Algebra 2 & the Engineering Design Process

Mr. Thomas Haas, University of Cincinnati

Thomas Haas: Thomas joined the United States Air Force in 2004 as an F-16 Avionics Technician. During 42 months of active duty service, Thomas received Airman of the Quarter and was nominated for the Technician of the Year. After leaving the Air Force, he received his Bachelors in Secondary Education and Mathematics from the University of Cincinnati in 2012. Thomas is currently teaching math and Foundations of Engineering at Norwood High School.

WORKSHOP PROPOSAL FORM

2015 Annual ASEE K-12 Workshop on Engineering Education
"Authentic Engineering: Representing & Emphasizing the E in STEM"
Presented by Dassault Systems

Saturday, June 13, 2015
8:00 A.M. – 5:00 P.M.
Sheraton Seattle | Seattle | WA

Please complete this form, save it as a PDF file *only* and upload it through the ASEE Paper Management system as shown in the K12 Workshop Presenter's Kit.

All notifications will be by email from the ASEE Paper Management system.
NOTE: To ensure that emails are not obstructed by spam blockers, please make sure to WHITELIST the email addresses: monolith@asee.org and conferences@asee.org and s.harrington-hurd@asee.org.

Direct questions to Stephanie Harrington-Hurd, ASEE K-12 Activities Manager, at s.harrington-hurd@asee.org. Additional workshop details are available at: http://www.asee.org/K12Workshop. Thank you!

Deadline

Friday, January 23, 2015 by 5:00PM EST
Presenters will be notified of acceptance status by March 14.
Late submissions will not be accepted.
Advanced Workshop Registration will open December 6, 2013.

SUBMISSION INFORMATION

Provide the first and last name of each presenter, including affiliations. If there is more than one presenter, designate one person as the organizer and provide only that person's contact information. The organizer is responsible for communicating to co-presenters.

Number of Presenters: 1

Presenter Name(s):

1) Last: Haas First: Thomas Affiliation: University of Cincinnati CEEMS & Norwood High School

2) Last First Affiliation

3) Last First Affiliation

Contact Person's Name: Thomas Haas

Contact Person's Email: haas.t@norwoodschools.org

Contact Person's Phone: 513-252-4207

Contact Person's Alternate Phone: 513-924-2891

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Please provide a one-paragraph bio for each presenter (in the order listed above). The bio should not exceed 70 words and should be written as you would want it to appear on the ASEE website and program materials.

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2)

3)

WORKSHOP INFORMATION

Proposed Title:

Algebra II and the Engineering Design Process

Abstract: Please provide a concise description that includes the workshop's learning objectives (maximum 750 characters). The abstract is used on the ASEE website, program materials, and otherK-12 Workshop promotional activities.

Participants will explore how to make Algebra II standards in the Common Core Math Standards seem more relevant to students by creating engaging instructional modules incorporating the engineering design process. Specifically, they will investigate how to enhance students' understanding of quadratic equations as they are applied to real life situations. Participants will apply the engineering design process to solve a stunt movie challenge. The challenge encompasses collecting data to determine if it follows a line/curve of best fit in order to find a solution using the two developed equations.

Workshop Description. Please provide a detailed description of the proposed workshop that, at minimum, explicitly addresses the following (maximum 4,000 characters):

a. Learning objectives
b. Hands-on activities and interactive exercises
c. Materials that participants can take with them

d. Practical application for teachers and outreach staff

Algebra offers some rich opportunities for teachers to show students real world applications of the complex concepts they learn in class. The concepts learned in Algebra II have a wide variety of uses in engineering. The workshop will focus on how to use a challenge that students can relate to in order to encourage students to generate a deeper understanding of important Algebra II concepts.

Specifically, a high school Algebra II teacher will demonstrate how to enhance students' understanding of quadratic functions and their graphs. Participants will be split into groups and issued a challenge to develop a model based on a real life stunt (similar to the one in *Fast and Furious* with two cars drag racing over train tracks just before the train goes through). Participants will be asked to work through the beginning steps of the engineering design process to create a method to solve the challenge. Using laptops that are supplied from the presenter, participants will analyze a student created video of a CO_2 car being fired in order to generate distance and time data. They will then use that data to generate an equation from the supplied graphing calculators based on the r^2 values found for the linear regression and the quadratic regression. Discussion of how the equation of the CO_2 car can be compared to the equation of the free falling object in order to solve the challenge will lead to how the students completed the engineering design process to find a solution to the challenge. The goal is to time the stunt perfectly so that the free falling object nearly misses the CO_2 car. Videos of students' success and failure will be shown at the end as well as student testimonials of the project. The testimonials will show a higher level of student engagement and a deeper understanding of quadratic functions as a result of the challenge. The engineering design process is stressed during the challenge to show students a proven method that is used by professionals to tackle challenges or societal issues. Students are encouraged at the end of the project to use the process to solve other real life problems. Hard copies of lesson plans will be provided to attendees.

Authentic Engineering Connection. Identify and describe how you will explicitly address the ways in which your lesson or activity is representative of the processes, habits of mind and practices used by engineers, or is demonstrative of work in specific engineering fields. At least one of those must be within the first four listed, below; i.e., do not only check "other". Check all that apply:

- ☒ Use of an engineering design process that has at least one iteration/improvement
- ☐ Attention to specific engineering habits of mind
- ☒ Attention to engineering practices (as described in the NGSS/Framework and as practiced by engineers)
- ☐ Attention to specific engineering careers or fields related to the lesson/activity
- ☐ Other (please describe below)

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Provide a description of how you will explicitly address these aspects of authentic engineering in your workshop (maximum 2,000 characters):

The challenge required students to outline the steps used in the engineering design process in order to progress in solving the challenge. Students were forced to brainstorm methods to solve the challenge as well as detail a sketch of how they were going to create their equations that the CO_2 car and free falling object were going to be generated. If the r^2 values that they were finding from their data were not above 85%, then the students were required to collect new data using a different method. After each group was tested, they were required to write about why their car was successful or not as well as how they would have made it more successful if they were to go through the process again.

Students approached engineering in a different light. In previous challenges that involved engineering, students were required to build or modify an object. However, in this challenge, students are tasked to focus on the modeling aspect of engineering in order to have a desired outcome in a scaled down version of a real world event. Students analyzed data to create equations and graphs that describe two different events that occurred, then altered their equations based on what they could affect in real life in order to transform their graphs into what needed to happen during their test.

Diversity. This year is the American Society for Engineering Education's "Year of Action on Diversity." It is essential that we have a diverse engineering workforce to solve diverse problems. To do that and to have an engineering-literate public, it is essential that we reach *every* preK-12 student with high-quality engineering education, drawing on issues of access and equity in the classroom and in the curriculum. Reviewers would like to know how your proposed workshop will address diversity.

Provide a description of how you will explicitly address diversity – e.g., diversity with respect to gender/sex, ethnicity or race, special education inclusion, socio-economic status, or LGBT status – in your workshop (maximum 2,000 characters):

The challenge that is being presented was created for students who attend a school where more than 50% of the student's population comes from low-income and/or single parent households. The challenge showed students that they can study and model real world challenges with low-cost materials and using basic technology. Students were given the freedom to paint their CO_2 cars any way they would like to help express their groups' identity. Many students took advantage of this and painted their cars with flowers on it, racing stripes, anime characters, or to look like the bat-mobile.

This challenge has many different entry points and tasks to be solved to enable students from all different abilities to jump in and help define a solution. The challenge needs people in the group

to generate ideas to find the equations for the free falling object and CO_2 car, sketch how the group is setting up to determine the equations, graph the equations once they are found, and many other tasks to be accomplished throughout the challenge.

Are there any online components to the proposal or presentation? (Note that these online components may only be available to presenters or those who have their wireless subscriptions, since wireless may not be available during the workshop sessions.)

☒ No
☐ Yes

Please describe:

Grade Level Target Audience (check all that apply):
☐ Primary (EC–2)
☐ Elementary (3–5)
☐ Middle School (6-8)
☒ High School (9-12)

Maximum Number of Participants:
25

If this number is greater than 25, please describe how your workshop will equally engage all participants.

All Seating is Classroom (tables and chairs).

Audio Visual Equipment Requests:
Note: *An LCD projector, screen and podium with attached microphone are provided. Requests for additional equipment or resources (e.g., internet connection or laptops) will incur extra charges. If you do not have additional requests, please indicate with "Not applicable."*

Not applicable

Reminder:

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Presenters must register and pay the registration fee to support their workshop attendance and audio/video costs.

Thank you for completing this proposal form!
Please review this document prior to submitting it to ensure that all items are complete.

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Date Received:

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