University fo Oregon - School of ARchitecture and Allied ARts - Department of Architecture
ARCH 407-507 Winter 2015 Wed 9:00am-11:50am in 405A Lawrence Hall
Professor Nancy Y Cheng, nywc@uoregon.edu, 541-346-3674 o, 541-556-4590 c
Office hours M 10:45am-12:45pm in 178 Onyx or Skype (ncheng1)

Form and Performance 1:
Natural Models for Environmental Fitness

SYLLABUS

Biomimicry Design Cycle by the Biomimicry Institute
http://www.biomimicryinstitute.org/about-us/biomimicry-a-tool-for-innovation.html

Purpose: This course will introduce biomimcry and parametric design.

Plants and animals thrive in their habitats because they have structures, mechanisms and systems that work efficiently in specific environmental conditions. This class will examine how natural organisms can be models for architectural design using Biomimicry 3.8 principles and morphogenetic parametric design. Starting from the beauty of nature as inspiration, students will study ways that architects and designers are examining nature's forms, mechanisms and systems to discover principles for approaching design problems. Design approaches will include processes of observation, description, analysis, metaphor and abstraction.

To develop flexible formal ideas, students will articulate geometric relationships with Rhinoceros-Grasshopper parametric design software. Climate visualization and solar simulation will be done using the Grasshopper-Ladybug plug-in.

Format

The course is conceived as a two-term sequence that develops understanding and skills over a long time of fruition, using synergy with other classes. The Winter term will emphasize fundamental principles and approaches with digital skill-building emphasizing static skins, while the Spring term continuation will assume greater skills in considering static structures and dynamic systerms. Students may opt to take only the Winter term course or both terms. Successful completion of both terms counts towards the advanced technology credit.

Class sessions will include presentations, discussions and hands-on activities. Students will need to bring a Windows laptop (fully charged) to each session. To accommodate student schedules, the class will meet for 7 weeks, then there will be independent design application, with check-in conferences prior to a final in week 11.

Pre-requisites: ARCH 4/571 & 4/572, 384 or permision of the instructor

Students do not need to bring a scientific knowledge, instead students are invited to investigate how organisms thrive in their environments, to grapple with understanding key biological, physical or chemical processes that underlie observed phenomena.

Course Calendar (subject to change)

Week 1. Wed 1/7 Biomimicry Introduction, Peer interviews: what do you want to learn?, Rhino GH intro

Week 2. Wed 1/14 Life's Principles, Patterning with GH Lists and Grids
Assignment 1a- Pattern due

Week 3. Wed 1/21 Systems Thinking & Closed Loops, Sun-path simulation with GH Heliotrope
Assignment 1bPaneling Tools and Report problem definition due.

Week 4. Wed 1/28 Growth and Form, Ladybug Climate Visualization
Assignment 2 Solar-driven surface and Report sketches, outline and task list due

Week 5. Wed 2/4 Skins, Ladybug Solar Simulation
Report rough draft due

Week 6. Wed 2/11 – Student Research Presentations
Assignment 3 Self-shading surface due

Week 7. Wed 2/18 - Student Research Presentations

Weeks 8. Wed 2/25 Illustrated Report due 5pm (no class)

Weeks 8, 9, and 10: Individual or small group conferences

Week 11. Final pinup of design applications 10:15am Wed March 18 location TBA

Course Requirements

All students must bring a Windows computer with Rhino 5.0 software installed to class. Students should have some knowledge of some kind of 3D modeling, previous experience with Rhino and Grasshopper is helpful but not required.

EXERCISES: Non-graded in-class digital exercises will build on documented tutorials. Students will be challenged to build on and modify parametric design definitions. Exercises will not be graded but results will be turned into the course folder to document abilities. Collaboration and peer coaching is encouraged.

ASSIGNMENTS: As long as students address the assignment intentions, aspects of the assignment may be customized - please check with the instructor if you have questions or suggestions. All work will be posted to the Course Folder for sharing. Image, Rhino and GH files as well as report files need to be optimized so that they are easily downloadable.

Section through a christmas rose leaf showing round chloroplasts from Michael Hensel's (Synthetic) Life Architectures: Ramifications and Potentials of a Literal Biological Paradigm for Architectural Design, Architectural Design journal, v.76 no.2, p. 20

ASSIGNMENTS

TERM PROJECT: Biomimicry Design Report

The major term project is to apply biomimetic and parametric design to a design problem. Students may choose to address an aspect or component of their design studio problem OR take on the 2015-2017 Biomimicry Global Design Challenge: Food Systems (more information will be released January 20, 2015 at http://challenge.biomimicry.org). Final report: Undergraduates ~750 words, Graduate students ~1200 words.

1/21 Problem definition due, w learning objectives and design process example (~250 words)
1/28 Analytical organism sketches, Report outline with task list due
2/4 Rough draft due
2/11 or 2/18 Verbal & Visual Presentations ~ 10 minutes per person
2/25 Illustrated Report due
3/18 Pinup of related design application, PDF files due at 5pm. Must include use of Rhino GH

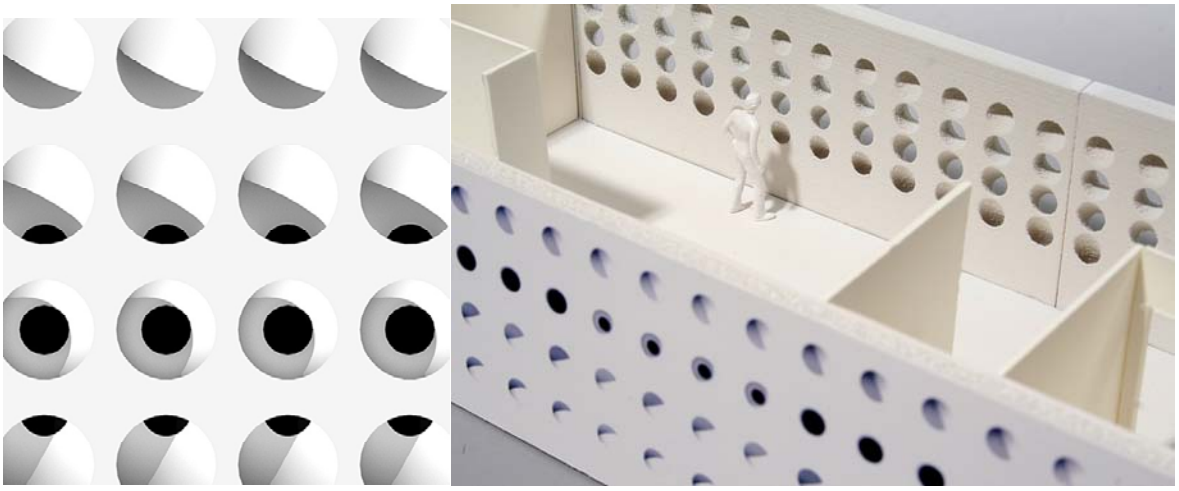
Assignment 1: Pattern

1A. due 1/14: Take a walk observe and sketch interesting natural patterns.
Using one natural pattern as inspiration, draw the basic element in Rhino or GH and then tessellate it using Grasshopper arrays (linear, polar) and grids (rectangular, triangular, hexagonal, etc.)
Create 3 variations simlar to those observed in nature, and try to create 3 with emergent shapes from the interaction between parts.

1B. due 1/21 with report problem definition
Use Paneling Tools-2DMorph to wrap your shape around surfaces different surfaces. Fill the shape and bake it. Next, model a 3D module and use Paneling Tools-3DMorph to stretch it between two surfaces

Assignment 2: Solar-driven surface due 1/28
Model a panel with a variable aperture through using a sliding, stretching, folding or rotating element. Use Heliotrope to make a shape change according to the sun angle: scaling, aligning, rotating, etc. Finally use Paneling Tools-3DMorphlist to make the pattern adapt to different sun angles.

Assignment 3: Self-shading surface due 2/11
Use Ladybug to climate data and sun paths. Test variations of Solar-driven pattern using Ladybug to measure incident and transmitted solar radiation.



Simon Cygielski's circlewall

Evaluation and Grading Procedures

Students discuss with the instructor how they are meeting their learning goals. They will receive quantitative feedback 3 times during the term. Successful completion means:

- Engagement with content, instructor and peers through discussion and evidence of reading comprehension. Communication is essential: asks questions and support others.
- Effort to grow beyond pre-existing knowledge and skills
- Completeness of assignments, with a high level of care and craft demonstrated (citations, layout, grammar and spelling)
- Technical virtuousity and aesthetic quality of digital design efforts

The infrequent meeting times means that students will need to do independent work to keep developing their knowledge of biomimicry as well as their digital skills.

Assignment 1A:	10 points
Assignment 1B:	10 points
Assignment 2:	15 points
Assignment 3:	15 points
Report - Research:	25 points
Report - Design:	20 points
Class Participation:	5 points

Resources and References

additional resources will be posted online

- The Self-Made Tapestry by Philip Ball
- Biomimicry, by Janine Benyus
- The Gecko's Foot by Peter Forbes
- Bio-structural analogues in architecture by Joseph Lim
- Thinking in Systems by Donnella Meadows
- The Way Nature Works, edited by Robin Rees
- On Growth and Form, by D'arcy Thompson
- Cats' Paws and Catapults, by Steven Vogel
- Biomimetics in Architecture by Petra Gruber
- Structural Biomaterials, by Julian Vincent

- Biomimicry 3.8 http://biomimicry.net
- http://Asknature.org
- Zygote Quarterly. Online journal http://zqjournal.org/ by Eggermont, Marjan et. al.,
- Nancy's annotated links: http://diigo.com/user/nywc/biomimicry

- Grasshopper3d.com
- Studio Mode Tutorials http://modelab.nu
- DesignReform.net
- Digital Toolbox http://digitaltoolbox.info/