Mathematics, Science & Technology

PART II.10

NOTE: This document is a work in progress. Parts II and III, in particular, are in need of further development, and we invite the submission of additional learning experiences and local performance tasks for these sections. Inquiries regarding submission of materials should be directed to: The Mathematics, Science, and Technology Resource Guide, Room 681 EBA, New York State Education Department, Albany, NY 12234 (tel. 518-474-5922).

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COMMENCEMENT

Standards & Performance Indicators

Boat Hull Design

MST 1

- ▲ investigation/technological invention
- ▲ creative solutions
- ▲ work schedules/plans

MST 2

- ▲ advanced features of software

MST 5

- ▲ creative solutions
- ▲ devise test solutions
- ▲ use equipment correctly
- ▲ explain tradeoffs

MST 6

- ▲ revise a model
- ▲ collect information
- ▲ mathematical models
- ▲ subjective decision making

MST 7

- ▲ analyze problems/issues
- ▲ design solutions
- ▲ observe phenomena
- ▲ gather/process information
- ▲ generate/analyze ideas
- ▲ realize results
- ▲ present results

BUILDING THE TEST TANK

There are a variety of materials available and suitable for this activity: balsa wood—hard wood—closed cell foam—cloth battery-operated motor—propeller—shaft—discarded wheel balancing weights wire—steel washers—clay—petroleum jelly—aluminum flashing

Working in teams of two to four, the students will develop at least three alternative boat designs. Included in the development process is: a rationale for selecting the type of hull, propeller, location of ballast, and type of building material used in the design; a selection and improvement on the most promising design; and a scale drawing of the most promising hull design with two or three views that include basic details and dimensions.

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Grades 9&12

In this activity the students will be required to demonstrate certain prior knowledge. Students should be familiar with the following: working in cooperative learning groups; researching information; using the design loop process to generate solutions to problems; brainstorming and developing concept maps; being familiar with 3-view and isometric drawings (CAD and CADD is optional); understanding mathematical modeling, concurrent engineering, material processing, and the use of computers.

There was a carnival atmosphere to this activity and a lot of excitement was generated among adults and students.
Teacher

MATH CONCEPTS:

- volume
- area (surface area)
- basic trig relationships
- basic geometry relationships
- decimal multiplication rules

SCIENCE CONCEPTS:

- Archimedes' principle
- Newton's laws
- mass and weight
- work and energy
- equilibrium
- stability
- speed and acceleration
- lift and drag

TECHNOLOGY CONCEPTS:

- Basic marine terminology
- propulsion
- what a mechanical drawing is
- design optimization
- tool usage
- center of gravity and buoyancy
- good craftsmanship
- decision making
- functionality of product
- design loop

Need To Know

Principles:
Archimedes Principles
Newton's Laws of Motion
Hydrodynamics
Flotation

Overviews:
History and development of marine transportation systems
Marine terminology
Types of boats
Importance of craftsmanship

Need To Do:

Design:
Construct prototypes
Test models
Evaluate results
Consider hull design, propulsion systems, keel, ballast, and rudder

Presentation:
Prepare analysis of collected data (speed, stability, and design variations) and report conclusions.
Present multimedia program to describe the solution to the problem.

ASSESSMENT

I TECHNOLOGICAL DESIGN:

The Design Process:

A) Research material contained in design portfolio
B) Multiple design solutions presented in sufficient detail
C) Alternative designs evaluated against established design criteria (design brief)
D) Optimal/final design explained in sufficient detail

The Design Solution:

A) Functionality of design meets established design criteria
B) Craftsmanship of final product (material process)
C) Scaled drawing of design (two views minimum, with dimensions)

II SCIENCE INQUIRY

A) Established task-related questions (scientific and experimental investigations)
B) Conducted investigations to answer questions (resources identified)
C) Conclusions reached are expressed in scientific terms
D) Use of conclusions to improve design (optimization)

III MATHEMATICAL ANALYSIS

A) Used measurements correctly as necessary
B) Collected data in a systematic organization
C) Organized data into charts and/or graphs
D) Prepared and analyzed charts/graphs and established conclusions

IV WORK HABITS

A) Used tools and materials safely and correctly
B) Shows evidence of collaborative efforts
C) Completed assigned tasks in a timely fashion

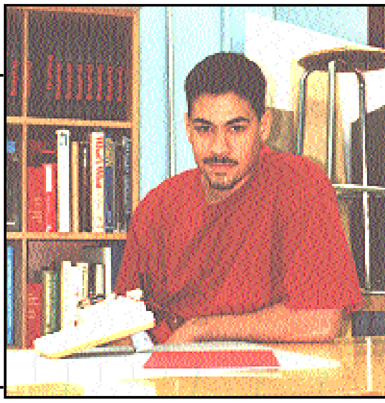
V COMMUNICATIONS AND PRESENTATIONS [optional]

A) Participates in an assigned role during group presentations of results
B) Demonstrates understanding of key concepts and ideas
C) Identifies problems and explains the solutions and how they were achieved
D) Uses charts, graphs, models, etc. to present results

Assessment is done using a Boat Hull Matrix. *There are three grading levels to the assessment.*

2.0	*Acceptable:*	Demonstrates that this portion of the activity fulfills the objectives of the constraints.
1.0	*Minimally Acceptable:*	Falls short of meeting the objectives of the constraints, needs revisions and more investigation.
0.0	*Unacceptable:*	Is incomplete or requires major revisions and additional investigation.

NOTE: An additional assessment is made using some form of an MST test.



I added a rudder to the craft to have it go in a straight line. I put the battery on the top front of the upper deck, so it can make-up for the wright in the back and I can be able to put the payload in the front deck.

Students with little or no experience with cooperative learning demonstrated tremendous cohesiveness and cooperative skills. They asked for more activities such as this.

Teacher

DESIGN CRITERIA & SPECIFICATIONS

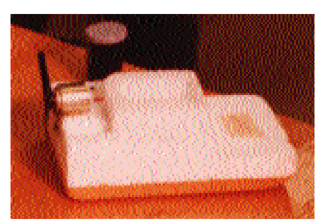
State the specifications which you will design your boat hull to meet or exceed.
(These specifications should be as clear and direct as possible.)

- I want to build a light weight hull.
- I want the craft to look like a hovercraft
- I want the craft to have a lot of speed.
- I want the craft to use one airpropeller.
- I want the craft geometry to be 8in. length and 4in. beam (width).
- I want the motor to be in the back of the craft and the propeller to be as close to the water as possible.

INVESTIGATIONS:

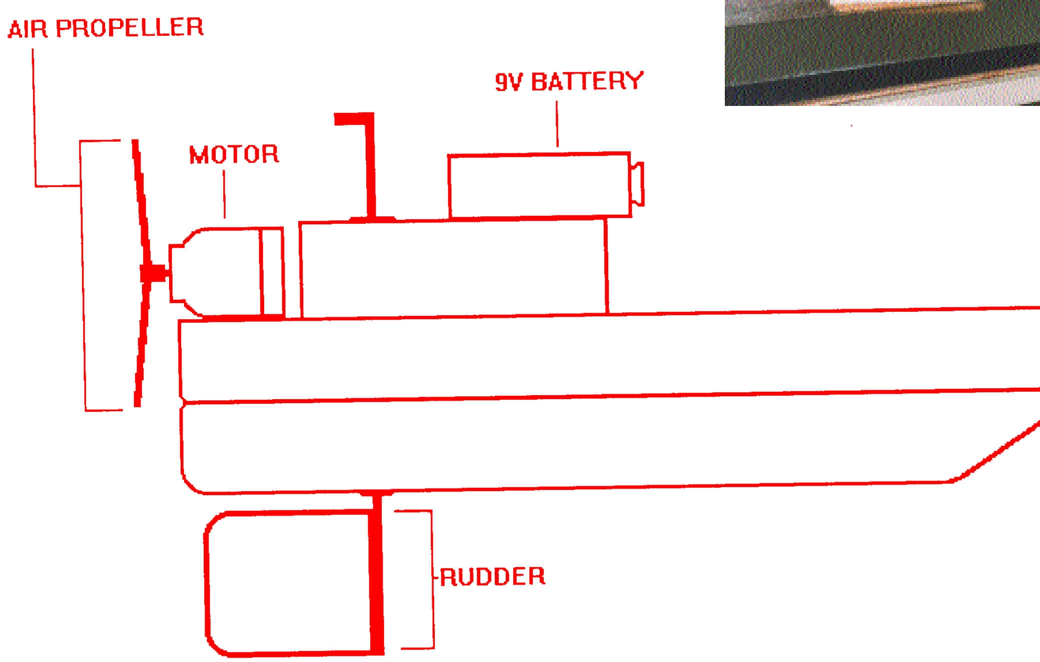
- List all of the questions that you believe must be answered to achieve a successful design.
- List the resources used to research the math, science, technology concepts and answer these questions.
- Describe what you learned by conducting the above investigations.

- will the design of the craft float?
- will the craft be light weight?
- will it go fast?
- will it go straight?
- How much weight it can carry?



Possible solutions

- I added a rudder so the craft can go in a straight line.
- I put the motor in the back of the craft and the propeller as close to the water as possible to give it more stability and more speed.
- I will distribute the weight all round, the craft, specially in the front so the craft can carry the maximum possible pay-load.



Craft Geometry

Lenght- 8 in.
Width- 4 in.
Weight- 141 mg.
Payload- 84 mg.
Total weight- 225 mg.
Speed- 9.5 sec. on a 10 ft. tank.

TESTING / OPTIMIZATION

- I put the rudder furthest to the back so the craft can have the best direction control. I also put the rudder in the back because thats where the air propeller's propulsion is and it gives the craft a more sensitive point of direction.

EVALUATION / SUMMARY

my primery objective was to built a light weight craft that would go fast. I was succeful in that the craft had excellent speed for its size. The craft wasn't able to carry a lot of payload but it was the fastest of all the air propeller in the classand one of the fastest against the marine propeller craft. To be able to carry more payload, I have to improve the design of the hull, I think I should make the beam (width) longer.