three sheets of 8½" x 11" paper
- Adhesive tape
- One 3" x 5" index card
- Four paper clips
- A pair of scissors (may not be a part of the final device!)
- Materials list is a proxy for constraints typically encountered in the engineering design process – cost, availability of parts, etc.

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Alignment with Standards

Source: "Keeping the Focus on Learning", B. B. Gaddy, C. B. Dean, & J. S. Kendall. McREL, 2002.

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Link to Illinois State Standards

EARLY ELEMENTARY: 11.B.1b. Design a device that will be useful in solving the problem.

- After completing this exercise, students will design and construct a flying device meeting specific constraints.

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Link to Illinois State Standards

LATE ELEMENTARY: 11.B.2b. Develop a plan, design and procedure to address the problem identifying constraints (e.g., time, materials, technology).

- After completing this exercise, students will design and construct a flying device meeting specific constraints.
- After completing this exercise, students will discuss the engineering design process by describing the basic steps in engineering design for this device.

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Link to Illinois State Standards

MIDDLE/JUNIOR HIGH SCHOOL: 11.B.3b. Sketch, propose and compare design solutions to the problem considering available materials, tools, cost effectiveness and safety.

- After completing this exercise, students will design and construct a flying device meeting specific constraints.
- After completing this exercise, students will discuss the engineering design process by describing the basic steps in engineering design for this device.

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Link to Illinois State Standards

EARLY HIGH SCHOOL: 11.B.4b. Propose and compare different solution designs to the design problem based upon given constraints including available tools, materials and time.

- After completing this exercise, students will design and construct a flying device meeting specific constraints.
- After completing this exercise, students will discuss the engineering design process by describing the basic steps in engineering design for this device.
- After completing this exercise, students will describe how he/she/they evaluated design trade-offs in the creation of the device.

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Link to Illinois State Standards

LATE HIGH SCHOOL: 11.B.5b. Select criteria for a successful design solution to the identified problem.

- After completing this exercise, students will design and construct a flying device meeting specific constraints.
- After completing this exercise, students will discuss the engineering design process by describing the basic steps in engineering design for this device.
- After completing this exercise, students will describe how he/she/they evaluated design trade-offs in the creation of the device.

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Student Performance Descriptors

Statements of Assessment that show whether the students have achieved the skills and knowledge defined by the Learning Objectives and the grade appropriate Standard(s).

- Learning Objective
  - After completing this exercise, students will design and construct a flying device meeting specific constraints.
- Assessment Statements
  - Students will sketch the flying device, meeting the specified constraints.
  - Students will construct their flying device from the sketch and make modifications to achieve the requirements that it stays in the air as long as possible and lands as close to a given target as possible.

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Student Performance Descriptors

- Learning Objective
  - After completing this exercise, students will discuss the engineering design process by describing the basic steps in engineering design for this device.
- Assessment Statement
  - Students will write a report (and/or make an oral presentation) describing the steps of the engineering design process that were followed in the construction of the flying device.

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Student Performance Descriptors

- Learning Objective
  - After completing this exercise, students will describe how he/she/they evaluated design trade-offs in the creation of the device.
- Assessment Statements
  - Students will report on the modifications made in the design of their flying device to assure achievement that it stays in the air as long as possible and lands as close to a given target as possible. They will also write on their design the reasons for the modification and the result of the modification.

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Design Exercise – Be the Engineer

- Divide into teams of three people (four people if we have an uneven number of participants)
- Brainstorm about possible designs
- Discuss the pros and cons for each design
- Choose one design
- Prototype and test your design
- Revise and retest until done
- Time limit for this workshop: 30 minutes!

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Design Exercise – Paper Drop Competition

- After students have prepared their designs, the competition is held. Normally we drop each device twice and measure the total time and distance for the two runs to determine the "winners" of the competition.

Design Exercise – Variations

- Vary the materials used in the competition and their quantities
  - Materials used are less important than the constraints they place on the designers
- Vary the relative importance of the design criteria
  - Example: time = 30% and distance = 70%
- Introduce "unknown" factors and encourage students to try to anticipate unknowns in their designs
  - An easy example: have a fan blow through the drop zone

Summary

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- For manuals, slides, and handouts, visit
  http://web.njit.edu/~carpinel/ASEE-Workshop/