

# PLTW Science Frameworks

**PLTW Course:** Civil Engineering and Architecture (CEA)

**Science Strand being addressed:** **The Nature of Science and Engineering**

**Science Sub-strand being addressed:** Interactions Among Science, Technology, Engineering, Mathematics, and Society

**Science Standard being addressed:** 9.1.3.3

## Overview:

**Science Standard and Benchmarks:** 9.1.3.3.1, 9.1.3.3.2

**Standard: 9.1.3.3** Science and engineering operate in the context of society and both influence and are influenced by this context.

**Benchmark: 9.1.3.3.1** Describe how values and constraints affect science and engineering.

*For example:* Economic, environmental, social, political, ethical, health, safety and sustainability issues.

**Benchmark: 9.1.3.3.2** Communicate, justify and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.

(Minnesota Department of Education, 2010)

### Correlation to AAAS Atlas:

1C/H5a\*, 1C/H8, 1C/H10\*\* (SFAA), 1C/H11\*\* (SFAA), 3C/H1, 3C/H6\*\* (BSL), 7A/H1, 7C/H1, 7G/H5\*\*

### 1. The Nature of Science

#### C. The Scientific Enterprise

- Current ethics in science hold that research involving human subjects may be conducted only with the informed consent of the subjects, even if this constraint limits some kinds of potentially important research or influences the results. 1C/H5a\*
- Funding influences the direction of science by virtue of the decisions that are made on which research to support. Research funding comes from various federal government agencies, industry, and private foundations. 1C/H8
- Because science is a human activity, what is valued in society influences what is valued in science. 1C/H10\*\* (SFAA)
- The direction of scientific research is affected by informal influences within the culture of science itself, such as prevailing opinion on which questions are most interesting or which methods of investigation are most likely to be fruitful. Elaborate processes involving scientists themselves have been developed to decide which research proposals receive funding, and committees of scientists regularly review progress in various disciplines to recommend general priorities for funding. 1C/H11\*\* (SFAA)

### **3. The Nature of Technology**

#### **C. Issues in Technology**

- Social and economic forces strongly influence which technologies will be developed and used. Which will prevail is affected by many factors, such as personal values, consumer acceptance, patent laws, the availability of risk capital, the federal budget, local and national regulations, media attention, economic competition, and tax incentives. 3C/H1
- The human ability to influence the course of history comes from its capacity for generating knowledge and developing new technologies—and for communicating ideas to others. 3C/H6\*\* (BSL)

### **7. Human Society**

#### **A. Cultural Effects on Behavior**

- Cultural beliefs strongly influence the values and behavior of the people who grow up in the culture, often without their being fully aware of it. Responses to these influences vary among individuals. 7A/H1

#### **C. Social Change**

- The size and rate of growth of the human population in any location are affected by economic, political, religious, technological and environmental factors. Some of these factors, in turn, are influenced by the size and rate of growth of the population. 7C/H1

#### **G. Global Interdependence**

- Communication and transportation technologies, coupled with political and economic policies, now allow people to interact with people in different countries almost as easily as they interact with people in their own country. This has allowed for the spread of political, economic, and cultural influences across the planet much more rapidly than had been the case in the past. Like any social change, there are trade-offs in the globalization of the planet, and it benefits some people more than others. 7G/H5\*\*

(American Association for the Advancement of Science, 2009)

### **Essential Understandings/Big Ideas:**

- \* Civil Engineering and Architecture is greatly influenced by our society and culture.
- Architects and engineers are designing structures that we live in, work in, and seek shelter in.
- How they design the structures greatly influences how people use it.
- Designs must consider societal, cultural, and environmental impacts.
- To meet all constraints, architects and engineers must communicate effectively to all the stakeholders of the project.

This course has several activities where students must keep all stakeholders in mind. There are two specific projects that focus on the communication and design for all stakeholders. They are Project 1.2.2 Design Charrette and Project 4.1.1 Commercial Building Design. In groups, students role-play each stakeholder's position. Together, students create a design that meets everyone's criteria and constraints.

### **What should students know and be able to do [at a mastery level] related to these benchmarks?**

Students will be able to:

- Identify societal, cultural, and environmental influences on design.
- Design a plan to meet the constraints of the project and the society.
- Work together in group to meet a common goal.

- Communicate their ideas and solutions to various parties involved in the project.
- Demonstrate how and why they address issues within their plan.

## **Misconceptions:**

### **Student Misconceptions**

- Students do not need to communicate with other stakeholders when they add or modify the design.
- Students believe they can work in isolation and not affect anyone else.
- There is an emphasis only on Engineering; correct grammar and proper use of language is not important.

## **Teacher Resources:**

### **Teacher Notes**

#### **Students will explore and gain an understanding of:**

Where does this fit?

The Charrette is the first important project the students perform. A Charrette is a meeting that is done at the beginning of major building projects. All designers must consider all economic, social, cultural, and environmental impacts of their designs. Using the Charrette begins our design process.

During the final Commercial Design Project, students will apply all skills learned from the first three units. This includes the first steps in the design process where a Charrette will take place. The students must consider all stakeholders needs or concerns when designing this commercial project. The students will present their finding to a board/owner for approval.

How to best introduce the concept?

1. Break the class into equal groups.
2. Ensure all group members understand their role in the process.
3. Define what a Charrette is.
4. Have students reflect what they experience as they role played. This is an attempt to get them to understand that all projects are affected by outside influences.

What students struggle with the most?

Students tend to struggle with the roles they are assigned in the Charrette. To help the students, the teacher can demonstrate the role, guide the conversion by asking guided questions, or have the students research their role the day before completing the Charrette.

### **New Vocabulary**

**Charrette:** An intensive workshop in which various stakeholders and experts are brought together to address a particular design issue.

## Vignette:

Students in CEA are exposed to multiple design projects where they need to consider constraints from many different stakeholders. This vignette is will be an example of the first design project, Project 1.2.2 Design Charrette.

The students have spent the past couple of weeks learning about different occupations within Civil Engineering and Architecture. It is now time to begin the design process. The instructor hands out two packets, Project 1.2.2 Design Charrette and Project 1.2.2A Stakeholder's Role. The instructor begins to divide the class into groups of four to six. As the groups are formed, the stakeholder roles are passed out from the instructor to each member of the group. The first task the groups must do is to decide which scenario to work on. Once completed, each member must research their role using Project 1.2.2A and other sources.

After a day of research, all groups are formed back together to begin the Charrette. Acting as professionals, the students take notes on their discussion and describe their concerns, needs, or wants according to their role. Then they conduct a brainstorming session which allows all points of view to be heard. From their discussions, they need to create a possible solution to the problem that satisfies all stakeholders' concerns.

Once completed, the groups present their work to the entire class. The groups must have description of each stakeholder, the problem statement, sketches, list of advantages of your plan, and a list of questions, barriers, or disadvantages. The group must demonstrate some future thought with possible solutions to their unanswered questions.

Then to summarize, the students are asked to reflect on their experiences during the Charrette in their notebook. The students make the realization that major projects are affected by many outside organizations.

### Additional Instructional Resources

Civil Engineering & Architecture Matteson, Kennedy, Baur, © 2012 ISBN-13: 978-1-4354-4164-4, Delmar, Cengage Learning PO Box 6904, Florence, Kentucky 41022t: 800-354-9706f: 800-487-8488.

Civil Engineering & Architecture Matteson, Kennedy, Baur, ©2012 Workbook ISBN-13: 978-1-4354-4165-1 Instructor Resources ISBN-13: 978-1-4354-4166-8,

Architectural Graphic Standards, 11th Ed. The American Institute of Architects ISBN-13: 978-0-471-70091-3, Delmar, Cengage Learning PO Box 6904, Florence, Kentucky 41022t: 800-354-9706f: 800-487-8488.

Revit – 2011 tutorial books – go to [www.leadinghighschools.com](http://www.leadinghighschools.com) to receive a complimentary examination copy

Architectural Drafting and Design – ISBN-13 978-1-4018-6715-7 Alan Jefferis and David Madsen, Thomson, Delmar Learning, [Jeanne.Blair@cengage.com](mailto:Jeanne.Blair@cengage.com) is the district rep and can provide information for you about the textbooks and can give you examination copies. Here is the website to get the examination copy <http://cengagesites.com/academic/?site=3243>

Francis D. K. Ching several books on architecture John Wiley & Sons, Inc. publisher:  
Architecture: Form, Space and Order, ISBN 978-0-471-75216-5.  
Architectural Graphics, ISBN 0471209066.  
Building Construction Illustrated, ISBN 0-471-35898-3.

Websites:

<http://www.charretteinstitute.org/charrette.html>

<http://www.fhwa.dot.gov/reports/pittd/charrett.htm>

<http://www.peopleandparticipation.net/display/Methods/Design+Charrettes>

<http://www.nae.edu/26187.aspx>

Civil Engineering and Architecture activities and/or projects incorporating the standards:

Project 1.2.2 Design Charrette – Students will role-play a design Charrette. They will be in groups of four to six. Each student will play a role of an important stakeholder of the project. The goal of the project is to witness how society can influence the design of the project.

Lesson 4.1 Commercial Design Problem – This lesson is a capstone activity that students must perform with less guidance than previous projects. During this lesson, students are grouped in four to six members. They conduct a Charrette, analyze a site, and create a concept plan and model. The goal is to sell their idea to a local board or owners.

These are the two main projects that focus students on thinking about societal influences. But throughout the course, students are constantly resolving constraints that are subject to outside influences. Such influences are storm water run-off, traffic flow, size restrictions, noise restrictions and even endangered animals.

## **Assessment:**

### **Assessment Methods**

Incorporating Explanation, Application and Perspectives:

1. Which of the following is a study that involves an evaluation of available utilities, site characteristics, and potential users of a new development?  
A. Site Discovery  
B. Traffic Flow Analysis  
C. Viability Analysis  
D. Title Search
2. If a person does not break any laws, but does not follow the accepted principles of professional conduct, that person would be considered \_\_\_\_\_.  
A. unlawful and ethical  
B. unlawful and unethical  
C. lawful and unethical  
D. lawful and ethical
3. A property owner is specifically not allowed to raise farm stock on her/his property. This is an example of a \_\_\_\_\_.  
A. covenant  
B. zoning law  
C. property lie  
D. building code

4. The orientation of a building site to its natural and cultural surroundings is an important element of site selection. Which of the following is not typically considered in this process?
  - A. sound
  - B. structural
  - C. solar
  - D. wind
  
5. “The minimum legal distance from a property line or street where improvements to a site can be built or the minimum distance from the property lines to the front, rear, and sides of a structure” is the definition of \_\_\_\_\_.
  - A. right of way
  - B. easement
  - C. setback
  - D. construction zone
  
6. Which of the following site characteristics will result in the largest rainfall runoff discharge?
  - A. sandy bare soil, steep slopes
  - B. clay lawn, steep slopes
  - C. clay lawn, flat slopes
  - D. grassy playground

## **Differentiation:**

### **Gifted and Talented**

To challenge the gifted and talented students, one possibility is to add more complex scenarios such as building a community on a deserted island, middle of the Sahara Desert, or in space. These are settings where current construction techniques are very challenging and many unique factors need to be considered. The final project is of their choosing. They are free to make it as complex as they need to. The teacher needs to encourage those students to push themselves in the design process.

### **Special Education**

Since this task is done as a group, the group needs to work together to achieve a common goal. Each group member must perform his or her role. Extra guided practice, leading questions, or time should be given to those that are struggling. The process and the understanding of all stakeholders are the goals of this project. Each special education student should be paired with another student that has or shows ability to master the concepts. Most work is hands-on with the computer and other tools. This typically aids in their understanding. Coordination with the individual’s case manager would be extremely helpful for any modifications to assignments and assessments. Formative assessments should be used for planning and the needs of the students.

### **English Language Learners**

The vocabulary will be the most difficult for ELL students. More time should be given for those ELL students who struggle in the translation. Extra observation and guidance may be required during the process. Post lessons, lectures, activities, and vocabulary with definitions on a class website or an online instructional tool such as Moodle. This will allow ELL students the opportunity to review the vocabulary at their convenience. Translations of documents can be formed by the ELL instructor within your school district. Your ELL instructor is your best support.

# Parents and Administration:

## Administrative/Peer Classroom Observation

<b>Students Are:</b> (descriptive list)	<b>Teachers Are:</b> (descriptive list)
Researching their role as one of the suggested stakeholders (some possibilities are listed below).	Explaining the process and assigning stakeholder roles.
Conducting a meeting with all stakeholders.	Observing, guiding conversation, and keeping all groups on task.
Taking notes during their meeting and developing a plan to solve the problem.	Modeling as necessary how to role play the stakeholder and how to conduct the meeting.
Developing a solution based on the constraints, needs, and wants that came from the stakeholders.	Observing and asking leading questions on their solutions.
Communicate their solution as a presentation with models, drawings, powerpoints, and other supporting documents.	Demonstrating a presentation so the students can model.

Stakeholders in a Charrette or design process:

- Architect
- Health and Safety Engineer
- Commissioning Agent
- Construction Contractor/Manager
- Environmental Engineer
- Energy Consultant
- Construction or Building Inspector
- Interior Designer
- Landscape Architect
- Urban Planner
- Civil Engineer/Site Planner
- Building Inspector/Code Enforcement Officer
- Structural Engineer
- Cost Estimator

### Professional Learning Communities:

Reflection – PLTW instructors should have an understanding of a design Charrette. Instructors could perform a Charrette within their meetings. This will give insight to the type of questions their students may have.

Materials – **PLTW instructors should use the above resources to lead discussions on societal influence in CEA.**

### Parent Resources:

Refer parents to the suggested lists and searches found in Additional Instructional Resources.

It would be very helpful to create a website in which the instructor can communicate with parents on assignments, topics, and additional support.

## References:

American Association for the Advancement of Science. (2009). *Benchmarks Online*. Retrieved July 1, 2011, from AAAS-Project 2061: <http://www.project2061.org/publications/bsl/online/index.php>

Minnesota Department of Education. (2010, May 24). *Academic Excellence: Academic Standards: Science*. Retrieved July 1, 2011, Minnesota Department of Education: <http://education.state.mn.us/mdeprod/groups/Standards/documents/Publication/013906.pdf>