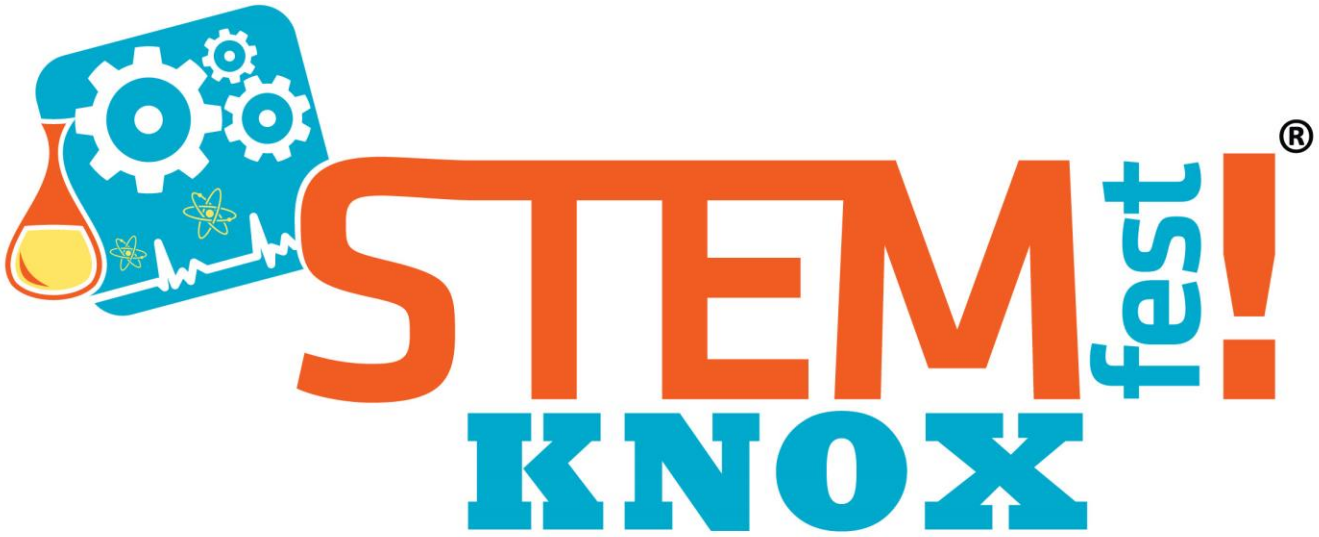

STEM fest!®
KNOX

November 2016

Re: STEMfest! Knox, February 25, 2017

Dear Education Partners,

Enclosed is information for middle and high school students interested in participating in the **2017 STEMfest! Knox Competition**. Each packet includes:

- A Letter of Invitation
- STEMfest! Knox Objectives to Student Career Development
- Ohio's New Learning Standards Addressed by STEMfest! Knox
- Important Dates and Registration Information Sheet
- STEM Resource Guide
- (3) **Problem Solving Challenge** Statements
- Persistent Scientist Nomination Form
- Scholarship & Internship Opportunities

STEMfest! Knox
Project-Based Learning
for Your Classroom or Afterschool Program!

To provide a thorough introduction to each Problem Solving Challenge, you and your students are invited to attend Challenge Presentations hosted by the experts in the field responsible for each challenge. Presentations include a chalkboard session to clearly introduce and outline the problem statement and an opportunity to ask questions about the problem or STEMfest! Knox process. There are three presentations scheduled, one for each problem solving challenge, and students and teachers are invited to attend one, or all presentations. Our goal is to allow you and your students to gain a visual point of reference, ask questions, become comfortable with the STEMfest! Knox process, and to ultimately select a problem-solving challenge.

We hope you will find one – or more! – of the challenges suitable for your students and are able to create a team or allow students to compete individually to represent your school for STEMfest! Knox 2017. The competition will be held at Central Ohio Technical College (COTC) Knox (236 S. Main St., Mount Vernon), Mount Vernon Nazarene University (MVNU) (Hunter Hall, 231 S. Main St., Mount Vernon) and Kenyon College (Wright Center, 400 S. Main Street, Mount Vernon). Additional exhibits and hands on activities will be located in COTC and at SPI Spot (400 S. Main St. Mount Vernon Ohio). ***All supplies needed for the problem solving challenges will be available for pickup at COTC to eliminate the cost to your school and the students***. Please refer to the enclosed "**Important Dates and Information**" and **"Challenge"** information guides for a complete listing of supplies and the dates these kits will be available for pickup.

You, your students, and families are invited to attend STEMfest! on February 25, 2017 from 10:00am – 4:00 pm. In addition to the STEMfest! Knox Challenge presentations, the event will showcase local businesses and industries with hands-on activities for middle and high school students. Judging of the STEMfest! Knox Challenges will take place on the day of competition for all participants. Judging times for each challenge will be sent out after registrations have been processed. If you have time constraints please let us know with your registration, we will do our best to accommodate requests as received. Awards for both Middle and High School winners will be presented at 4:00pm.

Please bring your family and encourage your students who might not be participating on a team to attend as well! ***The event is free of charge*** and your students will be amazed by the opportunities for future employment in Knox County industries and the variety of careers that emphasize training in science, technology, engineering and math.

STEMfest! Knox is an annual event. The STEMfest Knox Team is already planning for 2018 and looks forward to hearing your feedback about how to improve this experience!

Sincerely,
STEMfest! Knox Team

Table of Contents

STEMfest! Knox Objectives to Student Career Development

SELF AWARENESS	**GRADES K,1,6,9,11**	Gain knowledge of the importance of self-concept. Develop skills to interact with others. Gain awareness of the importance of growth and change.
CAREER INFORMATION	**GRADES K,2,4,6,8,10,11**	Develop skills to understand and use career information.
EXPLORATION	**GRADES 2,8,10,11**	Gain awareness of broad occupational areas. Experience the process of exploring careers.
REDUCTION OF BIAS	**GRADES 6,7,8,9,10**	Gain awareness of different occupations and changing male and female roles. Gain awareness of what constitutes equal career opportunities for all individuals regardless of race, ethnic background and/or handicapping condition.
FUTURE TRENDS	**GRADES 7,9,10,11,12**	Gain awareness of the importance of adapting to change.
EMPLOYABILITY SKILLS	**GRADES 3,8,9,10,11,12**	Gain awareness of the relationship between work and learning. Gain awareness of the importance of personal responsibility and good work habits.
DECISION MAKING-GOAL SETTING	**GRADES 3,4,6,7,10**	Understand how to make decisions and establish goals.
COMMUNITY INVOLVEMENT	**GRADES 3,6,11,12**	Gain awareness of the importance of involvement in the community. Gain awareness of the range of opportunities available for community service.

Standards Addressed: Architectural Engineering Challenge

Ohio's Learning Standards		
	Science	**Math**
Grade 6	**Matter and Motion (PS)** There are two categories of energy: kinetic and potential.	**Ratios and Proportional Relationships** Understand ratio concepts and use ratio reasoning to solve problems.
		Expressions and Equations Apply and extend previous understandings of arithmetic to algebraic expressions.
		Statistics and Probability Develop understanding of statistical variability. Summarize and describe distributions.
Grade 7	**Conservation of Mass and Energy (PS)** Energy can be transferred through a variety of ways.	**Ratios and Proportional Relationships** Analyze proportional relationships and use them to solve real-world and mathematical problems.
		Expressions and Equations Solve real-life and mathematical problems using numerical and algebraic expressions and equation.
Grade 8	**Forces and Motion (PS)** Forces between objects act when they are in direct contact or when they are not touching. Forces have magnitude and direction. There are different types of potential energy.	**Geometry** Understand congruence and similarity using physical models, transparencies, or geometry software
		Expressions and Equations Understand the connections between proportional relationships, lines, and linear equations.
		Functions Define, evaluate, and compare functions.
Grades 9 – 12	**Energy and Waves (PS)** Conservation of energy. Transfer and transformation of energy.	**Number and Quantity** Reason quantitatively and use units to solve problems.
	Forces and Motion (PS) Forces.	**Algebra** Understand solving equations as a process of reasoning and explain the reasoning. Represent and solve equations and inequalities graphically.
	Forces, Momentum, and Motion (P) Newton's laws applied to complex problems. Gravitational force and fields. Elastic forces. Friction force (static and kinetic).	**Geometry** Make geometric constructions. Visualize relationships between two-dimensional and three-dimensional objects. Apply geometric concepts in modeling situations.
		Statistics and Probability Summarize, represent, and interpret data on a single count or measurement variable.

Next Generation Science Standards – Engineering Design	
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combines into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

English Language Arts	
Grades 6 – 12	Reading Standards for Literacy in Science and Technical Subjects
	Listening and Speaking Standards

Standards Addressed: Biofuels – Power From Plants Challenge

Ohio's Learning Standards		
	Science	**Math**
Grade 6	**Matter and Motion (PS)** All matter is made up of small particles called atoms.	**Expressions and Equations** Apply and extend previous understandings of arithmetic to algebraic expressions.
		Statistics and Probability Develop understanding of statistical variability. Summarize and describe distributions.
Grade 7	**Conservation of Mass and Energy (PS)** Energy can be transformed or transferred but is never lost. Energy can be transferred through a variety of ways.	--
Grades 9 – 12	**Study of Matter (PS)** Atoms, Periodic trends of the elements, Reactions of matter	**Number and Quantity** Reason quantitatively and use units to solve problems.
	Energy and Waves (PS) Transfer and transformation of energy (including work) Electricity	
	Structure and Properties of Matter (Chemistry) Atomic structure, Quantifying matter, Phases of matter	**Statistics and Probability** Summarize, represent, and interpret data on a single count or measurement variable.
	Interactions of Matter (Chemistry) Chemical reactions	

Next Generation Science Standards – Engineering Design	
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combines into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

English Language Arts	
Grades 6 – 12	Reading Standards for Literacy in Science and Technical Subjects
	Listening and Speaking Standards
	Writing Standards

Standards Addressed: 3D Technology Challenge

Ohio's Learning Standards		
	Science	**Math**
Grade 6	--	**Geometry** Solve real-life mathematical problems involving area, surface area, and volume.
		Expressions and Equations Apply and extend previous understandings of arithmetic to algebraic expressions.
Grade 7	--	**Ratios and Proportional Relationships** Analyze proportional relationships and use them to solve real-world and mathematical problems.
		Expressions and Equations Solve real-life and mathematical problems using numerical and algebraic expressions and equation.
		Geometry Solve real-life mathematical problems involving angle, measure, area, surface area, and volume.
Grade 8	**Forces and Motion (PS)** Forces between objects act when the objects are in direct contact or when they are not touching. Forces have magnitude and direction.	**Expressions and Equations** Understand the connections between proportional relationships, lines, and linear equations.
		Geometry Understand congruence and similarity using physical models, transparencies, or geometry software.
Grades 9 – 12	**Forces and Motion (PS)** Motion, Forces, and Dynamics **Forces, Momentum, and Motion (Physics)** Elastic forces, Friction forces (static and kinetic), forces in two dimensions	**Number and Quantity** Reason quantitatively and use units to solve problems.
		Algebra Create equations that describe numbers or relationships.
		Geometry Experiment with transformations in the plane. Make geometric constructions. Understand and apply theorems about circles Find arc lengths and areas of sectors of circles Visualize relationships between two-dimensional and three-dimensional objects. Apply geometric concepts in modeling situations.
		Statistics and Probability Summarize, represent, and interpret data on a single count or measurement variable. Summarize, represent, and interpret data on two categorical and quantitative variables. Interpret linear models. Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Next Generation Science Standards – Engineering Design

MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combines into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

English Language Arts	
Grades 6 – 12	Reading Standards for Literacy in Science and Technical Subjects
	Listening and Speaking Standards

Dear Knox County Students,

The STEMfest! Knox Team Newark has created a partnership between you, your school and local industries to help you learn more about education and career opportunities in STEM fields (Science, Technology, Engineering and Math). **A central part of this STEMfest! Knox are the industry sponsored Problem Solving Challenges,** and you are invited to participate!

This year the challenges offered for your participation are related to **Architectural Engineering, Biofuels, and 3D Technology.** Each of these challenges deals with a variety of disciplines and relates that scientists and engineers encounter every day in their careers. The challenge statements are attached for you to review and to decide which one(s) you may want to select. You can accept the challenge to create solutions as an individual or form a team. More than one solution exists for each problem meaning there is no single "right answer." Solutions will differ based on the process of discovery and approach.

To provide a thorough overview of each challenge, you are invited to attend **Problem Solving Challenge Presentations** hosted by experts in each field posing a challenge. Presentations will be held at Mount Vernon Nazarene University (MVNU) – Hunter Hall and serve as a way to clearly introduce and outline the problem statement. You are invited to attend one or all presentations. The goal is to allow you to gain a visual point of reference, ask questions, become comfortable with the STEMfest! Knox process, and ultimately select a challenge to participate in!

Once you or your team has selected a challenge, all necessary supplies will be available for pickup at Central Ohio Technical College (COTC) at no charge to you or your school. Please refer to the enclosed **"Important Dates and Information"** and **"Challenge"** information guides for a complete listing supplies and the dates they will be available for pickup.

During STEMfest! Knox you and your team will present your findings to industry experts, teachers, and STEMfest! Knox visitors. Middle and High School students will present on Saturday, February 25, 2017, with awards to follow at 4:00pm. A panel of industry professionals will judge your solution on its uniqueness and quality and your presentation skills, including an explanation of your solution process and research.

Each one of the challenges will take a good bit of your time. Solving the challenge for your enjoyment may be the best reward. But here are some additional perks that may be important to you.

- Awards for top honors for middle and high school categories
- Scholarship and Summer Institute opportunities for high school students
- Press coverage for the event
- Participation certificates for all students for their career passports
- Opportunity for internship or job shadowing with local business and industry
- Ambassadors for STEMfest! Knox in 2018

Whether or not you decide to participate we hope you join us for this free event on February 25, 2017 from 10:00am to 4:00 p.m. In addition to the STEMfest! Knox challenge presentations, Scientists, Engineers and Technicians of local industries will display and engage you in interesting aspects of their technology used to produce a variety of products and machinery**.**

Sincerely,
STEMfest! Knox Team

Problem Solving Challenge Presentations Dates and Contact Information

All Presentations will be held on Saturday, December 10th
Hunter Hall, MVNU
221 S. Main St., Mount Vernon, OH 43050

Architectural Engineering Challenge

Presented by: Whit Tussing, COTC Engineering Technology
Time: 1:00 – 2:00pm
Contact information: wtussing@cotc.edu

Biofuels Challenge

Presented by: Matt Rouhier, Kenyon College
Time: 2:15 – 3:15pm
Contact information: rouhierm@kenyon.edu

3D Technology Challenge

Presented by: Richard Sutherland & David Winyard, Mount Vernon Nazarene University
Time: 3:30 – 4:30pm
Contact Information: Richard.sutherland@mvnu.edu, davwinyard@mvnu.edu

Presentation Videos and PowerPoints will be available after the presentation date.

The Works Contact Information

For more information about STEMfest! Knox, utilize these standard, on-line, and social media outlets.

The Works

- **Web Site:** www.attheworks.org
- **Mailing Address:** 55 S. 1st Street, P.O. Box 721, Newark, Ohio 43058-0721
- **Phone:** 740-349-9277
- **Fax:** 740-345-7252
- **E-Mail:** MeghanFederer@attheworks.org
- **Facebook:** http://www.facebook.com/attheworks
- **Twitter:** http://twitter.com/attheworks

Important Dates

- **October 24, 2016 – January 30, 2017 – STEMfest! Knox Registration Open**
  Registration must be completed by Challenge Coaches (Teachers or Parents) and include a **Team Name** and contact information for the coach. Individual and/or team registration forms MUST be submitted by January 30, 2017 in order to participate in STEMfest! Knox

  Visit **http://tinyurl.com/Knox2017** to register your team.

- **December 10, 2016 - February 04, 2017: Kit Pick-Up**
  Challenge Coaches and Teams may pick-up free **Problem Solving Challenge Kits** at COTC (236 S. Main St., Mount Vernon) from 8:00am – 7:00pm, Monday – Friday. **Teams MUST be registered for STEMfest! Knox 2016 before picking up a kit.**

- **December 10, 2016: Problem Solving Challenge Presentations**
  Students, teachers, and parents may attend one or all **Problem Solving Challenge Presentations** at the above mentioned dates and times. Please register with Meghan Federer at MeghanFederer@attheworks.org.

- **February 7, 2017: Presentation Skills Workshop**
  Students and teachers are welcome to attend the **Presentation Skills Workshop** Please note that **pre-registration is REQUIRED.** You must preregister for this event with Meghan Federer at MeghanFederer@attheworks.org by Tuesday, January 31st. In addition to preregistering please also be sure to contact Kaitlin Brucker at tm@weathervaneplayhouse.org with information about your presentation. This will allow her to better prepare the workshop for registered attendees.

- **January 16 – February 20, 2017: Persistent Scientist Nomination**
  Nominate **an individual team member** in recognition of their diligence, hard work and attitude throughout the STEMfest! Knox problem solving challenge. *A good scientist is always striving to find better, outside the box, inventive answers to any and all challenges. How a scientist approaches hurdles, works in a group and supports other team members is very important.*

  Visit http://tinyurl.com/KnoxPersistantScientist2017 to nominate a student for the Persistent Scientist Award.

- **February 25, 2017: Judging, Event and Awards 10:00am – 4:00pm**
  Come and visit the interactive industry and partner displays from 12:00-3:00pm and learn more about all of the exciting STEM innovations taking place in Licking County.

  Judging of the respective challenge solutions will take place in three (3) dedicated locations concurrently with the opportunities to explore the displays. *The event schedule is subject to change based on the number of teams participating.*

  Please bring your PowerPoint presentation on a flash drive. A laptop and projection system will be available to you. The order of presentations will be posted at the front desk and outside of judging rooms. Note: WiFi availability is not guaranteed during STEMfest! Knox.

STEMfest! Knox Team Registration Information

Coaches: Visit **http://tinyurl.com/Knox2017** to register your team.

Please have the following information available to complete your registration:

- School Information
  - School Name
  - Address
  - Phone Number
- Coach Information
  - First and Last Name
  - Email address
  - Phone Number
- Team Information
  - Student First and Last Names
  - Student Grade Levels
  - Team Name
  - Challenge(s) Selected

Presentation Skills Workshop

Supported by Weathervane Playhouse

Date/Time: Tuesday, February 7, 2016, 5:00 – 6:00pm
Location: The Works, 55 S. 1st St., Newark, Ohio 43058
Contact: Erika Twining Wills – ted@weathervaneplayhouse.org or Kaitlin Brucker – tm@weathervaneplayhouse.org

Supported by:

Presentation Skills Workshop Information: This "Presentation Skills Workshop" will help you, through the use of theatre exercises and acting skills, find the best way to present your projects! Come join theatre professionals from Weathervane Playhouse in Newark, Ohio for a fun, creative new way to present your projects and to find ways to make the whole process easy. Some of the things you will learn more about are detailed below:

1. IMPROVED PUBLIC SPEAKING SKILLS. A professional actor requires an ability to speak clearly and eloquently and to project a strong and steady voice – all while delivering convincing, persuasive and believable dialogue. The same skills that are the focus of almost any acting class are the exact same ones you need for public speaking engagements and to deliver persuasive oral presentations.

2. IMPROVED CONFIDENCE. How can you overcome self-consciousness and find the confidence you need to present a professional and convincing presentation? Just practicing a presentation or performance with classmates can help to build a strong sense of confidence that will carry over into your presentations and everyday life.

3. LEARNING TO WORK AS A TEAM. Acting classes often involve exercises of trust, teamwork and collaboration. Any good actor will tell you that they are only as good as the actors sharing the stage with them. To offer a truly compelling presentation you will have to show solidarity as a team. With this workshop you will learn about how work on the stage requires sharing thoughts and ideas, giving and receiving a lot of constructive feedback, and supporting your fellow actors and classmates as you work to make each other improve, as well as your presentations improve, in a safe and supportive environment.

4. COMPOSURE, CONVERSATION & CONVINCING. Learn to be aware of what your body is saying as well as your words. The awareness of body, posture and physical presence that is taught in acting classes and increased through experience is not abandoned on the stage or left in the classroom; instead, it can be utilized as part of how a person carries themselves, exudes confidence and becomes convincing. Actors also must learn to listen to what they are getting from other actors and have a clear understanding of what is being said, conveyed and how to respond. All of these things, and more, can help put your presentation on a whole new level.

Weathervane Playhouse is Ohio's oldest professional summer stock theatre presenting professional theatre productions for over 46 years.

STEM Resources

Go to www.lickingcountylibrary.info/researchdatabaes.aspx
Access requires a valid LCL card.

Additional assistance: Amy Gantt, Head of Teen Services, Licking County Library 101 West Main Street, Newark, Ohio 740-349-5552 or agantt@lickingcountylibrary.info

Science, Environment & Technology

GreenFILE (EBSCOhost)

Drawing on the connection between the environment and disciplines such as agriculture, education, law, health and technology, GreenFILE serves as an informative resource for anyone concerned about the issues facing our planet.

Oxford Reference Online

100 subject dictionaries and reference books in a single cross-searchable database with subject coverage of biological, earth & physical sciences and mathematics.

Science Online--Facts on File

Comprehensive overview of specific disciplines.

Computer Source (EBSCOhost)

Provides researchers with the latest information and current trends in high technology. This database offers full text for nearly 300 publications and indexing and abstracts for nearly 450 publications.

Magazines & Newspapers

Academic Search Premier

A collection of thousands of scholarly, full-text journals covering nearly all academic areas of study.

Student Research Center

Resources for high school students including full-text articles from over 25 national and international newspapers, 500 popular magazines.

Books (Selected Titles)

Architectural Engineering

Blockley, D. I.. *Bridges: the science and art of the world's most inspiring structures*. Oxford [England: Oxford University Press, 2010. Print.

Goldwater, Daniel, and Harvey Weiss. *Bridges and how they are built*. New York: Young Scott Books, 1965. Print.

Richards, Julie. *Bridges*. North Mankato, Minn.: Smart Apple Media, 2004. Print.

Biofuels

Mousdale, David M.. *Introduction to biofuels*. Boca Raton, FL: CRC Press, 2010. Print.

Reijnders, Lucas, and Mark A. J. Huijbregts. *Biofuels for road transport a seed to wheel perspective*. London: Springer, 2009. Print.

Soetaert, Wim, and Erick J. Vandamme. *Biofuels*. Hoboken, N.J.: Wiley, 2009. Print.

3D Technology

Barnatt, Christopher, and Christopher Barnatt. *3D printing: the next industrial revolution*. S.l.: ExplainingTheFuture.com, 2013. Print.

Dougherty, Dale. *MAKE: ultimate guide to 3D printing*. MAKE special issue ed. Sebastopol, CALIF: O'Reilly Media, 2012. Print.

Evans, Brian. *Practical 3D printers*. New York: Apress, 2012. Print.

Architectural Engineering Challenge

Sponsored by:
Central Ohio Technical College

Your Challenge: Design the most efficient, economical, functional, and aesthetic bridge using only toothpicks and glue. *Please note it will take time for your bridge to set and dry. Be sure to leave enough time for this process to occur before STEMfest.*

High School Addendum: If a *Truss Bridge* is chosen for your design, you may **not** use the following styles of trusses in your bridge: Allan, Bailey, Brown, Howe, K, Kingpost, Long, Pratt, Queenpost, Waddell, and Warren.

Bridge Criteria Overview:

- The **structural efficiency** is equal to the weight supported divided by the weight of the bridge (weight use for ratio calculation will be determined prior to testing at STEMfest by the bridge loading team).
- The **aesthetics** of the bridge will be determined through visual appeal, uniqueness, neatness and symmetry.
- **Cost effectiveness** will be determined based on self-reported use of construction materials (number of toothpicks and ounces of glue).
- Bridge **functionality** will include the clear span, deck, width, height, boat clearance, and loading connection.
    - Clear Span: The bridge is to serve as an overland route over a river, therefore your bridge to be considered functional the supports must be on land (see supporting images for layout). The bridge must have a ***minimum clear span across the water of 12 inches***, with the abutments resting on land on either side of the river. The abutments are to be part of the bridge. (See Support Images)
    - Bridge Deck: The bridge must have a ***minimum deck interior width of 1.5 inches***. The deck must be solid so that a car could travel the length of the bridge. *Please note: The loading block will be placed on the deck during testing.* (See Support Images)
    - Bridge Width: The ***maximum external width of the bridge is 2.5 inches***.
    - Bridge Height: The ***maximum height of the bridge is 8 inches*** from the river surface.
    - Boat Clearance: The ***minimum central clearance above the water must be 2 inches***. A 2-inch high boat must be able to pass unobstructed underneath the bridge at the center.
    - Loading Connection: The bridge must be able to accommodate the loading block (1.5 inches by 2 inches) at the midpoint of the deck. ***A hole in the center of the bridge MUST allow for a 1/4-inch rod to pass through the deck.*** (See Support Images)
- Points will be awarded for **presentation** and **presentation materials**. PowerPoint presentations should be between **7-10 minutes** in length and address:
    - Research into bridge terminology and designs
    - Strength of shapes and the forces that act on structures
    - Justification of your bridge design over other options
    - Bridge Cost
        - $100/ 1 toothpick

        - $100/ 1oz of glue (wet volume used)
    - Bridge Cost Effectiveness
        - Cost effectiveness is determined by dividing the total cost of the bridge by the possible weight held by the bridge.
        - Calculate cost effectiveness of your bridge at 10lbs, 20lbs, 30lbs, 40lbs, 50lbs, 60lbs, and 70lbs. Display your calculations in a data table.

Cost Effectiveness = Bridge Cost / Weight Held

    - Predicted Bridge Strength
        - Strength ratio is determined by dividing the weight held by the bridge by the weight of the bridge.
        - Calculate bridge strength ratios at 10lbs, 20lbs, 30lbs, 40lbs, 50lbs, 60lbs and 70lbs of weight held. Display your calculations in a data table.

Strength Ratio = Weight Held / Weight of Bridge

    - Pertinent career information related to design, manufacturing, and construction of bridges

Material Specifications:

- Round toothpicks (maximum 800 toothpicks)
    - Toothpicks may **ONLY** be glued in the following ways:
        - End to end – No more than ¼" of overlap.
        - End to side – No more than ¼" of overlap.
        - **NO side to side glue** – Toothpicks may be aligned side to side, but glue may NOT be applied to the entire length of the toothpick.
        - **NO coating of toothpicks or completed bridge with any material** (paint, stain, glue, etc.)
- Elmer's white glue. ***Epoxy, wood glue, hot glue, paint and super glues are not permitted.***
    - Glue may **ONLY** be used to attach toothpicks as outline above.

Testing Procedures:

1. All bridges will be weighed and measured for compliance with the bridge specifications for functionality. Bridges that are completed but do not meet the bridge specifications can be penalized up to ***sixty-five*** points. **NOTE: Bridges that do not meet the *minimum clear span of 12 inches* will not receive scores that depend on bridge loading (i.e., weight held), including strength and cost effectiveness.**
2. All bridges will be checked for compliance with material specifications. Bridges that do not meet material specifications can be penalized up to ***twenty*** points.
3. The loading block and testing apparatus will be provided and may not be altered. It is required for testing that the loading block be placed on the bridge deck. Be sure that the bridge deck can be accessed for loading.
    a. During the testing of the bridge, the bridge will be placed in the center of the testing apparatus.
    b. The load will be applied to a 1.5 inches wide by 2 inches long by 1 inch high loading block resting midway in the river. ***A hole in the center of the bridge must allow a 1/4 inch rod to pass through.***
    c. A pulling cable will apply pulling force straight down ***until a ½ inch deflection*** is measured. On the day of STEMfest the stress-strain curve will be projected during bridge testing. ***A maximum***

load will be applied to all bridges until a deflection of ½ inch is achieved. Some bridges may fail, but not all bridges will be tested to failure beyond the maximum load as established for the test.

<u>Scoring & Evaluation</u>:

On the day of STEMfest your bridge will be examined for appearance, adherence to bridge specifications and strength. Your team will be evaluated on each of the following categories:

1. Aesthetics (10 points)
2. PowerPoint Presentation (30 points): Points will be awarded for presentation and presentation materials. Presentations should be **between 7-10 minutes in length** and address:
    - *Presentation organization and required information (20 points)*
    - *Presentation engagement and participation (10 points)*
3. Bridge Specifications (10 points)
    a. *Clear Span (5 points)* **MUST** be at least 12 inches long.
        - A bridge with span less than 12 inches will receive **zero** clear span points.
        - A bridge with span less than 12 inches will also receive **zero** strength points and **zero** cost effectiveness points.
    b. *Bridge Deck (1 point)*
    c. *Bridge Width (1 point)*
    d. *Bridge Height (1 point)*
    e. *Boat Clearance (1 point)*
    f. *Loading Connection (1 point)*
4. Material Specifications (20 points)
    a. *No more than 800 toothpicks may be used. (3 points)*
    b. *Only Round uncoated toothpicks may be used. (2 points)*
    c. *Elmer's white glue must be used. (3 points)*
    d. *Bridges may not be coated with any material (paint, stain, glue, etc.). (6 points)*
    e. *Toothpicks may **ONLY** be glued in the following ways: (6 points)*
        - End to end – No more than ¼" overlap
        - End to side – No more than ¼" overlap
        - **NO side to side glue**

    *<u>High School Addendum</u>: Bridge incorporates truss styles that are not permitted (-20pts). Bridges will also receive **zero** strength and **zero** cost effectiveness points*.

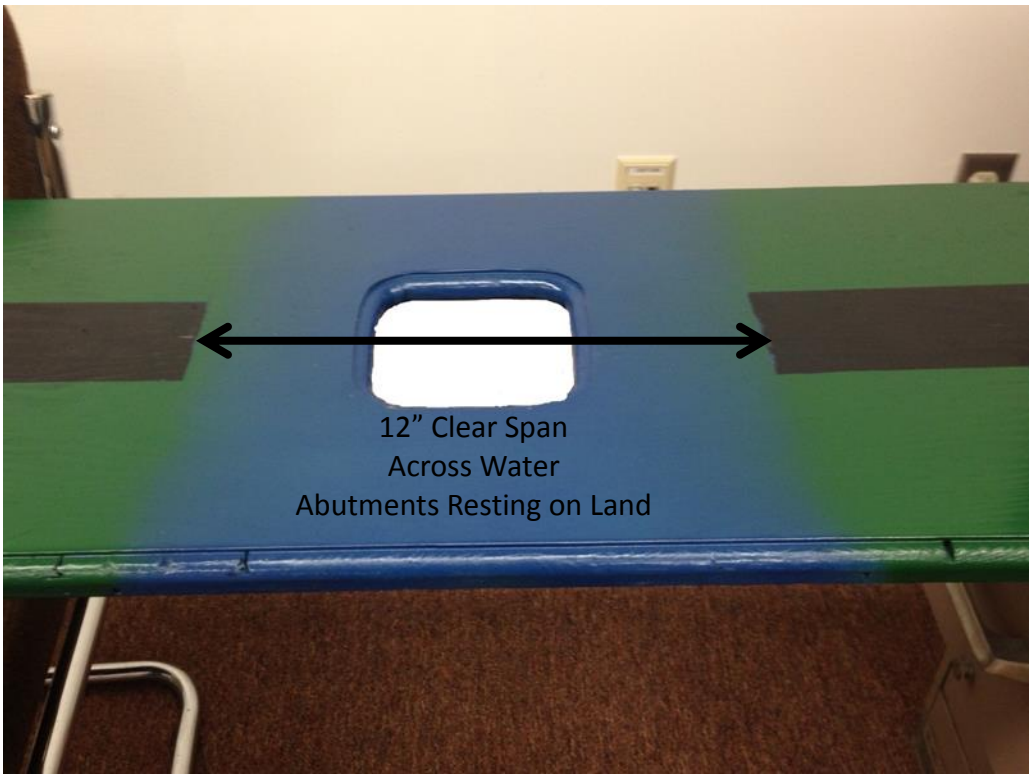
5. Strength Points (40 points)
    a. *Weight Held/Weight of Bridge; Points will be awarded as [(team ratio/maximum ratio)x40]*
6. Cost Effectiveness Points (15 points)
    a. *Cost of Bridge/Weight Held; Points will be awarded as [(team cost effectiveness/maximum cost effectiveness)x15]*
7. In the event of a tie the lightest bridge will be declared the winner.

<u>Sources for more information:</u>

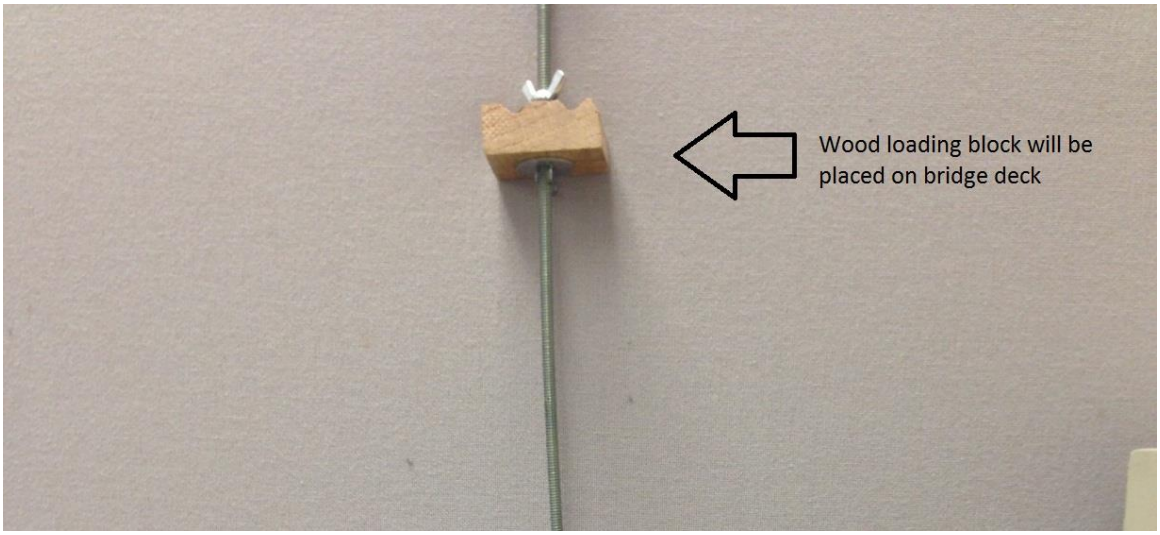
<u>http:// bridgecontest.usma.edu/</u> - West Point Bridge Design Software

Supporting Images:

Bridge Loading Platform

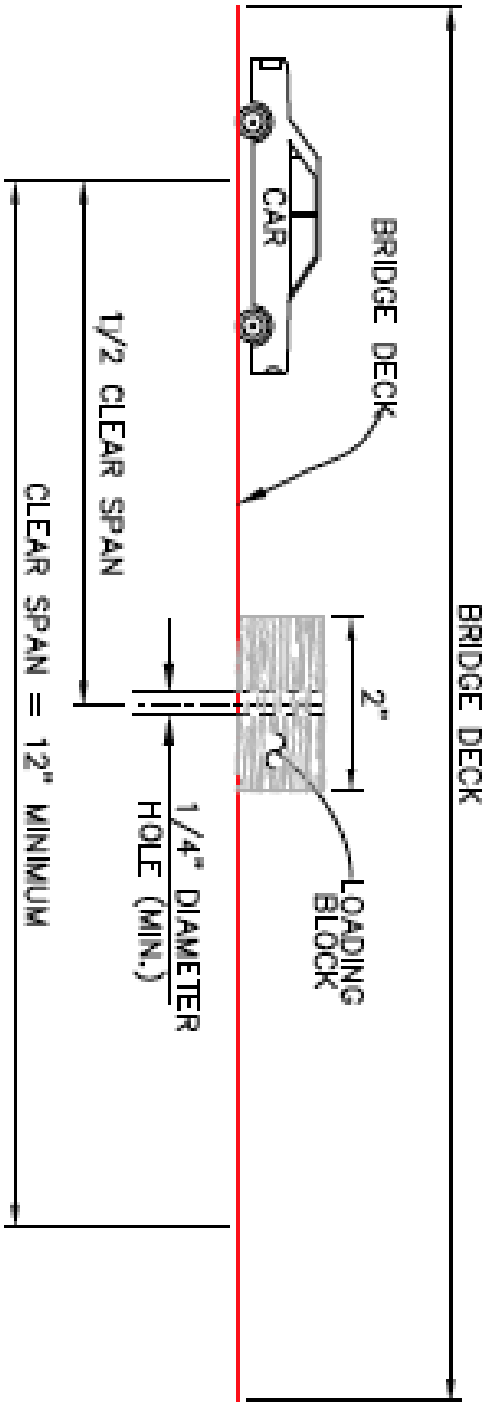


Bridge Loading Block with ¼" diameter rod



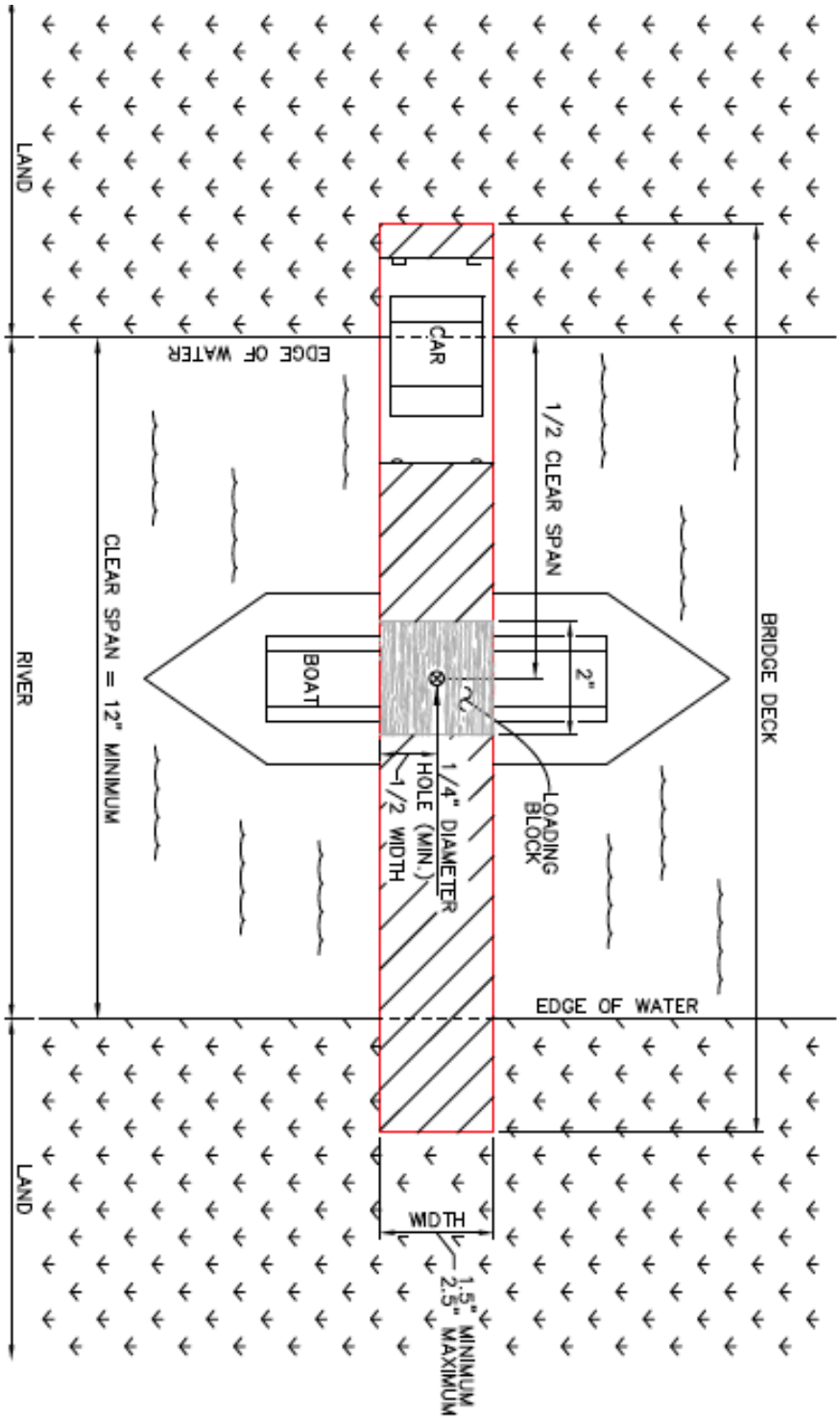
Bridge Deck Side View

Note the 12” minimum clear span refers to the space spanning the water, BETWEEN abutments resting on land.



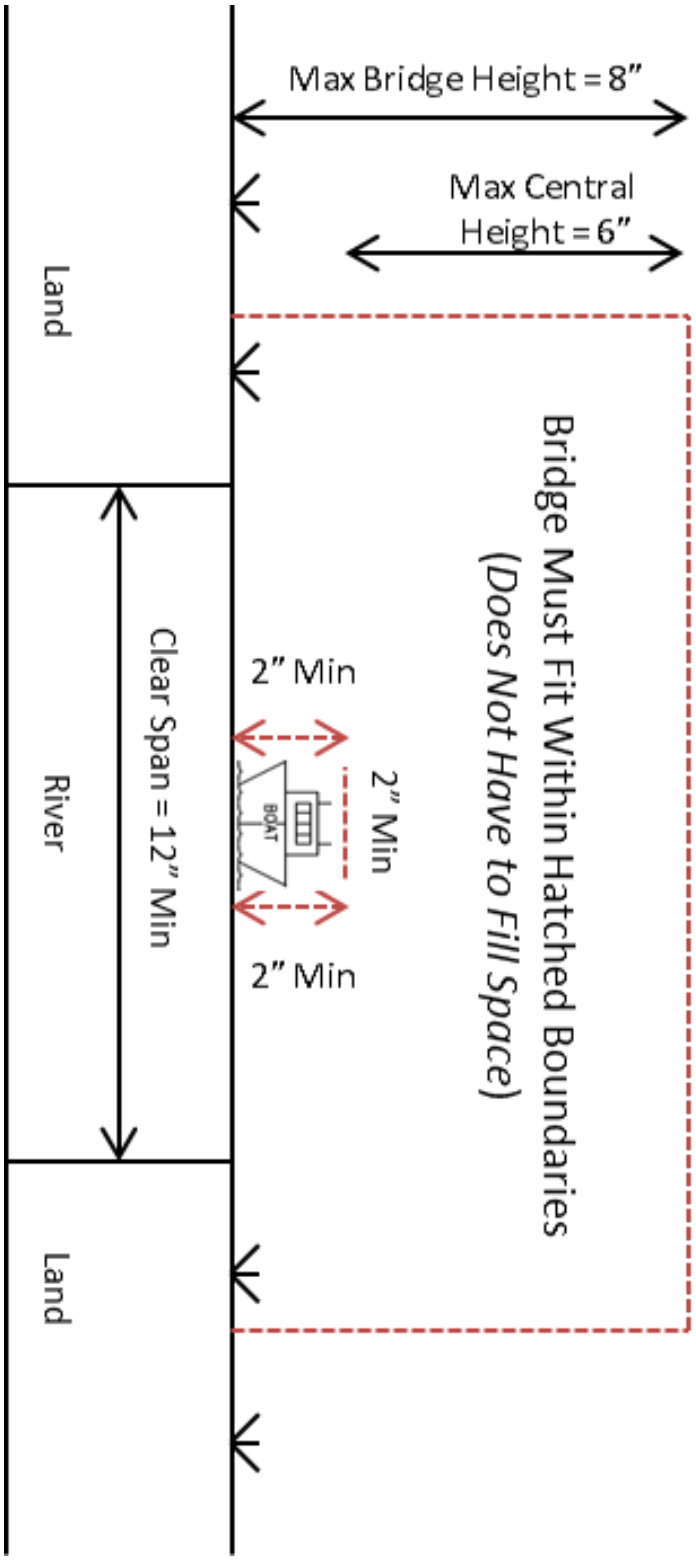
Bridge Top View

Note the minimum (1.5”) and maximum (2.5”) bridge deck width.



Bridge Side View

Note the 12” clear span across the water, the 2” central clearance under the bridge, and the 8” maximum total bridge height.



Biofuels Challenge: Power From Plants!

Sponsored by:
Kenyon College

Background Information:

One of the most important resources for our current way of life is energy. From charging a cell phone or running a computer, to powering a car or heating our homes in winter, we use energy in almost every aspect of our lives. Most of that energy comes to us from burning what are called fossil fuels. This includes natural gas (methane), propane gas, oil, and coal. In just the United States it is estimated that we use over **8 billion** gallons of oil **each day!** Across the world, our energy consumption is significantly greater, and continues to grow. Finding enough energy sources to power the planet, and doing so in a environmentally responsible or 'green' way is a great challenge facing us now and in the future!

The fossil fuels mentioned above hold energy in the form of chemical bonds, and that energy is released through burning it with oxygen gas. These fuels are extracted from the ground using mining techniques that can sometimes be dangerous to people and the environment. There are many other ways to produce energy. Some include harvesting sunlight with solar panels, using heat from the earth called geothermal, or using the wind to turn large turbines. As humans, we get the energy to live and move by eating food, including plants. Of course, plants have been used as a power source for heating (such as a wood burning fireplace) for many years. With a little bit of chemistry, we can harness simple plant materials to give us energy in forms that can be used to power engines and charge your phone!

Your Challenge:
Generate an effective form of energy from a plant source. The energy source will be tested for their efficiency on the day of STEMfest!. Winning teams for each Biofuels Challenge will be invited to be VIPs at a Kenyon College Summer Science Day in the summer of 2017.

- Middle School: *Investigate fruits as a source of stored chemical energy (i.e., a battery).* Using just a few metal materials, you can turn an ordinary piece of fruit into a battery!. This happens through a process known as electrochemistry, where the fruit acts like a 'salt bridge' between two different metals, called 'electrodes.' Your job is to experiment with different fruits and metals to make the most efficient battery.

- High School: *Synthesize biodiesel as a portable fuel from various vegetable oils*. Using a chemical reaction called saponification, plant oils such as soy oil can be converted into a type of fuel called biodiesel. This fuel can be used as a substitute for gasoline or propane in certain types of engines and generators. Your job will be to make the most efficient batch of biodiesel fuel possible, using any commonly available vegetable product. A basic procedure and materials for the conversion of vegetable oil into biodiesel is provided. You will need to research the chemical reaction and experiment with your technique and the available oils to generate the optimal fuel.

**Note*: Making a biodiesel requires access to laboratory space and safety apparel. If this is not available to your team, contact Alyssa Lawrence, administrative assistant, Office for Community Partnerships - 740.427.5419 or lawrencea@kenyon.edu and space/apparel will be provided. See details in High School Challenge section for dates and times.

Middle School Challenge: Making A Fruit Battery!

Investigate produce as a source of stored chemical energy.

Required Background Research & Information:

- What is electrochemistry? Define salt bridge. How does a normal battery (not Li ion) work?
- What is an electrode? Why are different metals used for electrodes?
- What is the role of the fruit in your battery? Why are some fruits better as a battery than others?
- What careers are involved in the Biofuel Industry? What is unique about the emerging career cluster?

Material Specifications:

- Nails: Copper, Zinc (short, shiny silver), Steel (long, dull and silver), and Aluminum
- Insulated copper wire
- (3) Light emitting diodes (LEDs): Red (2V), Yellow (2V), and Blue (3V). Use your three LEDs to figure out the *highest voltage* (Hint: you can string the LEDs together) and the *highest current* (Hint: higher current makes the LED shine brighter).
- (4) Pieces of Produce: Apples and Oranges (provided), *other produce may be explored at your discretion (note that any produce can be explored, it does not have to be fruit).* Your battery design can include up to four pieces of produce. You must determine which produce to use and how to put the battery together.

Scoring & Evaluation:

On the day of STEMfest you will set up your best battery and test it to see how much power it produces!
Make sure you prepare your battery with fresh produce the day of STEMfest! for optimal performance. Also, do not connect your battery until time for testing!

Your team will be evaluated on each of the following criteria areas:

1. Aesthetics (10 points): How neat and professional does your fruit battery look?
2. PowerPoint Presentation (40 points): Points will be awarded for presentation and presentation materials. Presentations should be between **8 - 10 minutes in length** and address:
    - *Presentation organization and required information (30 points)*
        - *Background research on how a battery works and metal conductivity*
        - *Comparison of various produce – why are some better than others?*
        - *Experimental process, including:*
            - *Rationale of design*
            - *Efficiency of design*
            - *Changes made*
            - *Comparison of different battery design*
        - *Career research*
    - *Presentation engagement and participation (10 points)*
3. Material Specifications (10 points): Battery includes only the specified functional materials. (additional materials of your choice may be used as supporting structure)
    - *No more than 4 produce items used (5 points)*
    - *Only the provided types of nails used (5 points)*
4. Battery Efficiency (40 points): The current and voltage of your fruit battery will be measured.
    - *Current (20 points) – Points will be awarded as [(team current/maximum current)*20]*
    - *Voltage (20 points) – Points will be awarded as [(team voltage/maximum voltage)*20]*

High School Challenge: Biodiesel Fuel

Synthesize biodiesel as a portable fuel from various vegetable oils.

***Note:** Making a biodiesel requires access to laboratory space and safety apparel. If this is not available to your team, Kenyon's Chemistry department will be hosting two Saturday sessions of Open-lab hours from 9am - 1pm on January 28th and February 4th. Preregistration is required to utilize the space, please contact Alyssa Lawrence, administrative assistant, Office for Community Partnerships - 740.427.5419 or lawrencea@kenyon.edu to reserve space during Open-lab hours.

Required Background Research & Information:

- What is biodiesel and how is it made?
- Explain the chemistry of the saponification reaction you carry out.
- How did you design your experiment? Why?
- How did you decide which oils to use? Why?
- What careers are involved in the Biofuel Industry? What is unique about the emerging career cluster?

Material Specifications:

- Gloves
- Lye
- Soy Oil (provided), *other vegetable oils may be investigated at your discretion.* **You must research and compare a minimum of 3 different vegetable oils**.
- Methanol
- Isopropanol
- Jars
- Graduated cylinders

Scoring & Evaluation:

On the Tuesday before STEMfest, (or sooner) bring at least 10 ml of your best fuel to COTC – Knox. An exact amount will be weighed and burned in a calorimeter to directly measure the efficiency, or amount of energy per mass, of your biodiesel. On the day of STEMfest, your sample will be examined for purity by color, turbidity, and consistency. Your team will be evaluated on each of the following criteria areas:

1. Aesthetics (15 points): Color, clarity, and homogeneity of biodiesel.
2. Efficiency (15 points): Amount of energy produced per gram of fuel. *Points will be awarded as [(team efficiency/maximum efficiency)*15]*
3. PowerPoint Presentation (30 points): Points will be awarded for presentation and presentation materials. Presentations should be between **8-10 minutes in length** and address:
    a. *Presentation organization and required information (20 points)*
        i. Research into biodiesel and production
        ii. Explanation of your experimental design process
        iii. Comparison of your (3) different vegetable oils and justification of final choice
        iv. Pertinent career information related to research, synthesis, and use of biodiesel fuels.
    b. *Presentation engagement and participation (10 points)*

Basic Experimental Procedure: Making Fuel from Vegetable Oil

1. Always wear gloves and goggles!! Everyone must wear protective gear while handling chemicals.
2. Measure out 100 ml or more of new vegetable oil and pour it into a large beaker.
3. Heat 100 ml of new vegetable oil to 50 °C on a hotplate using a stirrer. One person in your group should watch the temperature closely so the oil does not overheat.

Perform the following two steps under the chemical hood or other well ventilated space.

4. Measure 25 ml of methanol in a graduated cylinder and pour into your mixing bottle. Cap the methanol bottle and your mixing bottle tightly.
5. Weigh out 0.5 grams of sodium hydroxide (lye) and add to the methanol in your mixing bottle. Cap the bottle and swirl gently for a few minutes until all of the lye dissolves. You now have sodium methoxide in your bottle, a strong base. Be careful!
6. When the lye is dissolved and the oil reaches 50 °C, add 100 ml of warm oil to the methoxide and cap the bottle tightly. Invert the bottle once over a sink to check for leaks. Caution: Be certain that the oil is not over 60 °C, or the methanol may boil!!
7. Shake the bottle vigorously for a few seconds then, while holding the bottle upright, open the cap to release any pressure. Retighten the cap and shake for at least one minute venting any pressure occasionally. Set the bottle on the bench and allow the layers to separate.
8. Over the next 30-60 minutes, you should see a darker layer (glycerol) forming on the bottom of the bottle, with a lighter layer (biodiesel) floating on top. Complete separation of the reaction mixture will require several hours to overnight. If your procedure worked correctly, there should be two distinct layers remaining after settling.
    a. The darker layer at the bottom is a crude glycerine byproduct, and the lighter layer on top is biodiesel. If you pick up the settling bottle and rock it slightly from side to side, notice how the darker layer is thicker than the fuel floating on top. This higher viscosity of glycerine is one of the reasons that it isn't suitable for use in a diesel engine at room temperatures. By removing the heavier, more viscous part of the oil, the esters pass through the engine's injectors and combust that much easier.
    b. It is common to see a whitish third layer floating between glycerine and the biodiesel. This soap-like material is a result of adding too much lye, or having water in the oil. It should be discarded with the glycerine.
    c. If you see more than two layers, or only one, then something is wrong – possibly excessive soap or monoglyceride formation. These are both emulsifiers, and in sufficient quantities they will prevent separation. In this case, check your scales, measurements, and temperatures.

You will need to research how to best separate and wash your biodiesel. Your actual procedures may differ based on the type of oil used and your results.

3D Printing Challenge

Sponsored by:
Mount Vernon Nazarene University

Your Challenge: Design and a print a container with a closing lid that is both light weight and can hold three (3) Starburst® candies. This must stay together without any help (no tape, glue, etc.).

3D Printers are great for getting you out of problems because if you can think it you can make it. They allow you to manufacture items you would not normally be able to replicate in standard manufacturing practices such as square holes and undercuts, or any shape for that matter.

3D Judging Overview:

1) Appearance of container: Neatness and aesthetics of final container.
2) Shape of container: Meets specifications for height, width, and overall shape.
3) Strength Ratio: Weight of container/weight held as determined through a compression test.
4) Lift Test: Container must be able to be lifted by top half to approximately 12" above the table without separation.
5) Career Research: Share relevant careers that include 3D printing technology.
6) Presentation: Clear, informative, and complete

Material Specifications:

- 3D Design Software – see link below for available options
- SLS file to print
- 3D Printer
- Filament

NOTE You can schedule a time to run your calibration printing and container test printing through The Works. The Works will provide time with the printer and filament. There is free software available for designing the container and calibration piece and this should be done at your site. Some trial and error should be expected, plan to have some corrections and reprinting.

Printer Calibration:
Before using the printer to rapidly prototype samples or solve a machining problem the printer needs to be calibrated. This will create a precise method of making 3D printed pieces exactly to size. To calibrate the printer you will need to make a 1.000-inch cube block with 0.500-inch holes. (Figure 1.) After printing the part take actual measurements of the piece and see how close it actually is to 1.000-inch. Label the axis, x, y, and z. Record the measurements and use your recordings to calibrate the printer.

Testing Procedures:
The week leading up to STEMfest! your team will need to schedule a time for your container to be printed. On the day of STEMfest your container will be tested for strength and evaluated to determine that criteria for size, shape, etc. are met. You will also need to bring your calibration piece with you and be prepared to discuss how calibration affects the overall 3D printing process. We will test the container to confirm that it will stay closed without any help, can easily be opened, conforms to size constraints and can hold three (3) Starburst® candies. You will also give a brief presentation that should address the process of creating the 3D design, the importance of calibration, how well the container meets the requirements of size, shape, etc. and the career opportunities that involve 3D printing. The container containing the

three (3) Starburst® candies will be picked up by the bottom to approximately 12" above the table and held upside down.

Scoring & Evaluation:
Your team will be evaluated on each of the following criteria areas:

1) Presentation (0- 30 points): Clear, informative, and complete. The presentation will be timed and limited to a maximum of 8 minutes. At 8 minutes the presentation will be stopped and points will be scored on the material that had been presented up until that point. All team members should participate in the presentation. The presentation must include the following at a minimum:
    a. Design: Description of the design process - what worked, what didn't, why you chose your design, type of lid closure, etc.
    b. Calibration cube: Describe what the purpose of the calibration cube is and why it is important.
    c. Why the strength to weight ratio is important for designers/engineers and manufacturing.
    d. Career Research: Share relevant careers that would make good use of 3D printing technology.
    e. Lessons learned during the design and testing process.
2) Appearance of container (0-10 points): Neatness and aesthetics of final container. Middle School (MS) students may use either a round lid or a square/rectangular lid, however the lid does not have to align with the bottom when fully closed, but additional points will be given if it does (to the maximum 10 total points for this criteria). High School (HS) students must use a 3D design with a minimum of 4 sides (may not be a cylinder, sphere, cone, etc.) and the lid needs to closely align to the bottom when the container is fully closed. For HS students if the lid doesn't closely align (approx.. +/- 10 degrees), 0 points will be scored for this criteria. The lid should fit snuggly and not rattle, or be off center, points will be deducted for these issues.
3) Size of container (0-10 points): Meets specifications for height (2.50" or less), width (2.50" or less), and length (2.50" or less), and overall shape. If the container exceeds any of the required dimensions or cannot hold a minimum of 3 Starburst® candies in their original shape with wrapper on, it will result in 0 points being scored for this criteria.
4) Lift Test (0-10 points): Container must be able to be lifted by the lid to approximately 12" above the table without separation for 5 seconds. If the lid comes off, 0 points will be scored for this criteria. The lid may only be attached to the bottom by designed in features (screw on, snap on, cam lock, etc.). No additional materials or fasteners may be used such as glue, tape, screws, rubber bands, etc.. These methods will result in 0 points being scored for this criteria.
5) Strength to Weight Ratio (0-20 points): The amount of weight the container can hold in the compression test/the weight of the container. If the lid does not stay on the bottom in the upright orientation, the strength to weight ratio test cannot be performed and 0 points will be scored for this criteria. The team(s) that has the highest strength to weight ratio will receive all 20 points. All other qualifying teams will receive a percentage of 20 points based on the percentage of their ratio vs the maximum ratio. A maximum weight will be applied to the container, all qualifying containers holding this maximum weight will receive 20 points.

Sources for more information:
http://www.3ders.org/3d-printing-basics.html - General 3D Printing Information
http://www.shapeways.com/creator/tools - 3D Design Software
http://www.freecadweb.org/ - Free CAD
http://www.sketchup.com/ - SketchUp
http://www.tinkercad.com/ - 3D Design Software **(only MS students may use this software)**
http://www.openscad.org - OpenSCAD
http://makezine.com/2013/12/11/top-ten-tips-designing-models-for-3d-printing/ - Top 10 Tips for Designing 3D Models from Make Magazine
http://www.ic3dprinters.com/ - IC3D Printers Website (The Works and C-TEC have IC3D Printers)

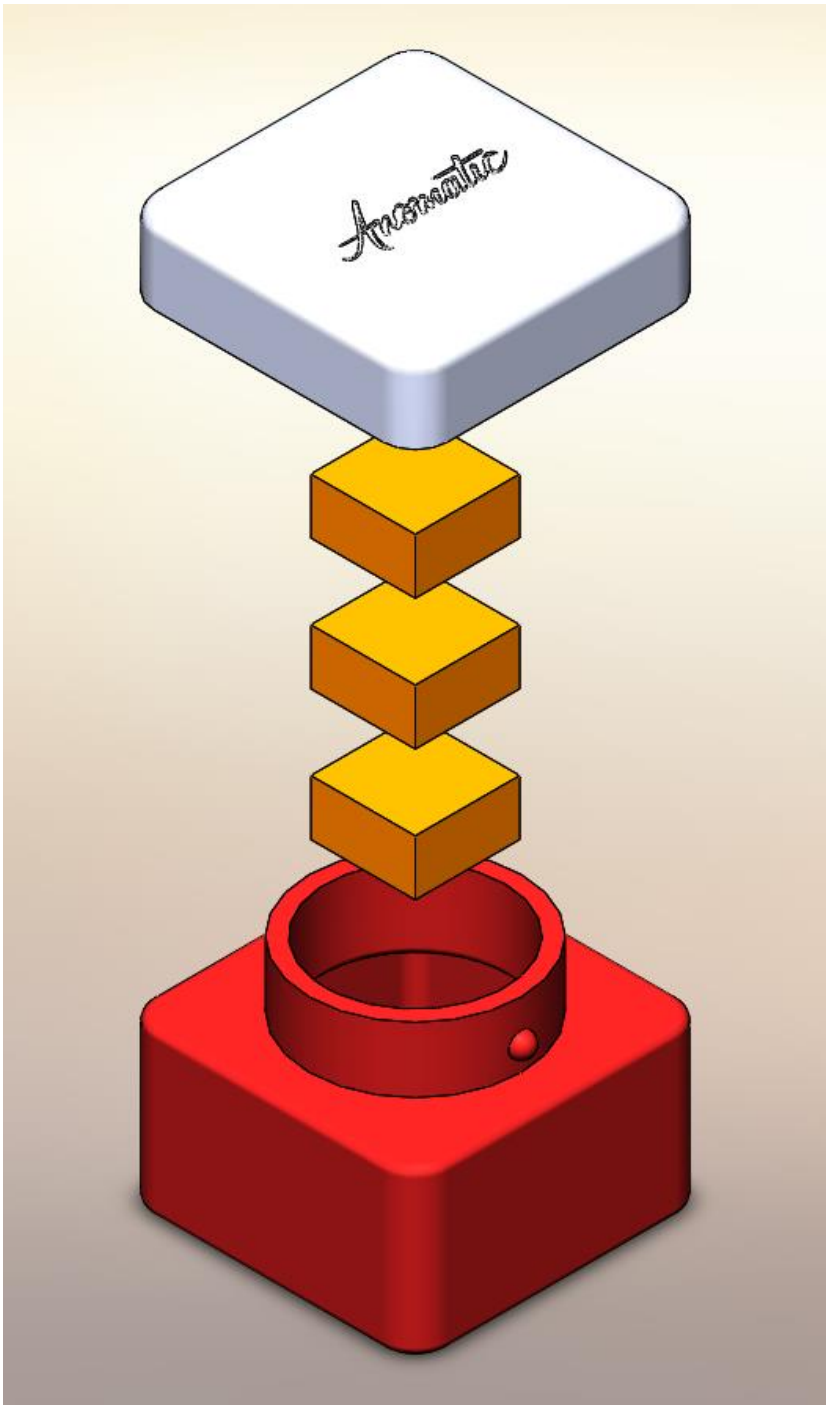


Figure 1: Exploded view of a 3D container and 3 Starburst® candies

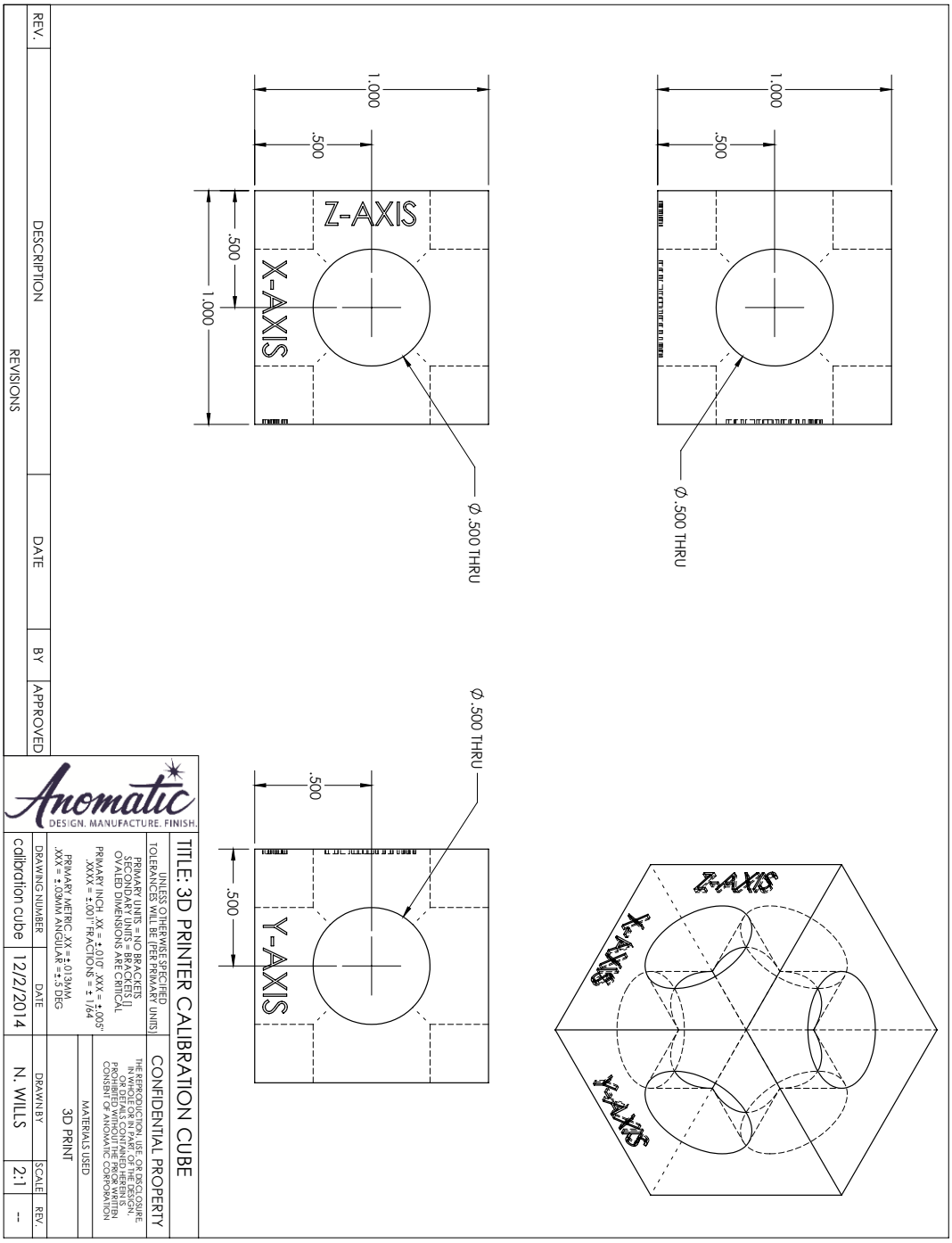


Figure 2: 3D Printer Calibration Cube Blueprint

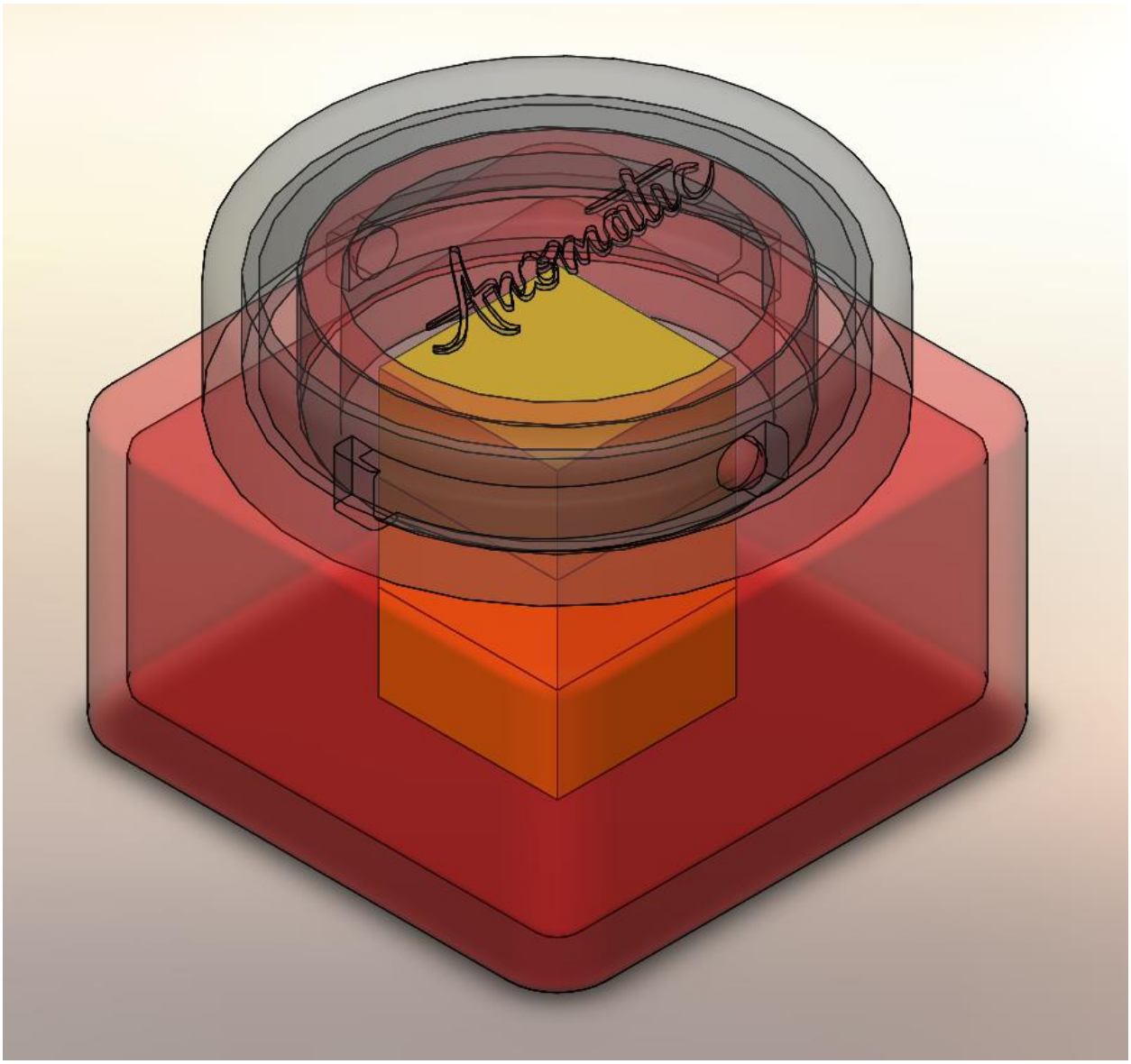


Figure 3: 3D rendering of a container with a square bottom and a round lid held in place with a cam lid.

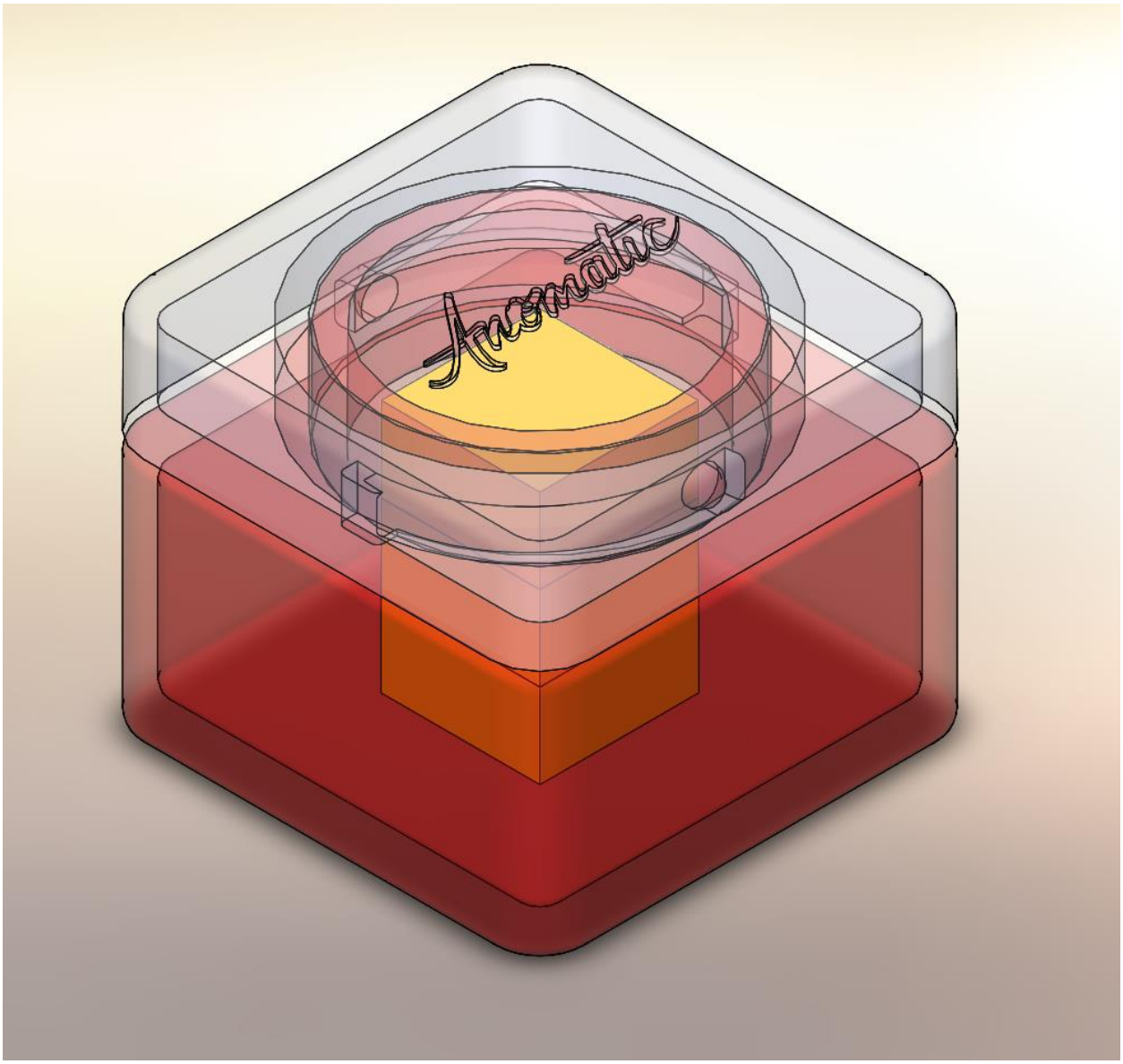


Figure 4: 3D rendering of a container with a square bottom and a square lid held in place with a cam lid and is aligned to the bottom.

Persistent Scientist Award Information

The Persistent Scientist award is presented to **an individual team member** in recognition of their diligence, hard work and attitude throughout the STEMfest problem solving challenge.

A good scientist does not always get the correct answer, but a good scientist is always striving to find better, outside the box, inventive answers to any and all challenges. Struggling is part of the process. How a scientist approaches those hurdles, works in a group and supports other team members is very important.

To nominate a student for the Persistent Scientist Award visit http://tinyurl.com/KnoxPersistantScientist2017 complete the nomination form.

Scholarship Opportunities

Winning high school teams competing in STEMFest! Knox Problem Solving Challenge will have the following scholarship opportunities.

- Each winning team member of the Architectural Engineering challenge will receive a $1,000 college scholarship to attend Central Ohio Technical College.
- Each winning team member of the 3D Technology challenge will receive a $1,000 college scholarship (distributed as $250 over four years) to attend Mount Vernon Nazarene University.

Summer Science Institute Opportunities

Winning teams of the STEMFest! Knox Biofuels Challenge will be invited to a Summer Science Day VIP experience at Kenyon College. During that day winners will interact with Kenyon summer science scholars during lab visits, meet science faculty, participate in team meetings and visit other areas of interest on Kenyon's campus.