Honors 1360: *Complexity and the Arts*
Spring 2016

Meeting Times: 11:30-12:20 MWF **Meeting Room: SER122**
Instructor: David Peak **Office: SER240**
Email: david.peak@usu.edu **Tel: 797-2884**

The Goals of Honors 1360

Concept mastery

- simple, stochastic, and complex
- physics and physiology of light and sound
- chaos
- fractals
- emergence
- the observer
- why do we do art and music?

To facilitate your ability to

- use a computer to explore some of the calculational methods of complexity science
- analyze and solve quantitative problems
- exercise your creativity by producing a work of generative art

What *Complexity and the Arts* is about

This course explores the interplay between physical and biological dynamical systems and the realm of the arts. As with any human endeavor, art emerges from a social milieu that includes the creator's and the observer's education, belief systems, cultural immersion, political commitments, and so on. What a work of art "means" to the artist and what it "means" to the observer clearly depend to a considerable extent on social factors. But esthetic response is also very much a physical phenomenon—shaped by how sense organs detect energy and by how information is processed in the central nervous system and the brain. The biophysical mechanisms associated with esthetic response result from eons of evolution occurring on an ordinary planet orbiting an ordinary star in an otherwise vast, cold, dark universe. This course argues that a full appreciation of the role of art and music in human culture requires at least some recognition of the irreducible influence of the physical universe on the realm of esthetics. In *Complexity and the Arts* we will explore the physics and physiology of sound and light. We will think some about observation and reality. And we will look at how the tools of complexity science can be applied to making new art(s) and, perhaps, to how they can help us understand why we "dig rock and roll music."

Course Structure

Text: There is no text for this course but *Chaos Under Control*, by D. Peak and M. Frame, W.H. Freeman, Publishers, 1994, ISBN 978-0716724292, and *Complexity: A Guided Tour*, by Melanie Mitchell, Oxford Press, 2009, ISBN 978-0-19-512441-5 are useful introductions to some of the material we will cover.

Web information: Click on http://www.physics.usu.edu/peak/honr_1360/index.htm or on the item **Syllabi, Homework, etc.** at www.physics.usu.edu, then click on HONR 1360. Please check often for new stuff.

Assessment: Based on a term project. See page 4 for details.

- You should treat this course as term-long research project.
- Projects will be done individually.
- Projects will be turned in **on Wednesday April 20.**
- Oral presentations will be the week of April 25.

Office hours (SER240): My formal office hours are **TTH 9:30-11:30 AM.** I'm around a lot of hours every day, so feel free to come see me at any time. If it is at all possible I'll be glad to make time to talk with you. Please call me—or better—**send me an email** to make sure that I'll be here when you come by.

My experience is that students who talk with me about their projects well before the deadline to do substantially better than those who don't. There will be formal opportunities to do this during the term.

Week of	Topic	Comments
1/11	Overview	Complexity, art, and music; Generative art; examples; AARON, Sybille Szaggars
1/20*	Sound	Pressure waves, the ear and auditory response Auditory illusions
1/25	Sound and light	Generative music: Emily Howell, Otomata, Circuli, Doctor Nerve; Electromagnetism, EM spectrum; the eye and visual response
2/1	Light	Image formation, color perception; sources of color; Binocular vision, depth perception; perspective in 2-d visual art; Illusions
2/8	Chaos I	Simple dynamical systems; chaotic music
2/16**	Fractals I	Iterated functions; Mandelbrot Set; fractal art
2/22	Chaos II	What is "random;" spectral decomposition: the rainbow and the piano; a taxonomy of noise; detecting chaos with symbols: IFS, color, and Ellsworth Kelly; controlling and synchronization; music and 1/f noise
2/29	Project interviews	One-on-one discussions of project progress
3/07	**Spring Break**	
3/14	Fractals II	Fractal forgeries; fractal dimension; Pollack, analysis, and appreciation
3/21	Why do we do art? Role of observer	Tally sticks, symbols, math and language The observer in science and social science; observation and reality; does every observer have equally valid opinions?
3/28	Project interviews	One-on-one discussions of project progress
4/4	Complex networks I	Simulating complex behavior in space & time; definitions, examples; Game of Life
4/11	Complex networks II	Fitness landscapes, adaptation, natural selection; genetic algorithms; Networks that perform tasks
4/18	Projects	Turn in projects
4/25	Projects	Project oral reports

* No class 1/18
** Monday classes on Tuesday

Turn in projects Wednesday 4/20.

Details of the project

- The project will consist of
    1. a generative creative *product* (an algorithmic piece of: music, painting, sculpture, electronic medium, modern dance, …),
    2. a running *journal* of your activities researching and preparing the project,
    3. an explanatory *paper*, and
    4. a short (15 minute) oral presentation.

- The *product* **must** incorporate concepts discussed in the course.

- Your *journal* must include the dates and times you worked on the project and summarize what you actually did. You should start your entries as soon as possible.

- The *paper* will follow a standard scientific format. I will include
    1. (a) an *introduction* describing the general context for the work presented and the hypothesis (guess, supposition, question, assumption, …) about what you intended to produce,
    2. (b) a section describing the *methods and materials* used to produce the work,
    3. (c) a description of the *results*,
    4. (d) an *appraisal* of whether the product bore out your hypothesis and any salient *conclusions*, and
    5. (e) an appropriate *bibliography*.

- While there is much to be gleaned from the Web, the bibliography must include written documents. As in all scholarly writing, correct and complete attribution of source material is required.

- As in all *scientific* writing, **the paper must be succinct yet contain sufficient detail that anyone who wanted to (and who had the requisite background and resources) could reproduce the result.**

- **Projects that include elements of quantitative analysis will generally receive higher evaluation than those that don't have such elements.**

The paper should be 10-ish double-spaced pages (certainly no more than 20); but there is no absolute length requirement. **The term project counts for your whole grade, so you should anticipate spending at least 40 hours on it.**