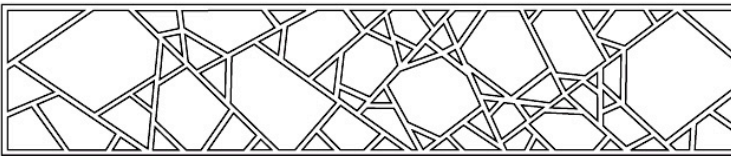
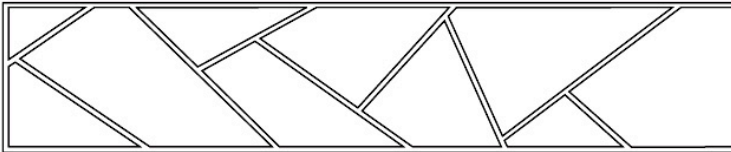


## ARCH 6508 Shape Grammars

Athanassios Economou, PhD  
economou@coa.gatech.edu

M-W 10.35AM – 11.55AM: COA 107  
Georgia Institute of Technology  
Fall 2012



## SHAPE GRAMMARS

Shape grammars is a powerful formal system for the generative description of designs. Their unique difference with all other generative systems is that they perform entirely *visual computations* rather than *symbolic computations*. Shape grammars are intended to form a basis for purely visual computation and in this sense they belong in the heart of design education and practice – both in precedent analysis and in a studio setting.

The course discusses the foundations of shape grammar formalism, provides a constructive understanding of the formalism through hands-on workshops and offers a generous overview of the history and logic of several of its applications in design research. A particular focus is given on a systematic exposition of basic rule schemas and the ways they are ordered and combined in sums and products to produce a compositional taxonomy of design.

Students are expected to attend the lectures, read the weekly readings, participate in the discussions and do the classwork / homework.

The course is open to M.Arch, MSc.Arch and PhD students with an interest in formal (spatial / mathematical) analysis and composition. Undergraduate students can take the class with a special permit.

## **Course description and objectives**

This course discusses in detail one of the most powerful systems for the generative description of designs, the shape grammars formalism. The unique difference of shape grammars with all other current generative systems is that they perform entirely visual computations rather than symbolic computations. And visual computations are the major machinery for design: instantiating, deleting, transforming and combining shapes, rapidly and erratically in design studio, or precisely and meticulously in formal design research, are the key mechanisms in both design (synthesis) and analysis. There is an incredible amount of things to be taught and to be tried out: What rule(s) to use? Where to use? How to use? When to use? Why to use? To these questions and all similar, the common denominator is that visual language guides the inquiry – the shapes, their materiality and the ways they capture and exemplify program, function, technology, and meaning. Shape grammars are indeed intended to form a basis for purely visual computation and in this sense they belong in the heart of design education and practice – both in precedent analysis and in a studio setting.

The course discusses the foundations of shape grammar formalism, provides a constructive understanding of the formalism through hands-on workshops and offers a generous overview of the history and logic of several of its applications in design research.

## **Course Procedure and Organization**

The course is divided in three parts: a hands-on workshop, a series of lectures on the fundamentals of the formalism and a student-led discussion of applications of shape grammars in various fields. A brief description of these parts follows below.

The first part is structured around a workshop to promote a constructive, hands-on understanding of the shape grammar formalism. The workshop focuses on tactile, physical, recursive computations with the Froebel kindergarten blocks to show the resources and conventions of the shape grammar formalism using a single rule schema ( $x \rightarrow x+t(x)$ ) and various assignments on the schema.

The second part discusses the theoretical foundations of the shape grammar discourse and focuses specifically on the systematic exposition of the rule schemas and in the ways schemas are ordered and combined to produce a compositional taxonomy of design. The objective of this second part 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 spatial examples. This part of the course is accompanied by a spatial study exploring systematically the rule schemas discussed in the class.

The third part discusses applications of shape grammars in different fields including architecture, landscape, painting and decorative arts. This part of the course essentially reverses the arrow of inquiry from rule schemas to shape rules and foregrounds the notion of a shape rule as an instance of an assignment in a rule schema. The topics are student led and review various applications in the field including the shape grammars for Palladian villas, Frank Lloyd Wright prairie houses, Giuseppe Terragni facades, Alvaro Slza's housing, Steven Hall's dormitories and several others. This part of the course is accompanied by a spatial study exploring systematically the shape rules discussed in the given grammars.

A final project on a complete authoring of a shape grammar concludes the class. The project can be built on any of the previous two studies or it can explore an entirely new theme.

The class meets twice per week, Monday and Wednesday 10.35AM-11.55AM. All readings and presentations are posted at the site of the course in T-Square.

### Course requirements

Students are expected to attend the lectures, participate in the discussions and do the classwork/homework. The grade for this course is divided in the following sections:

Attendance / Participation: 10%

Two studies: 25% each

Final project: 40%

### Course schedule / Topical Outline

The course schedule is given below.

#### INTRODUCTION

|   |    |     |   |
|---|----|-----|---|
| M | 20 | Aug | Introduction   Requirements   Expectations              |
| W | 22 | Aug | Shape grammars: Overview   Rule schemas and shape rules |

#### WORKSHOP ( $x \rightarrow x + T(x)$ )

|                     |    |     |  |
|---------------------|----|-----|--|
| M                   | 27 | Aug | Workshop: Kindergarten grammars (One shape A - symmetry 8)   |
| W                   | 29 | Aug | Workshop: Kindergarten grammars (One shape B - symmetry 16)<br><i>Study 1: 3D Weaves</i>                               |
| M                   | 03 | Sep | <i>Labor day – No class</i>  |
| W                   | 05 | Sep | Workshop: Kindergarten grammars (Two shapes: A/B)  |
| M                   | 10 | Sep | Workshop: Kindergarten grammars   Algebras of transformations $G_{ij}$   |
| W                   | 12 | Sep | Study 1: Preliminary Review  |
| <b>FUNDAMENTALS</b> |    |     |  |
| M                   | 17 | Sep | Shape and shape arithmetic - Algebras of shape $U_{ij}$  |
| W                   | 19 | Sep | Shape rules and rule schemas   |
| M                   | 24 | Sep | Recursive definition of rule schemas: $x \rightarrow d(x)$ ; $x \rightarrow p(x)$ ; $x \rightarrow b(x)$               |
| W                   | 26 | Sep | Study 1: Penultimate Review  |
| M                   | 01 | Oct | Recursive definition of rule schemas: $x \rightarrow x+t(x)$ ; $x \rightarrow \sum t(x)$ ; $x \rightarrow \sum t^*(x)$ |
| W                   | 03 | Oct | Taxonomy of rule schemas   |
| M                   | 08 | Oct | From rule schemas to shape rules   |
| W                   | 10 | Oct | <b>Study 1: Final Review</b><br><i>Study 2: Redescribing grammars</i>  |
| M                   | 15 | Oct | <i>Fall Break</i>  |

|   |    |     |   |
|---|----|-----|---|
| W | 17 | Oct | <b>APPLICATIONS</b><br>Palladian villas<br><i>Final Project: Design a shape grammar</i> |
| M | 22 | Oct | Mughul gardens  |
| W | 24 | Oct | Frank Lloyd Wright's Prairie homes  |
| M | 29 | Oct | Japanese tea houses   |
| W | 31 | Nov | Hepplewhite chairs  |
| M | 05 | Nov | Terragni apartments   |
| W | 07 | Nov | Siza's Malagueira's housing   |
| M | 12 | Nov | Queen Ann houses  |
| W | 14 | Nov | Steven Hall dormitories   |
| M | 19 | Nov | Project preliminary review  |
| W | 21 | Nov | <i>Thanksgiving</i>   |
| M | 26 | Nov | Project preliminary review  |
| W | 28 | Nov | Project preliminary review  |
| M | 3  | Dec | <i>Studio Week</i>  |
| W | 5  | Dec | <i>Studio Week</i>  |
| M | 10 | Dec | -   |
| W | 12 | Dec | <b>Project presentation</b>   |

### 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, 1999, "The symmetry lessons from Froebel building gifts" *Environment and Planning B: Planning and Design* 26(1) 75 – 90

Economou, A. (forthcoming). From shape rules to rule schemas and back

Grasl T and Economou A (forthcoming) "From Topologies to shapes: Parametric shape grammars implemented by graphs". *Environment and Planning: Planning and Design B*

Mitchell, W. 1990. "Languages of Architecture" in *The Logic of Architecture*. MIT Press, Cambridge.

Knight T and G Stiny, 2001. Classical and non-classical computation. *ARC: Architectural Research Quarterly* (Vol5: 04)

Stiny, G. 2006. *Shape: Talking about Seeing and Doing*. MIT Press, Cambridge

Stiny, G 2011. What Rule(s) Should I Use? *Nexus Journal*, Volume 13, Number 1, 15-47

### Study 2 Readings

Downing F and Flemming U, 1981, "The bungalows of Buffalo" *Environment and Planning B: Planning and Design* 8 269-293

- Duarte J P, 2005, "Towards the mass customization of housing: the grammar of Siza's houses at Malagueira" *Environment and Planning B: Planning and Design* 32(3) 347 – 380
- Flemming U, 1987, "More than the sum of parts: the Grammar of Queen Anne houses" *Environment and Planning B: Planning and Design* 14 323-350
- Flemming U, 1981, "The secret of Casa Guigliani Frigerio" *Environment and Planning B: Planning and Design* 8 87-96
- Knight T W, 1989b, "Transformations of the De Stijl art: the paintings of Georges Vantongerloo and Fritz Glarner" *Environment and Planning B: Planning and Design* 16 51-98
- Knight T, 1990, "Mughal gardens revisited" *Environment and Planning B: Planning and Design* 17 73-84
- Knight T, 1989, "Transformations of the De Stijl art: the paintings of Georges Vantongerloo and Fritz Glarner" *Environment and Planning B: Planning and Design* 16 51-98
- Koning H, Eizenberg J, 1981, "The language of the Prairie: Frank Lloyd Wright's Prairie houses" *Environment and Planning B: Planning and Design* 8 295-323
- Kotsopoulos S, 2010. "From design concepts to design descriptions" *International Journal of Architectural Computing*, issue 03. V.06, pp. 335-360
- Stiny G, Mitchell W J, 1978, "The Palladian Grammar" *Environment and Planning B: Planning and Design* 5 5-18
- Stiny G, Mitchell W J, 1980, "The Grammar of paradise: on the generation of Mughal gardens" *Environment and Planning B: Planning and Design* 7 209-226

### **Further references**

- Flemming U, 1987, "The role of shape grammars in the analysis and creation of designs" in Kalay Y E (ed.) *Computability of Designs* (New York: John Wiley amp; Sons) 245-272 (AE)
- Grasl, T and A Economou, 2011, "GRAPE: Using graph grammars to implement shape grammars" *Symposium on Simulation for Architecture and Urban Design, SimAUD*: 45-52
- Stiny G, 1976, "Two exercises in formal composition", *Environment and Planning B* 3 187 – 210
- Stiny G, 1980, "Introduction to shape and shape grammars" *Environment and Planning B: Planning and Design* 7 343-351
- Stiny G, 1980, "Kindergarten grammars: designing with Froebel's building gifts" *Environment and Planning B: Planning and Design* 7 409-462
- Stiny G, 1977, "Ice-ray: a note on Chinese lattice designs" *Environment and Planning B: Planning and Design* 4 89-98

### **Web references**

[www.shapegrammar.org](http://www.shapegrammar.org)  
[http://www.mit.edu/~tknight/IJDC/frameset\\_abstract.htm](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](http://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](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.