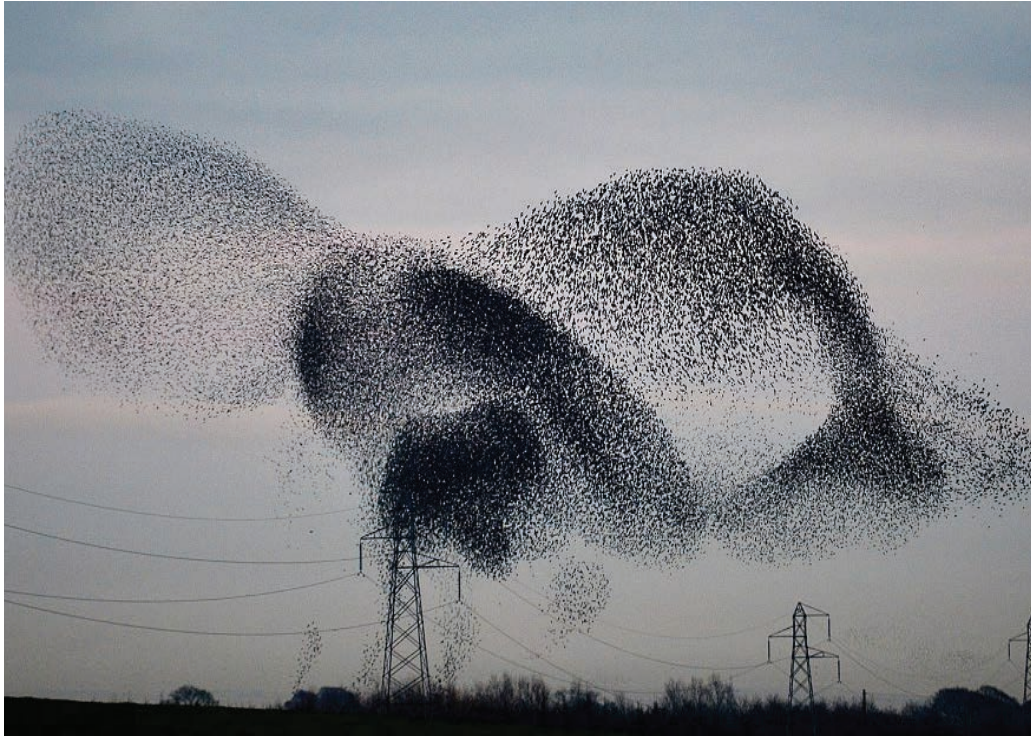


# DIGITAL TECTONICS

Algorithmic Forms &  
Generative Algorithm Modelling

K-Arts 2018 Media Studio 4: Advanced Computer Techniques

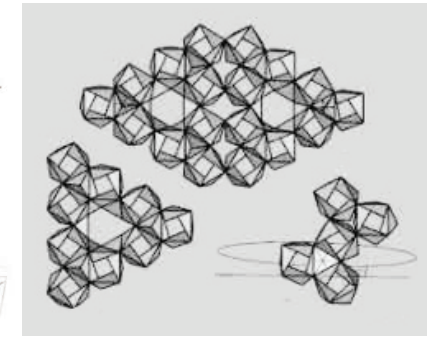
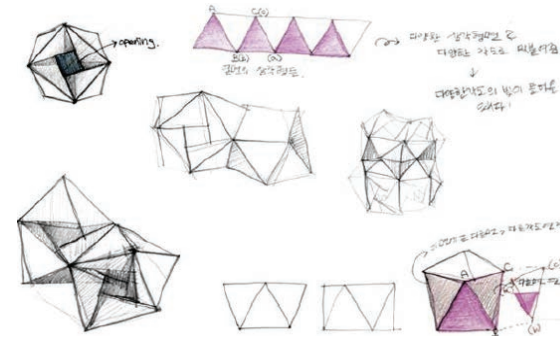
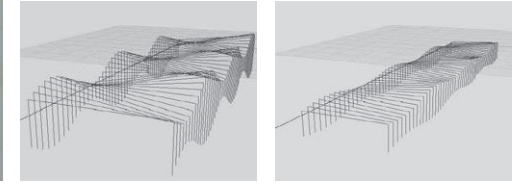
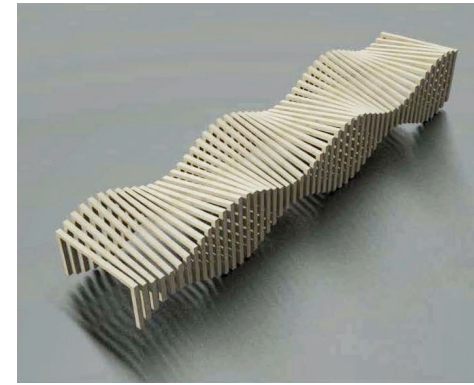
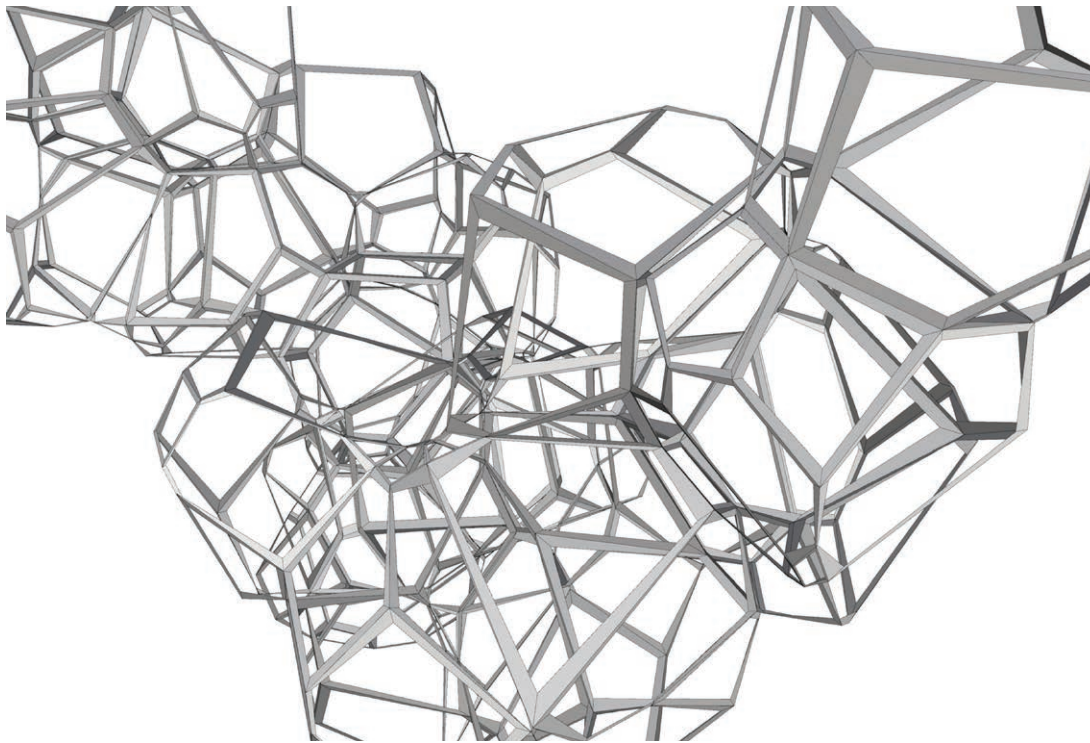


복잡계에 대해서 알아야 할 모든 것은 정보의 처리 과정으로 이해될 수 있다.

- 세스 로이드, 2001

*Everything that's worth understanding about a complex system can be understood in terms of how it processes information.*

- Seth Lloyd, 2001



### 강의 배경

미디어 스튜디오 4는 미디어 스튜디오 3의 연장선상에서 건축설계의 툴로서 컴퓨터의 활용 범위와 가능성을 지속적으로 탐구한다.

### 강의 목표

최근 건축설계의 한 가지 방법론으로 자리잡은 제너러티브 알고리즘(generative algorithm)을 이용한 모델링 기법을 중심으로 버저닝(versioning) 작업을 통한 형태 만들기(form-making)와 최적화(optimising) 작업을 통한 형태 찾기(form-finding)의 과정을 이해하고 이를 실제 프로젝트에 적용한다.

## Why Do We Learn Generative Algorithm Modelling?

In Historical Context: Need for New Decoration?

New Science: Understanding Nature

Associating Information: Mapping and Datascape

Controlling Complexity and Informality

## Why Do We Learn Generative Algorithm Modelling?

In Historical Context: Need for New Decoration?

New Science: Understanding Nature

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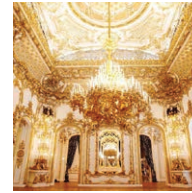
Controlling Complexity and Informality

Formalism ‹ — — — — ‹ Expressionism

Less Decorative ‹ — — — — ‹ More Decorative

Abstract ‹ — — — — ‹ Representational

Romanesque – Gothic – Renaissance – Baroque/Rococo – Neoclassicism – Romanticism/Gothic Revival



Early Modernism – Expressionism – International Style – Post Modernism – Neo Modernism



What Next?

## Why Do We Learn Generative Algorithm Modelling?

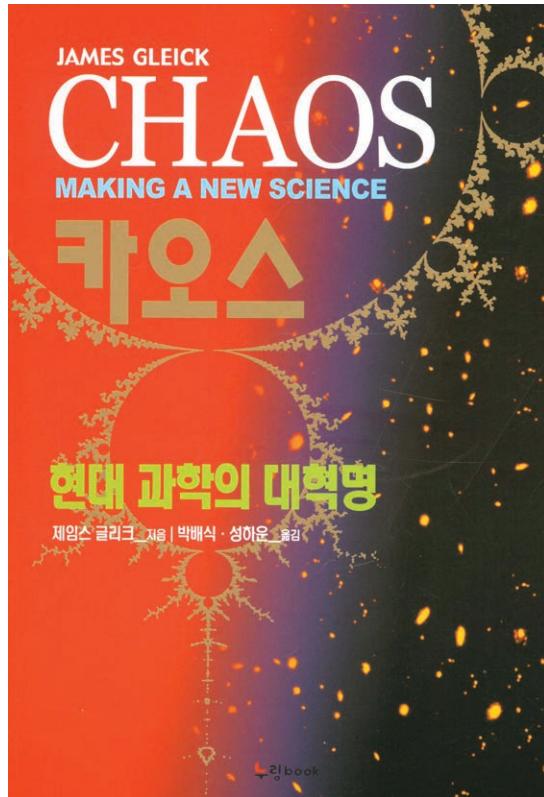
In Historical Context: Need for New Decoration?

New Science: Understanding Nature

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Controlling Complexity and Informality





James Gleick, 1987

An effort to explain and theorise  
the complexity of Nature

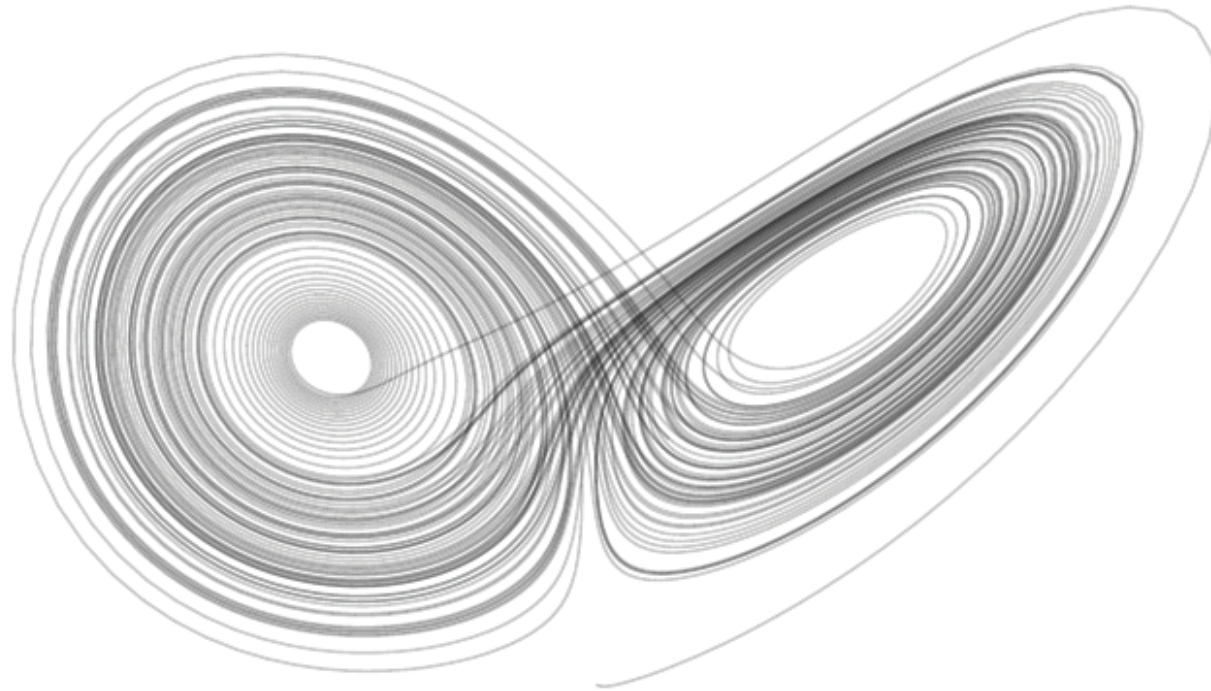


Philip Ball, 2011

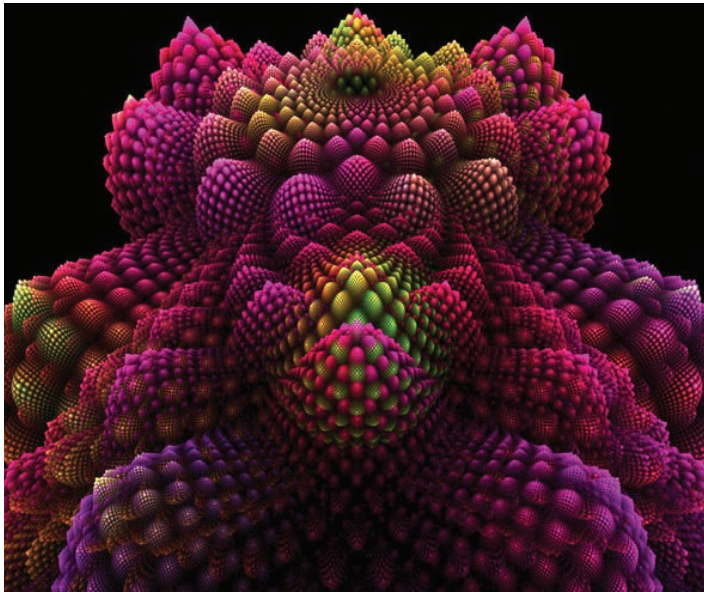
Nature's Patterns Trilogy:  
Morphology based on Algorithmic Forms

Strange Attractor (Lorenz's Attractor)

$$f(t, (x, v)) = (x + tv, v)$$

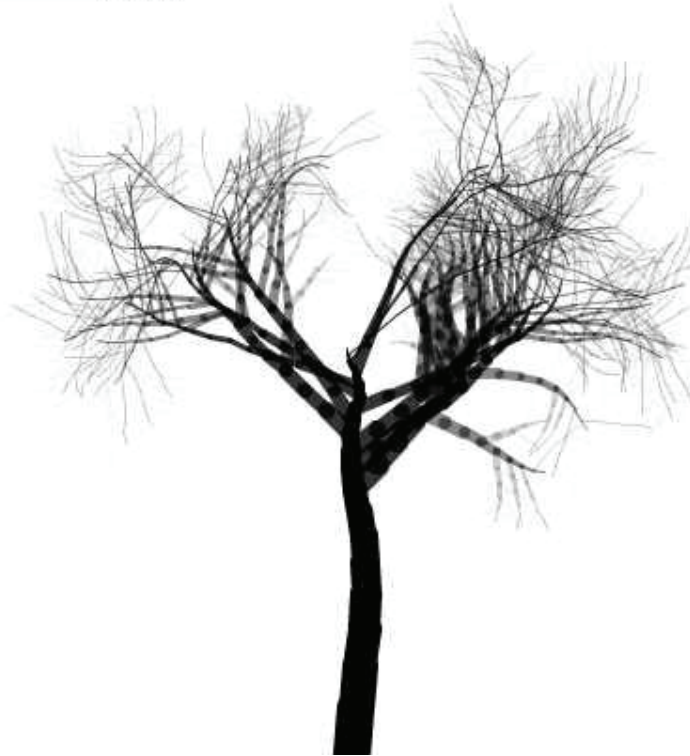


## Fractal Patterns

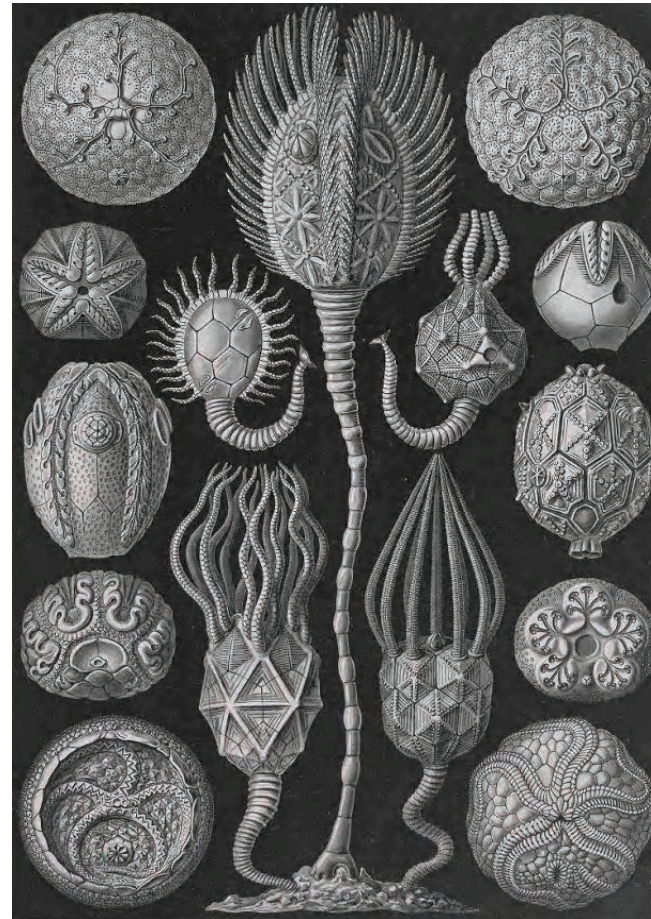
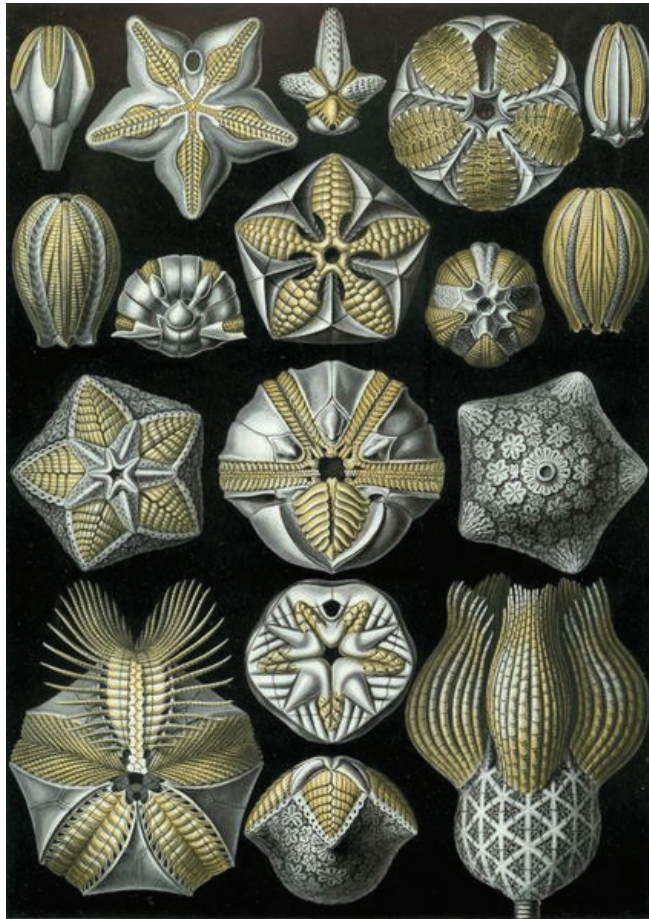


## Fractal Generator

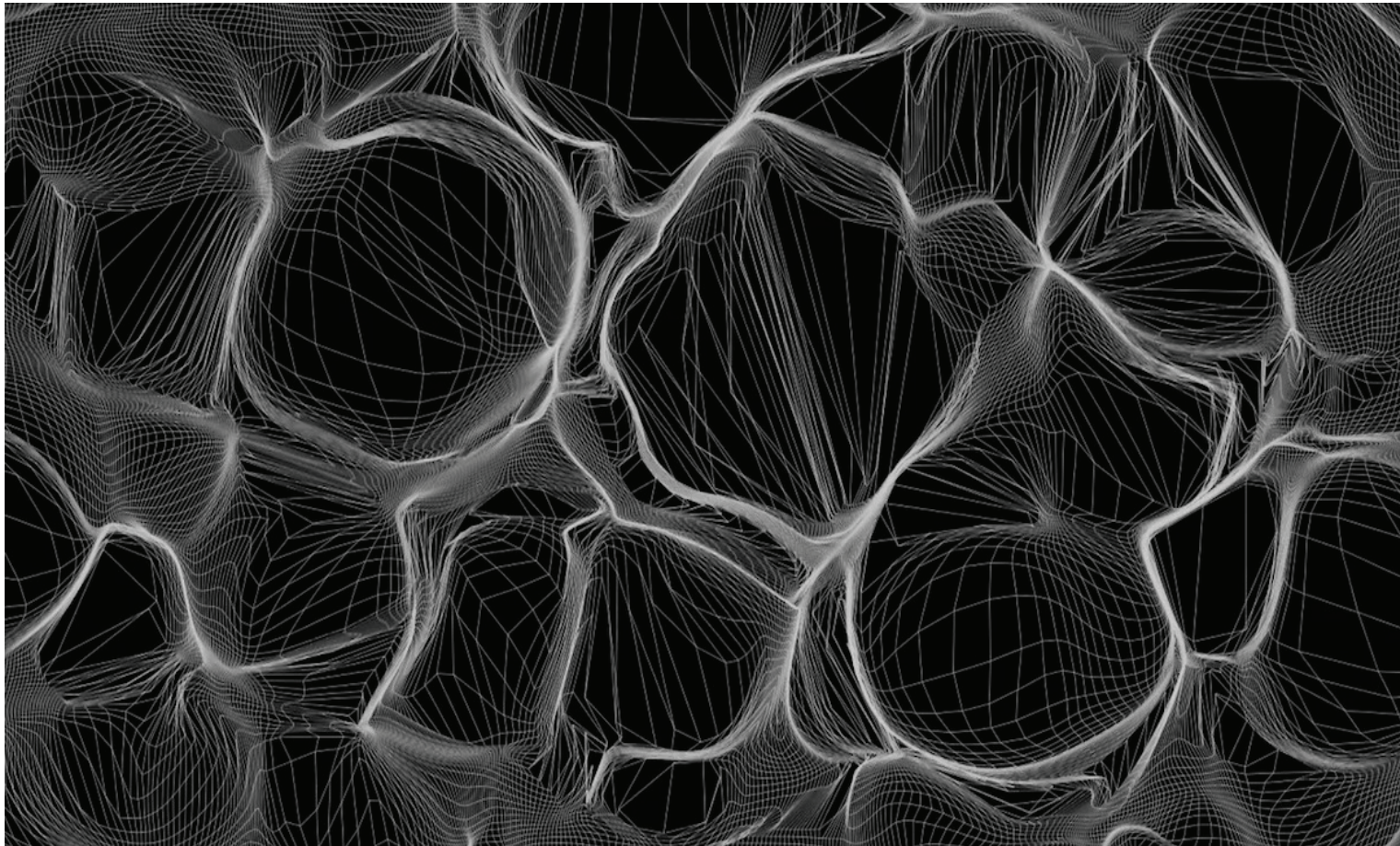
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<input type="checkbox"/>	Branch angle
<input type="checkbox"/>	Branch proba
<input type="checkbox"/>	curve angle
<input type="checkbox"/>	length coef
<input type="checkbox"/>	regularity



Sketches of Radiolarians: Ernst Haeckel (1834–1919)



## Contemporary Digital Generative Art



## Why Do We Learn Generative Algorithm Modelling?

In Historical Context: Need for New Decoration?

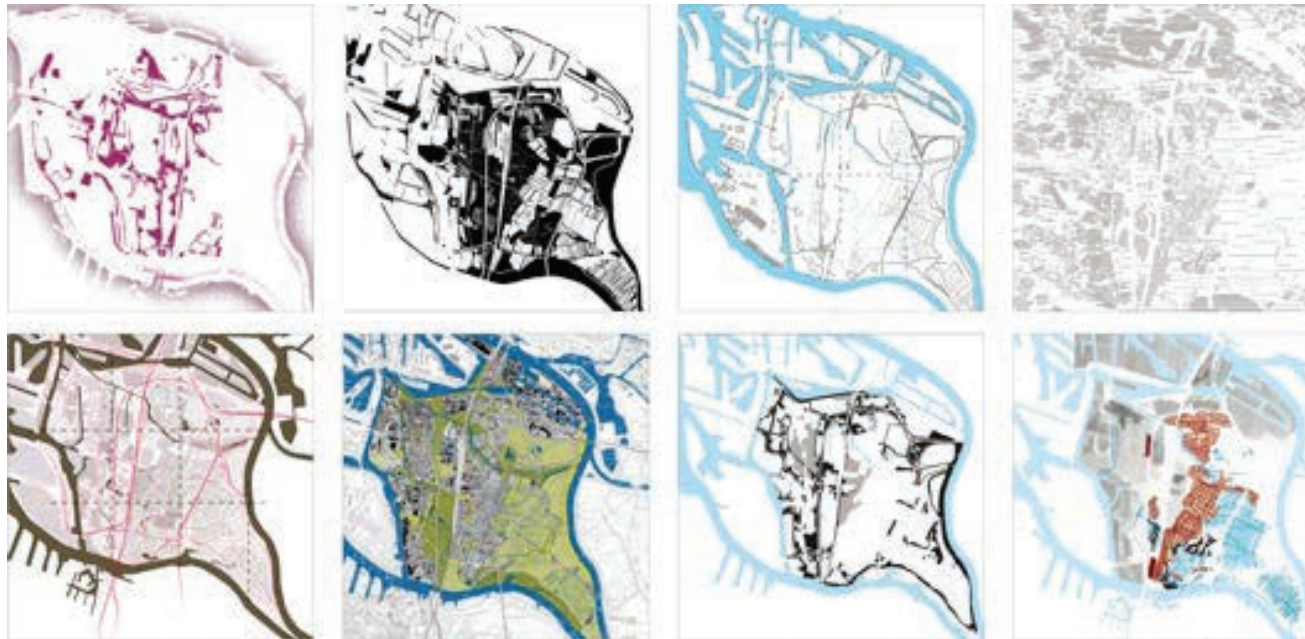
New Science: Understanding Nature

Associating Information: Mapping and Datascape

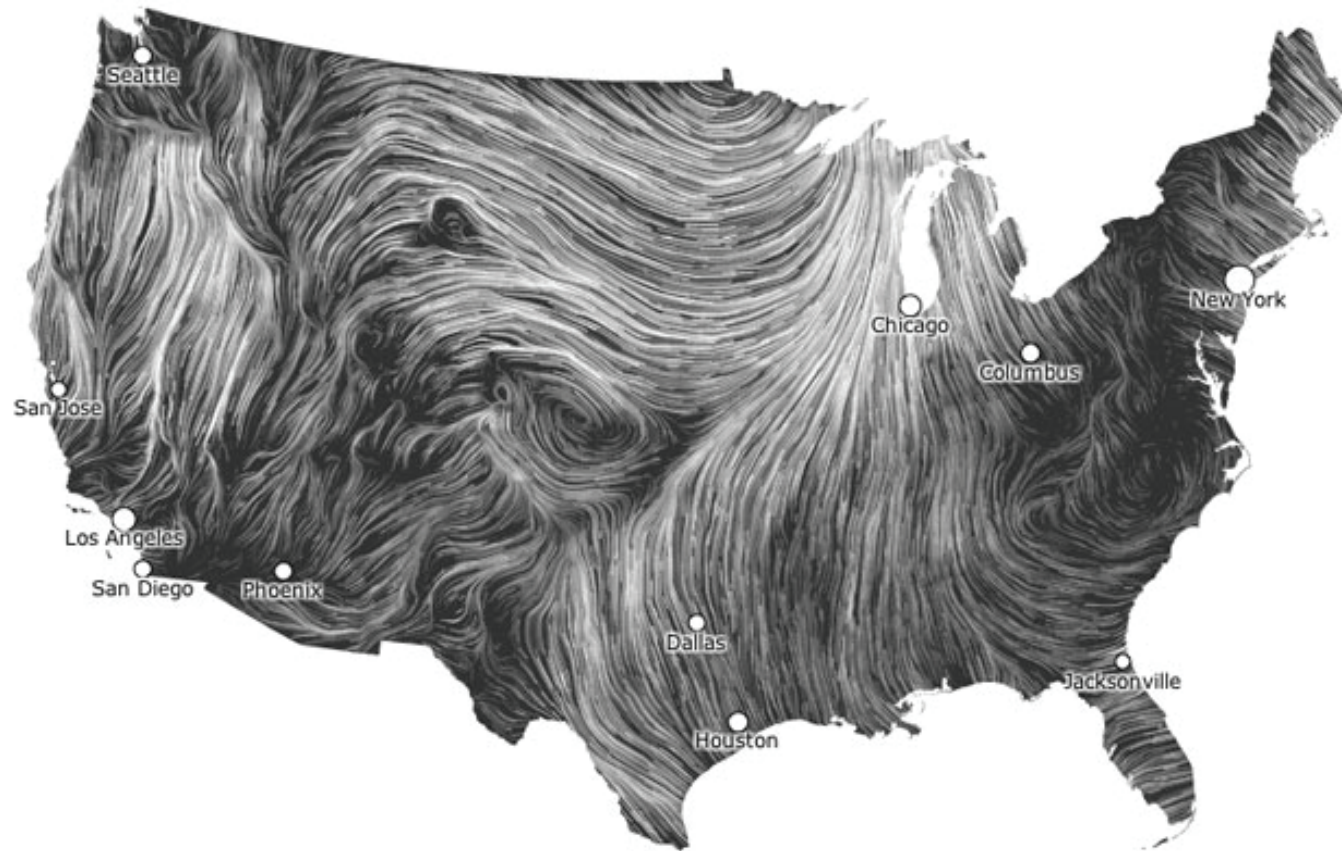
Controlling Complexity and Informality



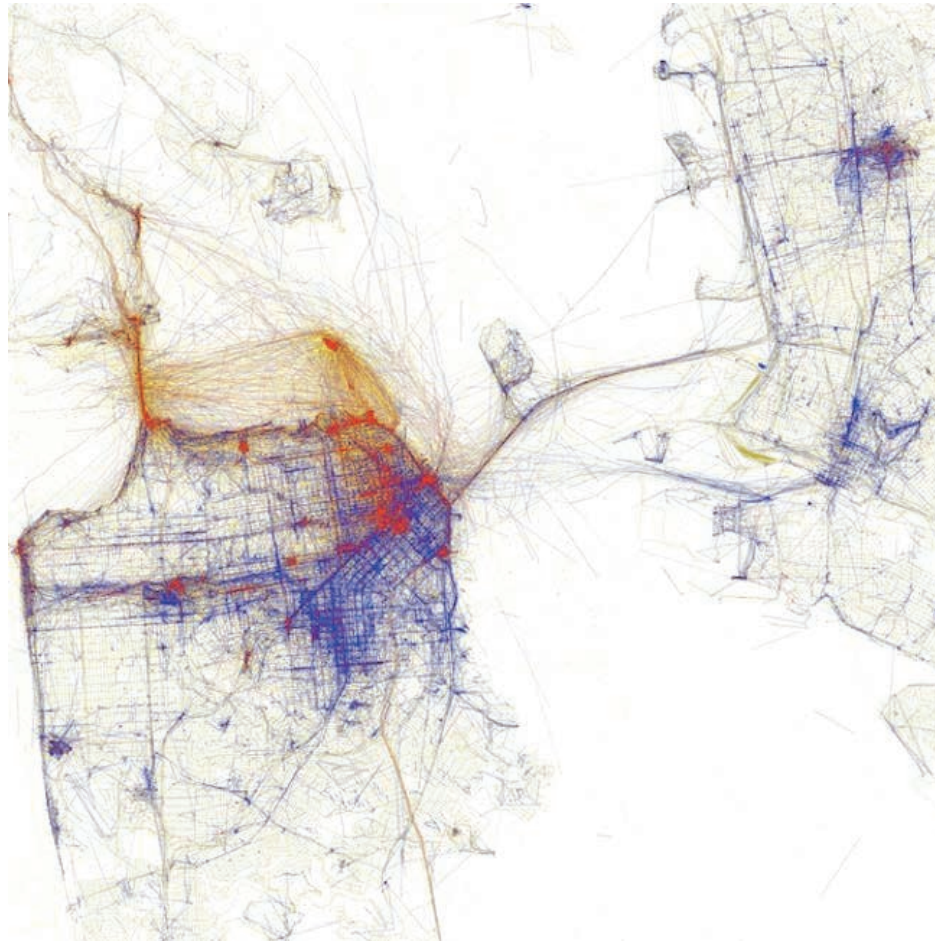
## Mapping and Datascape: Revealing Hidden Reality



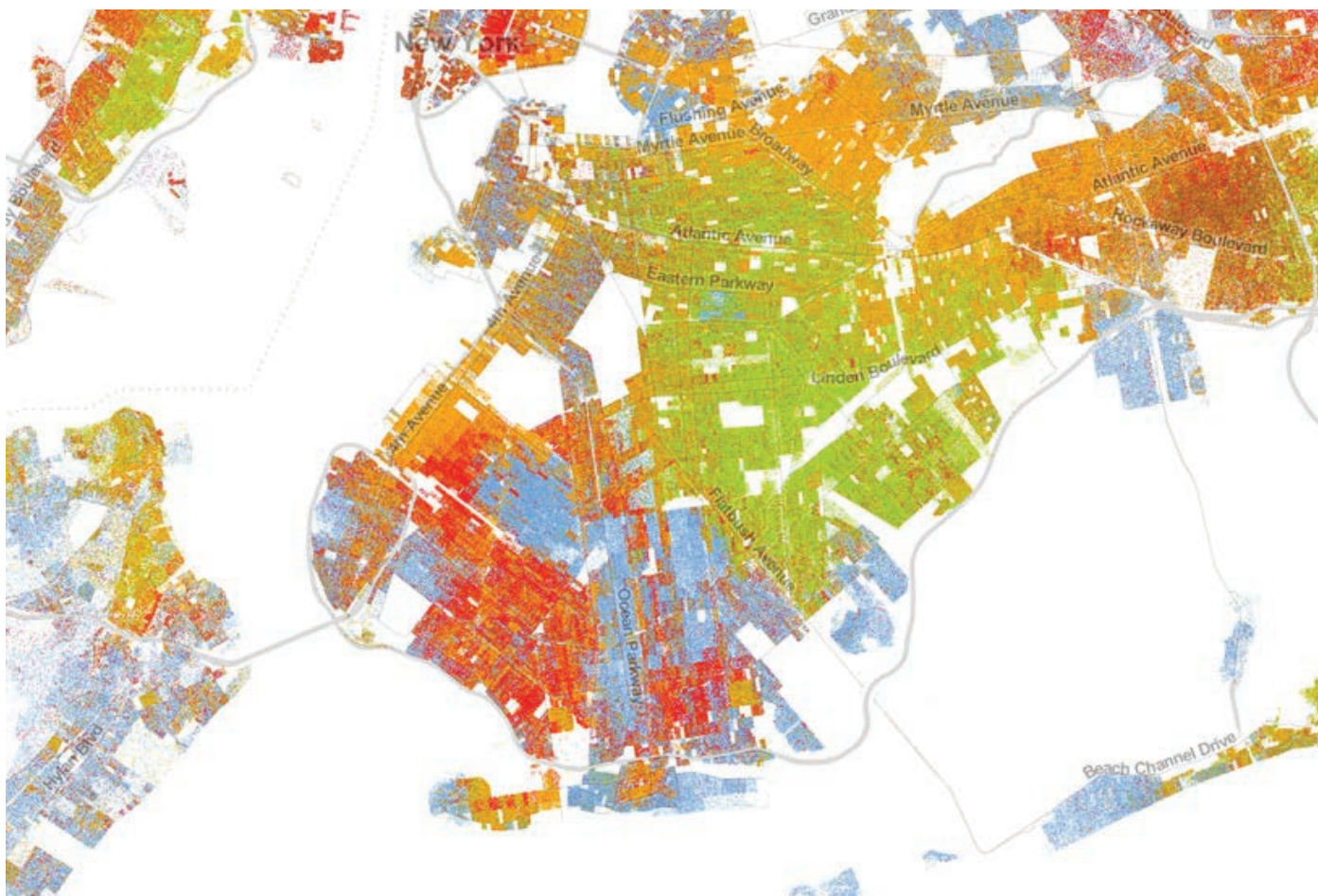
## Wind Map of North America



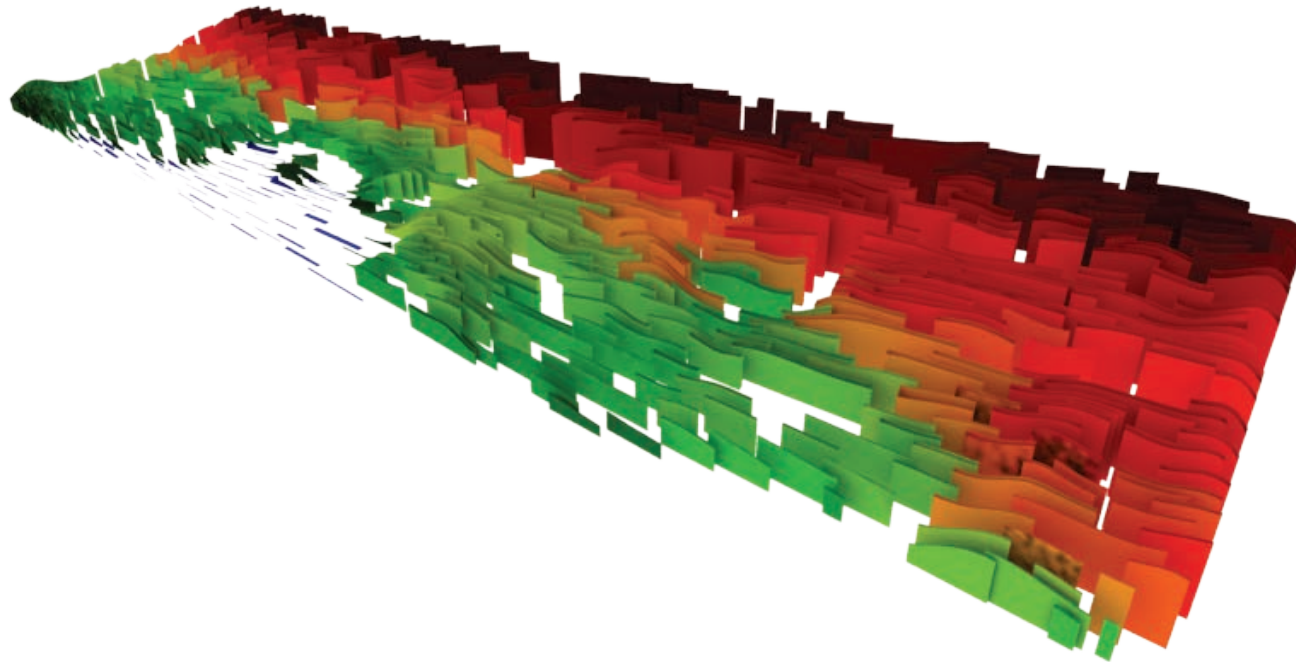
## Transportation Map of San Francisco



# Racial Map of Brooklyn



Information / Data — — — — — Design / Form ?



## Why Do We Learn Generative Algorithm Modelling?

In Historical Context: Need for New Decoration?

New Science: Understanding Nature

Associating Information: Mapping and Datascape

Controlling Complexity and Informality

## Logic behind Complexity and Informality



Logic behind Complexity and Informality (?)







**Land Use Area Tabulation**

Category	Area	Percentage
Total	4,430,810	
Administrative buildings	346,000	7.8%
Public	60,000	1.4%
Residential	50,000	1.1%
Commercial buildings	468,000	10.6%
Street	317,000	7.2%
Residential (High density)	183,000	4.1%
Residential (Low density)	30,000	0.7%
Open space	696,810	15.7%
Forest	590,000	13.3%
Water (Government)	238,000	5.4%
Water (Public)	232,000	5.2%

**Govt. Complex Area**

Category	Area	Percentage
Govt. Complex	346,000	7.8%
Public	60,000	1.4%
Residential	50,000	1.1%
Commercial	468,000	10.6%
Street	317,000	7.2%
Residential (High density)	183,000	4.1%
Residential (Low density)	30,000	0.7%
Open space	696,810	15.7%
Forest	590,000	13.3%
Water (Government)	238,000	5.4%
Water (Public)	232,000	5.2%

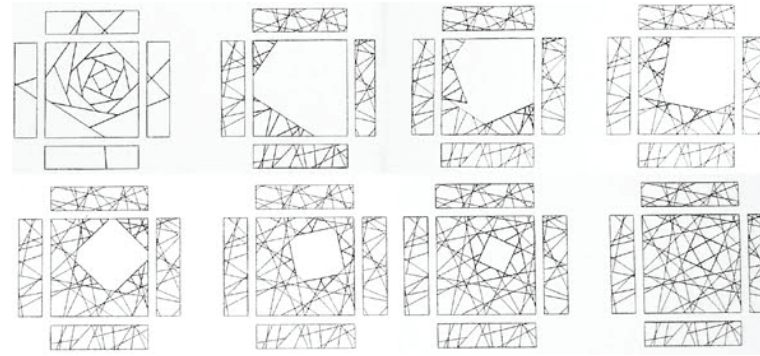
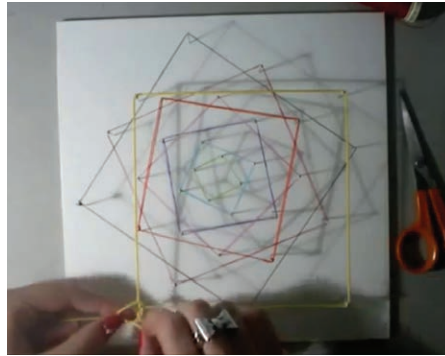
**FLAT CITY** is about equality. Here the iconic Plane, the physical and conceptual planes of nature building hierarchy, permeates the city and demonstrates the flow of the people and government inhabiting it. Public life flows between the street and the upper plane, the flow of the people and the city are played out both on the ground and in the sky. It is this equality to live in both places that sets the iconic Flat City apart from the iconic Plane with an expansive view of the cityscape and beyond, which citizens understand that they are in part of a larger community.

**LINK CITY** is the connective tissue of the PAT. It is a unique system of physical and virtual passages and linkages between the government and the people. The urban and the natural, the ground and the sky, allowing free movement from one realm to the other. With few barriers in Link City, enhanced communications can contribute to a more adaptable and efficient society.

**ZERO CITY** means zero waste. In nature, all waste from one system becomes the food for another. Zero City emulates nature's efficiency, loading four independent but interconnected infrastructure systems to help reuse waste and reduce pollution while taking care of essential city functions. In the end then, Zero City like Flat and Link City, is about enhancing our environment and our future.

Typical Govt Complex Flood Plan 1/1000  
Ground Floor Plan 1/1000

## Serpentine Gallery Pavilion 2002: Toyo Ito



## The Great Court, The British Museum

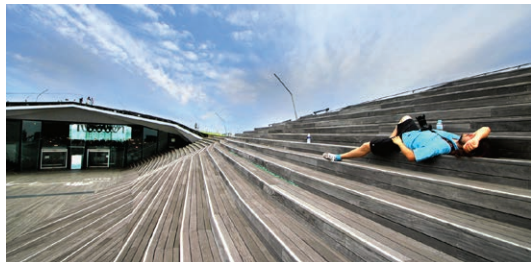


## Generative Algorithm Modelling

A new way to control complexity and informality via computerised algorithm and parameters, for intuitive, efficient and information based design decision making

직관적이고 효과적이며 정보에 기반을 둔 디자인 결정을 위해 자동 계산되는 논리체계와 변수를 사용하여 복잡성과 비정형성을 다루는 새로운 방법

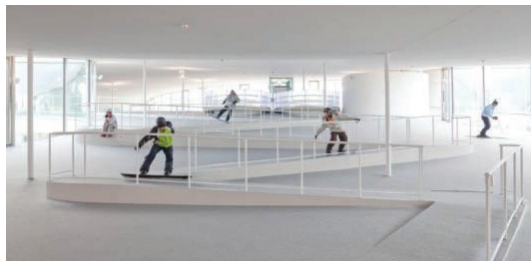
## Terminology



### Versioning

다양한 디자인 조건에 따라 특정한 해를 결정하는 작업

Process of creating versions of certain design solutions based on varying conditions



### Optimisation

반복 작업 (iteration)을 통해 최적의 해를 찾아가는 과정

Process of finding optimal solutions by repeating/cycling a certain set of steps (iteration)



### Nonlinearity

비결정론적인 역학계를 서술하는 수학적 특성

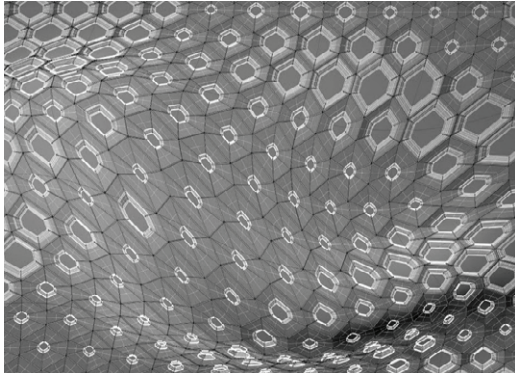
Mathematical characteristic which describes indeterminate system

### Open Narratives

비결정성에 바탕을 둔 열린 텍스트로서의 도시건축적 장치

Urban architecture as a type of open text based on the idea of indeterminacy

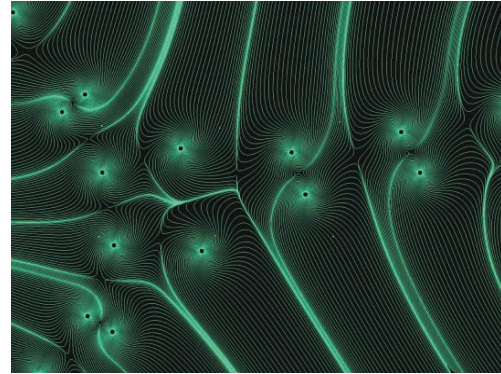
## Techniques of Generative Algorithm Modelling



Attractor



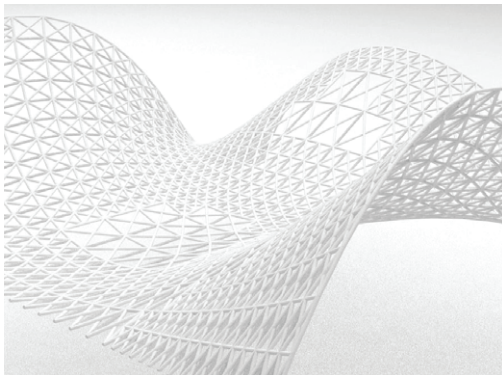
Recursion/Repetition



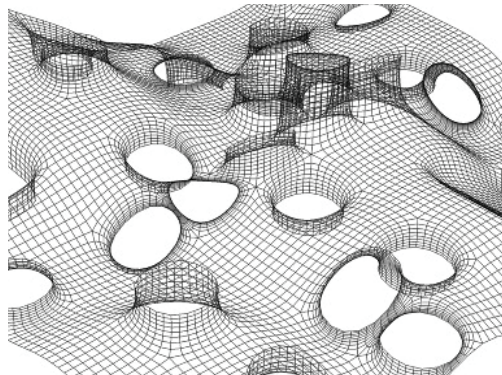
Force Field



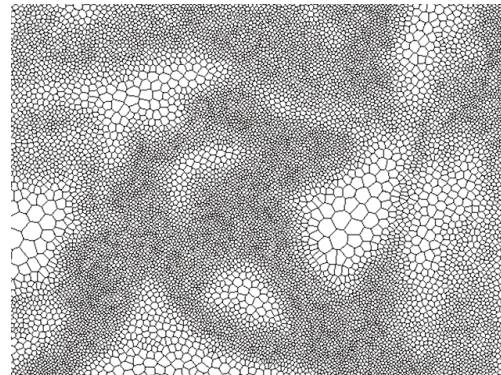
Tiling/Tessellation



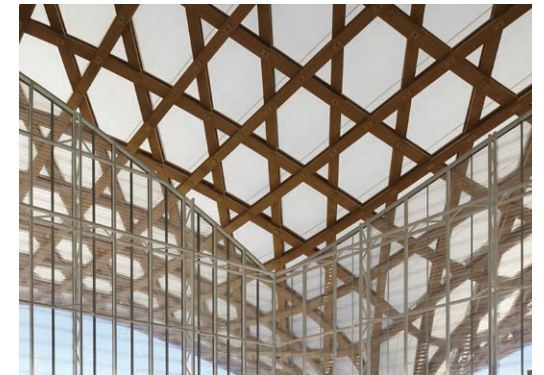
Subdivision



Topology



Packing

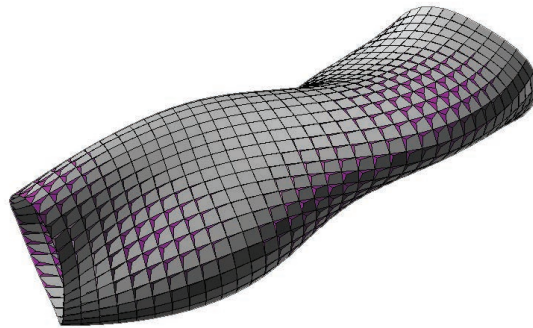
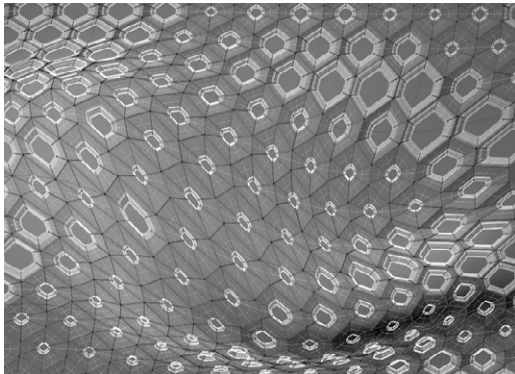


Weaving

질문: 형태 생성에 관여하는 정보가 수학적/논리적으로 연산 가능한가?

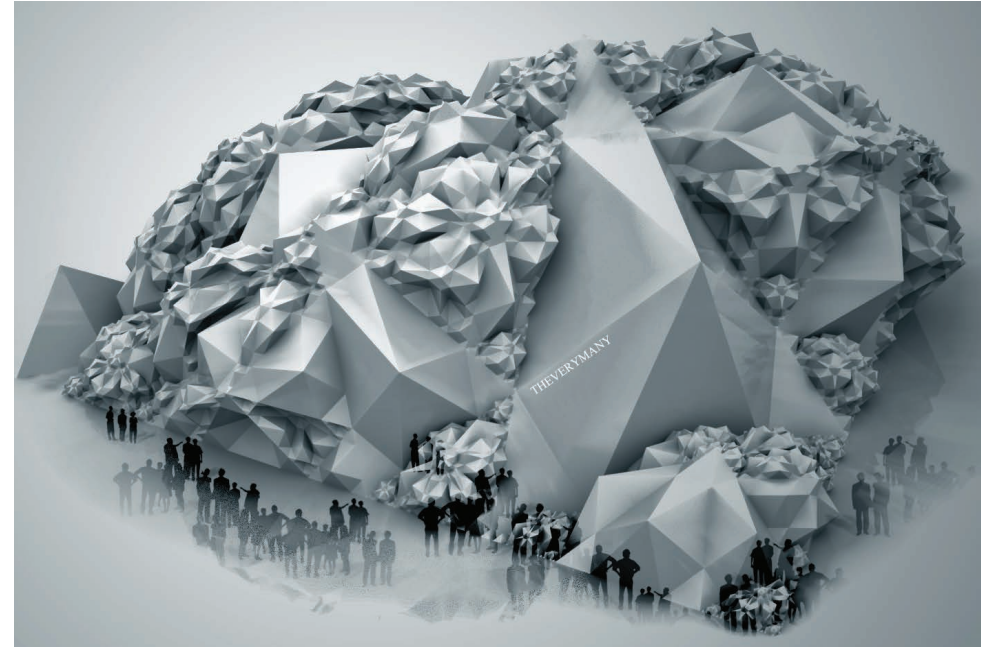
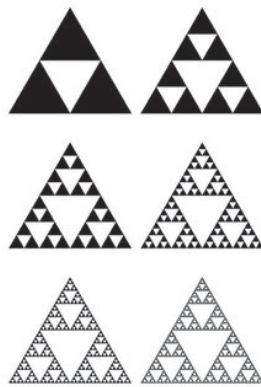
Question: Is the information that generates a form computational?

# Attractor



Cholula Student Housing, BNKR Arquitectura, 2012

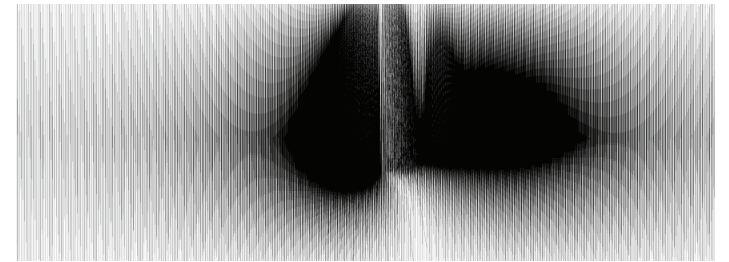
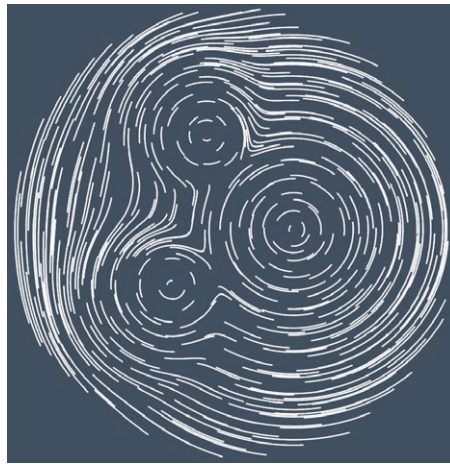
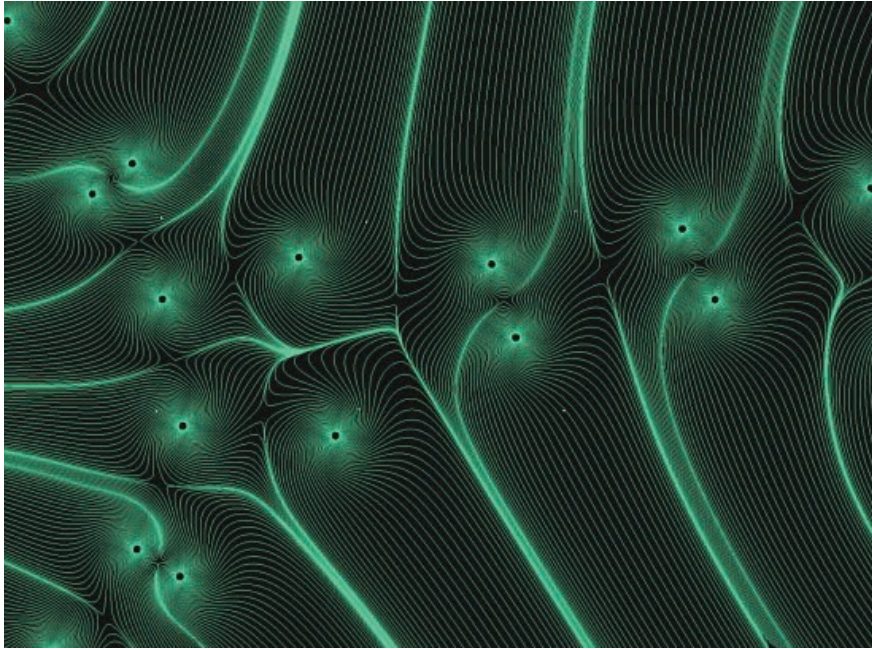
## Recursion / Repetition



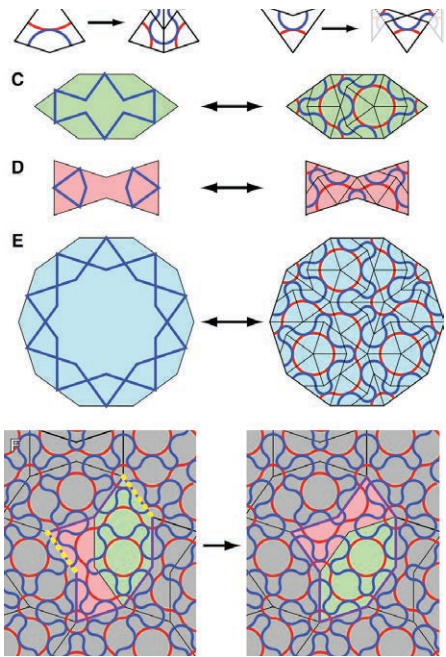
Recursive Growth Series 02, THEVERYMANY, 2008



## Force Field



# Tiling

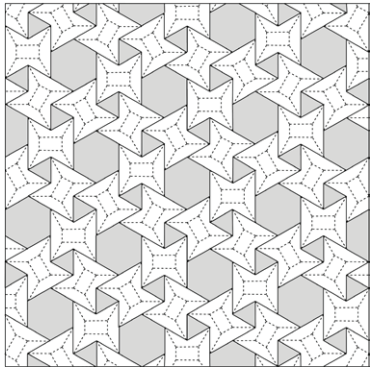


Federation Square, Lab Architecture Studio, 2002



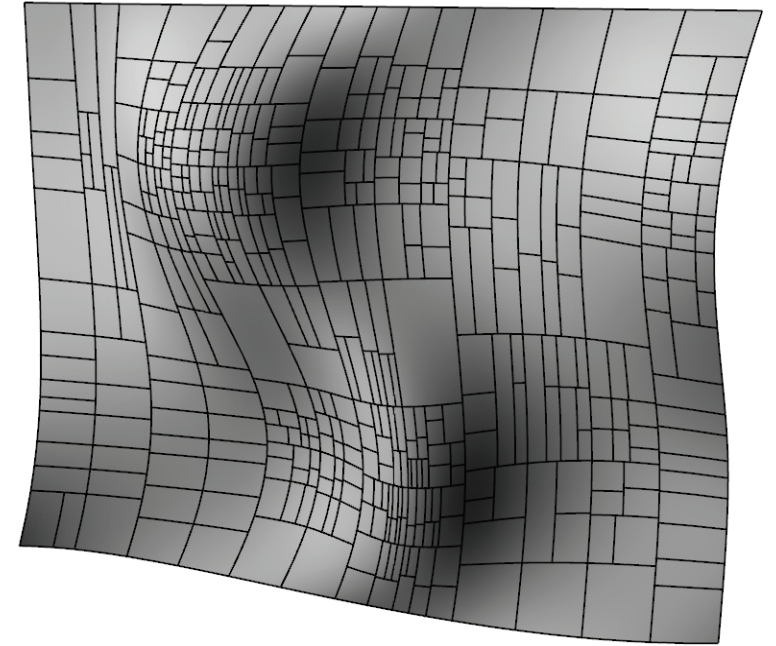
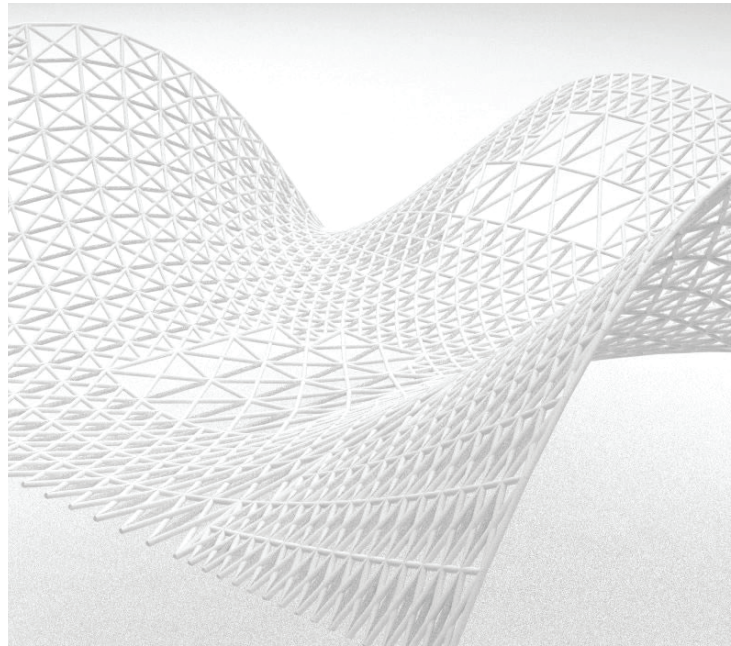
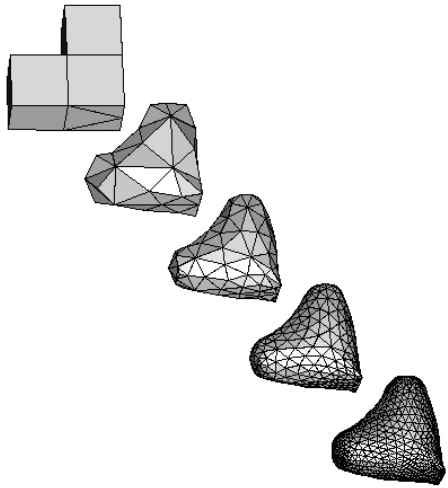
Ravensbourne College, FOA, 2010

## Tessellation

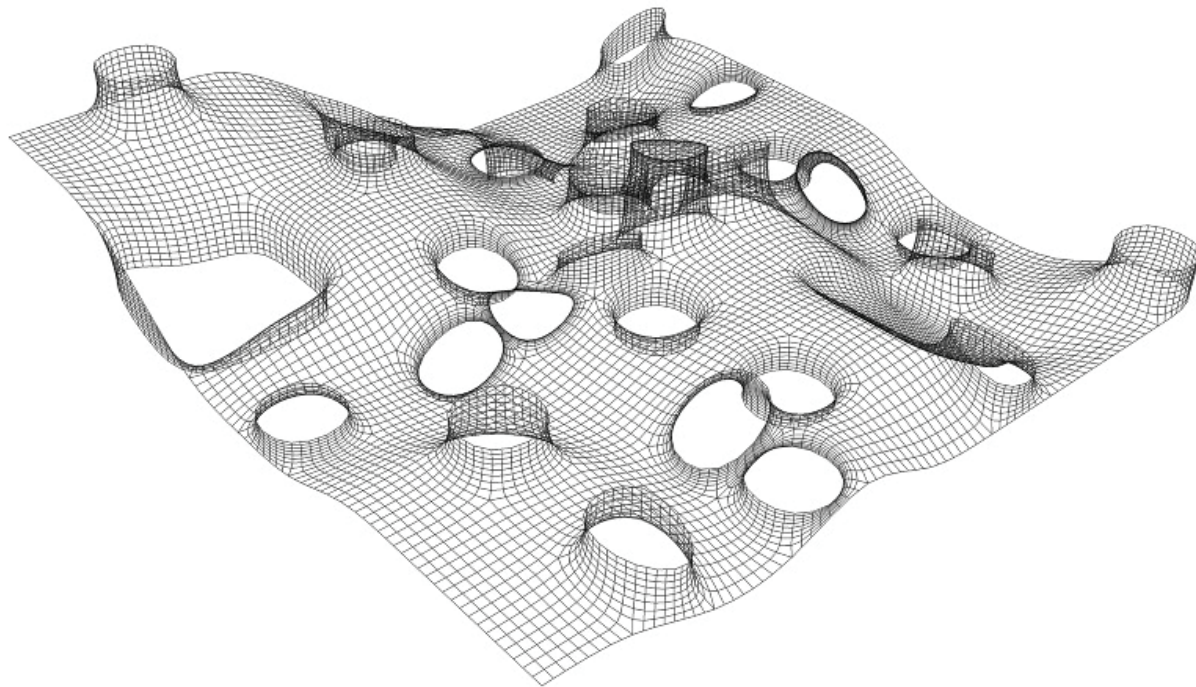


Liverpool Museum, 3XN, 2011

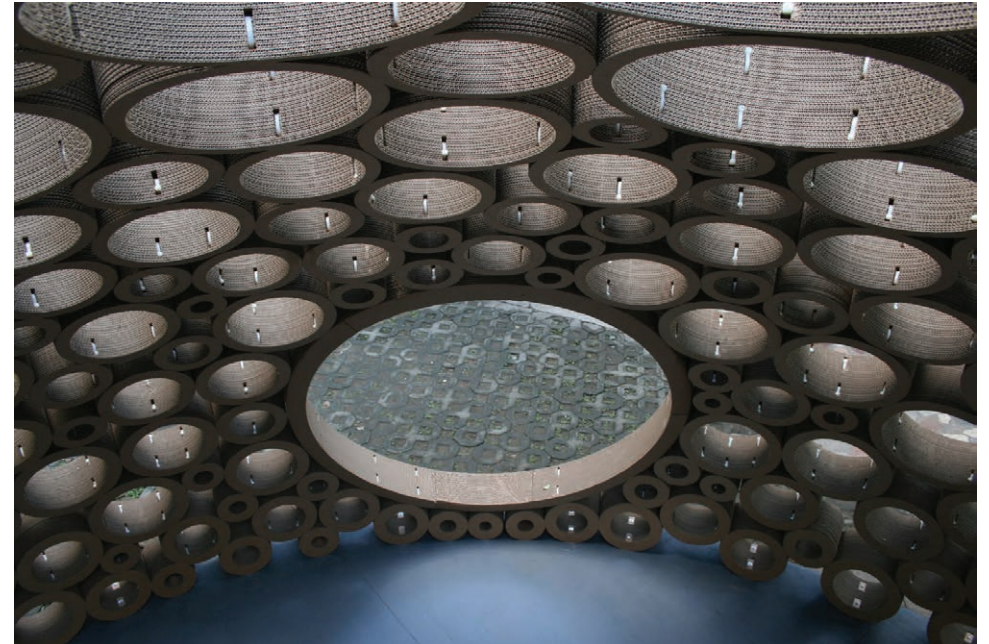
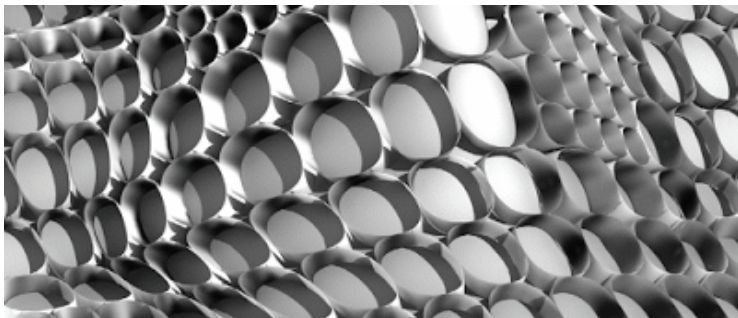
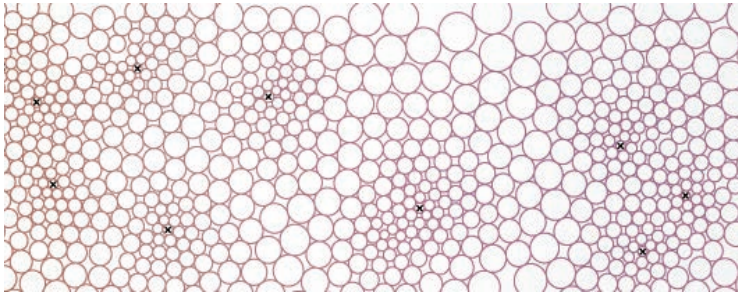
## Subdivision



# Topology

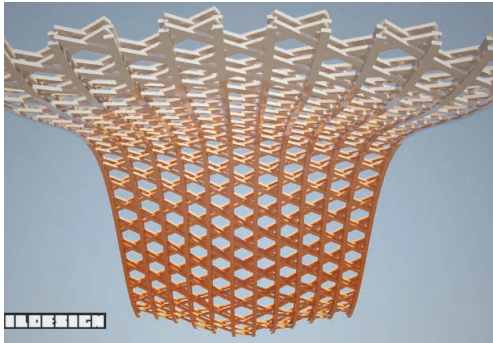


## Packing



⟨Packed⟩, ETH Zurich Students, 2011

## Weaving

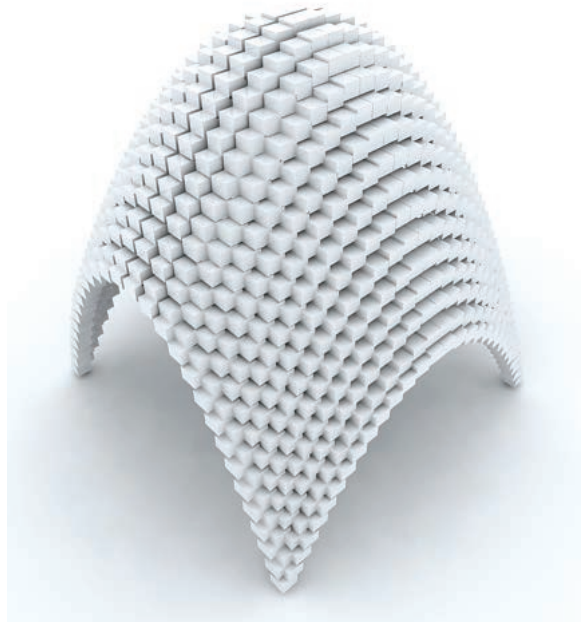
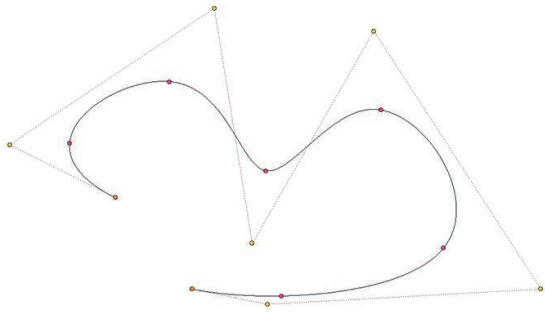


Aragon Pavilion, Olano y Mendo Arquitectos, 2008



Centre Pompidou-Metz, Shigeru Ban Architects, 2010

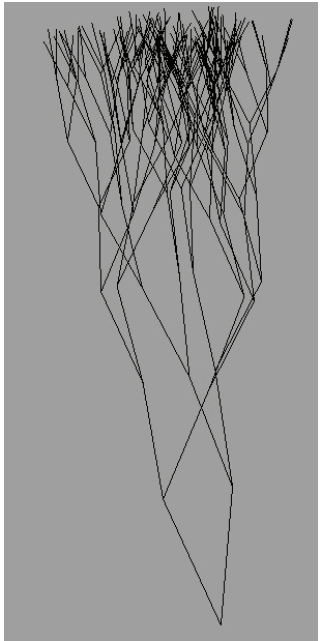
## Controller



Quadracci Pavilion, Milwaukee Art Museum , Santiago Calatrava, 2001



## Branching



Interior of Sagrada Família, Antonio Gaudi, 1883–



The Tote, Serie Architects, 2009

## 과제 / Personal Project

### 1. 2D 패턴

도시조직에서 바닥패턴까지 스케일에 관계 없이 제너러티브 알고리즘으로 구성된 2D 패턴으로 개념, 최종결과물은 렌더링되지 않은 2D 이미지로 표현.

### 2. 입면패턴

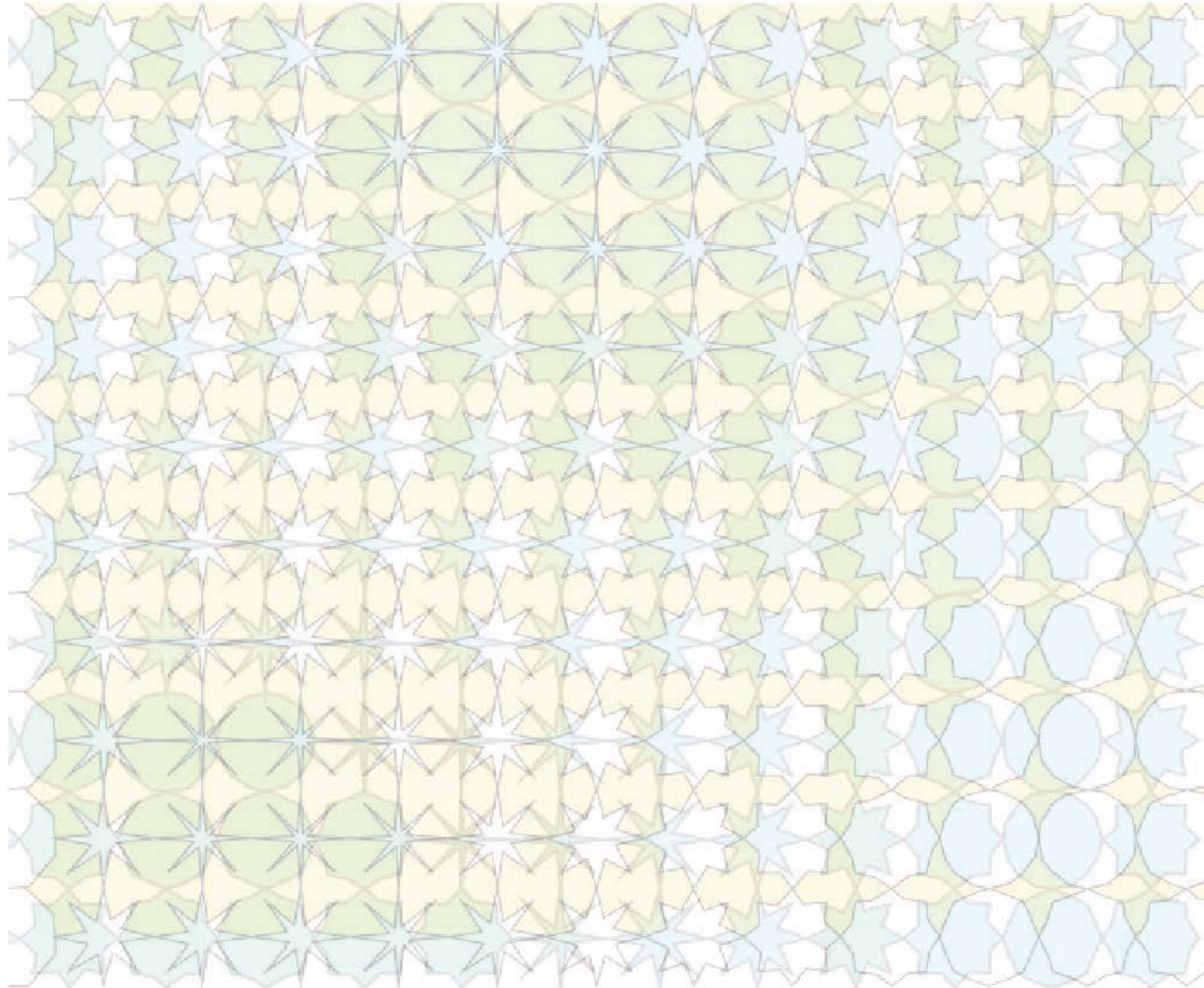
커튼월, 루버, 외장재 등 건축물의 입면을 이루는 구성요소의 일부 또는 전체를 제너러티브 알고리즘을 이용하여 제안. 최종결과는 렌더링된 2D 이미지로 표현.

### 3. 구조체

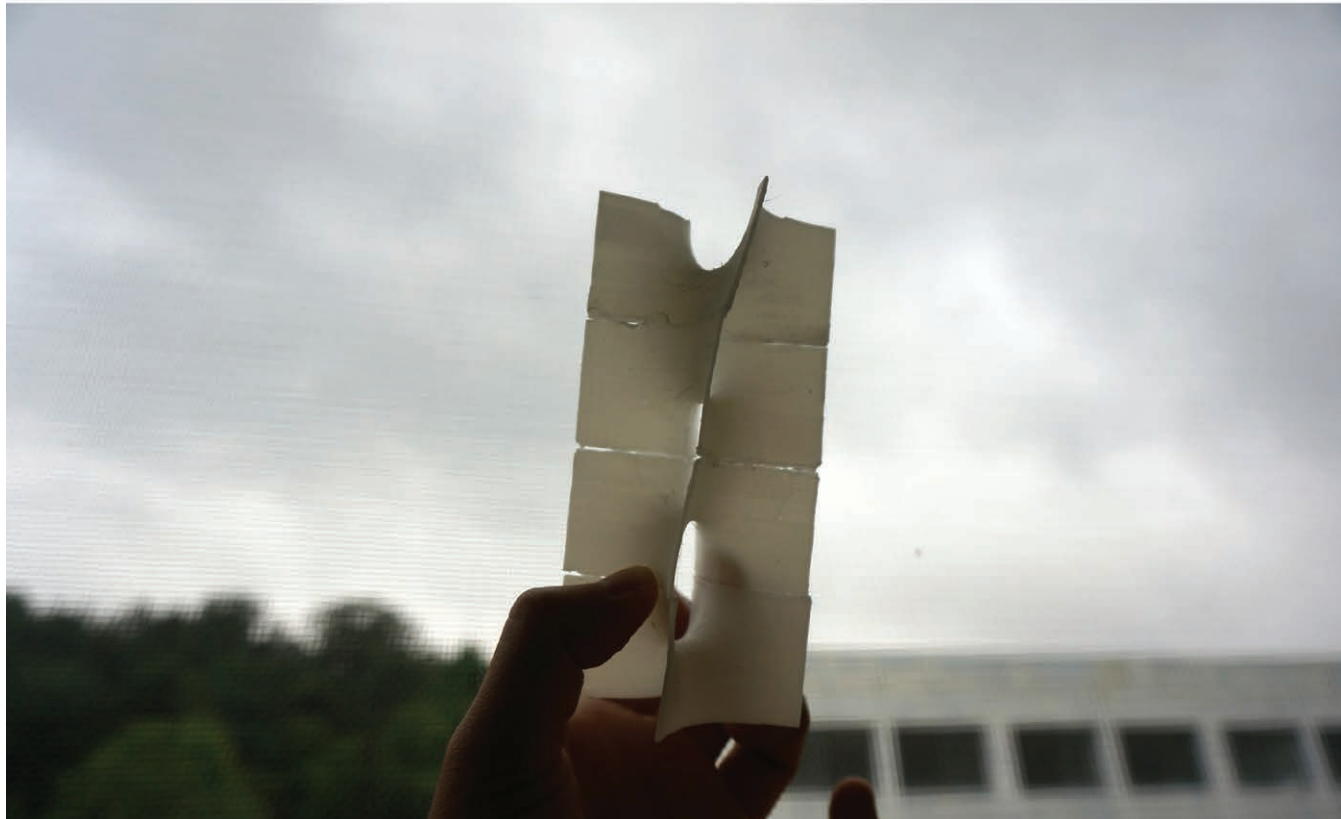
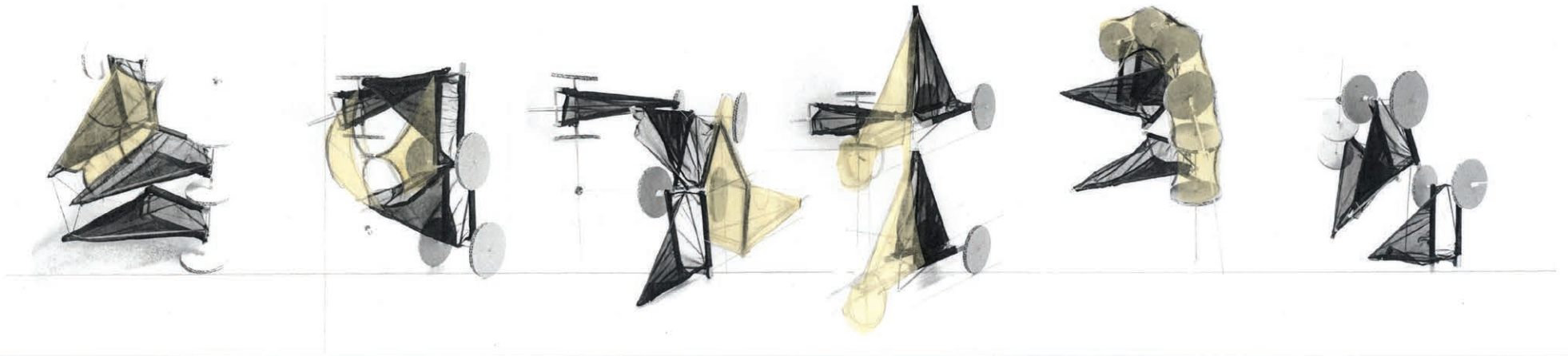
건축물 / 조형물 / 공작물의 구조체 일부 또는 전체를 제너러티브 알고리즘을 이용하여 제안. 대상은 제한 없으며 최종결과는 직접 제작 또는 3D 프린팅된 물리적 모델.

– 권장사항: 과제의 아이디어를 해당 학기에 진행되는 설계수업에 최대한 적용할 것.

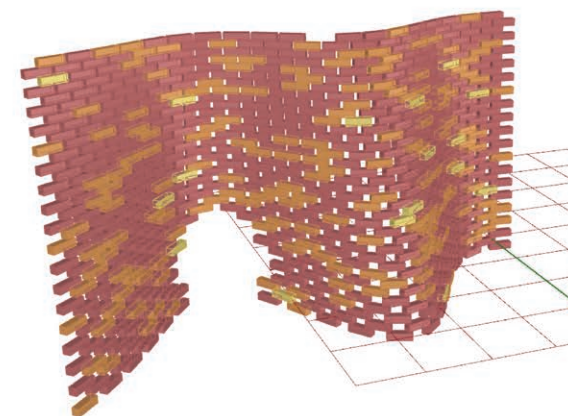
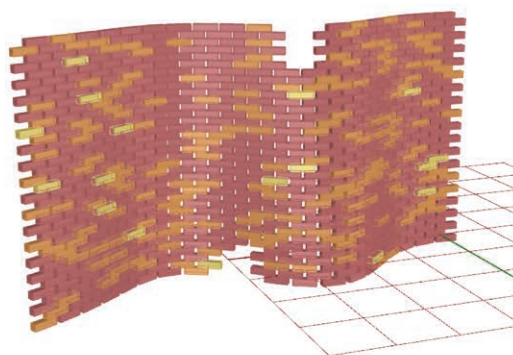
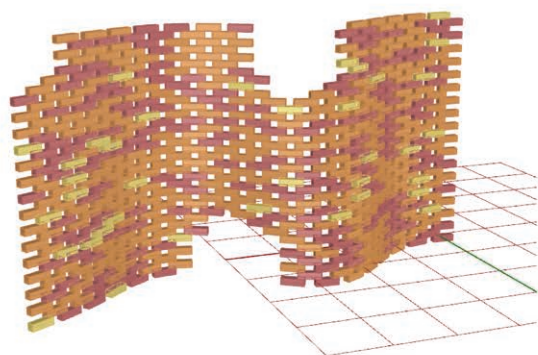
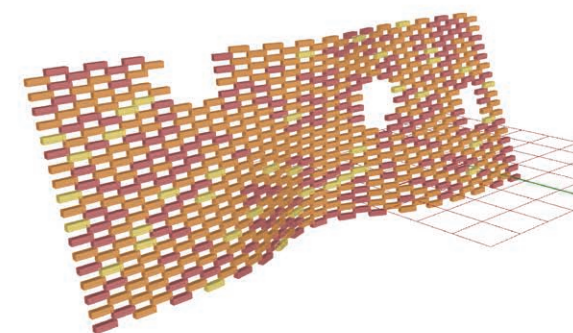
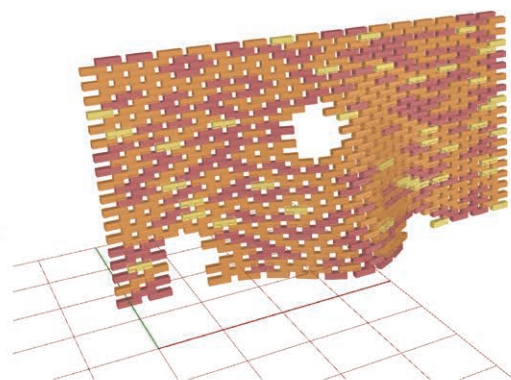
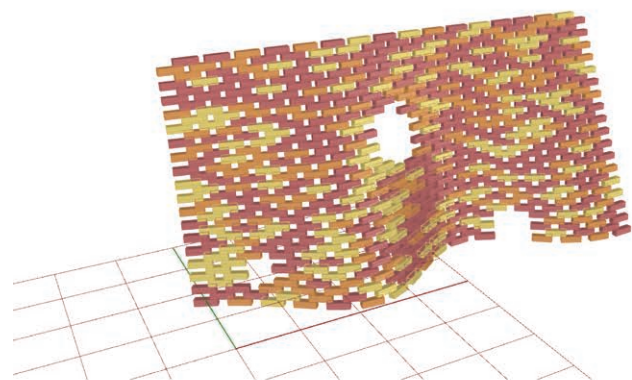
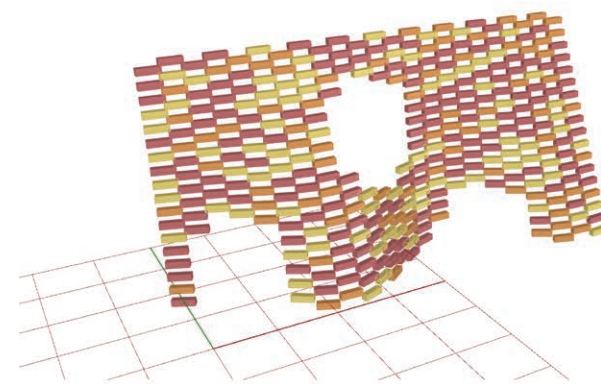
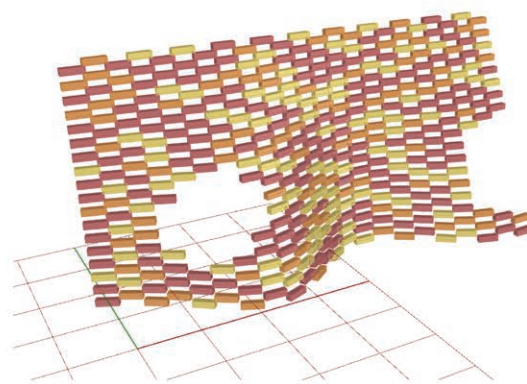
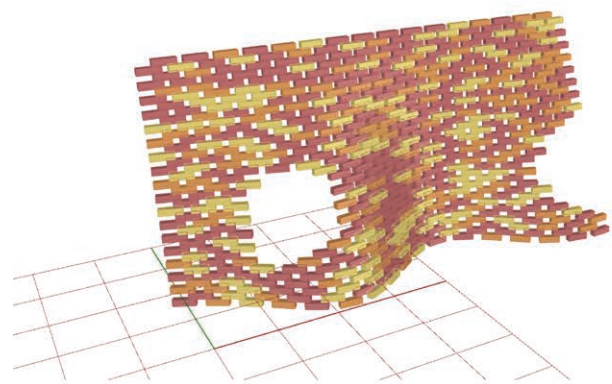
# Precedents



Precedents



# Precedents



## Precedents



## Precedents

