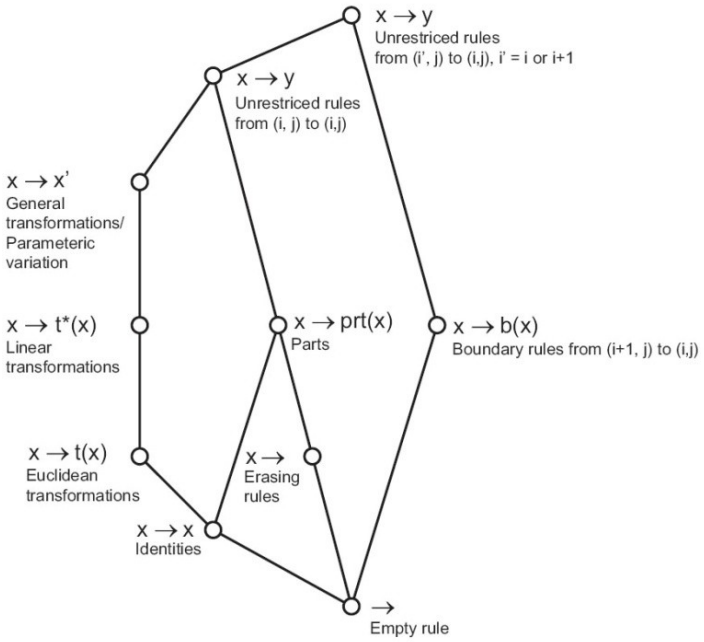
ARCH 4701: Analog – Digital Design Computation
Thanos Economou, PhD
T-H: 1:35PM – 2:55PM
COA West 259
Georgia Institute of Technology
Spring 2016

ARCH 4701: ANALOG / DIGITAL DESIGN COMPUTATION



An advanced examination of formal systems in design and their relationship to akin ideas in a variety of other fields, including art, philosophy, history and philosophy of science, linguistics and psychology, literature and literary studies, logic and mathematics, and artificial intelligence. The class looks at two key aspects of computation: representation and process and the ways both these two characteristics mold formal systems in design. The class builds upon a working distinction of representation systems in architectural design in terms of analog and digital notational systems and explores their affinities and differences to visual and symbolic systems of representation respectively.

Students are expected to read the weekly readings, participate in the weekly discussions, write a brief synopsis of papers read, produce a design study to illustrate ideas discussed in the class, and prepare a final project in the form of design study, a paper or a slide presentation.

The class meets twice per week, Tuesday and Thursday 3.05 p.m. - 4.25 p.m. at COA 250.

Course procedure and organization

The class is divided in three parts. The first past opens with a detailed discussion of languages of design of architectural form, their specification in terms of formal grammars, and their role in structuring design thinking. The readings associated with this part of the course are selected from Mitchell's "The logic of Architecture".

The second part focuses on shape grammars, a generous formal system for the generative description of design, and in particular in the design schemas and the ways schemas are ordered and combined to produce a compositional taxonomy of design. The objective of this part of the course is to produce pictorial illustrations of the basic schemas, their inverses and their combinations in sums and products, in terms of symbolic rules, shape rules, parametric rules and graphic examples. A pictorial essay will conclude this inquiry, to foreground the significance of schemas as abstract compositional procedures that can be used in a variety of ways. The readings structuring the discourse for this part are selected from Stiny's "Shape: Talking about Seeing and Doing".

In the third part, the emphasis is given in the broader theoretical relationships of the design schemas and the shape grammar formalism at large, to other domains in other fields. This part of the course will be student led and will be based upon the outcomes, claims and ideas discussed in the first two parts of the course. Suggested authors/readings to be presented and discussed include Kandinski, Klee, Alexander, Chomsky, Simon, Goodman, Schon, Rorty, and several others.

Course requirements
Students are expected to read the papers, write brief summaries, participate in discussions, and produce two projects in the form of pictorial essays or slide presentations. The summaries of the papers will be produced prior to their discussion in the class and they will suggest the indexing of the main ideas of the paper in three categories: agreed; disagreed; and uncertain/ ambiguous. The two pictorial essays or slide presentations will be based on readings given in the class and their main purpose is to show a clear understanding of the ideas presented in the papers and to guide the discussion in the class. The grade for this course is divided in the following sections:

Attendance / Participation: 10%
One-pager précis: 10 x 5% = 50%
Final project: 40%

Course schedule
The course schedule is given below.

			INTRODUCTION
T	7	Jan	Introduction | Requirements | Expectations
H	9	Jan	Classical / non-classical computation: Representation and process
			DESIGN, COMPUTATION AND COGNITION
T	14	Jan	Building descriptions - Design and description
H	16	Jan	Architectural Form
T	21	Jan	Design worlds
H	22	Jan	Critical languages

T	28	Jan	Reasoning about designs`
H	30	Jan	Types and vocabularies
T	4	Feb	Design operations
H	6	Feb	Languages of architectural form
T	11	Feb	Function
H	13	Feb	Functionally motivated design
T	18	Feb	Design machine revisited
H	20	Feb	Reflection and discussion
			SHAPE: SEEING AND DOING
T	25	Feb	Reasoning and calculation
H	27	Feb	Visual calculations
T	5	Mar	A taxonomy of design schemas I
H	7	Mar	A taxonomy of design schemas II
T	12	Mar	From schemas to design: Pictorial Essay presentation I
H	14	Mar	From schemas to design: Pictorial Essay presentation II
T	19	Mar	*Spring Recess*
H	21	Mar	*Spring Recess*
			AFFINITIES
T	26	Mar	Klee / Kandinsky
H	28	Mar	Alberti / Alexander
T	2	Apr	Metzger / Arnheim
H	4	Apr	Piaget / Langer E
T	9	Apr	Chomsky / Simon
H	11	Apr	James / Dewey
T	16	Apr	Schon / Lakoff
H	18	Apr	Langer S / Goodman
T	23	Apr	*Studio Week*
H	25	Apr	*Studio Week*
T	30	Apr	-
H	2	May	**Project presentation**

Evaluation Criteria / Policy on Absences

Attendance, participation, timely completion of work, depth of engagement, craftsmanship and completeness in all submitted work. More than three unexcused absences result in a letter grade reduction.

Required Readings

Economou A., Riether, G., 2011. "Design Machine Revisited" in Digital Narratives, ed. Javier Isado, Universidad de Puerto Rico Press; (in)forma Vol. 05, pp. 32-43.
Mitchell, W. 1990. The Logic of Architecture. MIT Press, Cambridge.
Stiny, G. 2006. Shape: Talking about Seeing and Doing. MIT Press, Cambridge
Stiny G, 2011. What Rule(s) Should I Use? In Nexus Network Journal 13 (2011) 15–47 Nexus Network Journal – Vol.13, No. 1, 2011, pp.15-47
Knight T and G Stiny, 2001. Classical and non-classical computation. ARC: Architectural Research Quarterly (Vol 5: 04)

Suggested Readings

A selective list of readings from a wide range of disciplines relevant to the concepts and ideas of computation in design is given below.

Art and Design

Alexander, Christopher, 1964, *Notes on the Synthesis of Form* (Harvard University Press, Cambridge)
Alexander, Christopher, 1979, *The Timeless Way of Building* (Oxford University Press, New York)
Arnheim, Rudolph, 1954, *Art and Visual Perception: A Psychology of the Creative Eye* (University of California Press, Berkeley)
Arnheim, Rudolph, 1971, *Visual Thinking* (University of California Press, Berkeley)
De Bono, Edward, 1968, *New Think; The Use of Lateral Thinking in the Generation of New Ideas* (Basic Books, New York)
Kandinsky, Wassily, 1979, *Point and Line to Plane* (Dover Publications, New York)
Ferguson, Eugene S, 1992, *Engineering and the Mind's Eye* (MIT Press, Cambridge, Massachusetts)
Klee, Paul, 1969, *Pedagogical Sketchbook* (Praeger, New York)
Mitchell J M, 1989, *The Logic of Architecture: Design, Computation and Cognition* (MIT Press, Cambridge, Massachusetts)
Mitchell J M, McCullough M, 1996, *Digital Design Media* (Von Nostrand Reinhold, NY New York)
Reuleaux Frantz, 1963, *The Kinematics of Machinery: Outlines of A Theory of Machines*
Schon, Donald, Wiggins G, 1992, *Kinds of Seeing and Their Function in Designing* (Design Studies 13: 135-156)
Schon Donald, 1983, *The Reflective Practitioner: How Professionals Think in Action* (Basic Books, New York)
Schon Donald, 1987, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions* (Jossey-Bass, San Francisco)
Simon Herbert, 1969, *The Sciences of the Artificial* (MIT Press, Cambridge, Massachussetts)
Thomson D W, [1917], 1992, *On Growth and Form* (Cambridge University Press, Cambridge)

Philosophy

Dewey, John, 1980, *Art as Experience* (Perigee Books, New York)
Dewey, John, Boydston, Jo Ann, 1986, *The Later Works, 1925-1953, Volume 4: The Quest for Certainty* (Southern Illinois University Press, Carbondale)
Dewey, John, Boydston, Jo Ann, 1986, *The Later Works, 1925-1953, Volume 12: Logic: The Theory of Inquiry* (Southern Illinois University Press, Carbondale)
Goodman, Nelson, 1976, *Languages of Art: An Approach to a Theory of Symbols* (Hackett, Indianapolis)
Goodman, Nelson 1978, *Ways of Worldmaking* (Hackett, Indianapolis)
Hook, Sidney, 1939, *John Dewey: An Intellectual Portrait* (John Day, New York)
Langer, Susanne, 1942, *Philosophy in a New Key: A Study in the Symbolism of Reason, Rite and Art* (Harvard University Press, Cambridge, Massachusetts)
Mead, George, 1938, *The Philosophy of the Act* (University of Chicago Press, Chicago)
Peirce, Charles, [1878], 1966*, How to Make our Ideas Clear*, Ed. P. P. Wiener, *Selected Writings: Values in a Universe of Chance* (Dover Publications, New York)
Putnam, Hilary, 1987, *The Many Faces of Realism* (Open Court, La Salle)
Quine, Willard, 1953, *From a Logical Point of View; 9 Logico-Philosophical Essays* (Harvard University Press, Cambridge, Massachusetts)
Rorty, Richard,1979, *Philosophy and the Mirror of Nature* (Princeton University Pressm Princeton)
Rorty, Richard, 1982, *Consequences of Pragmatism: Essays 1972-1980* (University of Minnesota Press, Minneapolis)
Rorty, Richard, 1989, *Contingency, Irony, and Solidarity* (Cambridge University Press, Cambridge)

Whitehead, Alfred, 1978, *Process and Reality: An Essay in Cosmology*, ed. D. Griffin, D. Sherburne (Free Press, New York)

History and Philosophy of Science

Duhem, Pierre, 1954, *The Aim and Structure of Physical Theory* (Princeton University Press, Princeton)
Feyerabend, Paul, 1988, *Against Method*, Rev. Ed (Verso, New York)
Hanson, Norwood Russell, 1958, *Patterns of Discovery; An Inquiry into the Conceptual Foundations of Science* (Cambridge University Press, Cambridge, Massachusetts)
Kuhn, Thomas, 1977, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (University of Chicago Press, Chicago)
Kuhn, Thomas, 1962, *The Structure of Scientific Revolutions* (University of Chicago Press, Chicago)

Linguistics and Psychology

Chomsky, Noam, 1965, *Aspects of the Theory of Syntax* (MIT Research Laboratory of Electronics, 11)
Chomsky, Noam, 1965, *Syntactic Structures* (Mouton, Hague)
Lakoff, George, 1987, *Women, Fire and Dangerous Things: What Categories Reveal about the Mind* (Chicago University Press, Chicago)
Piaget Jean, Barbel Inhelder, 1967, *The Child's Conception of Space* (Norton, New York)
Whorf, Benjamin, 1956, *Language, Thought, and Reality: Selected Writings* (MIT Press, Cambridge, Massachusetts)

Literature and Literary Studies

Fish, Stanley, 1980*, Is there a Text in this Class? The Authority of Interpretive Communities* (Harvard University Press, Cambridge, Massachusetts)
Fish, Stanley, 1989, *Doing what Comes Naturally: Change, Rhetoric, and the Practice of Theory in Literary and Legal Studies* (Duke University Press, Durham)

Logic and Mathematics

Goodman Nelson, Quine, Willard, 1972, *Steps Towards a Constructive Nominalism (1947), ed. N. Goodman, Problems and Projects* (Bobbs-Merrill, Indianapolis)
Leonard H, and Goodman, Nelson, 1940, "The Calculus of Individuals and Its Uses" *Journal of Symbolic Logic* **5**: 45-55
Tarski, Alfred, [1929], 1983*, Foundations of a Geometry of Solids*, ed. J. Corcoran, Logic, Semantics, *Metamathematics: Papers from 1923 to 1938* (Hackett Pub. Co, Indianapolis)

Computer Science

Dreyfus Hubert, Athanasiou Tom, and Stuart Dreyfus, 1986, *Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer* (Free Press, New York)
McCarthy, J, 1980, "Circumspection- A Form of Non-monotonic Reasoning" *Artificial Intelligence* **13**: 27-39
Winograd Terry, and Fernando Flores, 1987, *Understanding Computers and Cognition: A New Foundation for Design* (Addison-Wesley, Reading, Massachusetts)
Minsky, M, *The Society of Mind* (MIT Press. Cambridge, Massachusetts)
Minsky M, *On Frames in the Psychology of Computer Vision*, ed. P. Winston (MIT Press. Cambridge, Massachusetts)

Web references

www.shapegrammar.org
http://www.mit.edu/~tknight/IJDC/frameset_abstract.htm
http://iaaa.nl/cursusAA&AI/stiny.html

Appendix

1) Students with disabilities requiring special accommodations must obtain an accommodations letter from the ADAPTS Office [www.adapts.gatech.edu] to ensure appropriate arrangements.

2) Georgia Tech aims to cultivate a community based on trust, academic integrity and honor. Students are expected to act according to the highest ethical standards. For

policy information on Georgia Tech's Academic Honor Code, please see [http://www.catalog.gatech.edu/rules_regulations/#18].

3) All cell phones should be turned off during class and when entering the classroom.

4) In case of emergency (i.e. fire, accident, criminal act), please call the Georgia Tech Police at 894-2500. Please note that Perry Minyard, IT Support Administrator is also a firefighter and an Emergency Medical Technician (EMT) certified in performing CPR