SOCIETY OF ARCHITECTURAL HISTORIANS

SAH ARCHIPEDIA
ROTUNDA

TITLE: ARCHITECTURE AND THE ENVIRONMENT
SUBJECTS/TOPICS: ARCHITECTURE, GEOGRAPHY, HISTORY, SOCIAL STUDIES
GRADE LEVEL: 3-5 (1-2 CLASS PERIODS)
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LESSON OVERVIEW

In this lesson we will explore how environmental factors influence design and building performance, what makes a piece of historic architecture "green," and how some contemporary architects are dedicated to creating sustainable structures that beneficially impact the natural environment and the experiences of their users.

BACKGROUND

Read the following sections on the SAH Archipedia webpage: History and FAQ. Students will be using the database for research, so it is important to familiarize them with the resource and why it is valuable as an online tool.

In order to understand certain elements of architecture and its connection to the environment, students must become familiar with new vocabulary. An abbreviated vocabulary lesson is included at the end of this document.

Review the attached list of green architecture in SAH Archipedia. This will be a useful guide for some of the activities, especially if students are having trouble finding examples of certain environmental systems or project strategies. If students find additional projects, especially as SAH Archipedia continues to undergo regular updates, it would be a beneficial class endeavor to update or customize the list.

GUIDING QUESTIONS

What are the defining elements and competing factors for built and natural environments?

How do environmental forces (i.e., sun, wind, and water) impact architectural design?

LEARNING OBJECTIVES

Assess and identify the passive and active systems that bolster sustainable practices in the built environment.

Master the definitions and applications of essential vocabulary associated with sustainable design.

Explore life-cycle assessment at the scale of materials, whole buildings, and architectural complexes.

PREPARATION

There are many definitions of sustainable design and in these lessons, we will focus on the components of sustainable design that directly relate to the built environment: architecture. As you will learn, the design and implementation of "green architecture" is much more than adding a few solar panels, wind turbines, and green walls to a project. Therefore, it is helpful to look at pre-modern and vernacular architecture to see how passive and low-tech solutions were used to harness and mediate the impact of the sun and natural forces such as wind and rain. In many senses, historic architecture forms the basis for green design: buildings were constructed with local materials and labor because advanced technologies and transportation systems were not available.

You will be conducting visual and textual research using SAH Archipedia. Read the following sections to familiarize yourself with the project as a whole and how to navigate the database: History and FAQ.

Center for Advanced Energy Studies, GSBS Architects
Idaho Falls, Idaho
Photo credit: Kevin Van Den Wymelenberg

ACTIVITIES

Activity #1: Architecture and the Environment, an Overview

- Overall, it's estimated that buildings consume 40% of the world's energy. Can you think of some of the ways that buildings consume energy?

- Together with your classmates, complete a K-W-L chart on a board in the classroom:
    - In the first column, write: what do you know (K) about the relationship between architecture and the environment?

    - In the second column, write: what do you want to know (W) about the relationship between architecture and the environment?

    - You will not fill out the third column yet, but write the prompt and we will address this at the end of the activity: what did you learn (L) from this activity about architecture and the environment?

- How can we explore two concepts through their differences and similarities? Sometimes we refer to architecture as the "built environment," but there are some distinctions between architecture and the environment that we need to explore.
    - On a large sheet of paper or newsprint, create a Venn diagram: draw two circles that overlap. Within the left circle write "architecture" and within the right write "environment." What are some unique characteristics of architecture, or the built environment? Include these in the circle. Do the same for the term environment. Now, what are some concepts, characteristics, or ideas that both architecture and the environment share? Write these within the shared space between the two, overlapping circles.

    - Your Venn diagram should have text, but also think about how small sketches and color can help illustrate your ideas.

    - When you are finished, display your work around the room and have a gallery walk to see how your peers addressed this diagram activity. What were common themes between the different students' diagrams? Were there drawings or text in a certain diagram that were unexpected?

    - As a class, discuss look up the dictionary definitions for "architecture" and "environment." Based on your diagrams, do you think there are some elements missing? As a class, create an aggregated definition for "architecture" and "environment" then write these on the board.

    - Now, with your definitions on the board and with the Venn diagrams from all of your peers for reference, make one Venn diagram as a class. Use the board to create this distilled (edited and refined) version of the Venn diagram for the terms "architecture" and "environment."

- Now, individually or in small groups, explore SAH Archipedia and see if you can find some projects that successfully embody your class's Venn diagram, melding architecture and the environment.
  - Use the search box to look for key words, such as: daylight, solar power, sustainability, rainwater collection, and wind power. Try to come up with some of your own terms.

- Return to the K-W-L chart on the board in the classroom and complete the L (learn) column.

Teacher Notes:
- What are some ways buildings consume energy? Electricity, lighting, computers, heating and cooling systems, hot water, flushing toilets, watering landscape features, etc.
- Make sure students consult the Vocabulary List and implement this in their keyword search.

Activity #2: BUILD

- Instead of BINGO, we are going to play BUILD: be the first person to get five in a row in a horizontal, vertical, or diagonal direction. The center square is free and labeled "green" since you will need to find examples of green design on SAH Archipedia in order to complete BUILD.

- In this exercise, you need to successfully navigate SAH Archipedia to find projects that represent the green characteristics or features named in the squares of your BUILD card.

- As you research, write down the names of the projects matching the green characteristics or features in the appropriate square so that you can navigate to these projects later.

- Once you have 'BUILD', share your work with the class and make a list of all the projects that you and your classmates discovered.

Teacher Notes:
- This exercise can be completed with the provided BUILD cards, or it could be done digitally using an adapted Google Sheet or Slide. This would be effective for saving SAH Archipedia hyperlinks.

- If this proves to be a popular activity, you can make different bingo cards at http://print-bingo.com.

Activity #3: Beyond the Folktale: Advanced Design for the Three Little Pigs

- You are probably familiar with the story of the Three Little Pigs and it is essentially an architectural tale: each of the little pigs uses a different building material to resist the force of the Wolf's destructive gusts. In the world of architectural design, we would call this a wind load. To be successful and safe, architects need to design buildings that can resist forces from the wind, shelter inhabitants from the sun and the rain, and if the building is located in a seismic zone, architects need to create structures that are able to withstand earthquakes. These are a lot of environmental forces to consider!
In addition, architects have to think about how their buildings impact the environment: is the structure placed on the land in a way that ensures it doesn't interrupt a watershed or disturb an ecosystem? Does the building use local or renewable materials, or does it have a large carbon footprint? How is the building designed to create indoor and outdoor spaces that are healthy and give the inhabitants a beneficial connection to nature?

- So, let's take another look at the story of the Three Little Pigs. Your teacher may show some different versions of the story to refresh your memory of the tale.

- Now your task is to design a 21st-century residence for the little-known fourth little pig. Explore projects on SAH Archipedia as precedent research; this means that you will be looking for useful examples to study and build upon. Here are some guiding questions:
    - To resist the Wolf's attacks, your building will need to deal with substantial wind loads. Search for projects along the East Coast and Gulf Coast that are designed to resist wind from hurricanes. Do you notice any trends in terms of the use of certain materials or building forms?
    - The story of the Three Little Pigs talks about the buildings as objects in a landscape, but as we learned in the previous activity, a building's interactions with its site are critical.

- Draw a plan and elevation of your residence.

- Present your design to your classmates.

Teacher Notes:
- It would be useful to explore Steven Guarnaccia's *The Three Little Pigs: An Architectural Tale* (2010). This advances the tale, and associates each of the pigs with an architect that can be found on SAH Archipedia: Frank Lloyd Wright (1867-1959), Frank Gehry (b.1929), and Phillip Johnson (1940-2019).

- Although not in coastal areas, have students look at the following projects then talk about how the designed forms of these projects effective allow wind to pass around and through the structure with little resistance:

  - [Space House](#) (1970-1973)
  - [Spaceport America](#) (2006-2013)
  - [Amazon Conservatories](#) (2012-2018)

- For rich examples of landscape architecture, explore the [James Rose Center](#). The Center's website maintains useful [project pages](#) that explore diverse landscapes and drawing techniques.

Lesson Extensions and Resources:

- See the Architecture and the Environment Bibliography

- [Era of the Anthropocene](#) from the Smithsonian Magazine

- In terms of visualizing information, [Information is Beautiful](#) is an incredible site with a wealth of topics. To explore the process, watch [Making Data into Art](#). The following are of interest for architecture and environment:
  - [When Sea Levels Attack](#)
  - [How Do We Get to Zero Greenhouse Gas Emissions?](#)
  - [Methane](#)

- If you would like to see some inspiring TED Talks about architecture and forwarding-thinking design:
  - [William McDonough speaking on his concept of 'cradle to cradle' design](#)
  - ["Norman Foster: Building the Green Agenda"](#)

- One of the best ways to improve the energy performance of new buildings is to understand how we use energy within existing buildings. Check out this great [series of infographics on energy use in New York City](#).

Architecture and Environment Bibliography

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General Architectural Reference (with an American focus)

The Buildings of the United States series from the Society of Architectural Historians and the University of Virginia Press.

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Wines, James. *Green Architecture*. edited by Philip Jodidio. Hong Kong: Taschen, 2008.

Green Architecture on SAH Archipedia

The following "green" projects can be found on SAH Archipedia; this is just a sampling and there are many more to explore. For the more contemporary projects, it would be useful for the students to explore affiliated websites for the architects, engineers, and builders in order to learn more about the sustainable systems and building's overall intensions (ex. William McDonough + Partners project)

- Alta Vista Elementary School Addition (1957)
- Aqua Tower (2007-2010)
- Atlantic Station (1995-2006)
- Atwood-Higgins House (1730; 1919-1962)
- Austin Resource Center for the Homeless (2004)
- Baer House (1971-1972)
- Bateson Building (1977-1981)
- Benewah Medical Center (2012)
- Berry College (1850-present)
- Bogue Supply Building (1904; 2001)
- Borden Building (1907-1908; 2007-2009)
- Bowersock North Shore Power Plant (2011-2013)
- California Academy of Sciences (2000-2008)
- Cass Technical High School (2005)
- Cedar Street Bridge Public Market (1893-c.1926; 1983-2005)
- Center for Advanced Energy Studies (2005-2008)
- Cherokee Mountainside Theatre (1949-1950)
- Cordova House (1848)
- Cosanti (1956-1974)
- Dam no. 4, Hydroelectric Plan (1909)
- Detroit School for the Fine and Performing Arts (2005)
- Ford River Rouge Center (1917-1938; 2004)
- Frey House II (1963-1964; 1972)
- Eagle Sanctuary (1995-1999)
- Eli and Edythe Broad Art Museum (2010-2012)
- Equitable Building (1944-1948)
- Georgetown University (1792-present)
- Googleplex (2004; 2013)
- Greater World Earthship Community (1994-present)
- Greensburg City Hall (2008)
- Harley-Davidson Museum (2008)
- Herman Miller Greenhouse (1995)

- Intermountain Gas Company HQ (1965)
- International Quilt Study Center and Museum (2004-2008; 2012-2015)
- Islandwood (2002)
- Kauffman Farm (18th and 19th c.)
- Laboratory House (1950s; 2003)
- Lady Bird Johnson Wildflower Center (1995)
- Lone Mountain Ranch House (2010-2012)
- Massachusetts Museum of Contemporary Arts (1872; 1999)
- Mattress Factory Building (1907-1912; 2002-2003)
- McLauthlin Building (1856-1864; 1979)
- Monticello (1768-1826; 1934-1941; 1979-1994; 1993-2002)
- Mystic River Restoration (1893; 2009)
- National Museum of American History (1955-1964)
- Nature Conservancy HQ (2010)
- Paccar Environmental Technology Building (2014-2016)
- Park East District (2008)
- Rapid Central Station (2004-2005)
- Richard E. Dill House (1936)
- Rosie Joe House (2004)
- Simmons Hall (2002)
- Sky City Cultural Center and Haak'u Museum (2000-2006)
- Solar Building (1955-1956)
- Sunset Magazine Demonstration Desert Garden (1963, 1971)
- Target Field (2007-2010)
- University of Arizona Poetry Center (2007)
- Wayne Clough Undergraduate Learning Commons (2002-2011)
- Wells Fargo Center (1972-1976)
- Wetland Discovery Point (2009)
- Whitney Water Purification Facility and Park (1997-2005)

Architecture and the Environment Vocabulary

There are several important vocabulary words we need to understand in order to proceed with our lessons on sustainable design. Read the definitions below.

- **active environmental system:** any element or system of elements that function with moving parts and require regular user input. For example, a solar photovoltaic panel (PV) is an active solar device. The opposite of a passive system, but they often work together effectively.
- **adaptive reuse:** the conversion of a building, structure or area into a use other than that for which it was originally designed; this can often a 'green' practice since it saves existing structures and their associated embodied energy instead of completely demolishing a site
- **adobe:** thick earthen walls, effective thermal mass
- **apertures**: openings in a building, such as doors, windows, and skylights
- **brownfield:** a property that has or may have hazardous pollutants or contaminants; these need to be remediated (restore the soil, water, etc. to prevent further environmental damage) before redevelopment happens
- **building envelope:** the elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces. The major elements of the building envelop are the walls, windows and doors, the roof, and the floor or foundation.
- **cladding:** the exterior, protective and decorative layer of the building; this is separate from the structure
- **conditioned spaces:** the portions of a building that are mechanically heated or cooled; examples are rooms that have air conditioning
- **daylighting:** the use of the sun, instead of candles or electrical lighting, to illuminate interior spaces
- **ecology:** the interrelationships of living things to one another and to their environment, and the study of these interrelationships
- **embodied energy:** the amount of energy associated with extracting, processing, manufacturing, transporting and assembling building materials; a completed building has embodied energy
- **energy:** the potential to do work; power
- **energy flow:** the movement of potential/power from one part of a system to another
- **energy auditing:** the examination of the energy systems in a house as used by the current residents
- **energy ratings:** comparing existing houses to standard prototype residences
- **entropy:** the tendency for energy/matter to erode or become less organized over time in a system.
- **existing conditions:** the state of a site previous to the action of the designer. This includes all elements in the landscape and their arrangement. An existing conditions map, often call a base or index map, identifies and communicates these elements and often notes any particular challenges or opportunities. For design process purposes, it is essential that an architect fully study the existing conditions to understand key elements such as the environmental factors that may impact the site and the available, local material resources
- **feedback:** outputs of information, materials, or energy from a system. Positive feedback means that things are working well in the system; negative feedback means that one or more things need to be optimized in the system. Continually monitoring and management of feedback is important for getting the most beneficial and efficient results for a system.
- **glazing:** the use of glass in a building; to reduce solar gain and maintain indoor temperature balances, glass systems can be doubled, insulated and/or tinted
- **greywater:** water from bathroom sinks, showers, and any other non-kitchen and toilet fixtures. In terms of sustainable design practices, harvesting and reusing greywater can be a particularly valuable resource on a site.
- **infiltration:** accidental leakage of outside air into the building; major source of convective heat transfer through the building envelope

- **insulation:** a material that helps maintain temperature consistencies (heating or cooling) for parts of a building
- **lifecycle analysis (or assessment):** tracking the environmental consequences and energy needs of material systems from resource extraction, through manufacturing and construction, to service-life performance, providing a powerful tool for measuring resource and energy efficiency
- **Life Cycle Cost Analysis (LCCA):** a method for assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a building or building system
- **microclimate:** a small-scale climate usually resulting from a variation in solar gain (exposure vs. shade), wind patterns (still vs. calm), water flows (still vs. moving), and/or human-derived heat sources.
- **passive environmental system:** any element or system of elements which function without moving parts or regular user input. For example, a south facing wall of glass is a passive solar device since it naturally adds heat to a space. The opposite of an active system, but they often work together effectively.
- **recycled material:** a remade or repurposed item that can be used for building construction
- **renewable:** usually referring to sources of energy or materials that are produced in relatively short timeframes; an element that can be harvested and then replaced, however the amount of time needed for renewal can be variable.
- **solar energy:** photovoltaic (PV) panels collect energy from the sun that can be harvested and distributed for use in building systems. For the maximum annual solar gain, the panels should be tiled to be perpendicular to the sun at its zenith. For optimal tilt, it is important to know the latitute to know the position of the sun; elements that can reduce the effectiveness of PVs are humidity, cloud cover, pollution, and shadows.
- **solar heating:** evacuated tube solar hot water heaters are vacuum glass cylinders filled with water, glycol, and a copper tube that collect heat from the sun and convert it into steam to generate hot water for bathing, kitchen use, or radiant floor system. They work with a closed flow loop and are very efficient since 92% of the thermal energy collected can be used within the system.
- **specific heat:** the heat holding capacity of a material or surface; water and stone can hold heat well, so they have a high specific heat.
- **stack effect:** the buoyancy of warm air
- **thermal mass:** heavy materials with the highest specific heat (ability to hold heat) such as stone, water, or earth that store incoming solar heat (during sunny hours) and then re-radiate the heat when there is little or no solar gain. It is important to get the most sun exposure, so in the northern hemisphere elements using thermal mass are usually found on the southern side of a structure. In the built environment, structures with thermal mass are particularly effective where temperature fluctuations are high, such as the desert.
- **ventilation:** the way air moves through the building; this can be with passive systems (i.e., open windows, cool air entering at a low level then hot air rising and escaping through high windows) or active systems (air conditioning or heating)
- **Venturi:** this is the effect when air or water increases speed through tunnel because of constriction. A Venturi can happen unintentionally in a building or natural condition, but it can also be a designed element in the built environment that effectively generates passive cooling.
- **Volatile Organic Compounds (VOC):** Off gasses from such products as carpet adhesive and paint usually that often cause allergic reactions or can aggravate asthma. Most green buildings employ low-VOC (or no VOC) products.
- **walkability**: a measure of how friendly an area is to walking
- **waste:** a misplaced resource; this is typically an unintentional and unwanted output of a system. Systems that are the most efficient, naturally, or the best designed are able to match inputs with their waste to create a closed loop, or at least one with minimal waste.
- **windbreak:** a natural, biological or built feature that deflects or slows the flow of air.

B	U	I	L	D
hydroelectric	rainwater reuse	waste management	adobe	brownfield
vegetation	rainwater collection	sun shades	passive system (ID)	LEED
tinted glass	windbreak	*GREEN	solar heating	reflective material
recycled material	courtyard	wood	operable windows	walkable site
green roof	renewable material	bike facilities	solar hot water heating	wind turbines

B	U	I	L	D
recycled material	rainwater collection	wood	brownfield	walkable site
sun shades	stone	radiant floors	connection to nature	passive system (ID)
operable windows	courtyard	*GREEN	local materials	reflective material
windbreak	daylighting	insulation	solar panels	outdoor space
solar hot water heating	adaptive reuse	wind turbines	hydroelectric	vegetation

B	U	I	L	D
local materials	connection to nature	reflective material	renewable material	daylighting
passive system (ID)	recycled material	operable windows	insulation	outdoor space
bike facilities	wood	*GREEN	rainwater collection	adaptive reuse
solar heating	stone	windbreak	wind turbines	porch
skylight	brownfield	courtyard	solar hot water heating	LEED

http://print-bingo.com

B	U	I	L	D
solar heating	renewable material	adobe	porch	compost
hydroelectric	walkable site	wood	tinted glass	stone
LEED	outdoor space	*GREEN	vegetation	bike facilities
sun shades	solar panels	reflective material	insulation	windbreak
local materials	passive system (ID)	rainwater collection	skylight	brownfield

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B	U	I	L	D
hydroelectric	wind turbines	renewable material	brownfield	vegetation
solar panels	windbreak	rainwater collection	bike facilities	passive system (ID)
connection to nature	solar heating	*GREEN	daylighting	courtyard
skylight	stone	insulation	recycled material	rainwater reuse
operable windows	sun shades	reflective material	local materials	LEED

B	U	I	L	D
brownfield	walkable site	active system (ID)	solar heating	tinted glass
courtyard	wind turbines	porch	operable windows	passive system (ID)
connection to nature	solar panels	*GREEN	green roof	LEED
solar hot water heating	wood	waste management	vegetation	sun shades
reflective material	stone	recycled material	adaptive reuse	skylight

B	U	I	L	D
adobe	adaptive reuse	green roof	passive system (ID)	windbreak
local materials	operable windows	walkable site	active system (ID)	compost
bike facilities	solar hot water heating	*GREEN	wind turbines	insulation
reflective material	solar panels	renewable material	tinted glass	waste management
stone	LEED	rainwater reuse	recycled material	connection to nature

B	U	I	L	D
wood	sun shades	renewable material	porch	passive system (ID)
operable windows	skylight	bike facilities	compost	stone
reflective material	solar hot water heating	*GREEN	local materials	solar heating
vegetation	tinted glass	daylighting	courtyard	rainwater reuse
wind turbines	brownfield	waste management	solar panels	windbreak

B	U	I	L	D
skylight	adobe	renewable material	solar heating	rainwater collection
waste management	tinted glass	operable windows	sun shades	solar panels
green roof	windbreak	*GREEN	daylighting	recycled material
bike facilities	solar hot water heating	rainwater reuse	outdoor space	reflective material
stone	wood	insulation	brownfield	wind turbines

http://print-bingo.com

B	U	I	L	D
LEED	outdoor space	adaptive reuse	vegetation	solar hot water heating
courtyard	local materials	radiant floors	walkable site	recycled material
brownfield	rainwater reuse	*GREEN	solar heating	daylighting
waste management	hydroelectric	tinted glass	porch	green roof
skylight	insulation	stone	active system (ID)	solar panels

http://print-bingo.com