

NCGS STEAM Workshop 2015

“STEAM Class – Anything Goes!” by Dr. Stacey Boyette, The Madeira School

Selected projects from Madeira’s Topics in STEAM course will be presented to illustrate the wide variety of interests and emphases which can be incorporated into a STEAM course. Projects such as Origami for Wildlife (Spatial Reasoning), Ferris Wheels and Trigonometry (Mathematics of Motion), Composting on Campus (Local Activism), Global Health Design (Global Awareness), Madeira Redesign (Architecture), and Whirligigs (Art in Motion) will be presented. The structure, goals, and teaching and assessment methodologies utilized will be discussed as well as what has worked and what has not.

Madeira Topics in STEAM Course Description

In this investigative, project-based course, students will learn to look at the world through the lens of Science, Technology, Engineering, Arts and Math. By applying the fundamentals of math and science to a variety of projects, students will develop creativity, spatial reasoning, logic, and problem-solving skills. For all projects and activities in this course, students will be required to document their process for designing, constructing, and evaluating solutions to problems and to present their results and outcomes to the class through several modes of communication.

Collaboration is an integral part of this class as most projects are completed in teams.

Project Briefs

Origami for Wildlife

Students select and highlight the plight of a threatened or endangered species through origami. They practice basic paper folding, research their selected animals and affiliated country, and create origami displays incorporating conservation information. Along the way, students develop spatial reasoning and explore the practical applications of origami in architecture, aerospace engineering, and biomedical engineering.

Karakuri Dolls

Students fold card stock (80 lb.) paper into cams and gears which can be used to animate dolls with different movements. Karakuri patterns can be found in books and online or students can design their own moving artwork. During this project, students also study the motions and uses of levers, cranks, linkages, and Geneva stops.

Global Health Design Challenge

Student groups design a hands-free hand washing device designed for use by medical personnel during disaster relief or in developing country. Students investigate the issues surrounding clean drinking water in a specific country and give input for setting project goals, device criteria, and the grading rubric. Students use hand tools and power tools to complete their projects and use common household materials and hardware in their designs.

Composting on Campus

Student groups research and practice composting methods. They build composting boxes and screens, monitor temperature, turn the pile, monitor the carbon/nitrogen balance, and select various composting matrices. This can be a school-wide initiative as students collect compostable materials from the school cafeteria.

Madeira Redesign

In this architectural project, the students select a space on the Madeira campus to redesign. They take measurements, draft bubble diagrams, interview users of the spaces, take more measurements, and ultimately draft new floor plans for their visions. The floor plans are then converted into scale models made initially from cardboard and then upgraded to various types of wood. Through this project, students learn about architectural drafting, reading floor plans, green construction, and customer service.

Ferris Wheels and Trigonometry

Student groups assemble a motor-driven Ferris wheel and study the motion of a rider or single point on the Ferris wheel over time. Students measure the height at various points in the revolution of the wheel, plot height versus time, and discover what function fits the curve. The motion of the Ferris wheel can be studied with a ruler and a timer or electronic devices and the data can be plotted using a graphing calculator, spreadsheet software, or graphing apps.

Rollercoasters

Students study the concepts of gravitational potential energy, kinetic energy, transformation of energy, and power through the challenge of developing a functional roller coaster. The process begins with experimentation using straw rockets and online roller coaster research and design. Students then collaborate in groups to develop their visions and build their prototypes from tubing. After receiving feedback from their peers, calculating budgets, and shopping for supplies, the students construct, demonstrate, and present their final roller coaster designs.

Hand Prosthesis

This project begins with activities such as tying a shoe with one hand and dissecting a chicken wing to investigate the movement and structure of the human arm and culminates in building a prototype hand prosthesis. Students research prosthetic design and develop mechanical models to accomplish a specific task.

Deconstruction Art

Students deconstruct objects donated from the Madeira community to study how they work and then reassemble the component parts into literal or abstract works of art. Deconstruction is the first step in reverse engineering, a technique especially used during wartime to steal the secrets to the enemy's weaponry. Reverse engineering is also the basis of tinkering economies evolving in parts of the world where computer and cellular services are not readily available.

Whirligigs

Students select a movement, such as dolphins jumping over a wave, they want to animate and use coat hangers, wood, wire, and lawn ornaments to bring their designs to life. Students learn about the iterative design process and use hand and power tools to complete their projects.

NCGS STEAM Workshop 2015 – Readings, References, and Resources “*STEAM Class – Anything Goes!*” by Dr. Stacey Boyette, The Madeira School

Origami for Wildlife

How to Make Origami by Isao Honda [Ivan Obolensky, Inc, New York, 1959]

Coincidences, Chaos, and All That Math Jazz by Edward B. Burger & Michael Starbird
[W. W. Norton & Company, New York, 2005]

Chapter 8 – Origami for the Origamically Challenged – p.147-165

Documentary: “Between the Folds” by Vanessa Gould - Origami and its applications
<http://www.pbs.org/independentlens/between-the-folds/>

Karakuri Dolls

Karakuri by Keisuke Saka [St. Martins Griffin, New York, 2010]

Chpt. 2 – How Karakuri Works: Lever, Cam, Crank, Gear, Linkage, Geneva Stop

Global Health Design Challenge

See the website for Rice University’s Institute for Global Health

Composting on Campus

Food Waste Composting: Institutional and Industrial Applications by Mark Risse and Britt Faucette. *The University of Georgia Cooperative Extension, Bulletin 1189*, June 1, 2000.
[Subsequently re-published Feb 20, 2009 and May 14, 2009 and reviewed June 22, 2012.]

Madeira Redesign

The Architecture Handbook: A Student Guide to Understanding Buildings, by The Chicago Architecture Foundation, Chicago, Illinois, 2007.

Chapter 1 – The F10 House, Green Architecture, 10 Comparison Buildings

Chapter 3 – Scale

Chapter 10 – Planning Spaces

Chapter 11 – Circulation, Clients, and Guest Spaces vs. Family Spaces

Chapter 13 – Window Placement, Views and Light

Chapter 14 – Mechanical, Electrical, and Plumbing Systems

Chapter 20 – Reading and Drawing a Building Section

Chapter 21 – Forces and Structures

Chapter 23 – Comparing Construction Techniques and Materials

Ferris Wheels and Trigonometry

Trigonometry through a Ferris Wheel by Gail Kaplan. *Mathematics Teacher, Vol. 102 (No. 2)*, Sept. 2008, p.138-141.

Rollercoasters

Project STEM: Designing Roller Coasters by Candida M. Braun et al (Reviewers). [Pearson Education, Inc., Upper Saddle River, NJ]

Hand Prosthesis

Project STEM: Designing Prosthetic Devices by Candida M. Braun et al (Reviewers). [Pearson Education, Inc., Upper Saddle River, NJ]

Deconstruction Art

The Toaster Project by Thomas Thwaites [Princeton Architectural Press, NY, 2011]

Preface and Chapter 1 – Deconstruction – p.13-43

Engineering in Everyday Things

The Evolution of Useful Things by Henry Petroski [Vintage Books, New York, 1992]

Chapter 4 – From Pins to Paper Clips – p.51-77

Our Own Devices by Edward Tenner [Vintage Books, New York, 2003]

Chapter 1 – Technology, Technique, and the Body – p.3-29

To Engineer is Human by Henry Petroski [Vintage Books, New York, 1992]

Chapter 2 – Falling Down is Part of Growing Up – p. 11-20

Chapter 3 – Lessons from Play; Lessons from Life (Speak & Spell and Fatigue) – p.21-34

Chapter 5 – Success is Foreseeing Failure – p.53-63

Chapter 7 – Design as Revision (Iterative Engineering) – p.75-84

Chapter 8 – Accidents Waiting to Happen (Failure Case Studies) – p.85-97

Invention by Design by Henry Petroski [Harvard University Press, Cambridge, 1996]

Chapter 3 – Pencil Points and Analysis – p. 43-65

Chapter 8 – Water and Society – p. 141-151(-or-159)

NCGS STEAM Workshop 2015 – One Semester Course Sample Schedule

“STEAM Class - Anything Goes!” by Dr. Stacey Boyette, The Madeira School

STEAM	PLAN	SPRING 2014		
DAY	DATE	IN-CLASS PROJECT/ACTIVITY	READING	VIDEO
FR	1-3	DOPE, Keirsej, and Animal Posts	Virtual Class Day	
MO	1-6	Introduction, NB Set-up, Folding	Origami Basic Form	
TU	1-7	Origami For Wildlife – Practicum	Honda	
TH	1-9	Origami For Wildlife	Post – Animal Plight	Articles or Videos
FR	1-10	Origami For Wildlife	Lake Apopka Lesson	TED-PeacewithLions
			Audubon	
MO	1-13	“Between the Folds” Movie	Origami Challenged	CBS – Ai Weiwei
TU	1-14	Origami For Wildlife	Burger & Starbird	PBS – Kara Walker
TH	1-16	Origami For Wildlife	Post – Origami	
FR	1-17	Origami For Wildlife	Engineering	Articles or Videos
TU	1-21	Deconstruct Art	The Toaster Project	TEDigitallyUndersrvd
TH	1-23	Deconstruct Art	Thwaites	
FR	1-24	Deconstruct Art	Design As Revision	TEDArtw/wire,sugar,
			Petroski	
MO	1-27	Deconstruct Art	OwnDevices_Part1	
TU	1-28	Deconstruct Art	Tenner	IKEA Video
TH	1-30	Deconstruct/Repair Lamps	OwnDevices_Part2	
FR	1-31	Deconstruct/Repair Lamps	Tenner	TED-Dance Your PhD
MO	2-3	Deconstruction Art - Presentations 3 Scales – Steps, Math, Block Plan	Chpt03_Scale	
TU	2-4	3 Scales; Drafting – Nuts & Bolts		
WE	2-5	Complete Drafting – Nuts & Bolts		
TH	2-6	Madeira Redesign–Bubble Diagram	Chpt01_F10House	Building Videos –
FR	2-7	Madeira Redesign – Msmts/Q&A	Chpt10_PlanSpaces	Egypt & Greece
MO	2-10	Room Placement & Reading Floor Plan Activities	Chpt13_Windows	Architecture Videos – A Day Made of Glass,
TU	2-11	Madeira Redesign – Floor Plans	Chpt11_Circulation	Old Japan, FLWright
TH	2-13	Computer Aided Drafting Exercise	Chpt14_Mechanical	
TU[MO]	2-18	Madeira Redesign – Model Build	Chpt20_BldgSection	
TH	2-20	Madeira Redesign – Model Build	Chpt21_Forces	
FR	2-21	Madeira Redesign – Model Build		
MO	2-24	Madeira Redesign – Model Build	Lessons From Play	TED-Engineer Artist:
TU	2-25	Madeira Redesign – Model Build	Petroski	Art that looks back
TH	2-27	Madeira Redesign – Model Build		TED-Tiny Robots
FR	2-28	Madeira Redesign – Model Build		
MO	3-3	Madeira Redesign – Model Build		
TU/WE	3-4	Madeira Redesign – Presentations	Lever & Cam	Karakuri Dolls
TH	3-6	Madeira Redesign – Presentations	Crank & Linkages	Strandbeests
FR	3-7	Paper Karakuri	Gear & Geneva Stop	

MO	3-10	Paper Karakuri		
TU	3-11	Paper Karakuri	Accidents	Earthquake Videos -
TH	3-13	Tinkering with Moving Parts	Petroski	China & Japan
FR	3-14	Tinkering with Moving Parts		
MO	3-17	Tinkering with Moving Parts		
TU	3-18	Tinkering with Moving Parts		
MO	3-31	Whirligig - Research & Design		
TU	4-1	Whirligigs - Drafting Plan	Pencil Points_Part1	HowIt'sMade - Pencil
TH	4-3	Whirligigs - Begin Building	Petroski	Rube Goldberg -
FR	4-4	Whirligigs - Building Continues		Honda & Panera
MO	4-7	Whirligigs - Building Continues OR McLean Hardware Trip	Pencil Points_Part2	Kinetic Sculptures
TU	4-8	Whirligigs - Building Continues	Petroski	Lg Wooden Sculpture
TH	4-10	Whirligigs - Building Continues	Success	
FR	4-11	Whirligigs - Building Continues	Petroski	TED-PlanesthatDrive
MO	4-14	Whirligigs - Complete & Present	Falling Down	Ancient Water Videos
TU	4-15	Whirligigs - Complete & Present	Petroski	
TH	4-17	Water Filtration Activity	Water and Society	TED - Filthy Water
FR	4-18	Global Health Design Challenge	Petroski	Drinkable
MO	4-21	GHDC - McLean Hardware Trip	StudentPost-Global	Billboard That Makes
TU	4-22	Global Health Design Challenge	Water Issues	Water from Air
TH	4-24	Global Health Design Challenge		
FR	4-25	Global Health Design Challenge		
MO	4-28	GHDC - McLean Hardware Trip		
TU	4-29	Global Health Design Challenge		
TH	5-1	Global Health Design Challenge		
FR	5-2	Global Health Design Challenge		
MO	5-5	Global Health Design Challenge		
TU	5-6	Global Health Design Challenge		
TH	5-8	Global Health Design Challenge		
FR	5-9	Global Health Design Challenge		
MO	5-12	GHDC - Project Testing		
TU	5-13	GHDC - Project Testing		
TH	5-15	Building Trussed Dome		
FR	5-16	Pants Puzzle		