CNY Steamboat Challenge

AKA Pop-Pop Boats

ASHRAE Central New York Chapter

Project Stages

- For program details visit:

  http://ashraecny.org/Steamboat-Challenge
- Use internet for research
- Understand the operating principals
- Build a boat
- Test it
- Make modifications for improvements
- Enjoy and have fun

1. A pop-pop boat is a toy with a very simple steam engine without moving parts, typically powered by a candle or vegetable oil burner. The name comes from the noise made by the boats.
2. Construction
3. History
4. Principle of operation

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Purpose:

- ASHRAE CNY Chapter, in partnership with OBG and the MOST, collaborate with local schools and community organizations to motivate and encourage youth to pursue Science, Technology, Engineering and Mathematics (STEM) education and careers by demonstrating innovative applications of STEM principles.

- **Accomplishment:** The Steamboat Challenge program to date has reached 25+ schools across the CNY area including high-needs schools and has provided 400+ students & educators with opportunities to participate in STEM-focused hands-on learning activities.

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$$\mathbf{F} = m\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t} = m\mathbf{a},$$

Thus,
where **F** is the net force applied,
m is the mass of the body, and
a is the body's acceleration

F = ma

$$\mathbf{J} = \int_{\Delta t} \mathbf{F}\,\mathrm{d}t.$$

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Have fun!

- Use internet for research
- http://www.nmia.com/~vrbass/pop-pop/buildpop.htm
- Be creative
- For more event details go to the ASHRAE website.
- http://ashraecny.org/Steamboat-Challenge

https://www.youtube.com/watch?v=25HqjWyDW44

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Review Points

How to Measure Success of this Project?

- Make the fastest boat and win the race
- Learn new concepts and skills
- Work effectively as a team
- Encourage research, experimentation, and critical thinking
- Gain experience and confidence presenting to judges
- Discover opportunities and interests in STEM careers
- Have FUN!

S

- SCIENCE - systematic knowledge of the physical world gained through observation and experimentation.
  - Examples: Chemistry, Physics, Fluid Dynamics, Thermodynamics, Heat Transfer, Materials Science
  - Discover mathematical relationships to predict behavior

T

- TECHNOLOGY - the application of scientific knowledge for practical purposes (tools/machines or processes).
  - Examples: scissors, adhesives, soldering

E

- ENGINEERING - the art or science of making practical application of the knowledge of pure sciences.
  - Problem Solving through the application of science, technology & math

M

- MATHEMATICS - the abstract science of number, quantity, and space.
  - Develop and solve equations to predict behavior

Energy & Power

- ENERGY – the ability to do WORK.
  - Example: climb the stairs
  - Types: Heat, Mechanical (Kinetic + Potential), Chemical, Light
- POWER – rate of work.
  - Example: how fast can I climb the stairs
- FIRST LAW OF THERMODYNAMICS (conservation of energy)
  - the total energy of an isolated system is constant; energy can be transformed from one form to another, but cannot be created or destroyed.

Boat & Engine Design & Construction

- NOT prescriptive – does not need to be like the examples presented
- Encourage individual ideas – study and experiment to find what works best (apply STEM)
- Follow basic rules (dimensions and energy source)

Energy & Power – Pop-Pop Boat

- ENERGY
  - From the candle (chemical energy)
    - Amount of energy and power from the candle are the same for every team since the candles are all the same
  - Convert to heat energy (combustion/flame)
  - Capture heat to convert the water to steam (internal energy)
  - Steam expands to force water out of the nozzles (mechanical energy)
- How to make the boat fast (given the same candle for all)?
  - Require less effort to move the boat through the water
  - More efficiently convert the energy of the candle
- Also consider: reliability, safety, other?

Governing Principles – Pop-Pop Boat

- Focus on aspects of the problem that are important and parameters we can change to make the boat faster
- Weight, Shape, Materials, Dimensions
- Constructability, Reliability, Safety, Cost, Environmental Impact
- Hull
  - Minimize weight and drag of the hull
  - Make sure it floats, has stability, and tracks straight
- Engine (Boiler and Tubes)
  - Efficiently convert candle heat to steam
  - Number, shape and configuration of tubes to efficiently condense the steam and propel the boat
- Integration of hull and engine
  - Balance, flotation, shape of hull below water line, stability

Steam Properties

Gauge Pressure *(psig)*	Temperature *(^oF)*	Specific Volume Saturated Vapor *(ft^3/lb)*	Enthalpy		
			Saturated Liquid *(Btu/lb)*	Evaporated *(Btu/lb)*	Saturated Vapor *(Btu/lb)*
25 in Hg (Vacuum)	134	142	102	1017	1119
5 in Hg (Vacuum)	203	31.8	171	976	1147
0 [1)]	212	26.8	180	970	1150
1	215	25.2	183	968	1151
2	219	23.5	187	966	1153
3	222	22.3	190	964	1154
4	224	21.4	192	962	1154
5	227	20.1	195	960	1155

1 pint (~1 pound) = 0.0167101 ft^3

So the steam expands by a factor of 1,600 as it changes from liquid to gas (steam)

ASHRAE CNY Chapter
in collaboration with:

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  - O'Brien & Gere
  - MOST

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