Engaging Middle School Students in Hands-on Science and Engineering through Sustainable Design Thinking

Engaging Middle School Students in Hands-on Science and Engineering through Sustainable Design Thinking Calendars

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





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



Oregon Department of Education



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 evidencebased 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 trafts, explain how inherited trafts are passed from generation to generation, and describe the relationships 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 forces qualitatively to the laws of motion and gravitation.

Science Numbering Key Example: K.2P.1

- K = Grade
- 2 = Core Standard strand (strands are 1=Structure and Function; 2=Interaction and change; 3=Scientific Inquiry; 4=Engineering Design)
- P = Scientific inquiry, + Engineering Disign/ P = Scientific inquiry, D = Engineering Design)
- 1 = Number of the content standard for this grade, strand, and discipline

Standards By Design: Seventh Grade for Science

04/27/2012 2/4

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

Goals



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



energy production

Path to Net-Zero

Goals

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

Goal

Reduce the use of resources and increase environmental awareness through design, construction and use of the building and prounds



Methods

- Create a netzera energy building that uses no more energy than it creates through efficient building systems and responsible use of resources available on the site
- Create a building that teaches sustainable concepts and system
- Reduce impact on the water cycle.
- Reduce use of building material through the use of recycled and re-used materials
- Create an environment that is conducive to health and learning by making good use of daylight, acoustical properties and natural vestiliation.
- Create a site that can be used to produce food, provide habitat for native species, compost waster and bring community together.





Project Site



- Greenhouse
- 2 Science Classroom
- 3 Music Classroom
- 4 Bicycle Parking
- 5 Recycling Storage
- 6 Plaza

1

- 7 Amphitheater
- 8 Vegetable Garden
- 9 Bioswale
- 10 Underground Cisterns
- 11 Existing Historic School



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Integrated Design



Integrated Design

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 it's parts.





Dashboard

Current energy use at Hood River Music Science

May 2, 2012, 7:02 PM

Water Cycles

Much of the water for the building is collected, treated, processed (for heat), stored, used and re-treated ansite. Patable water (for sinks and fountains) is supplied through the city's water

Rainwater

Irrigation Water Water is collected from various sources onsite and used to irrigote fields and gardens.

CEFPI 2014

Toilet Water Rainwater is collected and filtered onsite and then used in the building's tailets.

Streamwater Water diverted from the creek is used for irrigation and flows through to host anchanger to pro-vide additional cooling for the building

Blackwater Waste water from tailets and sinks is sent to a sewage treatment facil-ity for treatment.

City Water Treated water is delivered by the City's water system for patable (drinking) water uses.

Stormwater Rainfall is callected from ansite roads, paths and sidewalks, and is treated in the ansite bioswale.

Building Materials

A slice through the building shows how it is constructed

Precessit Percept Cop A cap of precet concrete such the top of the well and precides a decentive element

Brick A nonstructural brick versus with an oir gap, baland it scenary water every from the balange and the the balanges its Nature context.

Precest Header A precess concrete header supports the brick along choirs and airdines.

Windows The wood windows have its obtained surface outside to protect them from the elements and how three panels of globa to increase their raw lating and accordin benefits.

Operable Windows in addition to providing dopingle to the closer recent, some windows can be optimed to allow accupation to control rotated vestilation

Precest Concrete Sill an off factors should not

Insulated Concrete Formwork (ICF) to are staded for h · The second rabor and contrate are placed inside to make when hand/and line and are to build water

Foundation System A cancelle foundation Fast supports the buildings weight and transfers 2 into the ground. A foundation show keeps water away from the building foundation.

Roaf System Standing search metal too and the majority pripriets (IPO) surdence on low slopes loop water out and reflect heat with their light color. Thick insulation loops lone risr temperatures steady and wood dealing with a lover of playered sheething form a still

Roof Trusses have the loss have including that was built in the THOs and tons down to moke soon far this building. The word pieces are held together with steal plates and bole. Recycled wood une also used as the framing for many interter

Gypsum Wall Board Well leaved is much leave 92% one; and provides a prooff interior limit-

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Cobinets Cobinety is constrained with learned work how 2001 negrebs wood them and a barry work mean. The surveys is in a baser dear mean new mode from during a survey with me optical context, which counters two not the tuncker efficies are reach from received pages.

Floor System The flue system The flue system consists of a rollian concrete slab which contains stell rubar and planic pipe, which contains stell rubar and planic pipe, and the contains of the concrete is a log-fault means. It shads no concrete is a log-fault results and a plants shart report known to keep cald and wontern fram rising into the concrete. The whole assembly sits on a solid surface of compacted gravel and earth.

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

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

Food Nutrition Exercise "Slow" food Inclusion/infusion into curriculum Relation to culture Availability Awareness Sense of caring

rom The Permaculture Classroom by Michael Becker

Resource Flows

Garden and Produce

Getting Dirty

Worm Bins

From Garden To Market

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Community Kitchen

Design Thinking

Design Thinking

PIPES BHW オー $V_{TRAY} = 55296 m^3 H = 12''$ $\times 2 = 110592 m^3 W = 48'''$ B -144 " $= 16588 m^3 W D = 192''$ TER HX 2 285 TT2 20 754 m³ TRAM D= WATER 17342 = DW = 1584 m² h = 8"= Н H=38" $1_{\tau w} = 16588 \text{ in}^3 = 1584.\text{ h}$ - 4 h = 10.5 in sh = 2.6 m = % ASSUMPTIONST D)=36" h 707. or V 70 25 11 35 5.00 WIN BE GRAVEL PLAN 2.7 m

Living Systems Machine

Fish Tanks

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Passive Solar House

Cobb Oven Project

Bridge Project

Greenhouse Climate Control

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Current Projects

Outdoor Kitchen Outdoor classroom Willow tunnel Climate battery Fish tanks Bridge **Plant propagation** Arches

Art + Science

Eco System Design Workshop

CEFPI 2014

CEFPI 2014

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

