Engaging Middle School Students in Hands-on Science and Engineering through Sustainable Design Thinking
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NOTE (07.16.14): Per Donna, session date and time still tbd.

Alec Holser, Opsis Architecture; Michael Becker, Hood River Middle School; Hood River Middle School Students, Hood River Middle School

How do we design curriculum and facilities that reach out and connect young adults to provide engaging experiences in science and engineering that will be critical for creating a sustainable future? Using the Hood River Middle School FACS Food and Conservation Science program and the LEED Platinum/ Net-Zero Energy Science and Music building as a platform for understanding, conference participants will work with an exceptional group of middle school students in a hands-on group design workshop to create a fully integrated learning ecosystem. The facilities architect, engineer and the program's teacher will provide the technical framework, while students facilitate side by side with conference participants in groups to discover how connections between systems are the foundation of integrated design.

Objectives:

- Attendees will meet an exceptional group of young students who completed an intensive design/build process that immersed them in the science and engineering disciplines.
- Attendees will gain perspective on how sustainable architecture can influence educational curriculum and captivate the interests and imaginations of a diverse student body.
- Attendees will explore ways they can use building and landscape architecture to create a living laboratory.
- Attendees will learn about the specific technical innovative sustainable design strategies to achieve a net-zero educational facility.
Hood River District Students

Michael Becker
Hood River Middle School

Alec Holser
Opsis Architecture
Future Greenhouse Emissions

Today’s Professionals

Class of 2018

Building

UK Department of Environment

+3.5 C

+2.5 C

CO₂ emissions (gigatonnes of carbon)
Basically, the earth needs a new operating system, you are the programmers, and we need it within a few decades.

- Paul Hawkins 2009
Hood River Middle School

National Historic Register Building
Hood River Middle School  1998

Outdoor Classroom Project
Science

Seventh Grade

Seventh grade science students refine their understanding of how the components and processes within living and non-living systems interact and affect their characteristics and properties. They learn about gravitation, forces, and laws of motion. They study atoms, elements, and compounds. They develop an understanding of reproduction, inheritance, phenotypes, genotypes, chromosomes, and genes. Students learn about the processes plants and animals use to obtain energy and materials for growth. They study how Earth’s atmosphere, land forms, resources, and climate change. Students deepen their understanding of scientific inquiry as the investigation of the natural world based on observation and science principles that includes proposing questions or hypotheses, collecting, analyzing, and interpreting multiple forms of data to produce justifiable evidence-based explanations. They build their understanding of engineering design as a process of identifying needs, problems, and constraints, and developing and evaluating proposed solutions.

*It is essential that these standards be addressed in contexts that promote scientific inquiry, use of evidence, critical thinking, making connections, and communication.

7.1 Structure and Function: Living and non-living systems are composed of components which affect the characteristics and properties of the system.

7.1P.1 Explain that all matter is made of atoms, elements are composed of a single kind of atom, and compounds are composed of two or more different elements.

7.1L.1 Compare and contrast sexual and asexual reproduction. Explain why reproduction is essential to the continuation of every species.

7.1L.2 Distinguish between inherited and learned traits. Explain how inherited traits are passed from generation to generation, and describe the relationship among phenotype, genotype, chromosomes, and genes.

7.2 Interaction and Change: The components and processes within a system interact.

7.2P.1 Identify and describe types of motion and forces and relate force qualitatively to the laws of motion and gravitation.
FACS - Food and Conservation Science

Food, Energy, Water, Waste
A Connective Approach

• Live things
• Independent leadership
• Hands-on interdisciplinary learning
• Project based learning
• Design Thinking – non linear / not preconceived
Our HRMS Roadmap

Relative Location Each Element Provides Many Functions Each Function Supported by Many Elements Efficient

Energy Planning Use Biological Resources Care of People / Care of Earth Obtain a Yield Energy

Cycling and Recycling Intelligent Redistribution Small Intensive Systems Accentuate

Succession Diversity is Stability Edge Effect

Creative Problem Solving
Defining A Sustainable Vision

Eco-Charrette
Path to Net-Zero

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Path to Net-Zero

Platinum Goals

**Sustainable Sites:** Open space, stormwater management, reduce heat island effect

**Water Efficiency:** Low water landscaping, efficient fixtures

**Energy & Atmosphere:** 67% energy use reduction

**Materials & Resources:** Recycle construction waste, use recycled/regional/rapidly renewable materials

**Indoor Environmental Quality:** Daylight and views, increased ventilation, enhanced thermal comfort

Net-Zero:

- Produce as much energy as the building consumes
- 33% energy production
Path to Net-Zero

Net-Zero Water
• Rainwater collection and storage
• Efficiency of use, treatment for use
• On site wastewater and stormwater treatment

Net-Zero Energy
• Reduce use through efficiency measures
• Produce energy through renewable technologies (solar and wind power)

Net-Zero Site
• Restorative and Food Productive Landscape
• Maximize learning opportunities
Resource Flows
Project Site

1. Greenhouse
2. Science Classroom
3. Music Classroom
4. Bicycle Parking
5. Recycling Storage
6. Plaza
7. Amphitheater
8. Vegetable Garden
9. Bioswale
10. Underground Cisterns
11. Existing Historic School
Integrated Design

daylighting

photovoltaic panels

reused wood trusses

thermal walls

radiant flooring
How does this building work?

Many strategies were used to conserve resources in this building. Architects and different types of engineers worked together to integrate building systems so that some elements of the building perform more than one task, while others work together to create a whole that is greater than the sum of its parts.
Dashboard

Current energy use at Hood River Music Science

May 2, 2012, 7:02 PM

Current Location:
Hood River Music Science
72 people, 5331 Sq. Feet

Did you know?
Solar panels produce electricity for use in the building or elsewhere. While there is no battery system to store energy on site, the goal is for the panels to produce as much energy over the course of a year as is needed to power the building.

Powered by Delta Controls. Copyright (c) 2010.
Water Cycles

Water moves through the site

Much of the water for the building is collected, treated, processed (for heat, steam, use and re-treatment) and then used for irrigation. Potable water (for sinks and faucets) is supplied through the city’s water system.

- **Rainwater**: Collected onsite from roof surfaces and stored in an underground tank.
- **Streamwater**: Water diverted from the creek is used for irrigation and flows through a heat exchanger to provide additional cooling for the building.
- **City Water**: Treated water is delivered by the city’s water system for potable (drinking) water uses.
- **Irrigation Water**: Water is collected from various sources onsite and used to irrigate fields and gardens.
- **Toilet Water**: Rainwater is collected and filtered onsite and then used in the building’s toilets.
- **Blackwater**: Waste water from toilets and sinks is sent to a sewage treatment facility for treatment.
- **Stormwater**: Rainfall is collected from onsite roofs, paths and sidewalks, and is treated in the onsite bioswale.
Building Materials

A slice through the building shows how it is constructed:

- **Precast Perimeter Cap:** A strip of precast concrete that forms the roof of the building and provides a functional surface.

- **Brick:** Large-stacked brick veneer with episodes behind a screen that runs down the building and on the building's exterior.

- **Operable Windows:** Windows in the wing provide a bridge to the classroom, allowing natural light in and creating a pleasant atmosphere inside the building.

- **Precast Concrete Sill:** A strip of precast concrete that forms the base of the wall.

- **Insulated Concrete Framing (ICF):** The structure walls are insulated concrete forms (ICF) with a vapor barrier, providing excellent insulation and reducing noise transmission.

- **Foundation System:** A structural support system that provides stability to the building, allowing for a solid foundation.

- **Roof System:** The roof is a combination of metal and wood, with waterproofing systems to prevent leaks. It provides a functional surface and enhances the building's aesthetics.

CEFPI 2014

Opsis Architecture | Hood River Middle School
Garden Flow - Permaculture

**Energy**
- What is it?
- Where does it come from?
- Production Issues
- Independent production
- Conservation measures
- Energy budget (net zero)
- Passive solar
- Solar hot water
- Choices
- Harness human energy
  - Commerce
  - Enthusiasm
- Increase in health/productivity

**Water**
- Cycles and Patterns
- Quality and Quantity
- Catchment
- Storage
- Movement
- Conservation

**Food**
- Nutrition
- Exercise
- “Slow” food
- Inclusion/infusion into curriculum
- Relation to culture
- Availability
- Awareness
- Sense of caring

**Sense of Place**
- Change over time: Human ability to effect change
- Belonging: Pride in job well done
- Sense of wonder and joy
- Demonstration to others
- Wellspring of ideas
- Observation inspiration
- Relationship with land
- Beauty

**Waste**
- Compost
- Recycling
- Raw/real food
- Reduction of transport
- Grown nutrients/fertilizer

From *The Permaculture Classroom* by Michael Becker
Resource Flows
Garden and Produce
Getting Dirty
Worm Bins
From Garden To Market
Community Kitchen
Design Thinking

Understand
Understanding ends in Insight.
Empathy  Define

Create
Creation ends in ideas.
Ideate

Deliver
Delivery ends in reality.
Prototype  Test
Design Thinking
\[ H = \frac{1}{2} B H W \]

\[ V_{\text{tray}} = 55296 \text{ m}^3 \]
\[ H = 12'' \]
\[ x2 = 110592 \text{ m}^3 \]
\[ W = 48'' \]
\[ D = 192'' \]

\[ V_{\text{water}} = 16588 \text{ m}^3 \]

\[ h_{\text{max}} = 8'' = h \]

\[ L = V_{\text{tw}} = 16588 \text{ m}^3 = 1584 \text{ in}^2 \]

\[ h = 10.5 \text{ in} \]
\[ h = 2.6 \text{ in} \]
\[ 2.7 \text{ in} \]

\[ 70\% \text{ of } V_{\text{tray}} = 55296 \times 0.7 \]
\[ W = 44'' \]

Assumptions:
- Real: 66.24%
- Will be gravel plants
Living Systems Machine
Fish Tanks
Passive Solar House
Cobb Oven Project
Bridge Project
Greenhouse Climate Control
Current Projects

Outdoor Kitchen
Outdoor classroom
Willow tunnel
Climate battery
Fish tanks
Bridge
Plant propagation
Arches
Art + Science
Eco System Design Workshop
Participants

6th Grade
Grace Whitmore
Audrey Becker
Kiki Hosaka
Erin Sutherland
Rose Dillon
Lauren Greenleaf
Brynnan Burns

7th Grade
Elle Smith
Lucy Fine
Julia S
Megan Daley

8th Grade
Victoria Kohner
Morgan Graves

High School
Beth Mixon
Collette Zack
Lucy McLean
Jestena Matsen
• Working on getting a movie for here