

Naim Korqa

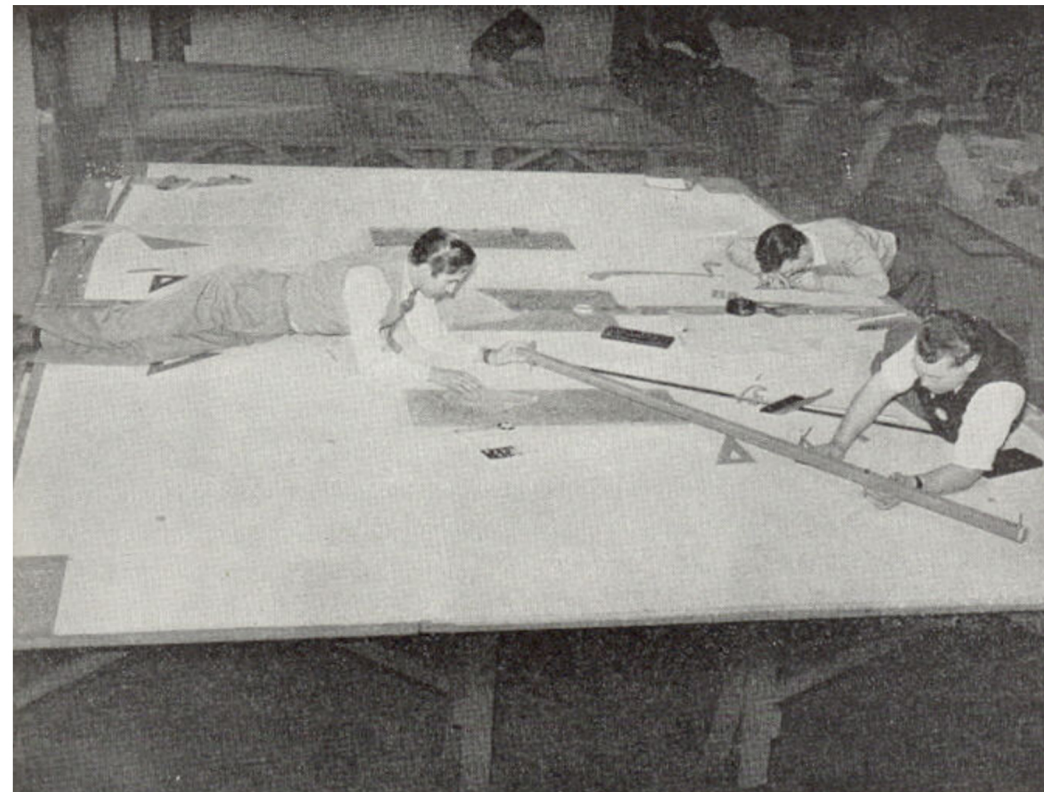
GENERATIVE DESIGN FOR BIM

Its Influence in the Design Process

November 2015



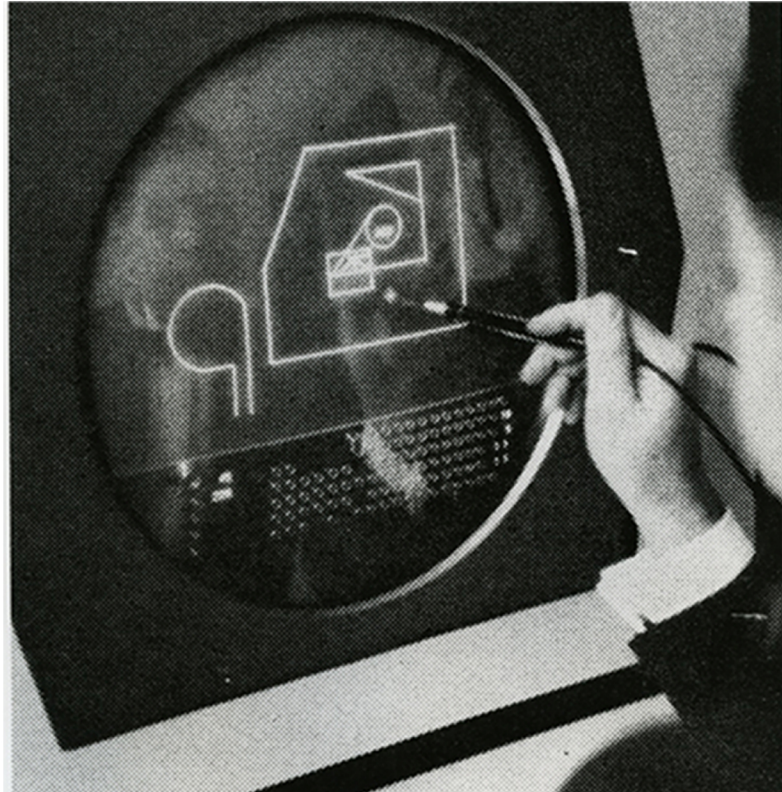
Introduction



Computer Aided Design (CAD)



Computer Aided Design



MIT Sketchpad program, ca.1965



Keith Bentley begins selling MicroStation

CAD + Scripting



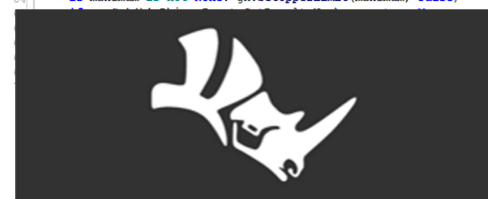
```
65  
66 (setq 1point (polar base_point (deg->rad 270.0) (/ int_support_diameter 2.1  
67 (setq 2point (polar base_point (deg->rad 270.0) (/ ext_feet_diameter 2.0))  
68 (command "...line" 1point 2point ""))  
69 (setq 1l (entlast))  
70 (command "...mirror" (ssadd (entlast)) "" base_point 2mirror_point "_N")  
71 (setq 12 (entlast))  
72  
73 (setq base_point2 (polar base_point (deg->rad 0.0) feet_thickness))  
74 (setq 1point (polar base_point2 (deg->rad 270.0) (/ ext_support_diameter 2.  
75 (setq 2point (polar base_point2 (deg->rad 270.0) (/ ext_feet_diameter 2.0))  
76 (command "...line" 1point 2point ""))  
77 (setq 13 (entlast))  
78 (command "...mirror" (ssadd (entlast)) "" base_point 2mirror_point "_N")  
79 (setq 14 (entlast))  
80  
81 (setq base_point2 (polar base_point2 (deg->rad 0.0) int_support_height))  
82 (setq 1point base_point2)  
83 (setq 2point (polar base_point2 (deg->rad 270.0) (/ int_support_diameter 2.  
84 (command "...line" 1point 2point ""))  
85 (setq 15 (entlast))  
86 (command "...mirror" (ssadd (entlast)) "" base_point 2mirror_point "_N")  
87 (setq 16 (entlast))
```



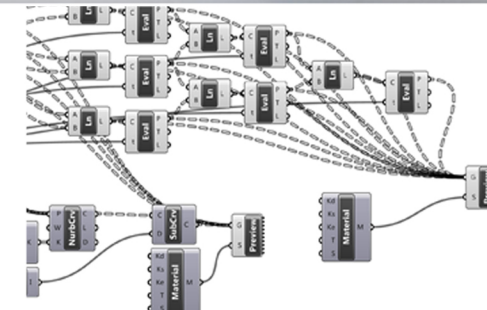
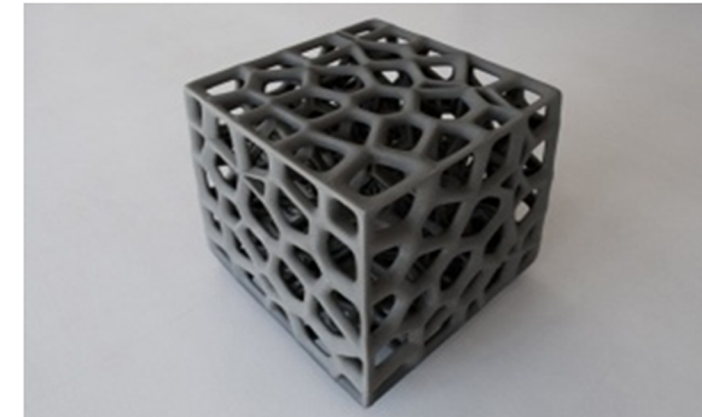
AUTOLISP - AUTOCAD



```
44 (setq prevPoint = gp.Point()  
45 (setq rc (append (prevPoint)  
46 (return rc)  
47 )  
48 )  
49  
50 def GetReal(message="Number", number=None, minimum=None, maximum=N  
51  
52 """Pauses for user input of a number.  
53  
54 Parameters:  
55 message [optional] = A prompt or message.  
56 number [optional] = A default number value.  
57 minimum [optional] = A minimum allowable value.  
58 maximum [optional] = A maximum allowable value.  
59  
60 Returns:  
61 The number input by the user if successful.  
62 None if not successful, or on error  
63  
64 """  
65  
66 gn = Rhino.Input.Custom.GetNumber()  
67 if message: gn.SetCommandPrompt(message)  
68 if number is not None: gn.SetDefaultNumber(number)  
69 if minimum is not None: gn.SetLowerLimit(minimum, False)  
70 if maximum is not None: gn.SetUpperLimit(maximum, False)
```



RHINOSCRIPT-RHINOCEROS

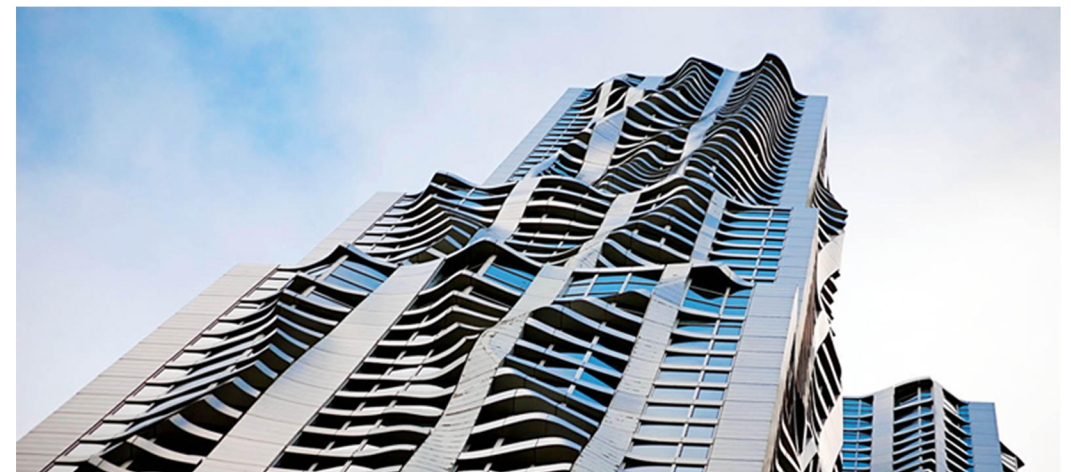


GRASSHOPPER-RHINOCEROS

Building Information Modeling (BIM)



FOUNDATION LOUIS VUITTON



BEEKMAN TOWER

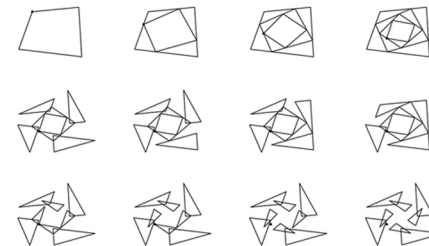
Building Information Modeling

BIM advantages:

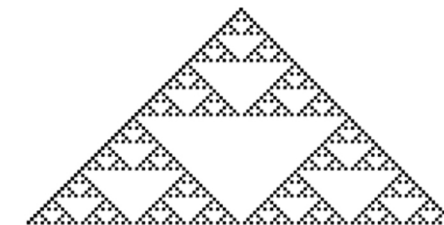
- 2D drawing & 3D model
- project information
- energy analyses
- collaborative design
- scheduling
- clash detection
- cost estimation



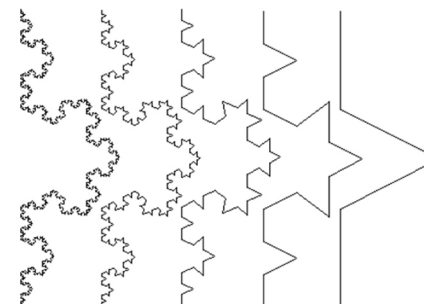
Generative Design (GD)



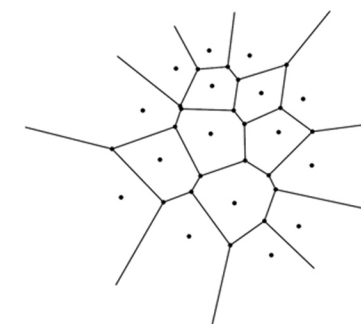
Shape Grammar



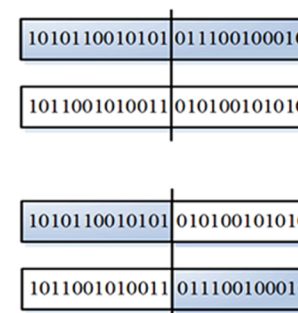
Cellular Automata



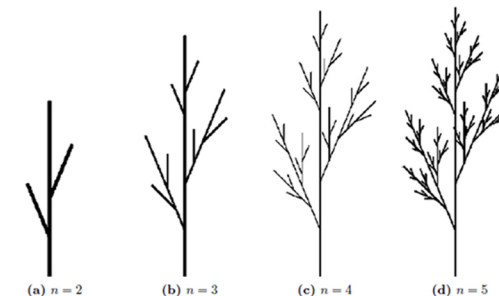
Fractals



Voronoi Diagramas

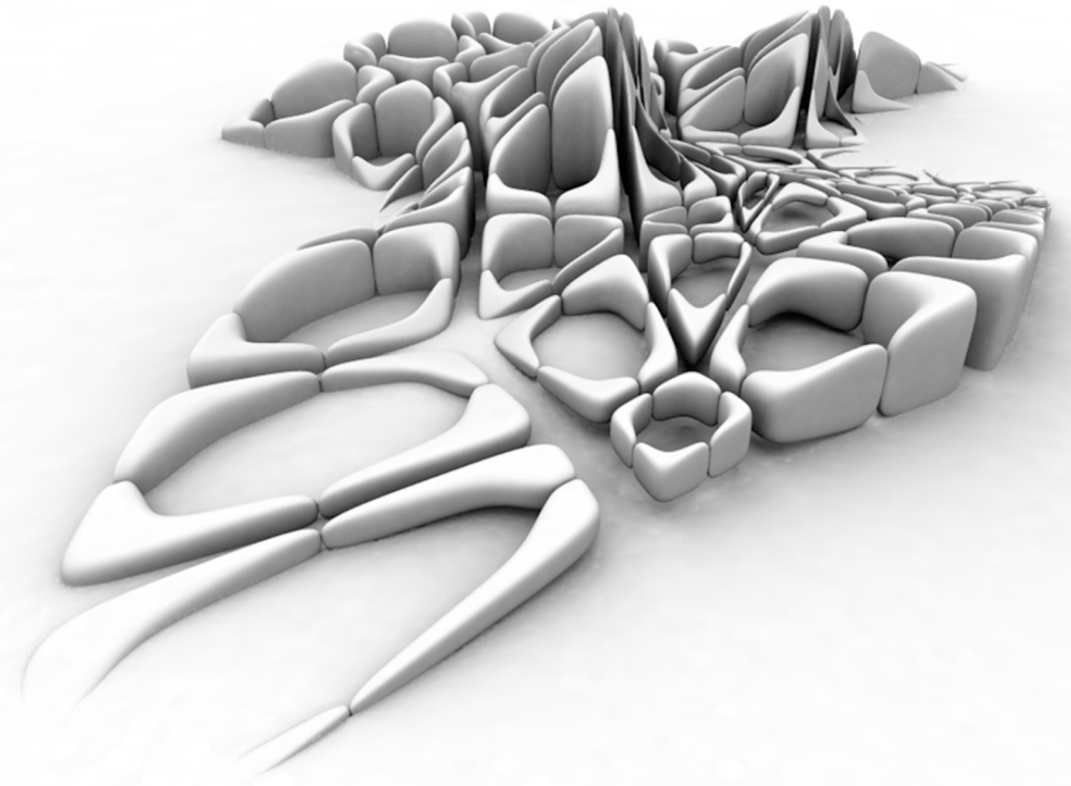


Genetic Algorithms

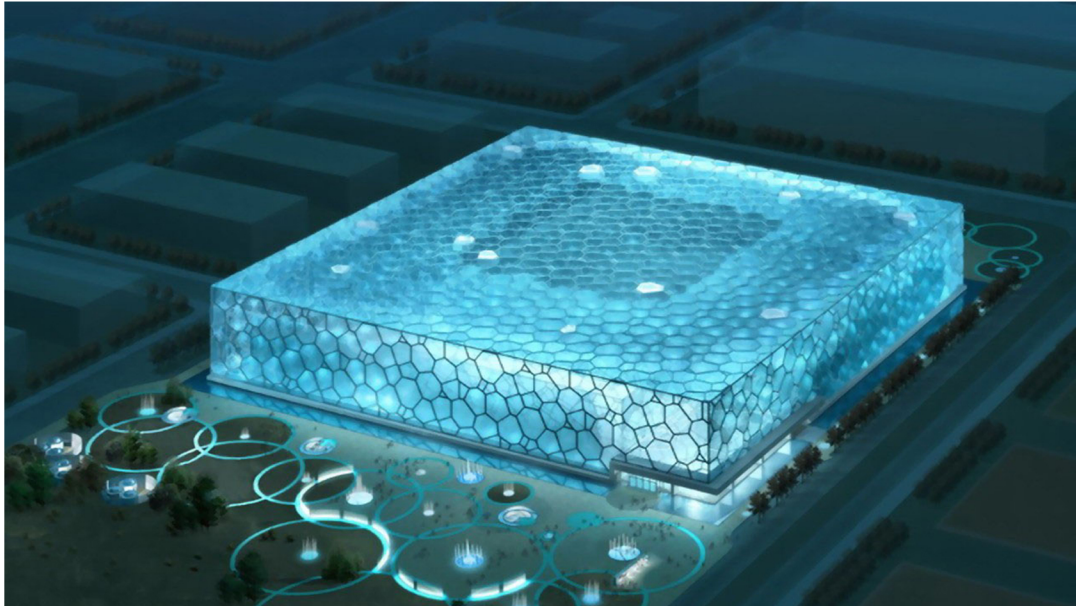


L-systems

Generative Design + BIM



Generative Design + BIM

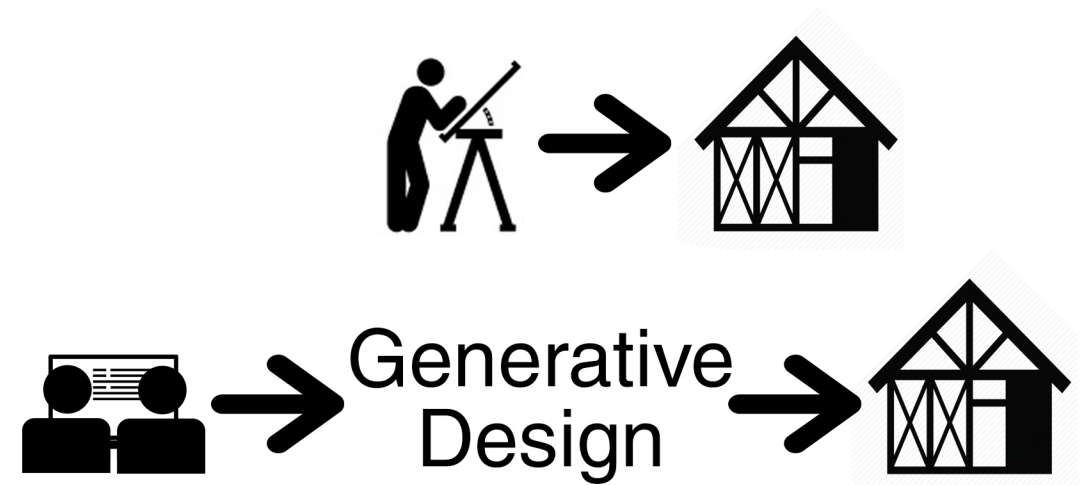


BEIJING NATIONAL AQUATIC CENTER
Architect: PTW architects & OVE Arup

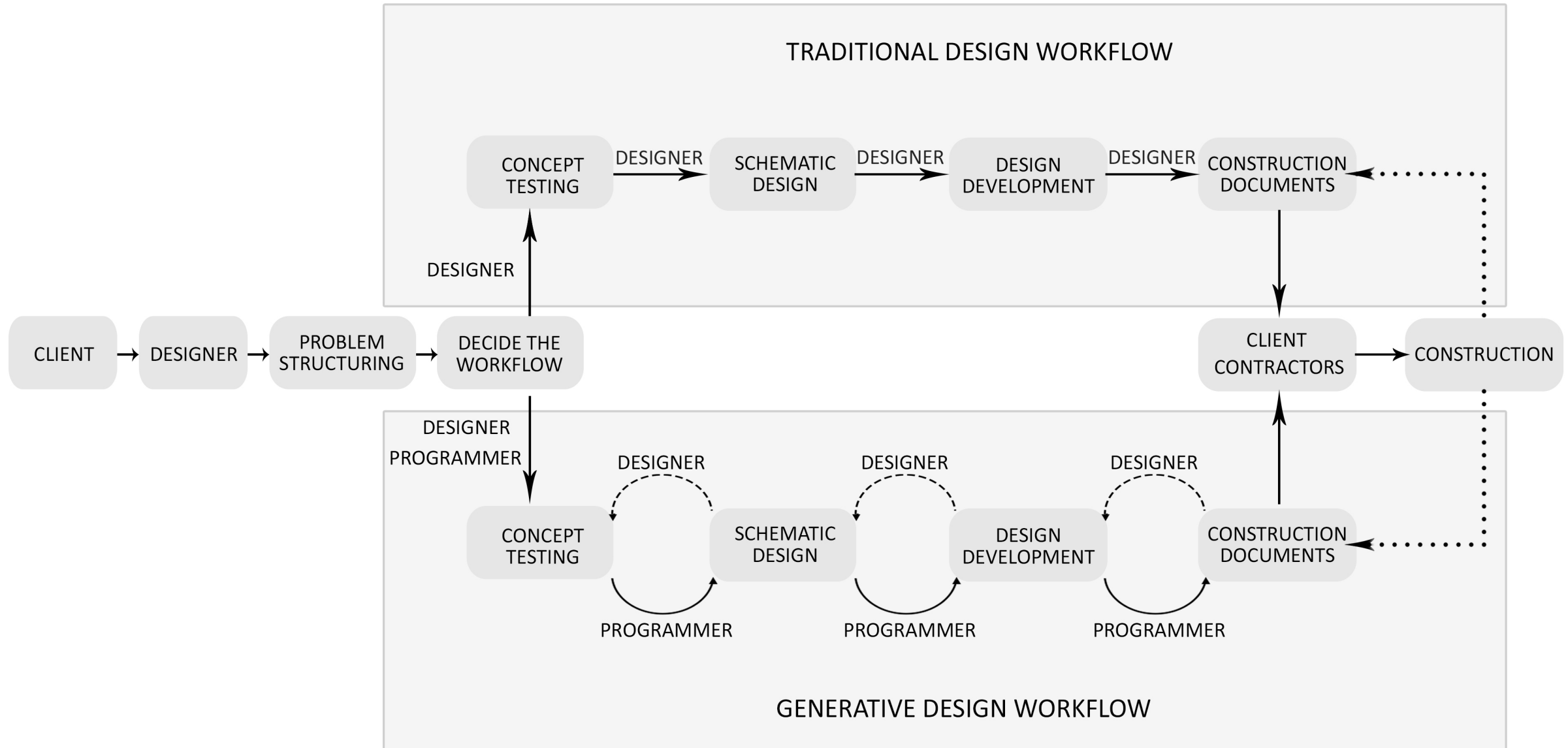


AVIVA STADIUM
Architect: Populous & Scott Tallon Walker

NEW WORKFLOW IN THE DESIGN PROCESS



NEW WORKFLOW IN THE DESIGN PROCESS



NEW WORKFLOW IN THE DESIGN PROCESS

Complexity depends on the:

- amount of description
- amount of elements needed
- time and effort involved
- number of elements in a system
- number of types of elements
- interrelationship between elements
- hierarchical relationships
- variety of modes of operation

Scale factors:

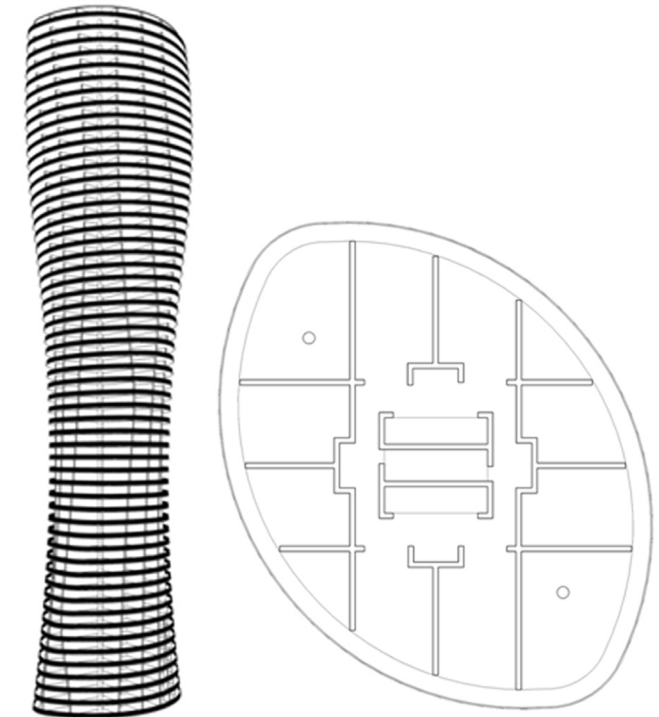
- type of program
- project duration
- client and
- project cost

	SMALL SCALE	BIG SCALE
NON-COMPLEX	BIM	BIM+Macro
COMPLEX	GD+BIM	GD+BIM

EVALUATION



EVALUATION

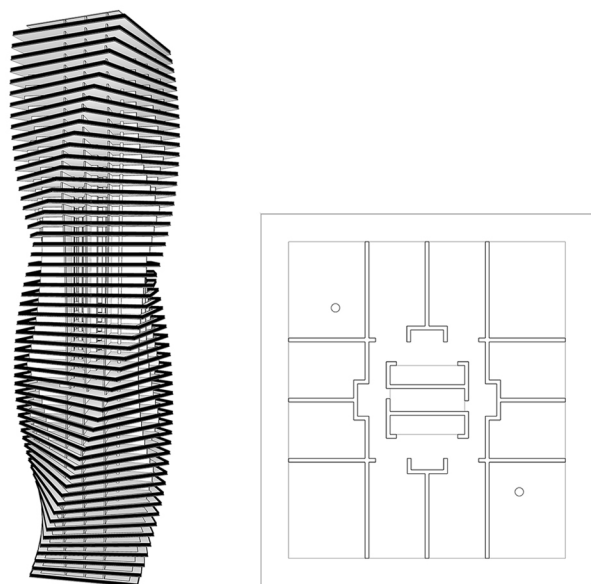


Absolute Towers exterior image/ plan

Production of the model

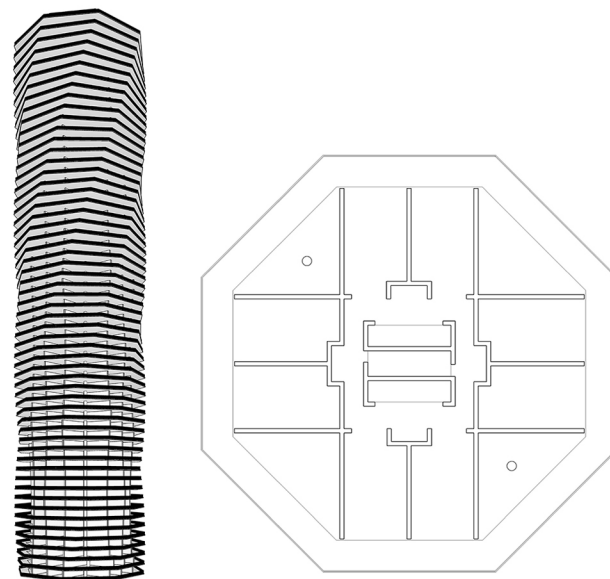
BIM	GD
2h 14 min	14 h

EVALUATION



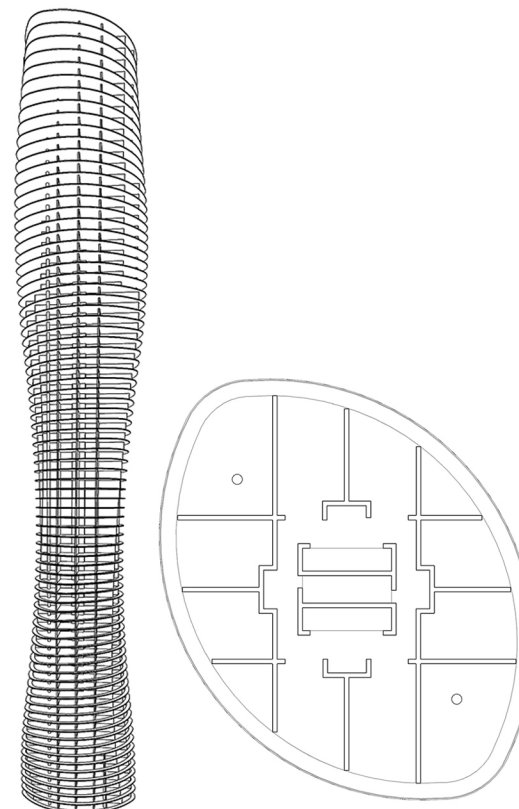
rectangle slab shape

BIM	GD
1h 25 min	10 min



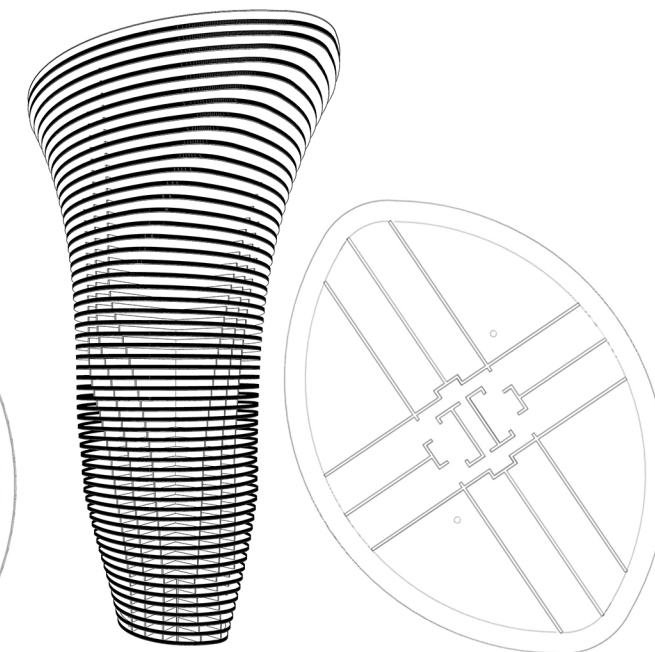
octagonal slab shape

BIM	GD
1h 35 min	11 min



80 levels

BIM	GD
48 min	7 min



increasingly slab area

BIM	GD
1h 52 min	4 min

CONCLUSION

- conceptual freedom to make changes
- more solutions and alternatives
- high performance design