Green Machine:
Building Sustainable Futures
Curriculum Pilot

Developed by Institute of Play
Written by Evelyn Roman-Lazen

Proof of Concept
Prepared for the Hive Digital Media Learning Fund
at the New York Community Trust

INSTITUTE of PLAY
www.instituteofplay.org

Introduction

Purpose

To share the Green Machine: Building Sustainable Futures curriculum pilot developed by Institute of Play as a first step toward exploring sustainability, design and engineering in the informal learning space.

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Curriculum Pilot Draft
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INTRODUCTION TO GREEN MACHINE

WHAT IS GREEN MACHINE?

GREEN MACHINE: BUILDING SUSTAINABLE FUTURES is a pilot curriculum generously funded through a grant from the Hive Digital Media Learning Fund and the New York Community Trust. The curriculum, written by science educator Evelyn Roman-Lazen for Institute of Play's Informal Learning program., was piloted as part of a series of after-school workshops at New York City's game-based learning public middle school, Quest to Learn (www.q2l.org).

The Green Machine team included Roman-Lazen; Don Miller, a mentor and technologist from the Institute's Informal Learning team; Quest to Learn math and science teacher Ameer Mourad; and experts in engineering and sustainable design. The Institute's game designers, research manager, learning strategist and curriculum developers consulted with the project team as well. This interdisciplinary team, overseen by Leah Gilliam, the Institute's Program Manager for Informal Learning, ensured that the modules engaged youth in gamelike, challenging ways by integrating design-, engineering- and science-learning was integrated into the activities.

Significantly, the team also included both the energetic and ever-ready youth playtesters from Quest to Learn and our esteemed Hive NYC colleagues: Michael Foster of the American Museum of Natural History, Jess Klein from Mozilla and Hackasaurus, Bryan Johnston from Iridescent Learning, Hillary Kolos of DreamYard, Helen Lee from Teachers College, Marc Lesser from Mouse, Lisa Mielke from The After School Corporation and Chris Lawrence, Director of Hive New York City.

PILOT OUTCOMES

Green Machine pilots were successful in sparking youth interest in engineering design, and local and global issues, but also in sharpening participant ability to propose strategies and build solutions to real-world problems. As part of development, Hive members came together in "curriculum jams," providing critical feedback, iteration and revision before we presented the curriculum modules to youth. What follows are the curriculum modules, written by Roman-Lazen and playtested and iterated upon by Institute of Play. The final module, Eco-Tiles was developed through a workshop with artist and materials researcher Corrie Van Sice (www.corrievansice.com).

INTRODUCTION TO GREEN MACHINE

WHAT IS GREEN MACHINE?

The curriculum consists of three learning modules: **H2O: Friend or Foe?** which addresses water quality and access around the world by challenging youth to purify water. **Plan It/ Build It**, which introduces engineering and architectural design concepts by challenging youth to build free-standing weight-bearing structures and create design briefs for futuristic buildings. **Eco-Tiles**, which explores green building through the design and creation of sustainable building tiles.

WHY GREEN MACHINE

Sustainability is emerging as one of the key fields that will help establish a healthier relationship between society and the environment. As a society, in order to preserve and conserve our natural resources and improve the living standard of developing nations, we need to find sustainable ways of living and change our relationship to how we utilize these resources.

GREEN MACHINE APPROACH

WHAT'S THE BIG IDEA?

Each module is organized around a number of larger themes and concepts or "Big Ideas." Green Machine often categorizes these in terms of Design, Engineering and Sustainability.

CHALLENGE-BASED LEARNING

Green Machine uses a problem-based design methodology to empower participants to use collaboration, critical-thinking, creative problem-solving and apply scientific knowledge and skills. Structured around a series of design challenges, participants are encouraged to exercise their creativity and ingenuity to collaboratively imagine and build solutions to problems with real social implications and impact. In so doing, they produce prototypes and models that propose solutions to the challenges at hand. Throughout the modules, participants work with recycled and re-purposed materials to create useful operational model structures. Participants use digital media tools to sketch and render technical diagrams and concept maps of their prototypes; use manual and power tools to construct and assemble their prototypes; use measuring tools to test and collect data to inform feasibility and efficiency; use research and digital tools to provide digital and graphical analysis of data.

DESIGN CHALLENGES

Each "problem" is introduced as a design challenge that will be divided across three or four sessions. Each session serves to address sustainability topics and engineering, and design skills introduced through hands-on, challenge-based learning activities or "Design Challenges."

GREEN MACHINE APPROACH

WHAT'S THE BIG IDEA?

Each module is organized around a number of larger themes and concepts or "Big Ideas." Green Machine often categorizes these in terms of Design, Engineering and Sustainability.

These challenges will empower participants to implement problem-solving strategies and develop skills inherent to engineering and design.

- Demonstrate creativity and innovation
- Communicate and collaborate
- Conduct research and use information
- Think critically, solve problems, and make decisions
- Design, build and test
- Use technology effectively and productively

LEARNING ENVIRONMENT

Engineering design is used as the foundational structure throughout the Green Machine modules. The activities are presented utilizing pedagogical "Rube Goldberg" methodologies, an approach that introduces participants to engineering and design by delving into projects with playful and unconventional guidelines that highlight creativity, intuition and insightfulness. Learning activities have been developed to engage with the fundamental concepts of engineering design. For Green Machine this entails developing a design concept —based on a global issue or local problem; building a system to represent that concept; and proving that the concept works using iteration, testing and prototyping.

DEFINING ENGINEERING DESIGN

Engineering entails design and problem solving under constraints, teamwork, resource considerations and deadlines, Green Machine remains a fun and playful curriculum. The context in which these activities occur promote a learning environment that fosters skills that not only enhance participant ability to think systematically but also creates a powerful motivation to learn relevant science content and follow engineering and design approaches that promote the development of systems and design-thinking, as well as engineering, science, technology skills and knowledge.

MODULE & ACTIVITY RESULTS

LEARNING GOALS

Participants are presented with a specific local problem or global issue and will be challenged to design, engineer and build systems that propose efficient and sustainable solutions.

Through these projects participants will:

- Build prototypes and systems following problem guidelines
- Test their prototypes and systems
- Analyze prototype and system efficiency
- Playtest and iterate system components to improve designs
- Perform experiments and use scientific and mathematical-related knowledge to assess prototypes and systems
- Evaluate the attributes of the design
- Evaluate the system for efficiency—How does it solve the given problem? Does it use energy and materials efficiently?
- Refine designs to minimize the use of materials and energy
- Propose and build final prototypes after multiple iterations
- Report to peers on how their systems work using technical and schematic drawings.
- Employ oral, graphic and media-based communication methods to model design and engineering processes

OUTCOMES & DELIVERABLES

During each challenge, participants work with tools to produce worksheets, diagrams, physical or digital models or some form of media. These "deliverables " are due at the end of the challenge and can be used as a way to assess particIpant learning and comprehension.

At the end of each challenge or design problem, participants are expected to share their outcomes; discuss their working process and articulate their ideas about sustainable design as it relates to environmental and social issues or their own interests.

Participants will be able to identify basic elements of design engineering such as: materials that may use to help complete the task; follow the design guidelines; build a system; test the system; and prove that it works.

Identify basic design related processes such as: conceptualize a possible solution; build and test the prototype.

INFORMATIONAL RESOURCES

LINKS

Green Machine provides informational resources, vocabulary words, links and worksheets to help participants to brainstorm, collaborate and learn in a hands-on way.

VOCABULARY

Each module includes a list of vocabulary words and definitions specific to the challenges and related concepts.

MATERIALS & SUPPLIES

Each module will provide a list of required materials, equipment and technology. When possible, Green Machine uses recycled materials and open-source software.

SESSION PLAN

ACTIVITY & CHALLENGE FACILITATION

Each module will provide a step-by-step sequence of instructions. These steps provide guidelines for the instructor and outline what participants will be working on. When possible, suggested running times have been recorded.

SHARING AND REFLECTING

THE WRAP UP

Time to share results and findings with the group is included in each module. Discussion questions and topics are provided as are any tips regarding the completion of specific activities or challenges.

EXTENSION ACTIVITIES

ADDITIONAL ACTIVITIES

The Green Machine pilot curriculum often includes suggestions of additional activities such as field trips or different levels for participants who may need a customized challenge. These "Extension Activities" also enable Green Machine to suggest activities that happen outside of the studio environment.

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CURRICULUM OVERVIEW

BIG IDEAS

DESIGN
What is the design process?
ENGINEERING
How can the engineering process inform what we design and build?
SUSTAINABILITY
How can we determine if our design satisfies sustainable requirements?

KEY DEFINITION AND TERMS

DESIGN
Design uses system level thinking to produce a plan or scheme that will inform the development of a product, system or service.
ENGINEERING
Engineering Design – The engineering design process translates an idea into a concrete system, product or service
SUSTAINABILITY
Sustainability considers the range of environmental impacts on our environment in making a decision.
Sustainable design or environmental design or environmentally sustainable design, is the philosophy of designing physical objects, the built environment, and services to comply with the principles of ecological, economic and social impact that are guided by conservation, preservation, use reduction and management of natural resources.

SKILLS TARGETED AND LEARNED

SYSTEMS-THINKING
Identifying and understanding the problem
Imagining possible solutions to a problem
Formulating and communicating concepts by translating thoughts into words, drawings, and modeling
Planning strategically of how to implement ideas
Imaging and communicating ideas
Proposing strategies to tackle and solve a problem
Analyze viable solutions
Use deductive reasoning with fluidity
Enhance critical thinking skills
SYSTEMS-DESIGN SKILLS
Conceptualizing ideas of possible solutions and communicate them
Identifying various approaches as to how to tackle a problem
Discern viable solutions through experimentation, tinkering and probing in a systematic and thoughtful fashion
Developing and constructing a prototype
Identify and understand constraints
Troubleshoot using a systemic way in which to analyze and test each component of the system
Build models that satisfy the problem adequately and efficiently using a variety of tools (e.g. mechanical, scientific, digital and mathematical)
ENGINEERING DESIGN SKILLS
Apply science and math concepts to inform the design, development, construction, and testing of a given model
Research similar systems in the natural and engineered world to inform design and prototyping
Design and build prototypes following specifications
Manage time during development, prototyping and testing

SKILLS TARGETED AND LEARNED

Test models through experimentation, identify variables, collect and analyze data, to assess viability and efficiency to achieve optimization
Measure efficiency through qualitative and quantitative means
Improve design through iterative process and data analysis
Design technological systems and components for the model prototype
Work in a collaborative fashion that promotes teamwork
Render schematic drawing with detailed parts of the system and how it works

CONTENT KNOWLEDGE SKILLS

SCIENCE
Apply the scientific method to inform the prototyping and viability process.
Experiment and make inferences based on the experimental process.
Understand the interdisciplinary nature of science through learning what science disciplines (e.g. physical, living, earth, and environmental sciences; chemistry and ecology) can be applied to help study and find solutions to a given problem.
Learn how to research science relevant content pertaining each problem.
Further develop an understanding of scientific concepts in an interdisciplinary applied fashion that connects to real world phenomena.
Properties of Materials
Understanding Properties of Structures: Tension, compression, how objects apply and respond to forces.
MATHEMATICS
Apply mathematical skills such as visualization, computation and measurement to design, build and test models.
Collect and analyze data.
Use Cartesian grid to design 3-D geometrical objects and models.
How structure, shape and form are relevant to how things work.
TECHNOLOGY

CONTENT KNOWLEDGE SKILLS

Apply mathematical skills such as visualization, computation and measurement to design, build and test models.
Collect and analyze data.
Use Cartesian grid to design 3-D geometrical objects and models.
How structure, shape and form are relevant to how things work.
COMMUNICATION SKILLS
Communicate their ideas explicitly using a variety to tools and mediums to highlight features in a mathematical, scientific and technological order.
Present their ideas effectively and succinctly.
Use concept mapping to convey progression of ideas or systems.

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Module 1: H20 FRIEND OR FOE

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MODULE PREMISE

SNAPSHOT
Access to water and clean water has been identified as one of the most pressing engineering problems of the 21st Century. About one out of every six people in the world does not have access to clean water.

DESIGN CHALLENGE OVERVIEW

WATER FILTER CHALLENGE
The purpose of this first activity is to immerse the participants in a quick design challenge where they can exercise their imagination and use their intuition. They will build a prototype of a water filter relatively quickly. This activity will produce a series of experiences, create new knowledge and a product that can be used to introduce and discuss the essential aspects of sustainable design engineering in a very practical and hands-on way.

BIG IDEAS

DESIGN
What is the planning and design process inherent in the design of the built environment?
ENGINEERING
How can the engineering process inform the design and function of structures with sustainable features?
SUSTAINABILITY
How can we determine if our design satisfies sustainable green building practices and requirements?

OUTCOMES

DELIVERABLES
Water Filtration System Worksheet
Prototype of water filtration system
BONUS ROUND: Water filtration system re-design

LEARNING GOALS

What will be covered?
Introduce the concept of sustainable design engineering.
Build working prototype with recycled materials provided by the instructor.
Follow a set of guidelines inspired by "Rube Goldberg" and problem-based learning approaches to inform their design and prototyping process.

SKILLS TARGETED AND LEARNED

DESIGN
Designing solutions
Conceptualizing ideas
Using systems-level thinking to produce a plan, schematic or 3-D model
Understanding how the design of a structure can incorporate sustainable features and systems
Identify basic architectural design related processes such as: building purpose, pre-design phase, structural elements, schematic and design phase, structural elements and features.
Introduce design-related processes
ENGINEERING
Define a challenge or problem
Identify viable solutions
Build and test for performance
Identify basic elements of design engineering such as: choose materials that may help complete the task; follow the design guidelines
Build a system; test the system; and prove that it works

SUSTAINABILITY
Identifying what makes a product green and sustainable
Conceptualizing different solutions within constraints
Articulating ideas about sustainable design as it refers to water resources, management and conservation

KEY DEFINITIONS AND TERMS

VOCABULARY
Filter – A porous device for removing impurities or solid particles from a liquid or gas passed through it.
Permeability - The state or quality of a material or membrane that causes it to allow liquids or gases to pass through it.
Porosity - Solid materials have pores in them, sometimes these pores are almost microscopic in size, and sometimes they're very visible.
Sediment – Naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself.
ENGINEERING DESIGN-RELATED VOCABULARY
Engineering design - is a formulation of a plan or scheme to assist an engineer in creating a product. The engineering design is defined as a process to meet desired needs. It is a decision making process (often iterative) in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective.
Conceptualization - Once an engineering issue is clearly defined, solutions must be identified. These solutions can be found by using ideation, or the mental process by which ideas are generated. The following are the most widely used techniques:
Brainstorming - this popular method involves thinking of different ideas and adopting these ideas in some form as a solution to the problem.
Trigger Word - a word or phrase associated with the issue at hand is stated, and subsequent words and phrases are evoked. For example, to move something from one place to another may evoke run, swim, roll, etc.

INSTRUCTIONAL RESOURCES

DESIGN
What is the Design Process? - www.teachersdomain.org/resource/phy03.sci.engin.design.desprocess/
Simple Solutions - http://www.teachersdomain.org/resource/eng06.sci.engin.design.amysmith/
WATER
www.water.org
www.canarywater.org

Green Machine: Building Sustainable Futures Curriculum Module 1: H20 FRIEND OR FOE?

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DESIGN CHALLENGE 1

CHALLENGE GOAL
This challenge helps participants make connections to the role of designers and engineers in helping solve the world's need for clean water. Participants build a multi-part water filtration system out of plastic bottles that will render dirty water clean.
CHALLENGE GUIDELINES
Each team will work collaboratively to achieve the goal
Water filtration systems will be made out of recycled materials
System will filter at least 8oz of muddy water
The filtered water should come out crystal clear
The team with the cleanest water wins the challenge
The instructor should ask probing questions if a design team appears to be stuck
The instructor can assist with tools and equipment but can not provide instructions or hints to teams
CHALLENGE CONSTRAINTS
The filter accomplishes its task with out any human intervention. Once participants pour the water into the filter they cannot manipulate the system
The system should consist of a minimum of three layers of provided filtration components (such as: cotton cloth, mesh, gravel, coffee filter, fabric, etc.)
The instructor should stress that communication and collaboration are key to the design and creation of a successful prototype.
CHALLENGE OUTCOMES
1 Water filtration system made from recycled materials
1 Worksheet describing prototype and design process

WHAT YOU'LL NEED

MATERIALS		EQUIPMENT	TECHNOLOGY
Clear 1 & 2 liter plastic soda bottles (2 or 3per team)	Butcher Paper	Scissors	Digital Camera
Gravel, Sand	½ yard Plastic screen mesh	Serrated Knife or small hand saw	Video Equipment
Potter's Soil	Sand	Wood 1 1/2" Nails	
Recycled nylon stockings (top and toe part cut off)	Recycled cotton fabric or clothing (bed sheets, tshirts etc.)	Hammer	
Coffee Filters	Measuring cups	Safety glasses	
1/2 yard plastic or mesh screen	Chart Paper		
1 bucket per team	Clear plastic cups		
Thick colored markers (5 per group	Recycled Plastic take-out containers		
Pencil shavings	1 bag cotton balls		

BONUS ROUND MATERIALS

Computers with Internet connection
Gimp software
Video Cameras or webcams

ADVANCED PREPARATION

ONLINE
Download the Design Process video link to avoid streaming problems: - http://www.teachersdomain.org/resource/phy03.sci.engin.design.desprocess/

ADVANCED PREPARATION

Copy worksheets for teams
LEARNING SPACE
Cover tables with plastic or butcher paper
Prepare muddy water in a bucket by adding potting soil to a 2 gallon bucket of water. Mix well and make sure to stir well before dispensing each cup.
Wash sand and gravel till water drains clear
Cover all tables with butcher paper or plastic
Lay all the materials out on a table or surface so they are easily accessible

SESSION PLAN

Introducing the Challenge
This challenge requires some background discussion with the participants. This discussion can be initiated by a question or phrase that can be used to stimulate conversation with participants. This is an opportunity for participants to showcase their topic-related knowledge. Participants are then asked to use a word or a set of words to describe what the questions or phrase means to them. Example: Clean Water... What do you think of when you think of clean water?
In a large group setting the instructor writes down the question and phrase on a chart sheet that will also be used to record participants answers. In smaller groups, instructor can provide a sheet of chart paper and a set of markers or have participants write on butcher paper on tables.
Once completed instructor reads through all the words and phrases participants used to describe "Clean Water."
Framing the Problem
Share some statistics related to the lack of clean water access for millions of people around the world.
- Out of Earth's total water supply 97% is salt water and only 3% is fresh water.
- Most of fresh water, 2.2% is trapped in glaciers and worlds ice caps.
- Only .08% of Earth's water is available for human use.
- 70% of the world's fresh water is devoted to agriculture.

SESSION PLAN

- Access to clean water has emerged as one of the major engineering challenges of the 21st century.
- Water borne disease cause 1.4 million children's deaths every year.
- Half of the world's hospitalizations are due to water-related disease.
Images that match the list of facts can be projected on a large screen to place a human face on the problem.
Once the scenario and the challenge are introduced the instructor distributes a written design guide that states the scenario; challenge guidelines; and list of available materials.
Making the Filter
Introduce participants to the materials on the table.
Let participants know they can use items however they please to accomplish the challenge goal (cut, reshape etc.)
Show participants the cutting tools and protective eyewear and let them know to seek out assistance before cutting. Please emphasize safety at all times.
Please refrain from giving them any further instructions
Show participants a cup of the muddy water next to a cup of clean water
Issue a reminder that filtration systems must clean the water so that it looks like the water in the clean cup.
Instructor will dispense muddy water
Water should be stirred each time. (If not, the suspended particles will collect at the bottom).

SHARING AND DISCUSSION

APPROACH
Once the participants have completed and tested their water filters, they will briefly share their design and engineering process with the group.
Have participants use worksheets to walk through their creation process

REFLECTION TOOLS & QUESTIONS

DESIGN THINKING
Which ideas came to your mind first?
What thinking process took place?
Which changes did you make and how did you decide to make them?
Which questions did you ask yourself and members of your group?
EXPERIMENTING & ENGINEERING
Which materials did you choose? Why?
Did the materials work how you anticipated?
Did you make any predictions about how you thought it would work?
Did the order in which you placed the materials impact your design?
How did you record and/or organize your discoveries?
What kind of problems did you encounter?
EXECUTING/BUILDING
What steps did you take during the construction?
Which tools did you use?
Did you have to change any of the materials? How?
How can you determine your design worked?
Does your design comply with the guidelines?
SCIENCE-RELATED
How did you clean the muddy water?
Would you drink this water? Why or Why not?
What do you think is still in the water?
Where does the water in the cup come from?

EXTENSION ACTIVITIES

Public Service Announcement
Have participants do some online research and continue to explore their concerns around water access, resources, management etc.

EXTENSION ACTIVITIES

Return to brainstorming words and categories to help prompt work
Have participants write a scenarios for 30-60 second Public Service Announcements (PSA) voicing one primary concern about the use and consumption of water
Visit charitywater.org for PSA examples
Product Design and Advertisements
Teams re-assemble and create companies to distribute and promote their water filters
Design logos on computer using Aviary or Gimp
Develop pitch and slogan and description for filter
Complete and print out poster and ahare out through mock sales pitch
Visit watercanary.org for examples
Water Testing
Have participants test their water to see what particles it contains
Participants can make their own ph paper strips from red cabbage: - www.wikihow.com/Make-Homemade-pH-Paper-Test-Strips
Over the counter water testing kits can also be purchased
After water has been tested have participants create an infographic or visualization to help others understand what's in the water

BONUS ROUND

CHALLENGE OVERVIEW
Participants analyze the various components of their water filtration prototypes to determine how effectively and efficiently their components work.
CHALLENGE GOAL
Build a more efficient water filter using water filtration prototype as a basis.
CHALLENGE GUIDELINES
Water filtration systems must have a reasonable flow rate
The amount of water poured into the system should approximately match the filtered amount
Second iteration of filtration systems must improve upon results of the first

BONUS ROUND

CHALLENGE OUTCOMES
1 Improved water filtration system
1 Morphological Design Chart
LEARNING GOALS & OUTCOMES
Analyze a system and its components and test for performance
Engage in the iterative design process of re-thinking and re-designing a prototype
Improve on a prototype based on test results
Use data to inform design changes
Testing and implementing ideas in a systematic fashion
VOCABULARY
Morphological Chart – helps with the generation of ideas in an analytical and systematic fashion. The left side of the chart lists the various components (or parameters) of a system and on the right side of the possible solutions. Each design feature or characteristic is listed in the chart, and different engineering solutions are proposed. Often, a preliminary sketch and short report accompany the morphological chart.
Flow rate – mass of a substance that passes through a given surface per unit time. In other words how long it takes a fluid to flow through a surface
Efficient - performing or functioning in the best possible manner with the least waste of time and effort.
Effective - adequate to accomplish a purpose; producing the intended or expected result.

SESSION PLAN

MATERIALS	
Recycled clear 1 & 2 liter plastic soda bottles – at least two or three for each team	½ yard Plastic screen mesh
Coffee filters	Sand
Recycled Old Cotton fabric	Dirt – potters soil
1 bag Cotton balls	1 bucket per team

SESSION PLAN

Recycled nylon stockings (top and toe cut off)	Measuring cups
Gravel	Recycled Plastic take-out containers
Chart Paper	Pack of thick colored markers for each group
EQUIPMENT	**TECHNOLOGY**
Scissors	Computers with Internet Connection
Serrated Knife or small hand saw	Video Cameras, Web Cams
Wood 1 1/2" Nails	Digital Still Cameras
Hammer	Open Source image manipulation software: Gimp - www.gimp.org Aviary - http://advanced.aviary.com/tools/image-editor
Safety glasses	

ADVANCED PREPARATION

LEARNING SPACE
Organize all materials and supplies
Make enough copies per team of the morphological chart
Prepare muddy water following the same recipe you used before
Prepare water filtration prototypes for distribution
DESIGN CHALLENGE
Introduce the new challenge to the students. Before they begin working play the Design Process video to prompt reflection about the design engineering process.

SESSION PLAN

Introduction to Challenge
Introduce the new challenge to the students. Before they begin working, share the Design Process video to prompt discussion and reflection about the design engineering process.

SESSION PLAN

In small design teams or as a large group discuss with participants the meaning of the words efficient and effective. What do they mean to them? How are they related to their new challenge?
Brainstorming and Testing
Participants brainstorm in their design groups which features of their prototypes need improvement to meet the new guidelines. Participants should also discuss how they will approach testing and re-designing prototypes.
Participants begin testing their systems by implementing changes and testing for water appearance, flow rate, and output.
Participants study, examine and analyze the function of each component to determine how it works and contributes to the filtration system.
Participants measure how fast the water filters through the system, how much water goes in and how much comes out. They should compare their filtered water to the appearance of tap water.
Documentation
Participants should document each design change by sketching or photographing their prototypes and system components.
Implementing Changes
Participants begin implementing their changes by exploring various options—using materials they haven't yet incorporated, changing the order in which their materials are assembled, etc.
Encourage participants to investigate as many properties of the materials as possible.
Participants may also perform experiments to learn, determine and collect data on the permeability of materials, filtration capacity, and absorption.

REFLECTING AND SHARING

GUIDING QUESTIONS
First, have participants reflect on their process and document their new prototypes and process
What aspects of the team's design needed improvement? Why?
What did you change? How did you change it?
What changes did you notice in the system after the changes?
How has the water filter improved since the first prototype?
Is the new prototype more efficient?
Documenting Findings
Record a short video of each team. Have each team member describe a different part of the design process in two sentences or less.
Encourage teams to use engineering, design and sustainability-related words

Green Machine: Building Sustainable Futures
Module 2: Plan It/Build It

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PREMISE

SNAPSHOT

Reducing the environmental impact of buildings has emerged as one of the greatest challenges for contemporary architects and engineers. To establish a healthier relationship between society and the environment we need to reconsider collectively the ways we design, build, develop and use the spaces where we live, work and play.

Although necessary for human survival and shelter, buildings consume enormous amounts of resources, generate lots of waste, and contribute to the degradation of the environment. Sustainable architecture seeks to minimize the adverse impact that the buildings have on the environment and human health.

Through the Plan It/Build It module, participants will have the opportunity to use systems-thinking and design skills to propose viable, sustainable building solutions. Through a series of design challenges, participants will develop a sense of how the design of the built environment and the implementation of sustainable design principles can reduce their ecological footprint and impact the design engineering process.

DESIGN CHALLENGES

SUMMARY

This module includes three design challenges. Each challenge will help guide the design process of a team through the implementation of various design constraints that are guided by green building principles. The ultimate goal is to complete a desktop model of a building or structure that demonstrates green building features prominently.

- Hold It—A challenge where teams engineer a free-standing weight-baring platform
- Plan It/Build It—A two-part challenge where teams plan and build structures that reflect environmentally-friendly practices and processes.

BIG IDEAS

DESIGN
What is the planning and design process inherent in the design of the built environment?
ENGINEERING
How can the engineering process inform the design and function of structures with sustainable features?
SUSTAINABILITY
How can we determine if our design satisfies sustainable green building practices and requirements?

MODULE OUTCOMES

OVERVIEW
Each team will design a structure using environmentally friendly solutions. Participants will be required to use recycled materials and carefully examine their properties to determine their aesthetics, functionality, life-cycle, etc. The structure's design will incorporate various green building features as specified by individual challenges.
DELIVERABLES
Design for weight-baring platform
Design Brief Worksheet
Challenge Solution Concept Map
Graphic Organizer Worksheet
Desktop model or structure

LEARNING GOALS

Introduce sustainable green architecture and its features
Understand green engineering and architectural design processes
Understand the built environment and how it works
Increase visual literacy as it relates to the built environment
Gain a better understanding of how architecture and engineering design impacts one's life
Identify basic design-related processes such as: building purpose, design phases, structural elements and building features
Transfer ideas about sustainable architecture through the design and creation of desktop models

SKILLS TARGETED AND LEARNED

DESIGN
How to design solutions
How to conceptualize ideas
Use systems-level thinking to produce a plan, schematic or 3-D model
Understand how the design of a structure can incorporate sustainable features and systems
Identify basic architectural design related processes such as: building purpose, pre-design phase, structural elements, schematic and design phase, structural elements and features.
ENGINEERING
Define a challenge or problem
Identify viable solutions
Identify basic architectural design related processes
Build and test for performance
Decide form and function of a structure

SKILLS TARGETED AND LEARNED

SUSTAINABILITY
Identify what makes a product green and sustainable
Conceptualize different solutions within constraints
Reduce environmental impacts by enhancing efficiency of materials, energy and natural resources.

KEY DEFINITIONS AND TERMS

VOCABULARY
Elevation - a drawing of a single vertical surface of an object or building.
Floor Plan - a diagram usually drawn to scale showing a view from above of the relationships between rooms, spaces and other physical features at each level of a structure.
Greenroof - is a roof that is covered in plants, which reduces stormwater run-off and lowers cooling costs. - http://science.howstuffworks.com/environmental/green-science/green-rooftop.htm
Performance criteria - a list of the things a design solution must do to be considered successful.
Structure - anything built or constructed
Urban Planner - is a professional who works in the field of urban planning and land use for the purpose of optimizing the effectiveness of a community's land use and infrastructure.
Rainwater Harvesting System - is the accumulating and storing of rainwater for reuse before it reaches the aquifer. It has been used to provide drinking water, water for livestock, water for irrigation, as well as other typical uses. Rainwater collected from the roofs of houses and local institutions can make an important contribution to the availability of drinking water.
The Experiential Design-Engineering Cycle consists of: - Goal Setting to Meet a Given Challenge with specific constraints. - Concrete Experiential Experimenting - Observing and Reflecting - Formation of Abstract Concepts and Conceptualization - Building, Testing, Applying and Improving

INSTRUCTIONAL RESOURCES

GREEN BUILDINGS

California Academy of Sciences - www.calacademy.org/academy/building/sustainable_design
The Green Building Council - www.urbangreencouncil.org/
The Solaire Building: - www.thesolaire.com/documents/green_building.html
Top 5 Green Buildings in NYC - www.greenbuildingsnyc.com/2007/12/04/top-5-new-york-city-green-buildings-2007/
Green Roof Building Project - www.hrt.msu.edu/greenroof/#
BACKGROUND INFORMATION
e2 PBS series: Stories feature design, energy, water, transport, urban development etc. - www.pbs.org/e2/about.html
Architecture Schematics - www.ehow.com/facts_5892641_architecture-schematics_.html#ixzz1iR0dPDnT
Green Features and Systems - www.builtgreen.net/features.html

Green Machine: Building Sustainable Futures Curriculum Module 2: PLAN IT/BUILD IT

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DESIGN CHALLENGE 1 OVERVIEW

HOLD IT!–THE PLATFORM CHALLENGE
In this challenge, participants use paper and a wooden platform to build a stable, free-standing structure. The activity allows participants to develop an understanding of structural balance and the forces that act upon it. Participants will also explore the role of geometry in shaping and supporting a structure.

BIG IDEAS

BIG DESIGN IDEAS
How does the architectural design process influence the shapes that will help a structure?
BIG ENGINEERING IDEAS
There is a direct correlation between shapes and weight baring objects and structures.
BIG SUSTAINABILITY IDEAS
How do the properties of the materials affect the structure?

LEARNING GOALS

PARTICIPANTS WILL LEARN...
How 3-D shapes play an important role in a structure's stability
How forces affect a structure's balance and equilibrium
Why buildings stand up and why they fall down
How shapes help provide stability and balance

SKILLS TARGETED

DESIGN
Communicate ideas with design team members
Conceptualize various solutions within constraints
Identify viable solutions to a challenge
ENGINEERING
Execute ideas with 3-D objects
Build and test for performance

CHALLENGE GUIDELINES

THE PLATFORM CHALLENGE
Platform must be free-standing with an elevation of 6” or taller
Platform must support weight of one person without collapsing
Participants can only use newspaper and tape to create stability

OUTCOMES

DELIVERABLES
A free-standing structure that will support the full weight of a person without falling down or collapsing.
LEARNING GOALS
Test various 3-D geometrical shapes out of paper by subjecting them to weight to see which shape supports the most weight.
How shapes play an important role in designing buildings
Learn about what are the forces that make buildings fall and what are the forces that help them stand.
Learn how columns help support and distribute the load of a structure.

INFORMATION & RESOURCES

VOCABULARY
Buckle - To bend, warp, or cause to give way suddenly
Gravity - The force that attracts a body toward the center of the Earth, or toward any other physical body having mass.
Load - Loads are forces that act on structures. All structures must withstand loads or they'll fall apart. Loads can cause stresses, deformations, and displacements in a structure. In order to build a structure, you need to know what kinds of external forces will affect it
Force - Any action that tends to maintain or alter the position of a structure.
Compression - The force that acts on an object and deforms its shape mostly by pushing it down and shortening it.
Structural Engineering - Primarily driven by the creative manipulation of materials, forms, and the underlying mathematical and scientific ideas. Achieves an end which fulfills its functional requirements and is structurally safe when subjected to the loads it could reasonably be expected to experience.
LINKS
Blender Building Collapse Animation - www.youtube.com/watch?v=EYfbz0w-ZRk
LINKS
Tacoma Narrows Bridge Collapse -www.youtube.com/watch?v=hBxQCvVykRE&feature=fvst

MATERIALS		TECHNOLOGY
Lots of recycled newspaper or recycled paper (all the same size)	3 sheets of paper per group (construction or typing paper will do)	Digital Cameras for documentation
1 Wooden platform 15" x 15" square & ¼" thick	Lots of books and magazines all sizes (soft cover hardcover, etc.)	
1 roll masking tape	Chart paper	

ADVANCED PREPARATION

LEARNING SPACE
Make sure you have a stack of paper at least 3" high for each group.
The warm-up activity will require folding the three sheets of paper into a triangle prism, a cylinder and a square prism. Fold the sheets of paper and shape them so that the height is equal to the length (longest side) See instructions below.
MATERIALS
Have plywood pre-cut at a lumber store

SESSION PLAN

Warm up Activity
The goal is for participants to note how changing the shape of materials can affect how much weight a structure can bare.
Balance as many books as possible on top of three 3-D geometrical shapes made out of paper. Use a square prism, triangle prism and cylinder and determine which one holds the most weight.
Paper provides a dramatic contrast because you are using a material that is perceived as weak and flimsy. By changing its shape and layering it you can create a very strong and sturdy shape.
Discuss the activity. Introduce vocabulary words to help participants explain the outcome of the challenge
Discussion Questions
These questions will draw attention to the weakness and strengths of each shape. They can also help participants brainstorm about how to modify shapes to make them stronger. This discussion will help prepare them for the design challenge.
Which shape supported the most weight?
Where were the weakest points in each shape?
Approximately how much weight do you think each shape can support?
Did the way you placed the load (books/weights) affect how the shape support it?
Where on the paper shape did signs of stress began to appear?
What could you do to make them stronger using the same materials?

SESSION PLAN

Warm up Activity
Platform Challenge
Now teams are ready for to build the support for the wooden platform
Participants can only use provided materials
Tape can be used at the seams only
Paper can be bended, folded, cut etc.
Participants must stay within the imposed time limit
When playtesting and standing on the platform, two people must spot the standee at all times

REFLECTION & DISCUSSION

ROLE OF INSTRUCTOR
Is important to help participants make the connections between the challenges, what they have learned and the process of building a structure. The instructor is instrumental in helping to make these connections so that the participants can transfer their knowledge, curiosity and design skills.
As participants discuss their ideas, struggles and observations, the instructor should take write out which themes begin to emerge and the types of questions that are generated.
DISCUSSION QUESTIONS
What did you learn about structure and balance by participating in these two challenges?
What did your group discuss as a result of working on this particular challenge?
What did you learn about 3-D shapes and their role in creating structures?
What role do you thinks shapes have in providing balance and stability to a building?
Did your platform stay balanced while you were testing it?
Did you think your team would be able to accomplish this task? Why or Why not?

BONUS ROUND
CHALLENGE MODIFICATION
This challenge can also be a desktop challenge with a smaller platform
In an outside environment, buckets of water can be balanced on a bigger platform
Each team can work with a different type of paper
The elevation can be higher or lower
The platform size can be expanded to support a larger group of people

Green Machine: Building Sustainable Futures Curriculum Module 2: Plan It/Build It

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DESIGN CHALLENGE 2: PLANNING GREEN

CHALLENGE OVERVIEW
Design teams will make drawings and schematics for a building with green features. Teams choose to either retrofit an old building or design a brand new structure. Designs will take into account geographical location, climate and time period. For the following challenge, participants will design and build a desktop model from recycled materials.
CHALLENGE GOALS
Create a schematic or design a blueprint
Design a building that will implement sustainable building principles
Create a desktop model from a building design
CHALLENGE GUIDELINES
Building designs must implement at least two of the following green building principles: - Use recycled materials to reduce the use and production of new materials. - Reduce the use and consumption of energy, water and other raw natural resources - Reduce waste, pollution, harmful emissions and environmental degradation.
Teams will use only recycled materials to create the model structure
Teams will delineate a "green plan" that describes types of buildings and systems
Designs and models must use building materials efficiently
Model must fit on a plot no larger than 15 x 15 square inches
CHALLENGE CONSTRAINTS
Limitations on geographical location city or rural area in a specified place - state or another country. Instructor will set the parameters. - Constraints based on climate (precipitation, cold, hot, tropical) - Time period - 10, 20, 30 years ahead, etc. - Natural disaster prone zone - flood zones, tornadoes, hurricanes, earthquakes.

CHALLENGE OUTCOMES
Design brief for a green building
Design schematic for a green building

WHAT YOU'LL NEED

MATERIALS		TECHNOLOGY	EQUIPMENT
Graph paper	Duct tape/Masking tape	Laptops with Internet connections	Hot Glue Guns
Rubber material	Recycled Styrofoam cups	3D design tools (such as TinkerCAD etc.)	
15' x 15" cardboard	Soda Bottles	Digital Cameras	
Egg cartons	Popsicle sticks		
Recycled cardboard, newsprint, paper for building	Wooden coffee stirrers		
Cans			

GUIDING QUESTIONS

ARCHITECTURE
What is an architect? What do they do?
Who is your client?
Who is going to use the building?
How will the building function?
How many people will use it?
Where will the building be located?
What are your perceptions about the needs of the surrounding community?

GUIDING QUESTIONS

How do you think it will impact the surrounding community—positively and negatively?
ENGINEERING
What sources of energy will the building use?
SUSTAINABILITY
What features and systems will be integrated into the building to help meet green building standards?
Which green building principles apply to your project?

GREEN BUILDING PRINCIPLES

Introduction
Immediately following the introduction the instructor should introduce some of the green building design principles
Use of low impact materials: choose non-toxic, sustainably produced or recycled materials which require little energy to process.
Energy efficiency - use manufacturing processes and produce products which require less energy. Implement renewable energy sources when possible.
Renewability: materials should come from nearby sustainably managed renewable sources that can be composted when their usefulness has been exhausted.
Design Impact - measures for total carbon footprint and life-cycle assessment for any resource used. Monitoring energy levels, water usage and CO2 emission levels.
Design for use of recycling products - Products used, and processes, and systems should be designed for performance in a commercial 'afterlife.' In other words how can these materials be recycled or repurposed by industry/commercially for other products.
Participants should discuss these principles in their design teams and list the two principles that they will adhere to as they are discussing, planning and designing their structures.

ADVANCED PREPARATION

Identify Resources
Instructor and students can begin early by recycling as many materials as possible.
Review Informational Resources, pulling images, videos and examples of green buildings
Have examples of architectural blueprints, schematics, design briefs, green features and definitions bookmarked or on hand so participants can see how architects layout their blueprints.
Make copies of Retrofit and New Structure Worksheets
Review statistics

SESSION PLAN

Introducing the Challenge
The Plan It/Build It challenge will be divided into several activities: - Thinking through and conceptualizing the type of structure to build - Deciding on which green systems and processes to incorporate - Determining the form and function of the structure
Framing the Problem
The statistics listed below can serve to provide background information about the importance of implementing sustainable building practices.
In the United States buildings account for: - 12% total water consumption - 68% total electricity consumption - 38% of the carbon dioxide emissions - The United States is the largest consumer per capita of energy in the world. - The US has only 5% of the 6.97 billion people on Earth, but it consumes 26% of the total's world energy. - 40% of the total energy consumed in the US comes from buildings mostly in urban areas.
Participants should discuss these principles in their design teams and list the two principles that they will adhere to as they are discussing, planning and designing their structures.
Brainstorming Ideas
Ask participants to list words, phrases and concepts that elicit ideas about designing and building green structures

SESSION PLAN

Use videos, photographs of green buildings or ordinary common buildings to introduce the challenge and inspire teams to draw constrasts and observe specific features. - www.pbs.org/e2/about.html
Take a walk around the neighborhood to notice and describe the different types of building designs and contexts that are visible in the community.
Virtually visit green buildings around the world. See Informational Resources for links.
Take a field trip to a green building to spark student imaginations
As a group, collaboratively brainstorm the re-design of an old, out-dated building.
Planning
Facilitate conversations and help teams organize their ideas in a systematic and logical way
Teams should be introduced to the use of schematic and graphic organizers to help them brainstorm ideas related to the features and function of the planned structure.
Schematics can be simple or as elaborate as time will allow.
Teams meet and begin informed discussions about what type of building they want to build and decide which green building principles will be featured in their models.
Introducing the Design Brief
When teams have decided approach, hand out appropriate worksheet: - Retrofit Design Brief - New Building Design Brief
Design brief sheets will help participants document their ideas and possible solutions
Share green building principles with design teams.
Participants should discuss these principles in their design teams and list the two principles that they will adhere to as they are discussing, planning and designing their structures.
Completing the Design Brief
Encourage participants to pay special attention to dimensions, labeling and the locations of essential building components.
Teams should be encouraged to make changes and modify their plans as they go along.

SHARING AND DISCUSSION

APPROACH

SHARING AND DISCUSSION

Each group should present their building plans and design brief. They should share their "blueprint" with others and discuss the green features that they have decided to incorporate.
Sample questions: - What type of questions did you ask of yourselves as you were working? - How did you reach a consensus? - What were the different ideas presented by the individual team members? - Did you have enough planning time? - Were there any additional resources you wished you had access to?

REFLECTION TOOLS & QUESTIONS

DESIGN THINKING
What features and architectural details did you decide to incorporate in your design plan and why?
EXPERIMENTING & ENGINEERING
What green features did you decide to incorporate? What do you expect to achieve with these green features?
How will these features help reduce the inhabitants carbon footprint?
SCIENCE-RELATED QUESTIONS
How much energy will your building require to operate?
How will the green systems you have planned or invented work?
How much water will your building use?

EXTENSION ACTIVITIES

Visit architecture museums and award wining green buildings in the city that have obtained the Leadership in Energy and Environmental Design (LEED) Award. Have students create presentations, blueprints. design briefs and schematics based on site visits. List of green buildings in New York City vicinity - www.greenbuildingsnyc.com/2007/12/04/top-5-new-york-city-green-buildings-2007/

EXTENSION ACTIVITIES

Use Retrofit Design Brief worksheet and collaboratively redesign a well-known building. Mix-up design teams and challenge them to create new solutions based on a specific green building principle or feature.
Solar Circuits - Design and construct a desk top structure that derives 40% to 100% of its total electricity from solar technology.
Green Roof - Design team will build a structure that incorporates green roof technology.
Identifying Possibilities - Participants study their community, buildings, parks, or a selected type of community structure to study and propose possible solutions to reducing the ecological footprint.

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DESIGN CHALLENGE 3: BUILD IT

OVERVIEW
Now it's time to start implementing architectural features through the process of building and designing. Completing this challenge will take a minimum of at least five two-hour-long sessions. Depending on the skills and content the instructor wants to emphasize it may take longer. For example, if there is an emphasis on developing participants architecture skills there can be a series of supplemental activities that address specific skill sets. The same can be said with green building codes, engineering of alternative sources of energy, green roofs, etc.
BIG IDEAS
Participants will begin to work with materials and explore design issues and constraints. As they do so it's important to help them discover basic aspects of real-world architecture and engineering:
PHYSICS OF STRUCTURES
No matter what we build, on what scale and with what materials, the basic physical forces of nature will be at work:
- Gravity tries to pull things down
- The seasons cool and heat them
- The wind pushes and batters them
- Rain, snow, ice and hail fall on them
- The soil, rocks, clay on which they rest move with time
- Earthquakes sometimes move them suddenly and forcibly
- Internal stresses in each part of the structure resist the above environmental forces
- Human use of structures wears them down.
DESIGN ISSUES
What is the purpose of the structure?

DESIGN CHALLENGE 3: BUILD IT

How does this influence the size, shape, physical design of the structure?
What physical statement is the structure going to make?
What are the physical features that will stand out or will be emphasized?
What materials will best work to highlight the design?
MATERIALS EXPLORATION
Exploring materials, their availability, durability and ecological footprint
Inevitably all materials come from nature - how can the selection of materials reduce the carbon-footprint of a building?
What types of materials will help accomplish the work at hand?
What properties of materials are best suited for the job?
What are the various constraints and design issues that need to be considered when selecting the materials?

SESSION PLAN

Introducing the Challenge
Each design team should have the time to explore all of the different types of materials available for their buildings.
Ask participants to focus on the main features of their building, specifically how they will incorporate the two sustainable green building features and what type of materials and design will influence how they will be incorporated into the structure. Participants should be encouraged to research a particular green feature to become acquainted with how they work and other aspects related to a particular design. Once participants have a fairly good list of materials that will be needed for the structures they should begin experimenting with building the structures.
The questions listed below can help guide the thinking and construction process to help participants pay attention to important details such as:
Guiding Questions
How much weight will the building have to support?
How will the foundation be laid out - will it have special features?
How much load will the building have to support?

SESSION PLAN

Will the walls be bare or covered?
Will the walls be straight or curved?
How will it meet the challenge constraints and the green building sustainable features? How will these be measured and accounted for?
Reflection while working
As participants are working walk around and talk to them about what they are doing and the logic behind it What is the logic?
When necessary pause the entire group and talk about what is happening and have them reflect on the process. - How are the materials working? - What just happened? - What did you notice? - What type of solutions did you find? What kind of theories are you working on? - How did your design team solve a particular problem? - Are your sketch, floor plan and design brief working? If not, what modifications have you been making?
Making time to reflect during the design engineering process helps to refocus participants and acknowledge their successes. It can also be instrumental in helping to move the process along and help participants think in a systematic fashion about what they are doing. Real-time reflection helps center a participant's work within the experiential design-engineering cycle.
Assessing the Structures
As the structures progress it is important that participants are reminded to pay special attention to details, aesthetics, shape and form. Emphasize that they will have a reasonable time to complete their buildings.
If something is not working encourage them to try materials and different solutions off the building plot.

Green Machine: Building Sustainable Futures Curriculum Module 3: Eco-Tiles

Curriculum Draft
Institute of Play
December 2011

PREMISE

ECO-TILES DESIGN CHALLENGE
In this challenge, participants learn about sustainability and mold making and exhibit what they've learned through a hands-on activity and sharable documentation.

CHALLENGE

SUMMARY
Participants will create eco-friendly plaster tiles out of recycled materials and cardboard molds. Then they will create mock advertisements for these tiles, pairing up to create their own eco-tile company with a logo, slogan, and sales pitch.

BIG IDEAS

DESIGN
How can recycled materials be used to influence the look of new products?
ENGINEERING
What steps are necessary to create a seamless mold?
SUSTAINABILITY
What is the environmental impact of using recycled materials in buildings?

RESULTS

DELIVERABLES
Completed eco-friendly plaster tile with recycled filler
One page mock advertisement and sales pitch for tile company

LEARNING GOALS

PARTICIPANTS WILL LEARN...
An overview of sustainable building materials and green building
Simple mold making techniques using recycled materials
How to work with plaster and recycled materials to create casts
How to create a mock advertisement that exemplifies their knowledge of sustainable materials

SKILLS TARGETED AND LEARNED

DESIGN
How to conceptualize various solutions within constraints.
ENGINEERING
How to build and test for performance.
SUSTAINABILITY
How to identify what makes a product green and sustainable.

INFORMATION AND RESOURCES

GREEN BUILDING
Introduction to green building and materials - www.calrecycle.ca.gov/greenbuilding/materials/
MAKING TILES
- www.ehow.com/how_7853395_make-glass-clay-tiles.html

INFORMATION AND RESOURCES

- www.youtube.com/watch?v=uClo_yakWnA

KEY DEFINITIONS AND TERMS

Mold - a hollowed-out block that is filled with a liquid like plaster

Cast - the solid part which is ejected or broken out of the mold

Frame / Pattern - the rigid material that the mold is created from

Filler - material inside of mold to fill space, aside from plaster

Release Agent - wax paper on cardboard to make removing cast easier

Plaster - dry powder mixed with water to form a paste that hardens

Eco-friendly materials - things that inflict little or no harm on the environment

ECO-TILES DESIGN CHALLENGE

OVERVIEW

In this 2-hour design challenge, participants will learn about eco-friendly and sustainable building materials and practices. Then they will create eco-friendly tiles of their own that could be used in a larger structure.

GOALS

Participants will create eco-friendly plaster tiles out of recycled materials and cardboard molds.

Participants will create a mock advertisement for their eco-tile company.

GUIDELINES

Tiles must include recycled filler material.

Mock advertisements should include an image, logo, slogan, sales pitch, and description.

DELIVERABLES

Participants will use what they learn about recycled materials and mold-making to create a plaster tile, as well as an advertisement.

WHAT YOU'LL NEED

MATERIALS		EQUIPMENT	TECHNOLOGY
Scrap Plastic	Paper	Clip-on fans	Computers
Plaster	Scrap Cardboard	Hot glue guns	Printer
Cups	Dye	Scissors	Wacom tablets
Scrap Glass	Markers	Clip-on lights & Lamps	Digital Cameras (or Webcams)
Clay	Stirring Sticks & Spoons		

SESSION PLAN

Keynote (15 mins)
Overview of sustainable design / green buildings
What is green building? What is sustainable design?
Examples of buildings and materials
Tie in to today's project: tile made of eco-friendly plaster and filled with recycled materials
Prepare filler material (20 minutes)
Cut up paper / cardboard to use inside of tiles
Crush plastic into smaller bits to use inside of tiles

Make molds out of cardboard for tiles (40 minutes)
Put down wax paper on flat piece of cardboard as release agent
Cut cardboard frame for tile
Fold and tape frame to desired size / shape
Hot glue cardboard frame to flat piece of cardboard to seal mold
Use clay to fill any holes in hot glue to prevent plaster from leaking
Place filler material(s) inside of frame

SESSION PLAN

Mix plaster, put in filler, pour in molds (30 minutes)
Facilitator will mix plaster in large bucket in center of room.
Facilitator will quickly distribute cups of plaster, as well as cups of powered dye.
Participants will pour plaster into molds and mix in any dye and any final filler materials.
Place tile to dry overnight or up to two days (with clip on fans or lamps).
Create advertisement (30 minutes)
Students pair up, take pictures of drying tiles, transfer to computer
Design logo on computer, possibly with Wacom tablets
Come up with slogan, sales pitch, and description
Complete and print out poster and share out through mock sales pitch

BONUS ROUND

AN EXTRA CHALLENGE
Make two or more tiles that fit together seamlessly
Create patterns with filler material on top of the tile (cut off or sanded down later to make tile flat)
Make multi-layer tile with pouring new colored layers of plaster on semi-dried layers
Create swirls of color in tiles by carefully mixing in dye

WRAP UP

FINISHING TOUCHES
Facilitator should check that each tile includes recycled filler material
Facilitator should check that advertisement meets requirements

SHARING & DISCUSSION

WRAP UP

GUIDING QUESTIONS
What makes a building and/or material sustainable?
How were the tiles we made sustainable and/or eco-friendly?
What did you learn about mold making? What are some tips you'd give to someone else making a mold for a plaster tile?
What are possible uses for eco-friendly tiles such as they ones you made?

EXTENSION ACTIVITIES

Eco-Tiles Sales Pitch
Participants will work in pairs to create an mock one page advertisement. This ad will be used to "sell" their eco-tiles. Pairs will photograph their tiles and include their images in their advertisement. Next, pairs will come up with a name for their company. Then design a logo, come up with a slogan, and devise a sales pitch. Finally, students will create an advertisement that highlights the environmentally friendly aspects of their tiles and tries to capture the attention of potential buyers.
Create a 3D structure
Use wire to create 3-D structures
Dip cheesecloth in plaster to strengthen 3-D structures

Green Machine:
Building Sustainable Futures
Curriculum Pilot Worksheets

Developed by Institute of Play
Written by Evelyn Roman-Lazen

Green Machine: Building Sustainable Futures

Curriculum Pilot
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CURRICULUM MODULE 1: H20 FRIEND OR FOE

Water Filtration System Worksheet

Components of the System Draw a diagram of your filter in the space below. Be sure to label your diagram with all components used, including layers of materials.

Next, describe your filter and how it works. Be as detailed as possible, taking us through the process step by step. Be sure to use the names of the components you drew above. Use the back of this page if you need more space.

_____

_____

_____

_____

GREEN MACHINE: BUILDING SUSTAINABLE FUTURES

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CURRICULUM MODULE 1: H20 FRIEND OR FOE BONUS ROUND

MORPHOLOGICAL DESIGN CHART EXAMPLE

Green Machine: Building Sustainable Futures

MODULE 2: Plan It/Build It

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CHALLENGE SOLUTION OUTLINE CONCEPT MAP

DEFINE THE CHALLENGE

SUSTAINABLE FEATURES

IDEAS

What should your building look like?

Which architectural features will be prominent?

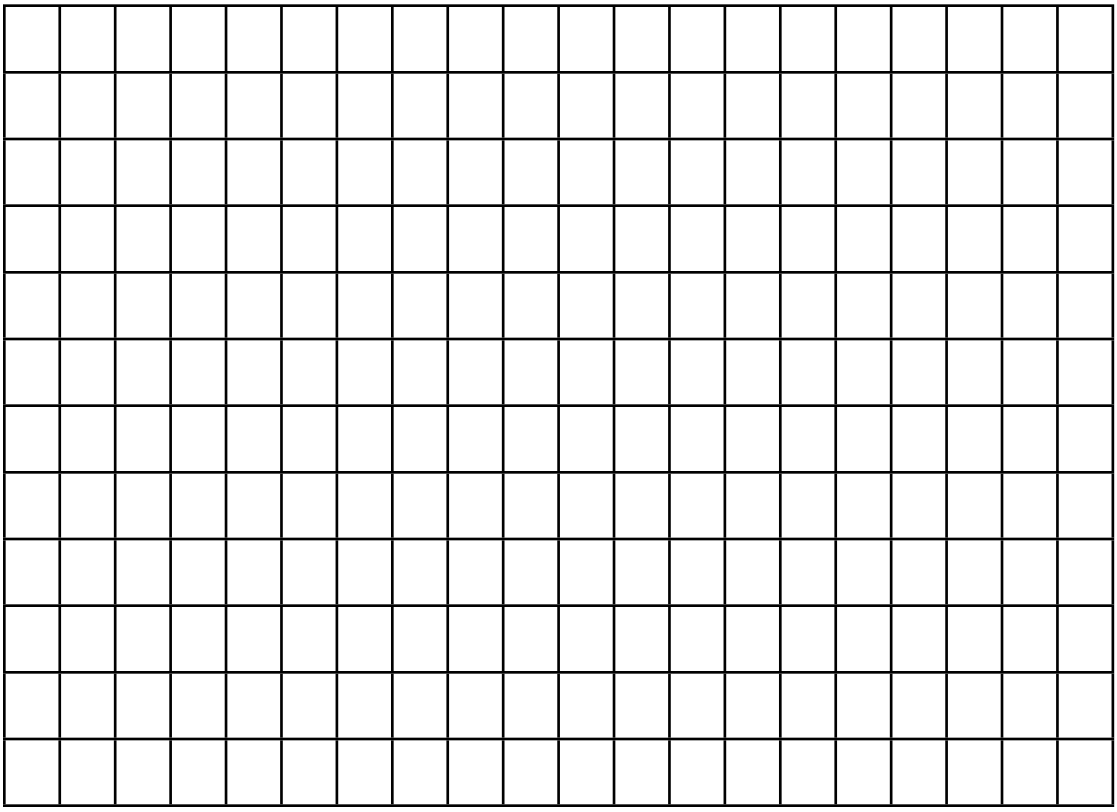
What type of statement will the building make?

BUILDING FEATURES

BUILDING SYSTEMS

SCHEMATIC DRAWING

Draw a quick sketch of what the exterior of the building will look like. Add as much detail as possible. Use tracing paper and a cardboard backing to add various layers. You can quickly research some tips on architectural drawings via the following links:



Trips on Trace Architecture Drawing

- www.ehow.com/way_5192322_tips-trace-architecture-drawing.html

How to sketch like an architect

- www.youtube.com/watch?v=vmHoGicPQQQ&feature=related
- www.youtube.com/watch?v=7Gq6vpmR3CQ&feature=related

3-D Schematic

- www.youtube.com/watch?v=9i_xqR1Jh-8&feature=related
- www.youtube.com/watch?v=iQ3vhJE2TLI&feature=related

GREEN MACHINE: BUILDING SUSTAINABLE FUTURES

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MODULE 2: Plan It/Build It

MODULE VOCABULARY

Aesthetic - relating to the qualities of people, places, ideas, or things considered beautiful.

Architect - one trained in the art and science of conceptualizing, planning, communicating, and coordinating the building of structures.

Architecture - The art and science of design and erecting buildings and other physical structures.

Black water - is a term used to describe wastewater that contains fecal mater and urine.

Built environments - the designed and assembled structures, graphics, and products that together create the places in which people live, work, and play.

Carbon footprint - the carbon footprint is a measurement of all greenhouse gasses we individually produce and has units of tons (or kg) of carbon dioxide equivalent. http://www.greenhq.net/carbon-footprint/

Civil Engineer - is a professional engineering discipline that deals with design construction and maintenance of the physical and naturally built environment including buildings, bridges, roads, dams, water treatment facilities, etc.

Compression - the state of being pressed down under a weight.

Construction manager - takes care of the overall planning, coordination and control of a project from inception to completion aimed at meeting a client's requirements in order to produce a functionally and financially viable project that will be completed on time within authorized cost and to the required quality standards.

Design brief - a written record of the parts of a design problem, including the need, the person or group in need (the client), and the situations affecting the need.

Detailed drawing - drawings that sow the specific physical characteristics of a design.

Dimensions - the length, width, and height of rooms of objects.

Ecological footprint - measures humanities demand on the Earth's ecosystems. The ecological footprint estimates the amount of land and ocean area required to sustain your consumption patterns and absorb your waste on an annual basis.

- www.epa.vic.gov.au/ecologicalfootprint/about/whatdoesitmean.asp
- www.myfootprint.org/
- www.footprintnetwork.org/en/index.php/GFN/page/calculators/

Elevation - a drawing of a single vertical surface of an object or building.

Floor Plan - a diagram usually drawn to scale showing a view from above of the relationships between rooms, spaces and other physical features at each level of a structure.

Greenroof - is a roof that is covered in plants, which reduces stormwater run-off and lowers cooling costs. http://science.howstuffworks.com/environmental/green-science/green-rooftop.htm

Performance criteria - a list of the things a design solution must do to be considered successful.

Structure - anything built or constructed.

Sustainable Design - a design that, in its conception, planning, and production takes into account its long-term impact on society, the environment, and the economy; and addresses such issues as energy conservation, human health and safety, waste production, and alternative uses.

Urban Planner - is a professional who works in the field of urban planning and land use for the purpose of optimizing the effectiveness of a community's land use and infrastructure.

Rainwater harvesting system - is the accumulating and storing of rainwater for reuse before it reaches the aquifer. It has been used to provide drinking water, water for livestock, water for irrigation, as well as other typical uses. Rainwater collected from the roofs of houses and local institutions can make an important contribution to the availability of drinking water.

Retrofit - to retrofit a structure to add green features means changing or enhancing some of its operational systems (electrical, heating, water heating) to reduce the use of energy, water, natural resources, and toxic chemicals.

Green Machine: Building Sustainable Futures

Curriculum Pilot
Institute of Play
December 2011

DESIGN BRIEF WORKSHEET-A NEW BUILDING

STEPS IN THE ARCHITECTURE + DESIGN PROCESS

- Identify the Problem
- Brainstorm Ideas
- Propose Solutions
- Plan a solution
- Sketch ideas
- Build

This design brief will guide the team through the architecture and engineering design process. The design brief is divided into six sections. Each section has a series of tasks and questions that are designed to serve as a guide. Sketches and bulleted notes can be very useful to help record and convey ideas as well as structure the teams thinking process. It is recommended to complete all the steps before building models, however becoming familiar with the materials that will be available for this challenge can help influence the ultimate execution of the design and building of the desktop model.

The team will need some tools and materials to complete the design brief:

Pencils	Markers	Google Earth	Chart paper	Masking Tape
Colored Pencils	Pens	Graphing paper	Measuring and drafting tools: rulers, protractors, T-square and compass	

STEP 1 - IDENTIFY THE PROBLEM

DESIGN CHALLENGE: Design and build a model of a new building that uses renewable sources of energy.

What are renewable sources of energy?

Renewable means energy that can be replenished naturally, it comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat.

Examples

Solar energy can be used for – water heaters, energy for buildings and homes, chargers, spacecrafts, calculators, among other uses.

- Wind Turbines – power cities, homes, boats, and farms.
- Water conservation and preservation systems - grey and black water recycling systems.
- Geothermal – The Earth's natural heat is used to transfer heat to heating and cooling buildings, water, etc.

Expand your research with the following web sites to learn more about how renewable sources are used in the green building design:

Renewable energy systems - solar, geothermal for cooling and heating & wind.

Youtube videos solar systems:

- www.youtube.com/watch?v=5S7xDxrHI5s
- www.youtube.com/watch?v=ZNZrwfjqKh0&feature=related
- www.youtube.com/watch?v=ZNZrwfjqKh0&feature=related
- www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html

Water Harvesting, Greywater recycling systems & Green Roofs

Water Harvesting

- www.savetherain.info/media-centre/rainwater-harvesting-faqs.aspx#two

Greywater

- http://hcourses.washington.edu/onsite/GraywaterPresentation.pdf

Greenroofs

- www.fairmountwaterworks.org/GreenRoof.pdf

Notes: (Use this space to write down important information that will be useful throughout the project)

STEP 2 – Now that you understand the challenge...what type of building would your team like to build? And why?

Discuss within the team what type of building would you like to design and build:

- Home or Apartment Building
- School
- Museum
- Community Center
- Hospital
- Other

It's time to select a location and site The following questions will help guide the team:

LOCATION

- Where will the building be located? City, rural area (country side), by river or ocean, in the mountains, in the U.S.A, elsewhere around the world.

ENVIRONMENT

- Which environmental factors, such as wind, ice, sun, heat, cold, rain, earthquakes, must be considered?
- Are their violent storms? Hurricanes, winter storms, etc.

Examples:

If the building is in:

- San Francisco – Earthquakes and type of weather.
- Boston – Hot summers and cold winters.

Once you have selected the type of building and site you can go to Google Earth to learn more about the physical location. You can fly to the city or region you have selected. If you are not familiar with Google Earth you can ask your instructor for assistance.

STEP 3: DESCRIBE

Type of Building (include detailed information – how many floors? how big? how many people will use it? will it be used all day mostly evenings? A rough sketches are also a good way of helping visualize ideas of the features of a building.

Location (include as many details as possible):

Climate and geographical features (include as many details as possible):

STEP 4 – BRAINSTORM

List the type of green features that will be incorporated in the building design. Also describe which problem the renewable features will solve or improve. How will it affect and enhance the building? Why does your team consider this feature important?

List and describe which renewable sources the team will incorporate in the buildings design:

Renewable source 1 :

Renewable source 2:

STEP 5 - PROPOSE & PLAN SOLUTIONS

The list of guiding questions will help you develop a detailed plan for your team. When making sketches and thinking, pay careful attention to the architectural features your team wants for your building!

GUIDING QUESTIONS

- What will the general appearance of the building be? Does it make a statement? Will it have any unique features?
- How will the team incorporate the renewable technology? Will the technology be incorporated as part of the building façade?
- Google- Images of Building Facades- link below and Green Building Façade
- What equipment will you need to install?
- What will the equipment look like? Will it need to be concealed? Which architectural features can help the equipment blend in and not compromise the architectural character of the building?
- Will it affect the exterior or interior of the building, etc.?

Google: Green Building Images, Green Buildings Around the World

You can use the following image links to brainstorm ideas:

Links:

- www.geekabout.com/2007-12-31-438/greenest-buildings-in-the-world.html
- www.laccdbuildsgreen.org/docs/energyToolkit/Presentations&Papers/Neutrality_Through_Conservation_and_Renewable_Energy.pdf

STEP 6 – BUILD

What will be affected by your new green improvements? You have a piece of 15" x 15" cardboard to build on. This will be the scaled size of your plot. Create several practice sketches to figure out dimensions and the location of your new green features.

- Think of the dimensions of the actual building and how you will represent them.
- Which materials will best represent the design ideas and convey your ideas of the building?
- Will the features and equipment be apparent and obvious to the exterior of the building, will they form part of the building material?
- Will others be able to understand what you are trying to convey with your 3-D model?

Tips

- Use graphing paper, pencils and erasers!
- Draw, sketch and write in bulleted form as many features that will help you design and build the buildings 3-D model.

- Try to make the visual presentations of your drawings as clear as possible. Color code items and create legends.
- Once all of the ideas have come together in the design brief and sketch it is time to build a 3-D prototype.

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December 2011

DESIGN BRIEF WORKSHEET-RETRO-FIT BUILDING

STEPS IN THE ARCHITECTURE + DESIGN PROCESS

- Identify the Problem
- Brainstorm Ideas
- Propose Solutions
- Plan a solution
- Sketch ideas
- Build

The design brief will guide the team through the architecture and engineering design process. The design brief is divided into six sections. Each section has a series of tasks and questions that are designed to serve as a guide. Sketches and bulleted notes can be very useful to help record and convey ideas as well as structure the teams thinking process. It is recommended to complete all the steps before building models, however becoming familiar with the materials that will be available for this challenge can help influence the ultimate execution of the design and building of the desktop model.

The team will need some tools and materials to complete the design brief:

Pencils	Markers	Google Earth	Chart paper	Masking Tape
Colored Pencils	Pens	Graphing paper	Measuring and drafting tools: rulers, protractors, T-square and compass	Computer with Internet access

STEP 1 - IDENTIFY THE PROBLEM

DESIGN CHALLENGE: Design and build a model of a retro-fit building that uses renewable sources of energy.

What are renewable sources of energy?

Renewable means energy that can be replenished naturally, it comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat.

Constraints

The model will be built out of recycled and other materials provided by the instructor. The team can only pick two green features that will be retrofitted.

What does "retro-fitting" mean?

Retrofitting a structure to add green features means changing or enhancing some of its operational systems (electrical, heating, water heating) to reduce the use of energy, water, natural resources, and toxic chemicals.

Examples

- Install energy efficient lighting and appliances (energy efficient bulbs, LED bulbs, appliances, etc.).
- Install renewable energy systems such as solar panels, wind turbines, solar water heaters to supplement energy consumption.
- Install water conserving devices such as: toilets, faucets, etc.
- Install rainwater capturing systems.
- Change windows to increase insulation and climate control.
- Replace or retrofit incineration systems

Solar energy can be used for – water heaters, energy for buildings and homes, chargers, spacecrafts, calculators, among other uses.

- Wind Turbines – power cities, homes, boats, and farms.
- Water conservation and preservation systems - grey and black water recycling systems.
- Geothermal – The Earth's natural heat is used to transfer heat to heating and cooling buildings, water, etc.

Expand your research with the following web sites to learn more about how renewable sources are used in the green building design:

Renewable energy systems - solar, geothermal for cooling and heating & wind.

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- www.youtube.com/watch?v=ZNZrwfjqKh0&feature=related
- www.youtube.com/watch?v=ZNZrwfjqKh0&feature=related
- www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html

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Greywater

- http://hcourses.washington.edu/onsite/GraywaterPresentation.pdf

Greenroofs

- www.fairmountwaterworks.org/GreenRoof.pdf

Notes: (Use this space to write down important information that will be useful throughout the project)

STEP 2 – Now that you understand the challenge...what type of building would your team like to retro-fit? And why?

Discuss within the team what type of building would you like to design and build:

- Home or Apartment Building
- School
- Museum
- Community Center
- Hospital
- Other

It's time to select a location and site.

LOCATION

- Where will the building be located? City, rural area (country side), by river or ocean, in the mountains, in the U.S.A, elsewhere around the world.

ENVIRONMENT

- Which environmental factors, such as wind, ice, sun, heat, cold, rain, earthquakes, must be considered?
- Are their violent storms? Hurricanes, winter storms, etc.

Examples

If the building is in:

- San Francisco – Earthquakes and type of weather.
- Boston – Hot summers and cold winters.

Once you have selected the type of building and site you can go to Google Earth to learn more about the physical location. You can fly to the city or region you have selected. If you are not familiar with Google Earth you can ask your instructor for assistance.

STEP 3: DESCRIBE

Type of Building (include detailed information – how many floors? how big? how many people will use it? will it be used all day mostly evenings?) Rough sketches are also a good way of helping to visualize ideas

Location (include as many details as possible)

Climate and geographical features (include as many details as possible)

STEP 4 – BRAINSTORM

List the type of green features that will be feasible to fit into the building design. Also describe which problem the renewable features will solve or improve. How will it affect and enhance the building? Why does your team consider this feature important?

List and describe which renewable sources the team will incorporate in the buildings design:

Renewable sources of energy – solar, wind, geothermal (see definitions list and links.
Water conserving devices.
Rainwater harvesting
Other

Green Feature 1

Green Feature 2

Environmental - Develop a list of environmental problems and sustainability issues that your building will address

Sustainable

STEP 5 - PROPOSE & PLAN SOLUTIONS

The list of guiding questions will help you develop a detailed plan for your team. When making sketches and thinking, pay careful attention to the architectural features your team wants for your building!

GUIDING QUESTIONS

- What will the general appearance of the building be? Does it make a statement? Will it have any unique features?
- How will the team incorporate the renewable technology? Will the technology be incorporated as part of the building façade?
- Google- Images of Building Facades- link below and Green Building Façade
- What equipment will you need to install?
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- Will it affect the exterior or interior of the building, etc.?

STEP 6 – SKETCH & BUILD

What will be affected by your new green improvements? You have a piece of 15" x 15" cardboard to build on. This will be the scaled size of your plot. Create several practice sketches to figure out dimensions and the location of your new green features.

- Think of the dimensions of the actual building and how you will represent them.
- Which materials will best represent the design ideas and convey your ideas of the building?
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- Will others be able to understand what you are trying to convey with your 3-D model?

Tips

- Use graphing paper, pencils and erasers!
- Draw, sketch and write in bulleted form as many features that will help you design and build the buildings 3-D model.
- Try to make the visual presentations of your drawings as clear as possible. Color code items and create legends.
- Once all of the ideas have come together in the design brief and sketch it is time to build a 3-D prototype.

Sustainable Building

Corrie Van Sice
corrievansice.com


EVROLET
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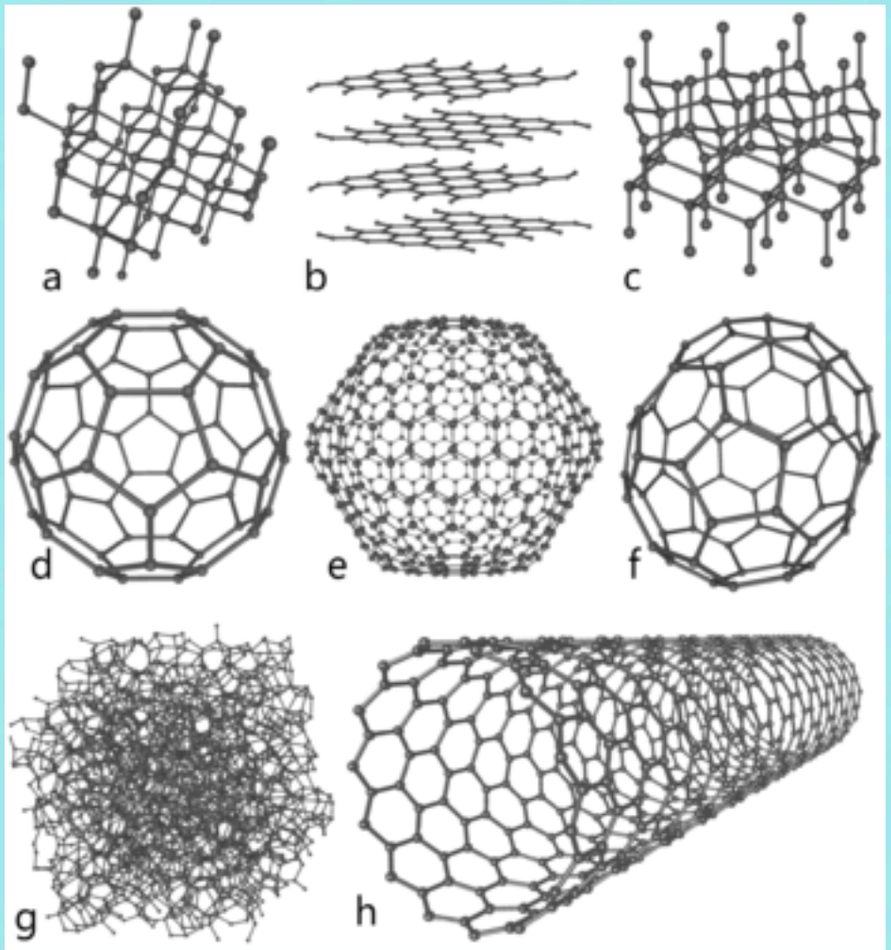
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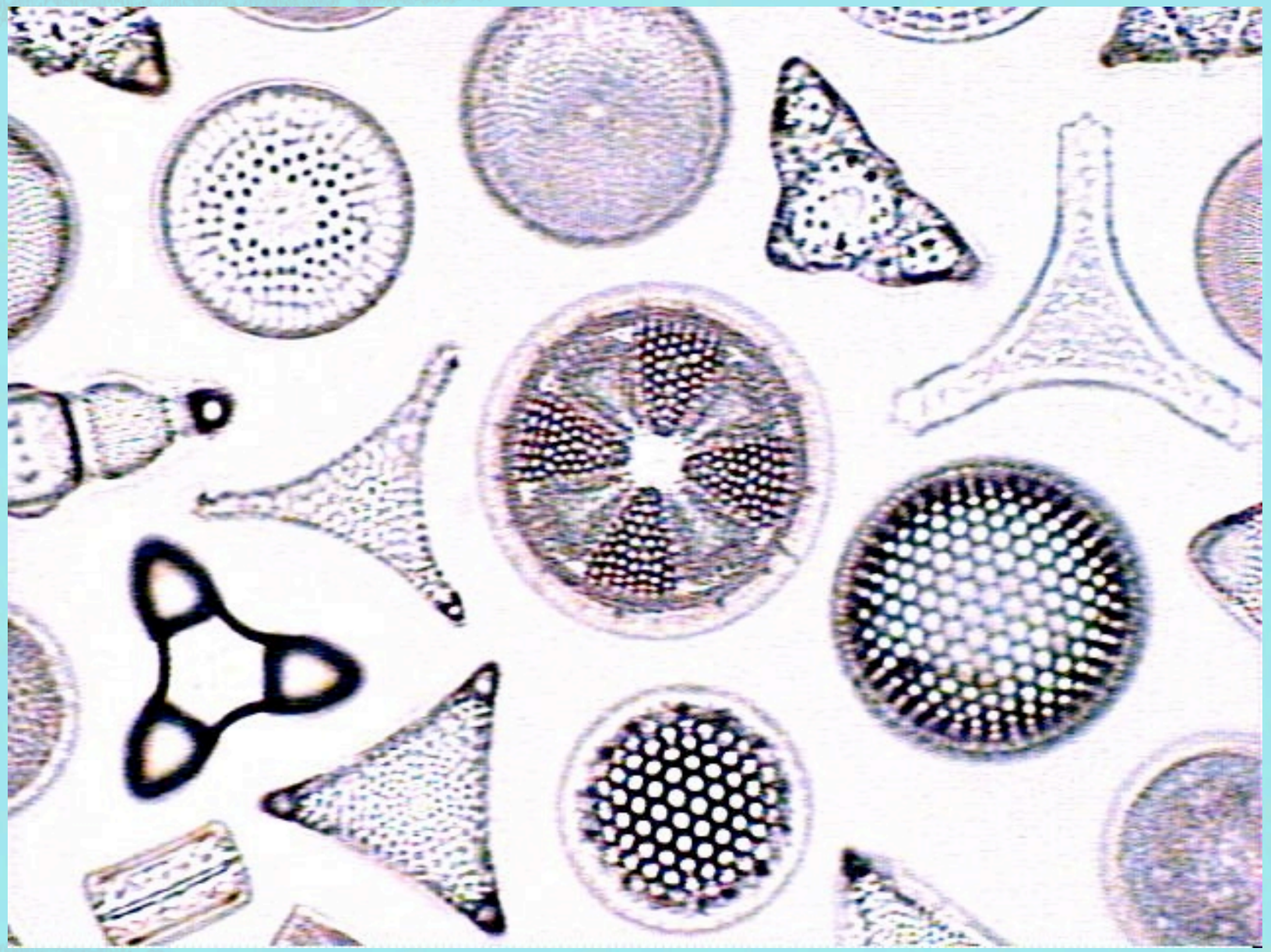


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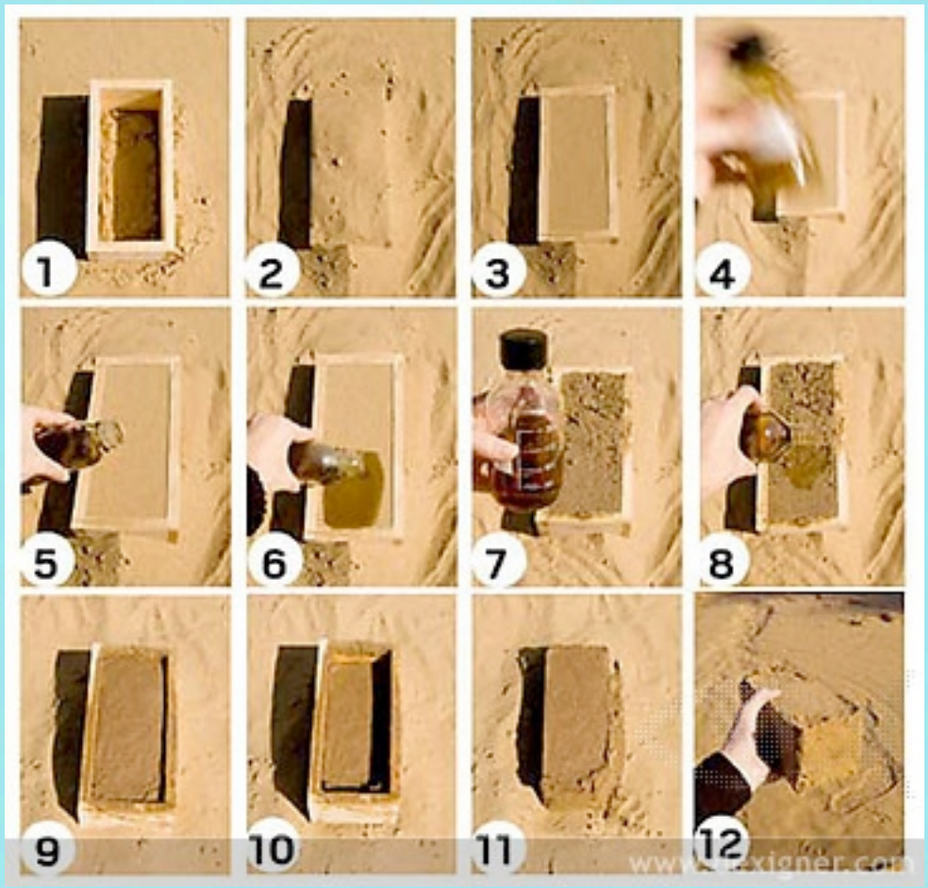
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Growing Materials
transforms waste into high performance goods
Our patent pending process utilizes mycelium (fungi) to transform industrial and agricultural waste by digesting it to grow a strong three-dimensional matrix.
Mycelium
Producing a single unit of the Greensulate results in 10 times lower CO2 emissions and 5 times less energy use than an equivalent amount of Styrofoam and costs much less!
Our GROWING organism uses its mycelial network to convert waste into strong biological composites without external energy inputs. Growth occurs indoors at room temperature, in the dark, without any fossil fuel.
Finished Insulating Panel
Agricultural Waste
ecovativedesign