

#### P E R K I N S + W I I I

# Applying Generative Modeling Procedure to Explore Architectural Forms

Dr. Zaki Mallasi Design Application Manager



### 1) Introduction

- What is Generative Design?
  - Nature as the origin and how the technique emerged in design



**Dynamic Sea Waves and Form** 



**Trees and Columns** 



**Sea Shell Form** 

### 1) Introduction

#### • What is Generative Design?



Peter Eisenman Aronoff Center for Art (new building)

#### **Existing Building**



**Building Section** 

Site/Topological Qualities are traced, transformed, shifted, reoriented to disrupt the building form



#### 1) Introduction

- What is Generative Design?
  - Design Process Definitions:
    - Allows the designer during early stages to interact with simple shapes via a generative program.
    - A mechanism that triggers creativity and inspires designers using anything: shape, geometrical combinations, spatial relationship, proportions, etc.
    - Resulting complex shapes are generated by applying simple mathematical rules.
    - **Results interpretation** to a possible built form can be dealt with after the form has evolved.

### 2) Motivation of Work

- Spirolateral Shape Grammar:
  - A Spirolateral shape is defined by simple rules: turning angle, number of segments, and the number of repetitions, which create a closed figure.







Source: Robert Krawczyk (2001): The art of Spirolateral Reversal

 In essence: generative design process have emerged from the search for a medium to explore alternative design solutions (ideas) using CAD tools.

### 2) Motivation of Work

- Features of 3D Spirolateral and Architecture:
  - The main value of Spirolateral for architectural design is in its spatial potentiality.
  - It is easy to verify its similarity using simple configurations in relation with architectural forms.





Interpretation for Interior Space



#### Interpretation to Skyscraper

Source: Barrionuevo et. al., in ASCAAD 2004: Spirospaces in Architectural Design

### 3) Main Objectives

- Development in This Work:
  - To explore the principles for constructing generative forms as means to fuel the designer's creativity.
  - To support designers with a simple tool that create shapes computationally based on Spirolateral grammar and rules.
  - To explore design ideas in a creative process without the need to write complex computer program.
  - To take advantage of a Building Information Modelling (BIM) environment and integrate it with this development and framework.

### 3) Main Objectives

- What is BIM:
  - Building Information Modelling (BIM) is the new generation of CAD tools.
  - All building design information (graphical and nongraphical) are stored in on Central file.
  - (Mis)Understanding BIM: every building element is described once.
  - Each 2D/3D element has ONE intelligent representation and behaviour.
  - BIM is a new process in architectural design.

## 3) Main Objectives

• What is BIM:

BIM Working Environment



### 4) ArchiGen Tool Development

#### Language and Steps for Creating 3D Spirolateral

Steps	Description	3D View (fixed height)	<b>3D View (random height)</b>
<b>Step (1)</b> Initial Shape or Piece	Specify starter piece shape such as rectangle (width, length, and height)		
Step (2) One Module	Rotate two duplicates of starter piece at 90° with increasing width/length ratios around centre point		
Step (3) One Element (open Spirolateral)	Replicate one entire Module by rotating three time at 45°		*
<b>Step (4)</b> Two Elements ( <i>open</i> <i>Spirolateral</i> )	Group of two and three Element created by rotating one Module at 90°		
<b>Step (5)</b> Three Elements ( <i>open</i> <i>Spirolateral</i> )			
<b>Step (6)</b> Four Elements ( <i>closed</i> <i>Spirolateral</i> )	A closed Spirolateral is defined by creating a group of four modules.		

ASCAAD 2007, Alexandria, Egypt, November 28-30

1 7

 $\Theta \Theta \Theta$ 



### 4) ArchiGen Tool Development

• Implementing and Exploring ArchiGen Tool



The general site and location for the design scheme.



#### Proposed Phases & Approach for creating & transforming the building form into BIM model

Phase	Description	Representation
<b>Phase (1):</b> Initial Shape Selection	Designer select starter shape which can be either in the available interface or User Defined. The designer then interacts with ArchiGen to place the initial shape within the site boundary.	
<b>Phase (2):</b> Spiro- Shape Configuration	Designer configures the Spiro- Shape by applying ArchiGen generative rules such as: piece count, rotation, X & Y offsets, module rotation,	

#### Proposed Phases & Approach for creating & transforming the building form into BIM model

Phase	Description	Representation
<b>Phase (3):</b> Spiro- Shape Transformation	A basic form is selected. The designer utilizes ArchiCAD environment to manually re-evaluate the resulting form. The designer re-defines the 3D form by applying: Stretching the form to site constraints, Boolean operations, add/remove horizontal & vertical circulation, etc.	
<b>Phase (4):</b> Define Architectural Character	Designer utilizes ArchiCAD BIM components to realize the architectural character for the building. For example, objects like: Wall, Curtain Systems, Floor slabs, and structural elements.	



4/8









#### 6) Summary and Discussion

- Approach aims at exploring architectural forms using Generative rules using ArchiGen tool.
- Designers interact with the tool via a GDL object.
- The architectural character is anticipated at initial shape configuration phases to produce multiple ideas/solutions..
- Visualization of different design ideas was improved while working within BIM environment.
- Advantage as result of linking schematic concept model to produce developed design.