



Seattle

122nd ASEE Annual  
Conference & Exposition

June 14 - 17, 2015  
Seattle, WA

*Making Value for Society*

Paper ID #14289

## **Introducing Industrial Engineering and Systems Thinking to Middle School Students with Authentic Engineering Problems**

Dr. William J. Schell IV P.E., Montana State University

# 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](mailto:monolith@asee.org) and [conferences@asee.org](mailto:conferences@asee.org) and [s.harrington-hurd@asee.org](mailto:s.harrington-hurd@asee.org).

Direct questions to Stephanie Harrington-Hurd, ASEE K-12 Activities Manager, at [s.harrington-hurd@asee.org](mailto: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: 2

Presenter Name(s):

1) Last Schell First William Affiliation Montana State University

2) Last Glime First John Affiliation Granite School District - Utah

Contact Person’s Name: William Schell

Contact Person’s Email: [wshell@ie.montana.edu](mailto:wshell@ie.montana.edu)

Contact Person’s Phone: 406.224.0857

Contact Person’s Alternate Phone: 406.994.5938

# 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 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.

**WILLIAM SCHELL** (PE, PEM) is an Assistant Professor of Industrial and Management Systems Engineering at Montana State. He earned his PhD in Industrial and Systems Engineering from the University of Alabama - Huntsville. During more than fourteen years in industry, he held positions focused on process improvement and organizational development with Fortune 50 and Inc. 500 companies, designing and implementing many large scale change initiatives to improve business performance.

2) **John Glime** teaches 6th grade in Holladay, Utah. He earned his Master of Education from Westminster College where his research investigated effective use of classroom technology. During his twelve years teaching, he has taught a range of socioeconomic and racially diverse students in three different elementary schools, including 3 years in a Title 1 school. He is ESL certified and teaches all subject areas including math, science, and language arts.

---

---

## WORKSHOP INFORMATION

---

---

### Proposed Title:

Introducing Industrial Engineering and Systems Thinking to Middle School Students

**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 other K-12 Workshop promotional activities.

Many of the greatest challenges facing our society require interdisciplinary collaboration and approaching problems from a systems thinking perspective. Yet almost our entire educational system focuses on discipline specific approaches that break complex problems down to simple components to be solved individually. Oftentimes when these solutions are reassembled, significant unintended consequences occur. This workshop utilizes industrial engineering approaches to introduce educators to age appropriate tools and methods that can bring a systems thinking perspective to problem solving. Participants will see how a systems level problem and systems thinking approach can address large swaths of the core curriculum. Examples and activities are utilized that fit a wide range of middle school students with diverse backgrounds and abilities.

**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

# 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

- b. Hands-on activities and interactive exercises
- c. Materials that participants can take with them
- d. Practical application for teachers and outreach staff

This workshop will provide middle school educators with a hands on and interactive session that will present the foundation of systems thinking and provide grade appropriate scenarios to utilize with their students. Session participants will hear concise presentations on systems thinking, learn about industrial engineering tools that can be used to approach systems level problems, and work in small teams to examine a complex problem where systems thinking develops improved solutions (compared with those created from a single perspective). At the conclusion of the workshop, participants will be able to:

1. Describe the Industrial Engineering profession and systems thinking.
2. Explain how Industrial Engineering tools can be utilized to promote systems thinking in middle school students.
3. Develop solutions to sample complex problems using a systems thinking approach
4. Prepare students to solve authentic engineering problems using a systems thinking approach.
5. Judge the effectiveness of student generated solutions to authentic engineering problems from a systems thinking perspective.
6. Identify authentic engineering problems which are applicable to their diverse student population and require a systems thinking approach for solution development.

The core of the workshop will have participants working in teams to solve a sample systems level problem, supported by the facilitators. This approach is discussed in more detail in the authentic engineering section below. The group work will be supported with a series of brief presentations on a systems thinking framework to problem solving and key industrial engineering tools, such as root cause diagrams and process maps, which can be applied to the systems level problem being worked. These tools will assist students in seeing multiple perspectives and analyzing trade-offs. All tools presented will be further documented with take-away materials that attendees can use in their classroom. In addition, the workshop will address the prerequisite skills and mindset needed to successfully apply systems thinking approaches with middle schoolers and how the approach can be adapted for varied student readiness levels.

The workshop materials go beyond mere topical content and a sample problem. Participants will also be provided 1) three additional problems that they can bring into their classroom, 2) a step-by-step methodology for expanding sample problems or developing their own systems thinking problems for classroom use, 3) a grade appropriate rubric tied to key common core areas for use in evaluating student developed systems solutions, and 4) access to an online repository where new problems can be shared as they are developed by the community.

# 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

At its essence, systems thinking provides educators with an interdisciplinary approach to help their students see how the materials learned in class apply to their world. This macro to micro approach provides an avenue to grab students attention with a topic they care about and then show them how the approaches learned in math, science and language arts can be utilized to generate solutions to their problem. Participants will see how a systems level problem and systems thinking approach tie directly to Common Core State Standards in language arts and mathematics, and to Washington State’s K-12 Next Generation Science Standards. Some examples include: drawing inferences about populations (CCSS.MATH.CONTENT.7.SP.B.3), developing compelling arguments and recommended solutions using clear reasoning and relevant evidence (CCSS.ELA-LITERACY.W.6.1.C), and using systems thinking skills to develop solutions to societal problems (EALR 1: SYS). Educators will leave the workshop feeling comfortable with the knowledge that an implementation of these strategies in the classroom will also maintain a fidelity to the Common Core.

**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.<sup>1</sup> 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)

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

The workshop will introduce authentic engineering through the use of real world systems level engineering problems that are appropriate and relatable for a middle school audience (e.g. use of dams for renewable energy, choosing paper or plastic at the store, creating an accessible Wi-Fi network in apartment housing, building a winning professional sports team, etc.). The workshop illustrates the iterative nature of engineering design by showing how large-scale engineering problems are traditionally approached in a discipline specific manner, examining the shortcomings that can occur from that approach, and then applying a systems level approach to overcome some of those limitations. Participants will have the opportunity to apply the iterative nature of design by first approaching a problem from a specific discipline perspective and then revisiting it two more times as additional disciplines and concerns are added to the system. This will be done by breaking participants into teams representing specific disciplines (each team will be given

# 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

supporting background information) and then merging teams into larger groups as the exercise progresses. The workshop will investigate several engineering practices including aspects of engineering design (defining a problem, developing potential solutions) and the interdependence of science, engineering and technology. Key habits of mind will also be emphasized through the materials presented in the example problem. These include asking questions, building models, interpreting data, applying mathematics and designing solutions. The field of Industrial and Management Systems Engineering (IMSE) and its toolkit will be explored throughout the exercise. This provides an opportunity to introduce this important field to an audience typically not familiar with the discipline.

**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 engineering profession strives to solve society’s problems. However, whose problems are being solved? Too often it is not those of underrepresented groups or the most vulnerable members of our society. One reason for this lack of focus is that it is difficult for a member of one culture to understand the needs and nuances of another culture. Therefore engineers need to be developed from all cultures, especially when the goal of public education should be to create equality of educational opportunities for all students. A diverse group of engineers will possess the needed empathy and understanding to work on the problems closest to them, which they understand best. This means that low socio-economic and culturally diverse neighborhoods will benefit directly from producing engineers. Therefore it should be the goal of schools everywhere to allow this to happen. The unique expertise and backgrounds of the facilitators will be utilized to present systems thinking as an approach that is inclusive of diverse backgrounds. By addressing macro analysis of engineering in a middle school setting, we introduce students to engineering in a way that takes away a general perceived notion of engineering as a difficult profession that is only for the very top academic performers. While academic performance is certainly important, this approach can demystify the purposes of engineering and enable students from all backgrounds to see the benefit of pursuing a career in engineering. Since engineering can be utilized as a tool for positive social change, the workshop introduces system analysis of problems for a broad range of students which will allow them to see how engineering plays a part in their life. By providing middle school students ways to find relationships to their own

# 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

experience, the workshop can create a bridge to the micro analysis of engineering of which so many students are intimidated by.

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.

N/A

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.”*

Two Post-it® style flip charts with easels

## Reminder:

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

# 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

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

---

---

ASEE USE ONLY

---

---

Date Received:

Received By:

Proposal ID Number: