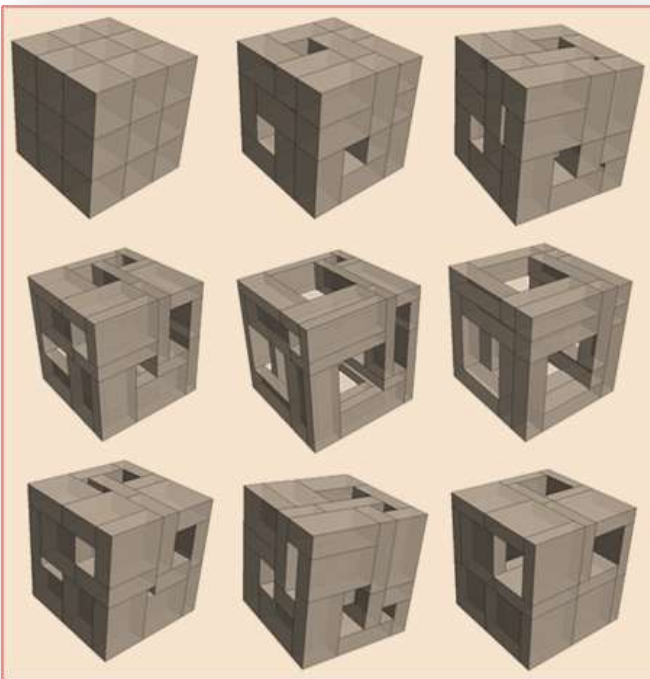


The Box Packing

As a mathematical concept
interpreted architecturally



Doc. dr Mirjana Devetaković, dipl. ing. arh.

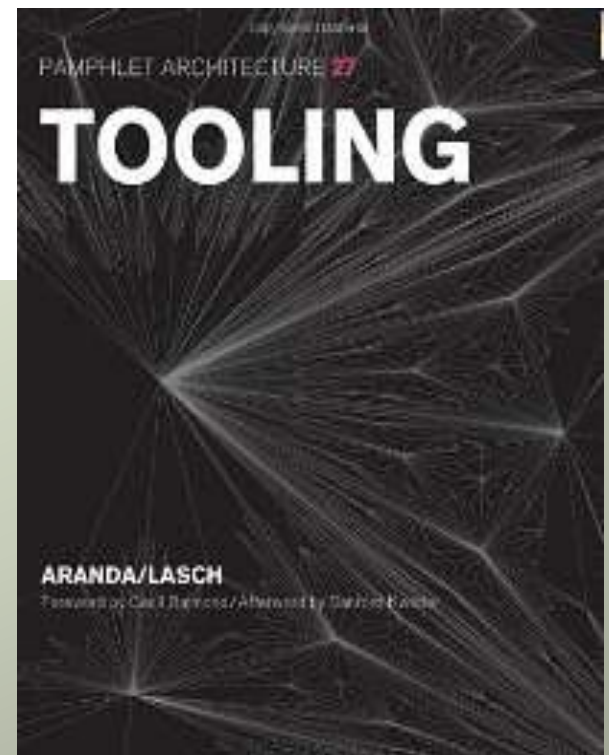
Prof. dr Ljiljana Petruševski, dipl. mat.

Jelena Kijanović, dipl.mat.

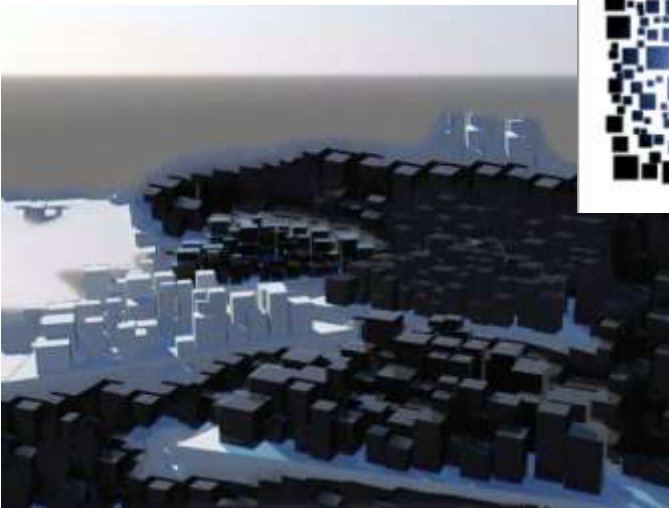
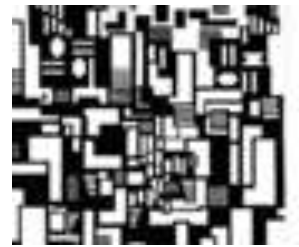
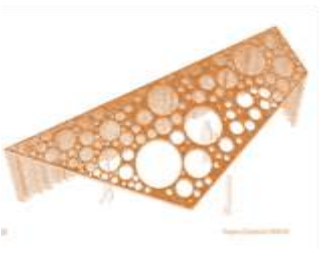
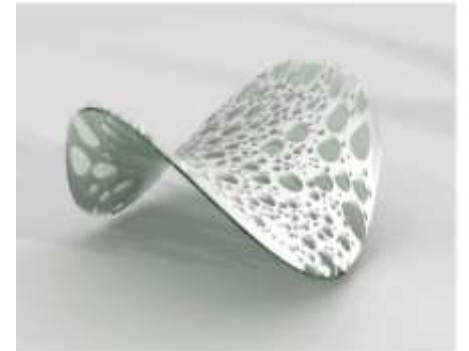
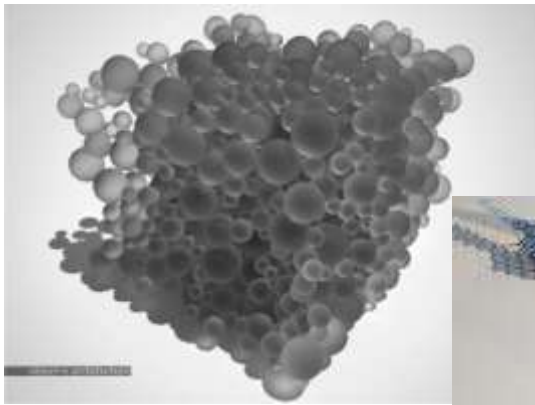
Exploration of Tooling, Benjamin Aranda and Christopher Lash

Seven generative concepts:

- Spiraling
- **Packing**
- Weaving
- Blending
- Cracking
- Flocking
- Tiling



The Packing concept

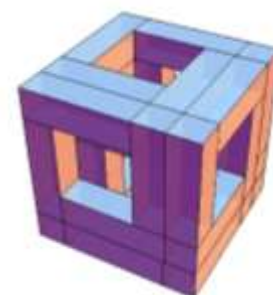
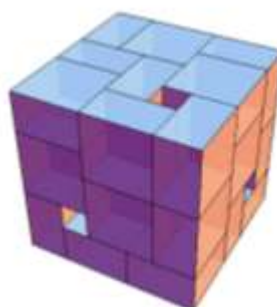
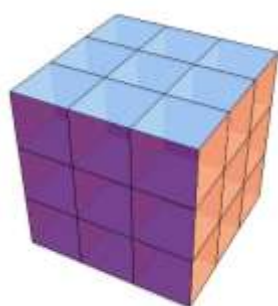
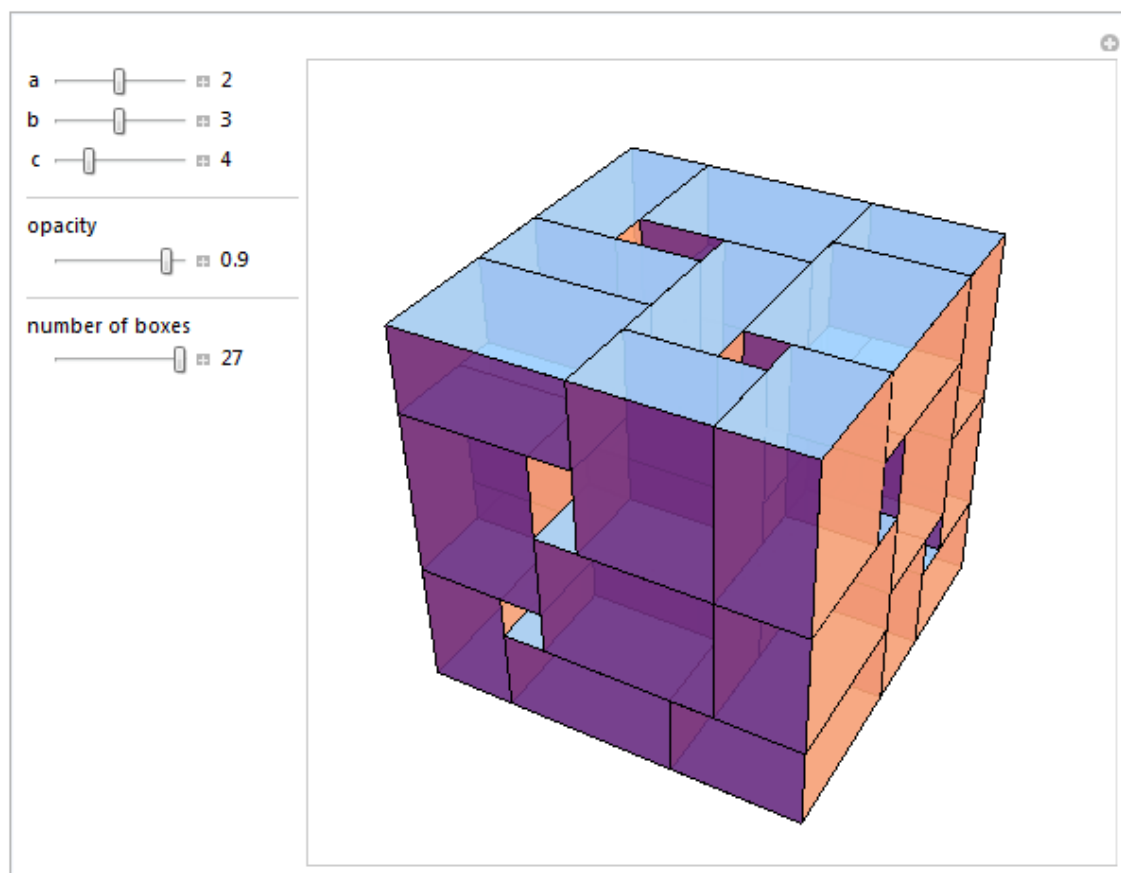


The Box Packing within the Wolfram Demonstration projects

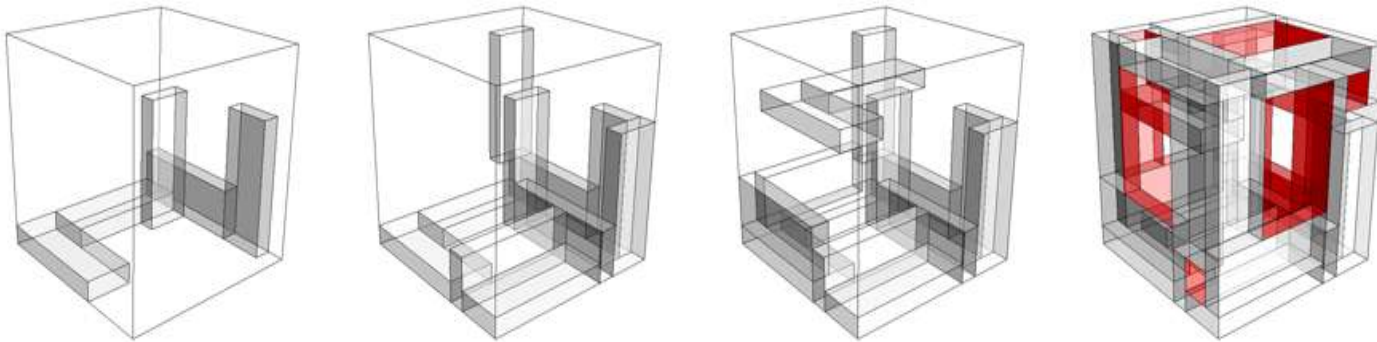
Wolfram Demonstrations Project

demonstrations.wolfram.com »

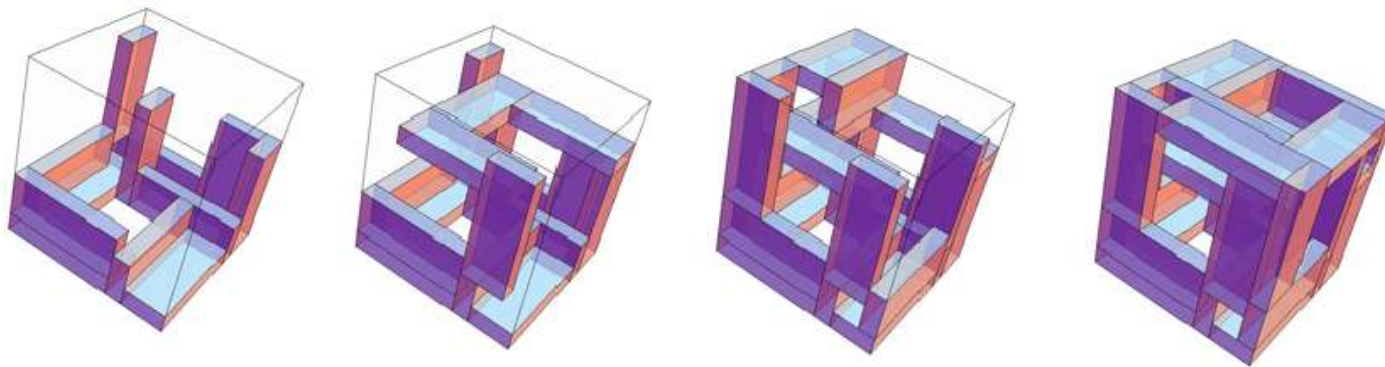
Box Packing



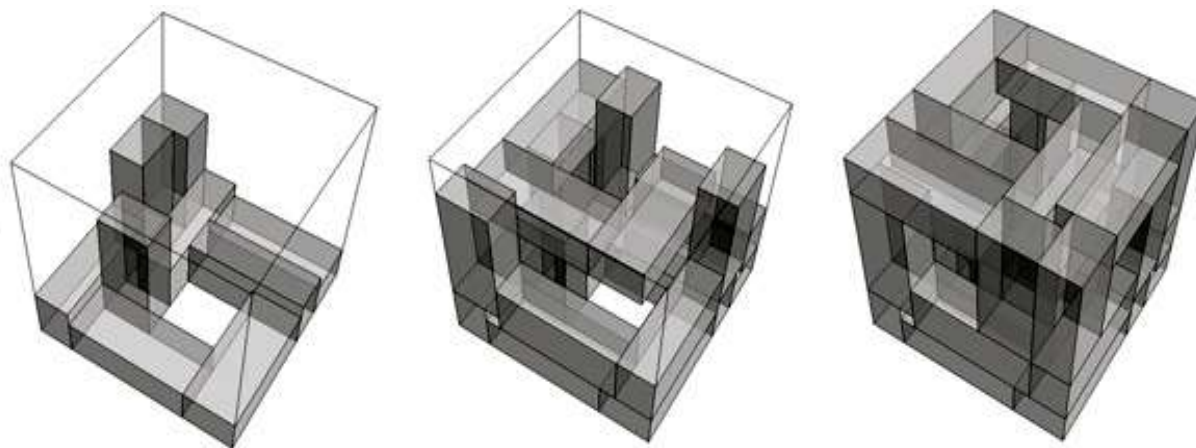
27 identical cubic elements changing their proportions



$a = 1$
 $b = 2,6$
 $C = 7$



$a = 1$
 $b = 2,5$
 $C = 6,5$



$a = 1,2$
 $b = 1,7$
 $C = 4$

Box packing. U prvom su seriji labornih predmeta pod nazivom Generička ispitivanja, student istražuje u obliku generiranja forme, bezcrtanog na primeni savremenih matematičkih konceptata. Kurs Generička istraživanja 01 zaključio je sa nastavljeni na predmetu Matematika u arhitekturi 1.

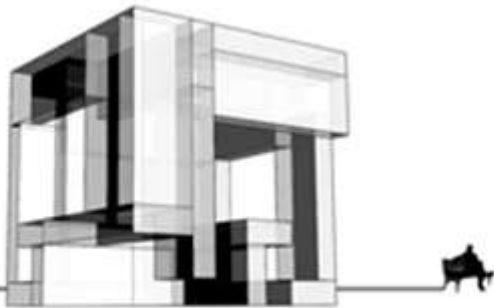
Na slici 1.01 prikazane su etape istraživanja dobijene forme koja se sastoji od 27 identičnih elemenata koji sačinjavaju strukturu kocku. Prikaz se međuvremeno razlikuje po broju elemenata i uglu prikaza kako bi se što bolje videlo i objasnio postupak generiranja ove forme.

Na slici 1.02 videti se prikaz dobijene forme u zamisljivom prostoru. Načelom zapadati da se pomoću Box packing-a mogu dobiti zanimljive arhitektonične forme.

Sl. 1.01



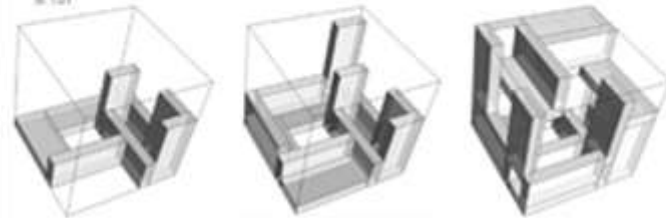
Sl. 1.02



Box packing

Istraživanje prostorne forme slaganjem identičnih elemenata koji formiraju strukturu, a zajedno čine kocku. Maksimalan broj elemenata je 27, a njihov oblik i veličina se mogu menjati promenom parametara a, b i c.

Sl. 1.01



Sl. 1.01
Na slikama je prikazano postepeno formiranje strukture uz pomoć identičnih elemenata, promenom njihovog broja i oblika. Vrednosti parametara:
a = 0.1,
b = 0.3,
c = 0.7.

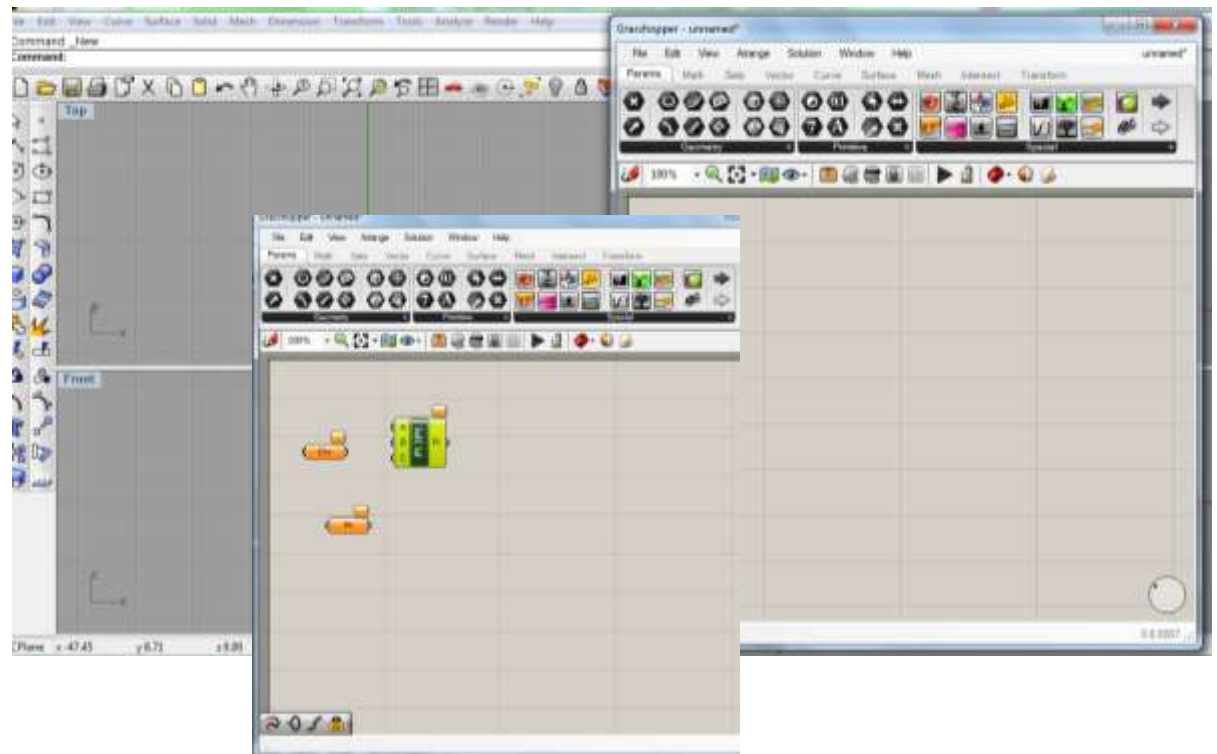
Sl. 1.02
Prikaz strukture dobijene pomoću 19 datih elemenata. Struktura je uklopljena u zamisljivo okruženje tako da može predstavljati arhitektonski objekat.



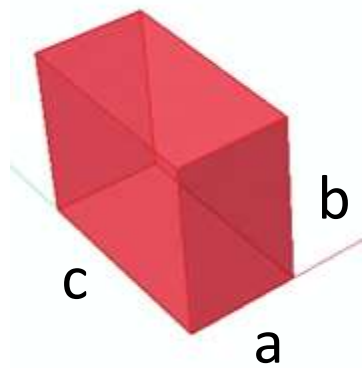
Some students' results of manually packing boxes in Rhino

Grasshopper

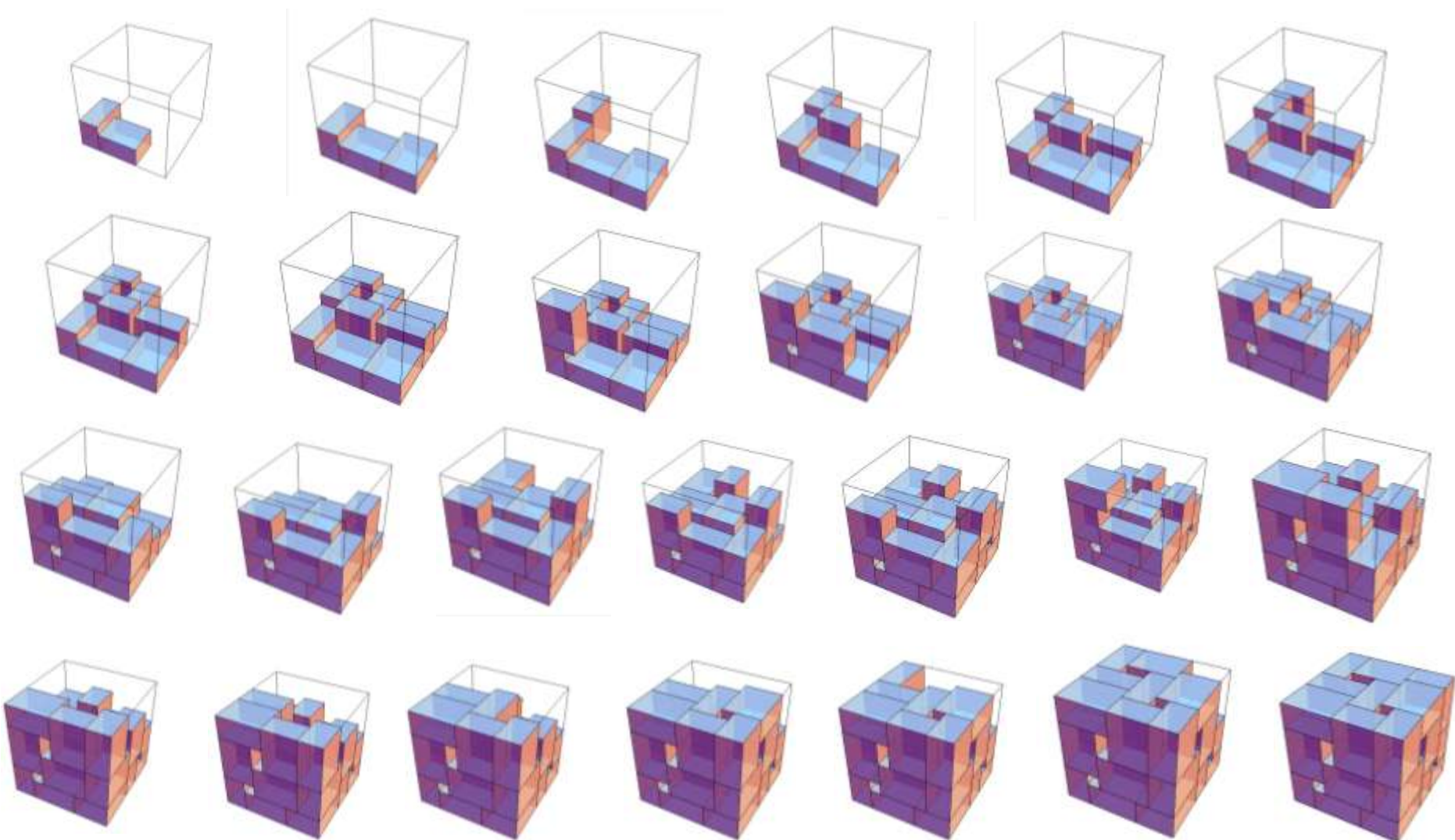
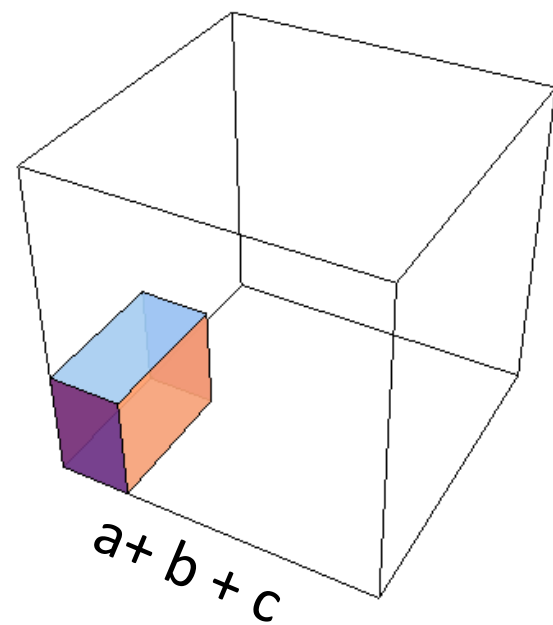
- Rhino plug-in
- Graphical editor
- Algorithm editor
- Parametric modeling in creation of 3D objects
- No need of scripting knowledge
- Building form generators
from the simple to awe – inspiring
- The most common professional architectural tool for
development of generative concepts
- Ability for expert users to extend the system with C# and
Visual Basic

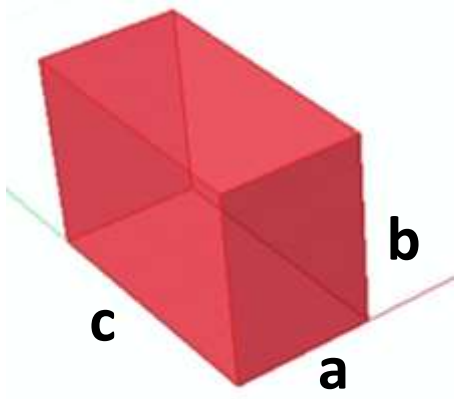


27 identical cubical elements



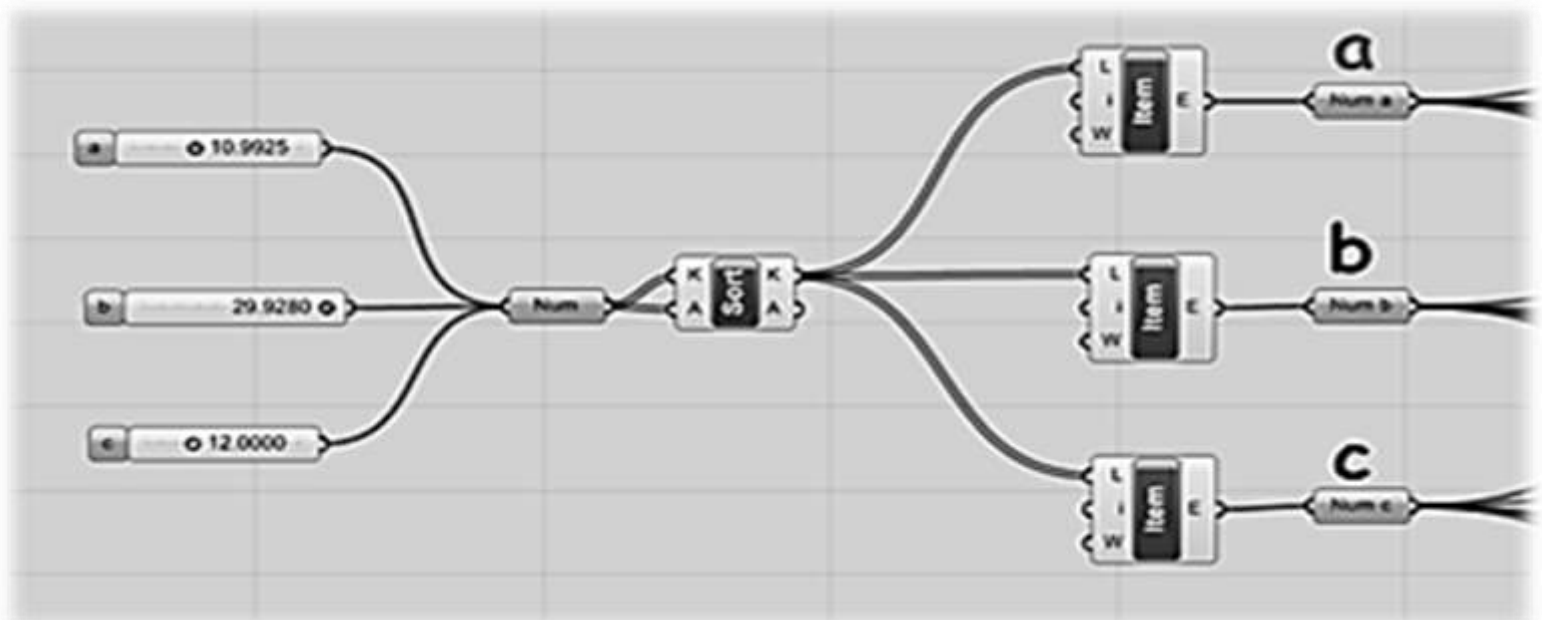
packing →





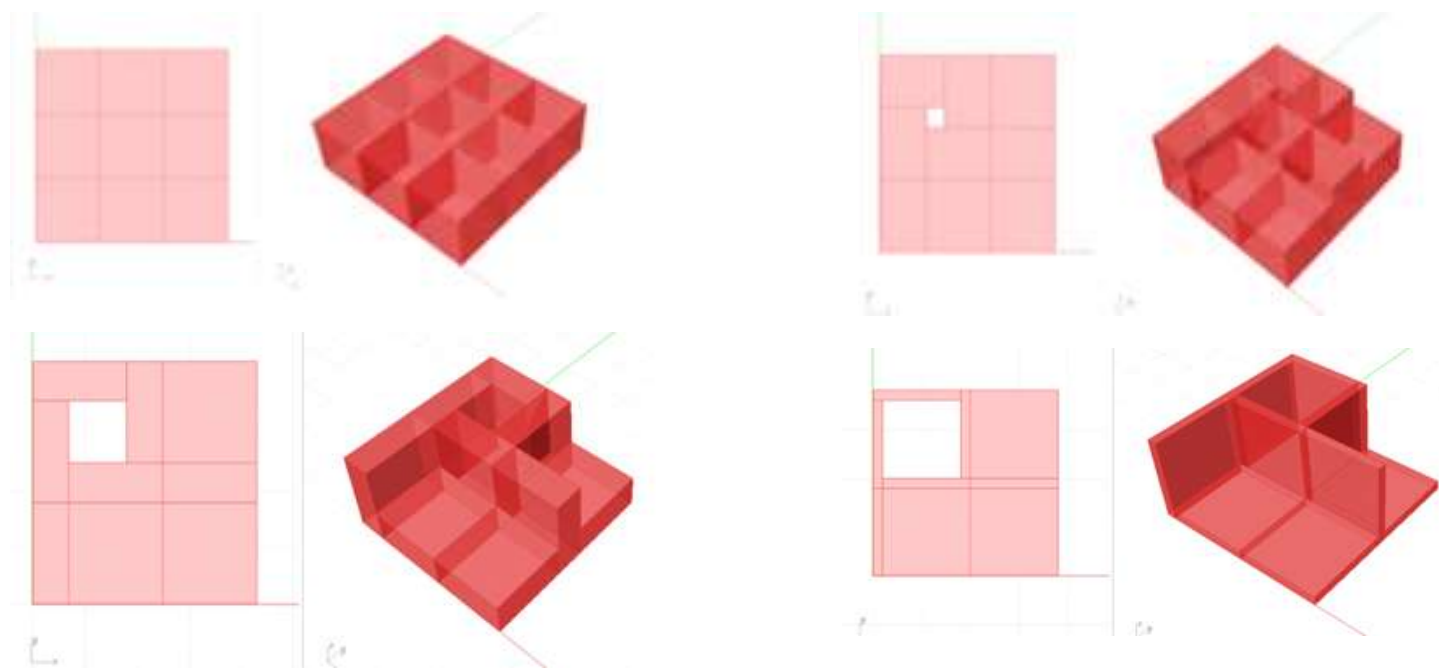
defining conditional relation

$$a < b < c$$

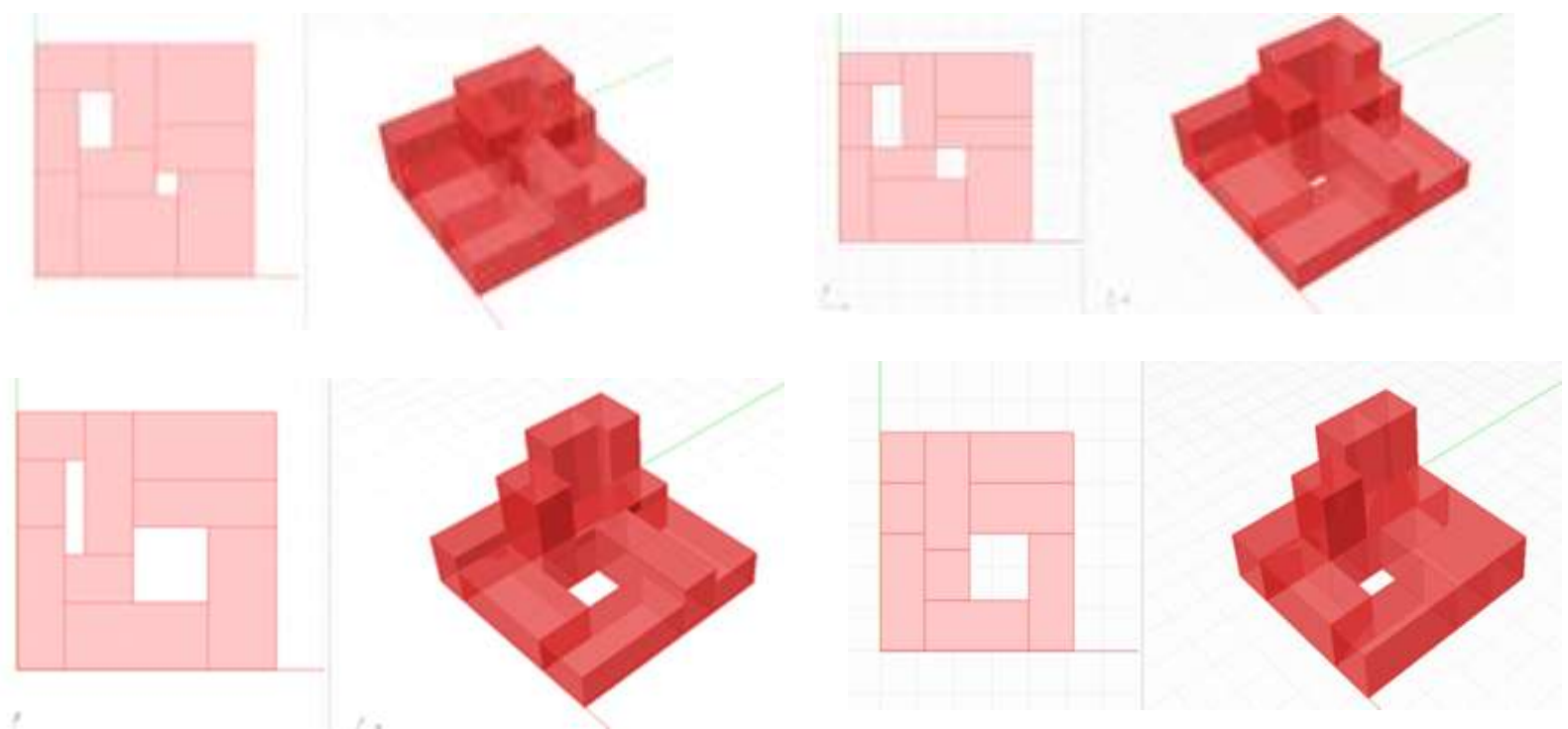


Realization in Grasshopper definition

Decreasing of one of the lowest parameter a



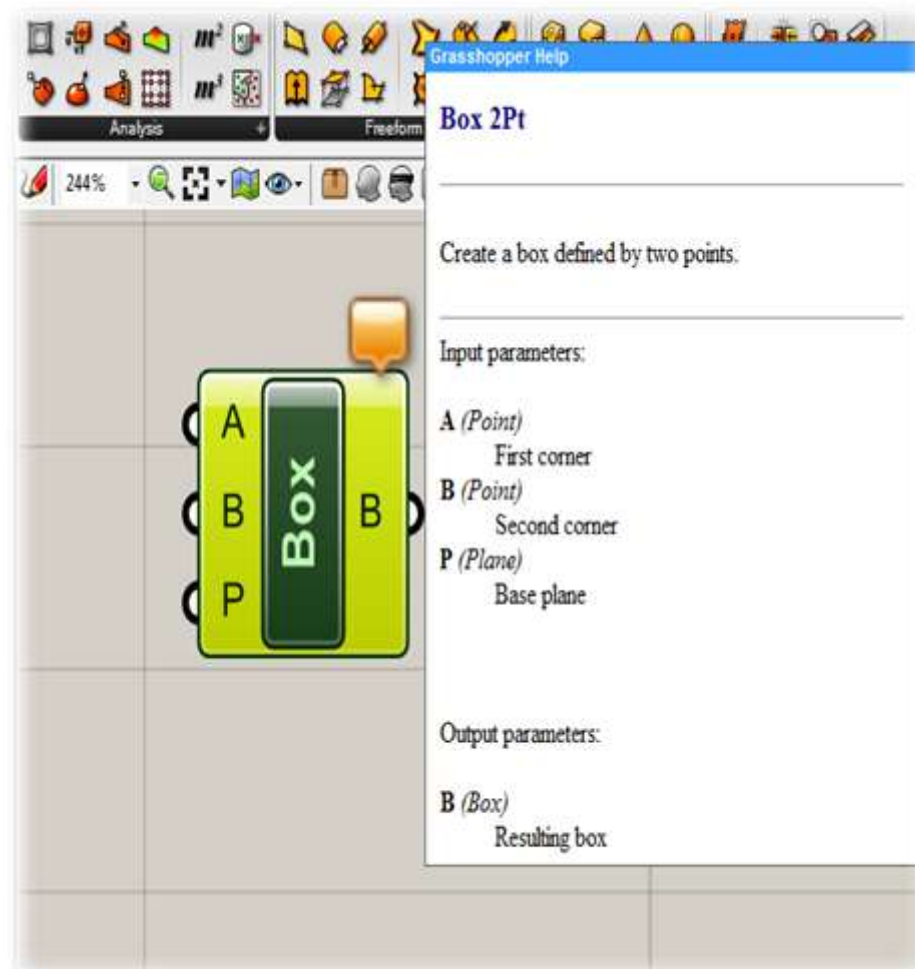
Increasing of the highest parameter c



<u>packed element</u>	comer A (x, y, z)	comer B (x, y, z)
1	(0, 0, 0)	(a, c, b)
2	(a, 0, 0)	(a + c, b, a)
3	(a + c, 0, 0)	(a + b + c, c, a)
4	(0, c, 0)	(a, b + c, a)
5	(a, b, 0)	(a + b, a + b, c)
6	(a + b, c, 0)	(a + b + c, a + c, b)
7	(0, b + c, 0)	(b, a + b + c, c)
8	(b, a + b, 0)	(a + b, a + b + c, b)
9	(a + b, a + c, 0)	(a + b + c, a + b + c, a)

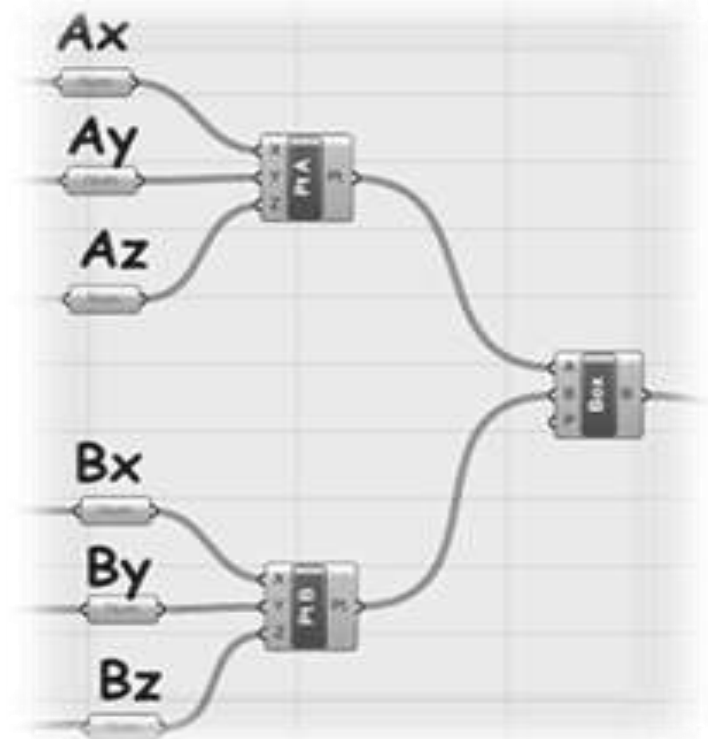
<u>packed element</u>	comer A (x, y, z)	comer B (x, y, z)
10	(0, 0, b)	(b, a, b + c)
11	(b, 0, a)	(b + c, a, a + b)
12	(b + c, 0, a)	(a + b + c, c, a + b)
13	(0, a, c)	(c, a + b, a + c)
14	(c, a, c)	(b + c, a + c, a + c)
15	(b + c, c, b)	(a + b + c, b + c, b + c)
16	(0, a + b, c)	(b, a + b + c, a + c)
17	(b, a + c, b)	(a + b, a + b + c, b + c)
18	(a + b, b + c, a)	(a + b + c, a + b + c, a + b)

<u>packed element</u>	comer A (x, y, z)	comer B (x, y, z)
19	(0, 0, b + c)	(c, b, a + b + c)
20	(c, 0, a + b)	(b + c, a, a + b + c)
21	(b + c, 0, a + b)	(a + b + c, b, a + b + c)
22	(0, b, a + c)	(c, a + b, a + b + c)
23	(c, a, a + c)	(a + c, a + c, a + b + c)
24	(a + c, b, b + c)	(a + b + c, b + c, a + b + c)
25	(0, a + b, a + c)	(a, a + b + c, a + b + c)
26	(a, a + c, b + c)	(a + c, a + b + c, a + b + c)
27	(a + c, b + c, a + b)	(a + b + c, a + b + c, a + b + c)

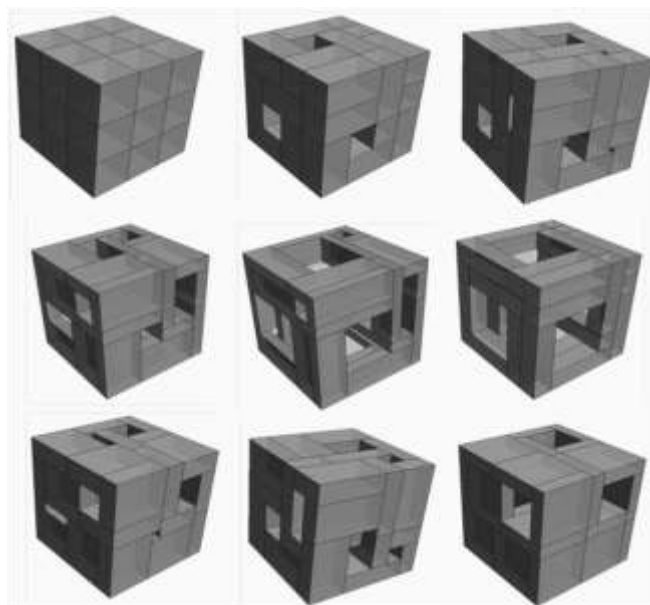
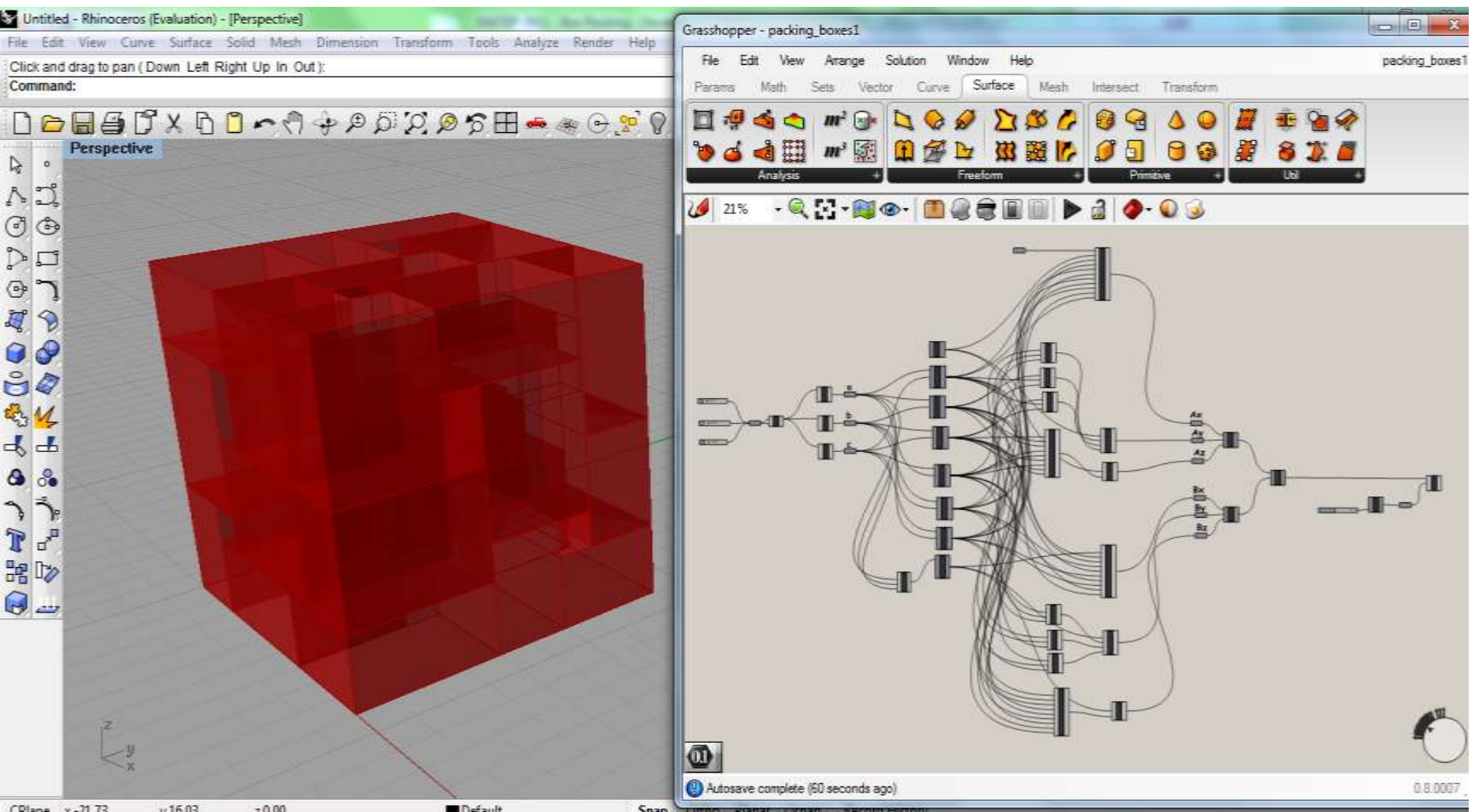


Matching six numerical lists for packing element's corner in definition

	Ax	Ay	Az	Bx	By	Bz
1	0	0	0	a	c	b
2	a	0	0	a+c	b	a
3	a+c	0	0	a+b+c	c	a
4	0	c	0	a	b+c	a
5	a	b	0	a+b	a+b	c
6	a+b	c	0	a+b+c	a+c	b
7	0	b+c	0	b	a+b+c	c
8	b	a+b	0	a+b	a+b+c	b
9	a+b	a+c	0	a+b+c	a+b+c	a
10	0	0	b	b	a	b+c
11	b	0	a	b+c	a	a+b
12	b+c	0	a	a+b+c	c	a+b
13	0	a	c	c	a+b	a+c
14	c	a	c	b+c	a+c	a+c
15	b+c	c	b	a+b+c	b+c	b+c
16	0	a+b	c	b	a+b+c	a+c
17	b	a+c	b	a+b	a+b+c	b+c
18	a+b	b+c	a	a+b+c	a+b+c	a+b
19	0	0	b+c	c	b	a+b+c
20	c	0	a+b	b+c	a	a+b+c
21	b+c	0	a+b	a+b+c	b	a+b+c
22	0	b	a+c	c	a+b	a+b+c
23	c	a	a+c	a+c	a+c	a+b+c
24	a+c	b	b+c	a+b+c	b+c	a+b+c
25	0	a+b	a+c	a	a+b+c	a+b+c
26	a	a+c	b+c	a+c	a+b+c	a+b+c
27	a+c	b+c	a+b	a+b+c	a+b+c	a+b+c

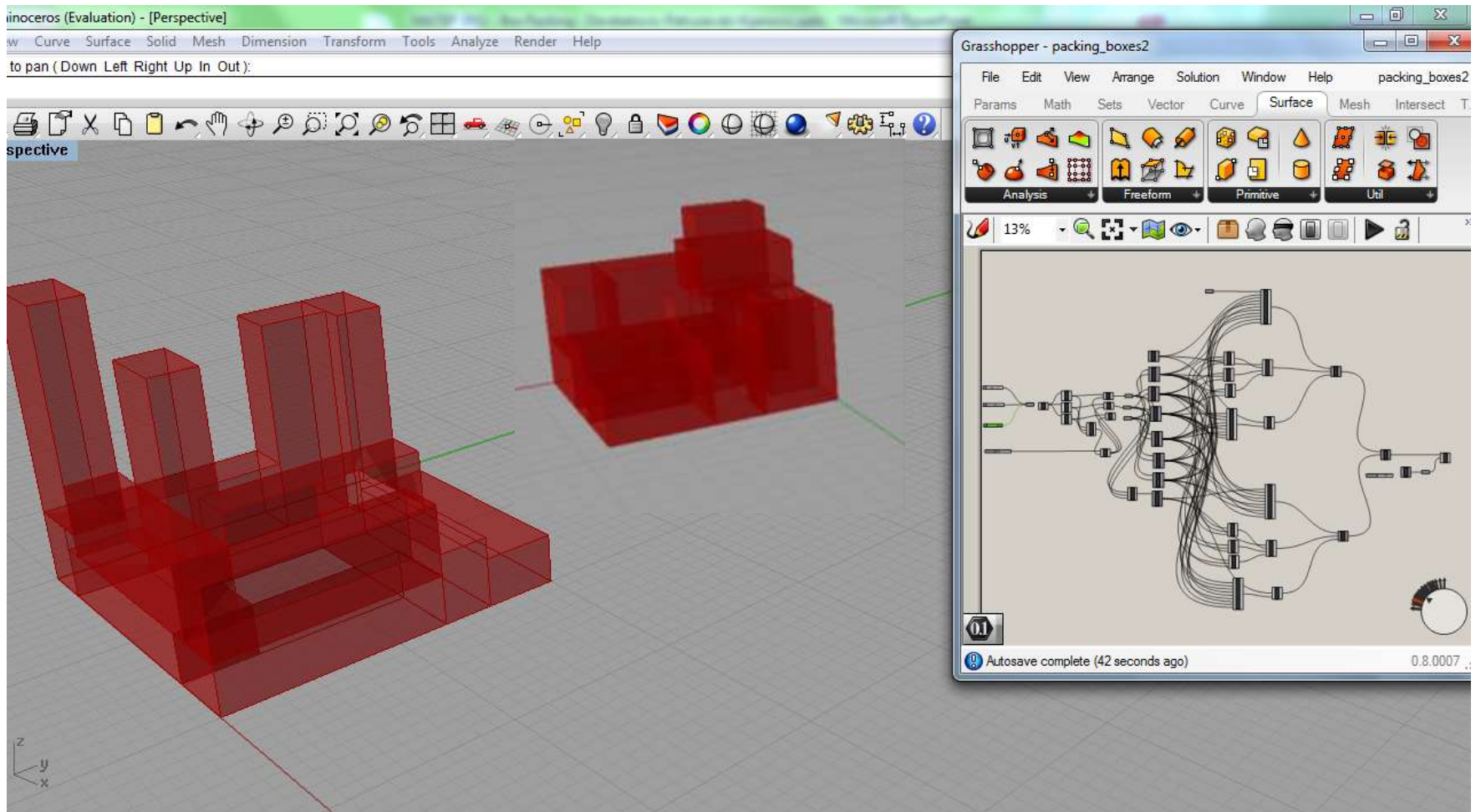
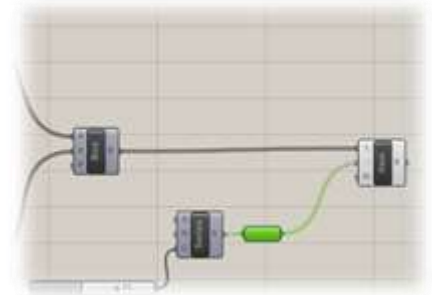


Final possible effects of initial Grasshopper definition



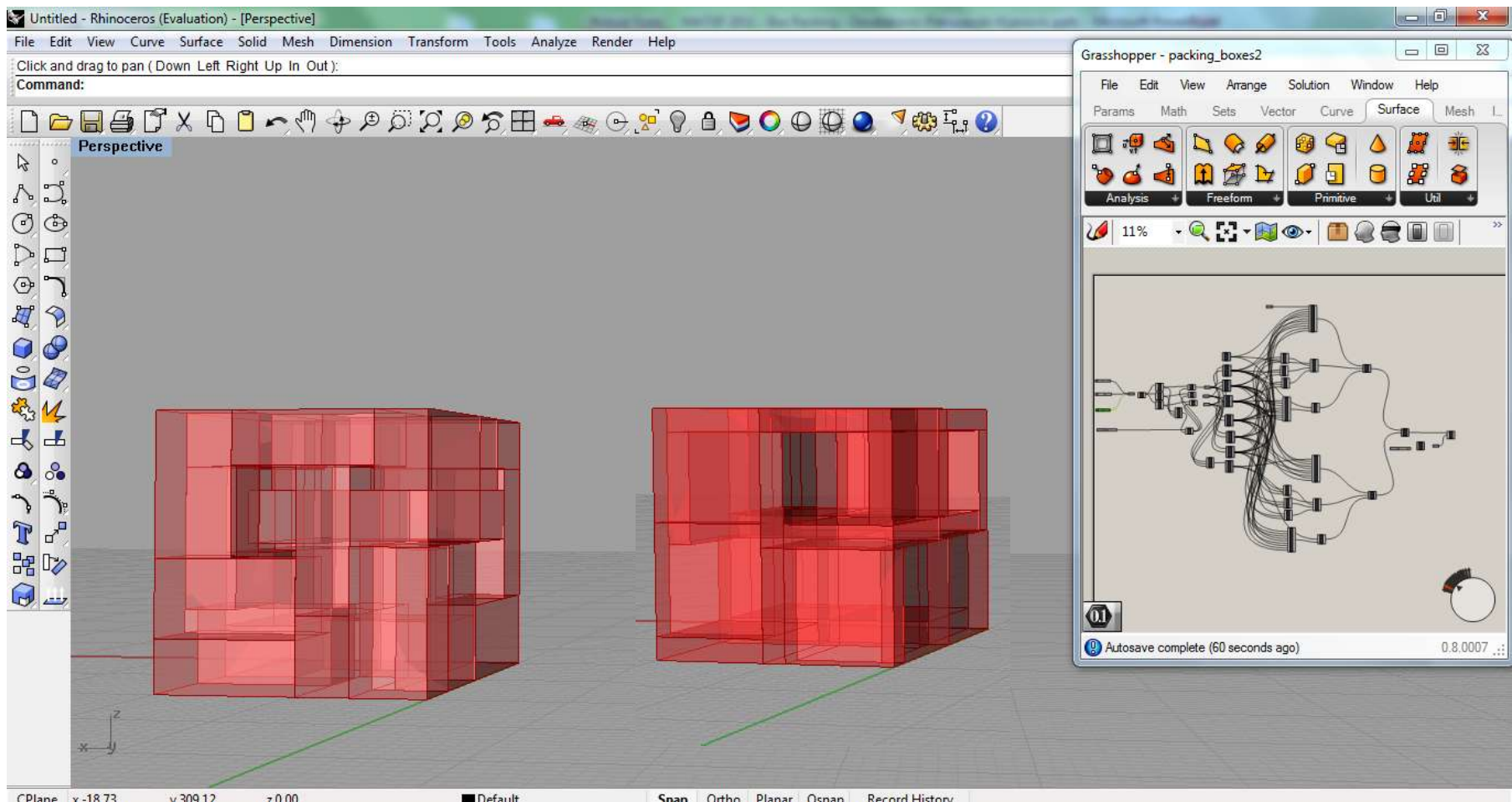
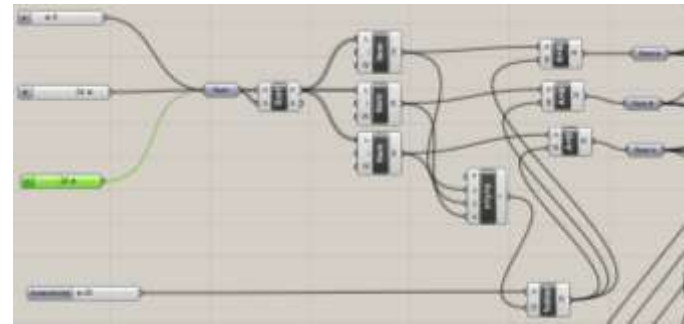
Modification and extending of initial definition

1. Varying number of backed elements



Modification and extending of initial definition

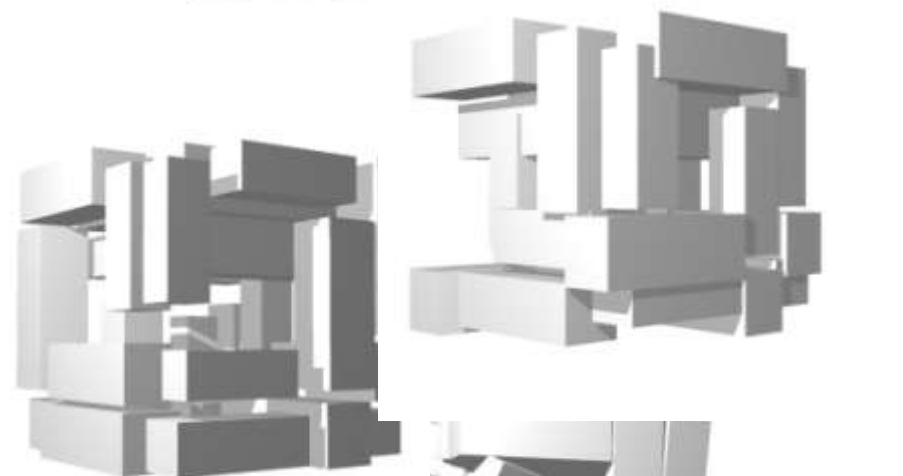
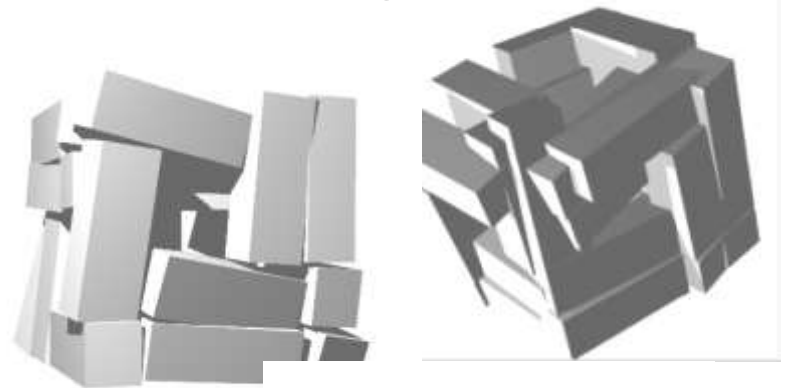
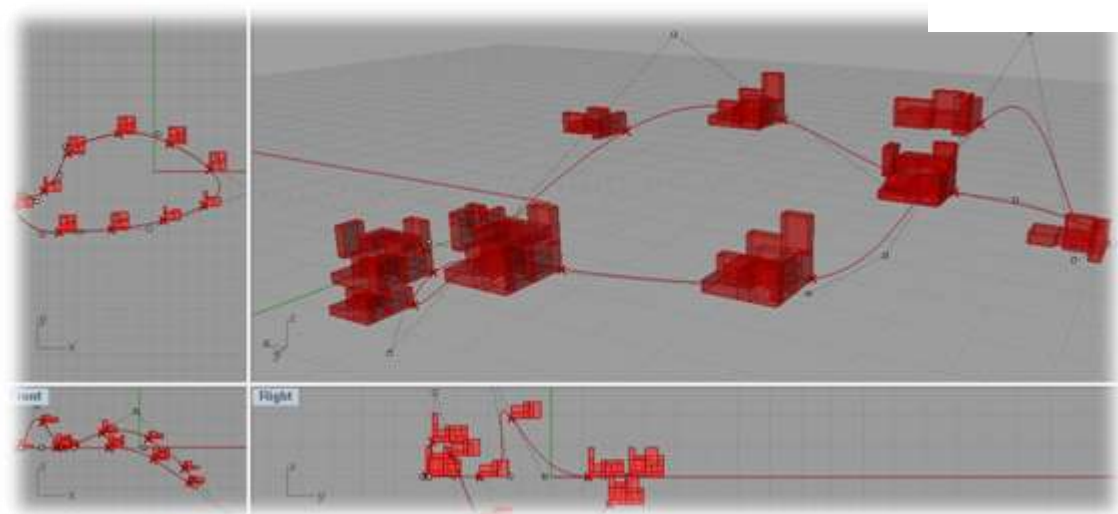
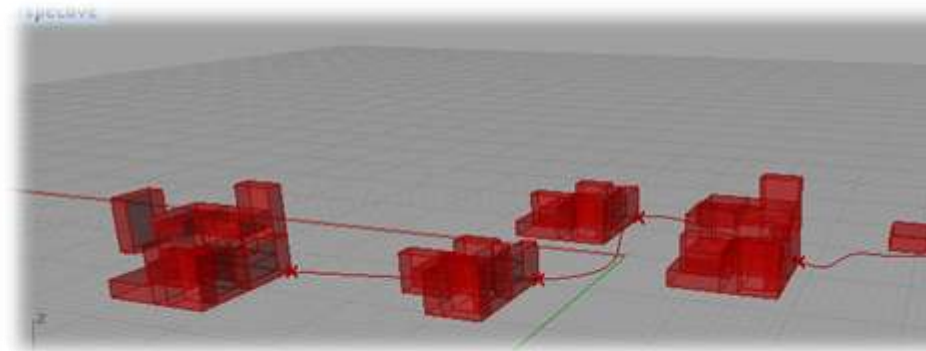
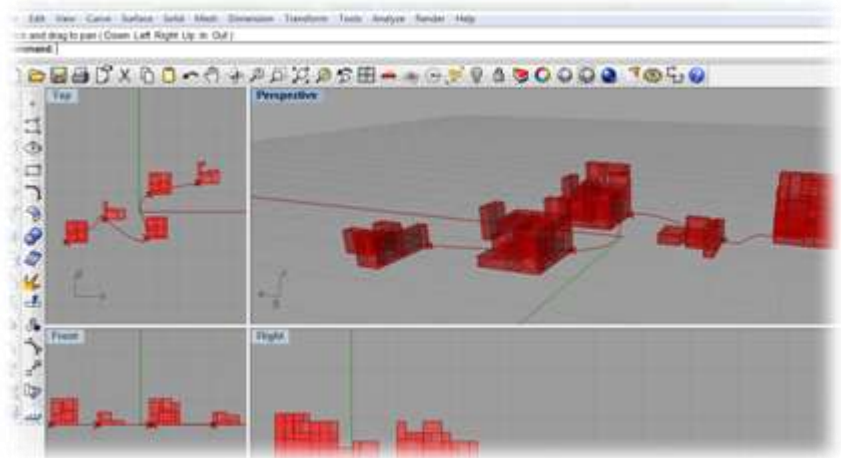
2. Varying the size of body keeping measure $a+b+c$





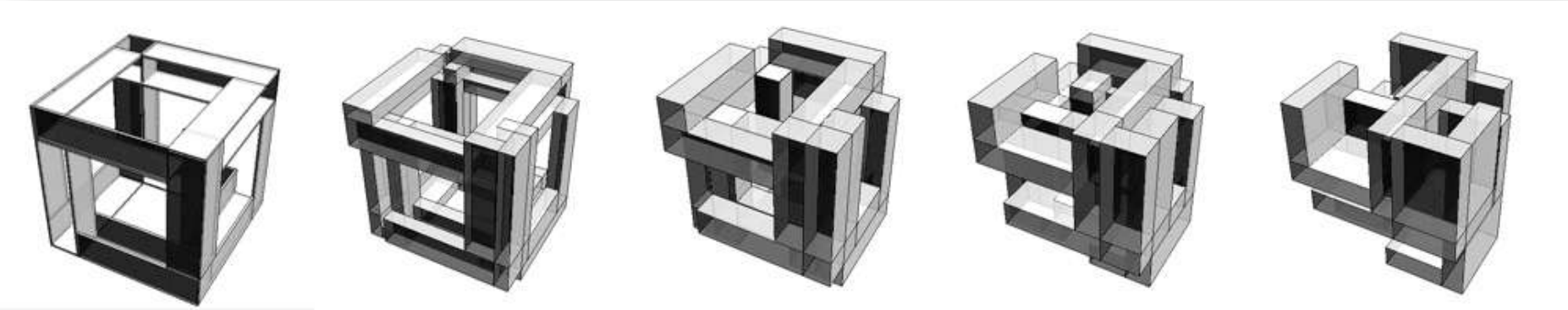
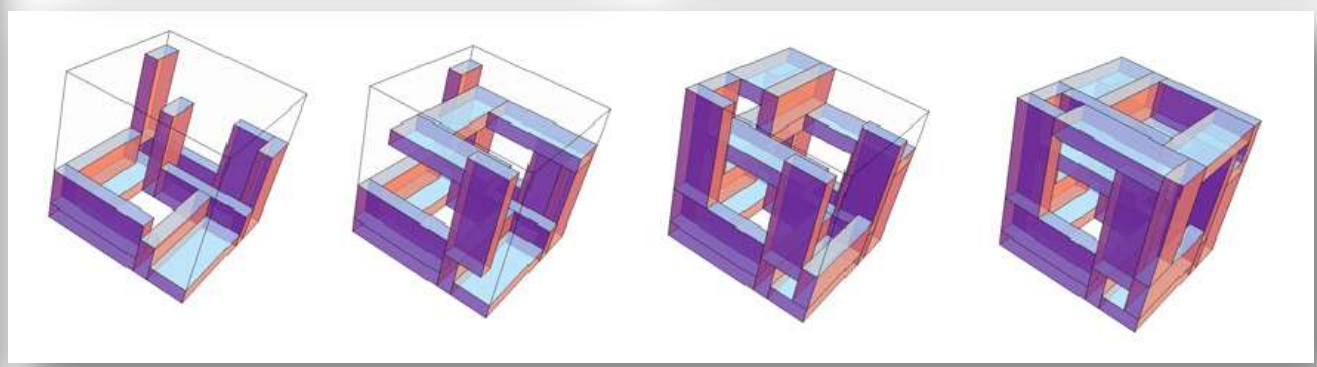
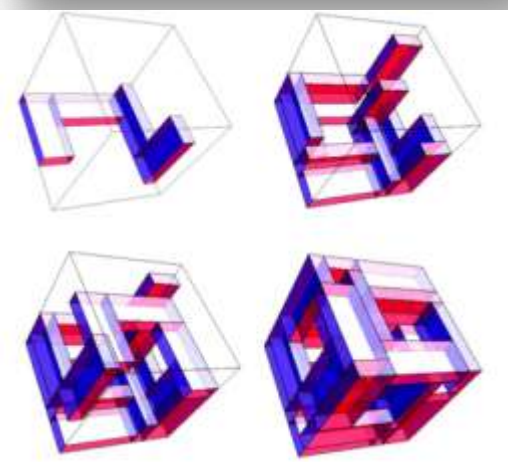
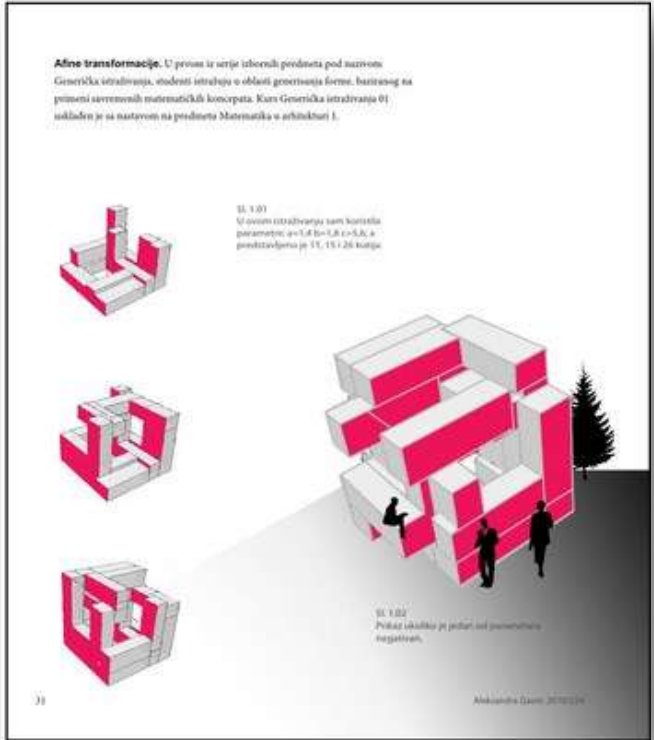
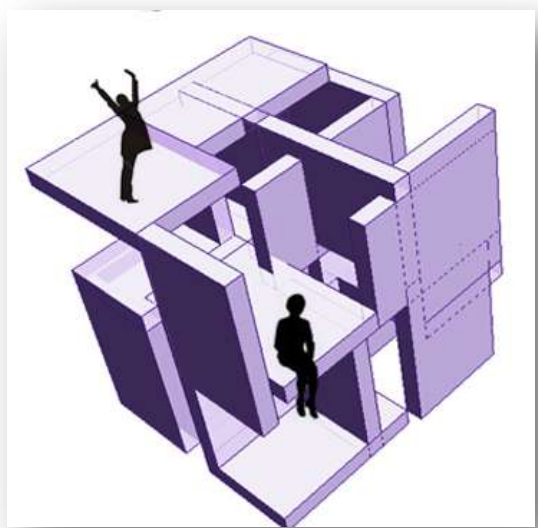
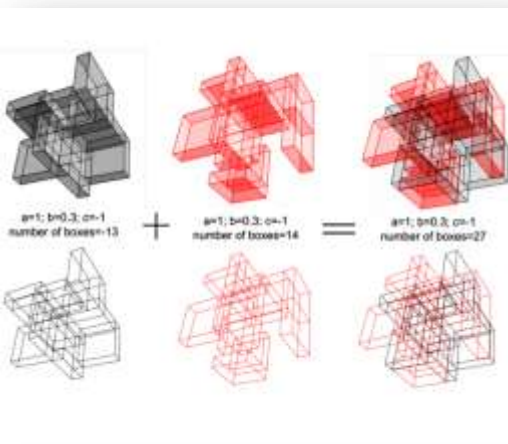
Modification and extending of initial definition

2. Multiplication, scaling and distribution along curve



**> 3D Visual Communications:
Box Packing – Exercises**

> Box Packing: The Wolfram Demonstration



> Box Packing: Analogue model 01

Analogni model 01 Kao rezultat istraživanja koncepta Box packing, nastao je analogni model kocke koja se sastoji od dvadeset sedam elemenata napravljenih od čamovine. Pored izuzetnih mogućnosti sagledavanja vizualnog modela, formase realno sagledava tek nakon izrade fizičkog modela.



SI 1.01
detalji modela



SI 1.02
koraci pravljenja modela

parametri:
a, b, c
d, e, f
g, h, i



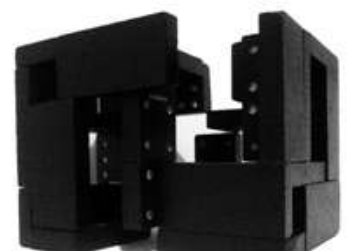
SI 1.03
analogni model traženima Box Packing vježbama

Danko Đeržić 2010/2010

Analogni model. Prikazane su fotografije modela dobijenog preko Box Packing-a, a napravljenog od 27 domina dimenzija 0,5x2x4. U prikaz su sada uvedeni i različiti izvori svjetlosti koji daju akcente različitim delovima modela.



SI 1.01
Niz fotografija cele i kocke iz delova.



SI 1.02
Kocka od 27 domina razdvojena na 2 karakteristična dela.

Katarina Krumić 17/3/2010

Box packing
Ovo je fizički model koji se sastoji od 27 elemenata, koji se mogu koristiti za pravljenje prostora.




SI 1.01
detalji modela

Analogni model: Box Packing
Ovo je fizički model koji se sastoji od 27 elemenata, koji se mogu koristiti za pravljenje prostora.




SI 1.01
detalji modela

Box packing
Ovo je fizički model koji se sastoji od 27 elemenata, koji se mogu koristiti za pravljenje prostora.






SI 1.01
detalji modela

Box Packing
Ovo je fizički model koji se sastoji od 27 elemenata, koji se mogu koristiti za pravljenje prostora.





SI 1.01
detalji modela

Analogni model: Box Packing
Ovo je fizički model koji se sastoji od 27 elemenata, koji se mogu koristiti za pravljenje prostora.

SI 1.01
detalji modela

Prikaz 3D modela kocke. Ovo je prikaz kocke parametara 1*2*7 po modelu generisanom u programu Wolfram, koji se zasniva na algoritamskom rešavanju elementata. Model može da formira različite forme, u zavisnosti od delova koji na koje se rastave.

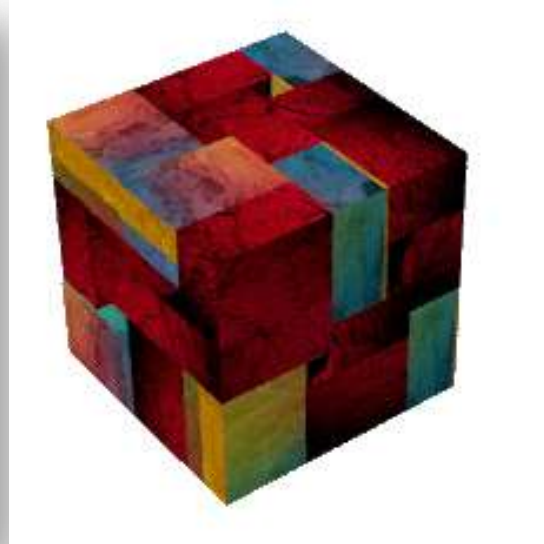
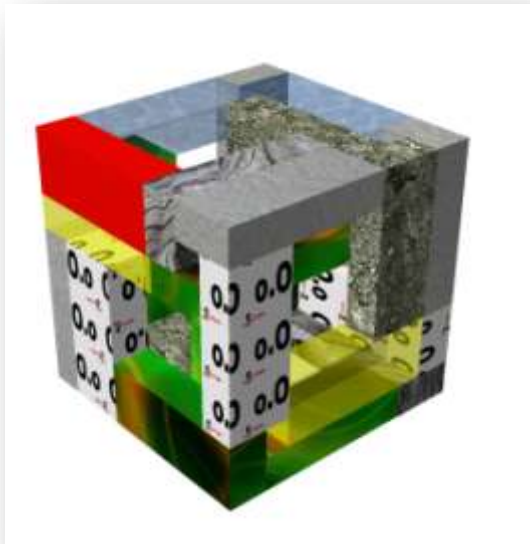
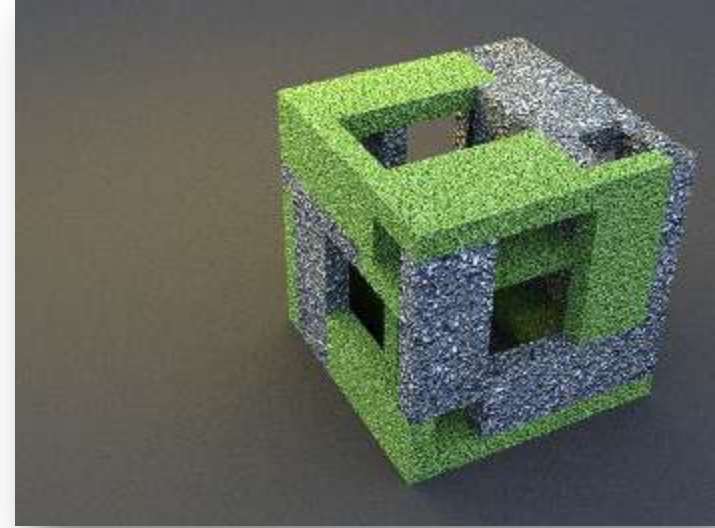


Slika 1:
Različiti prikazi kocke



Slika 2:
Cela kocka

> Box Packing: Materialization

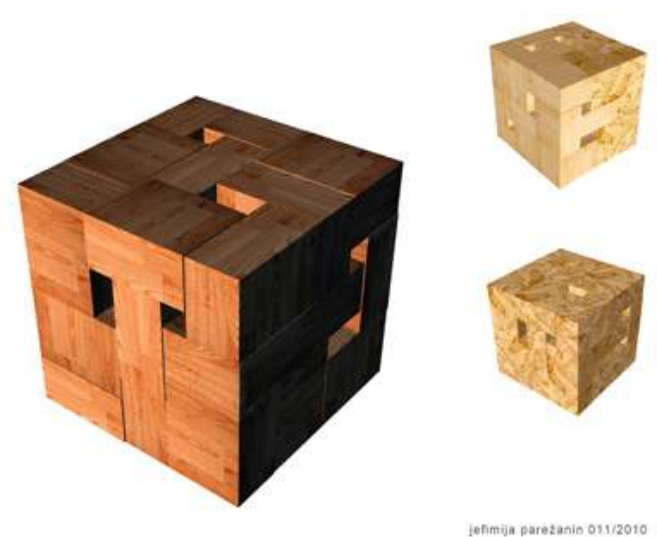


različite materijalizacije



drvena kocka_box packing

Zahvaljujući Rhino programu možemo materijalizovati box packing kocku i na taj način dati joj različite karaktere.
Različiti materijali daju drugačije odlike forme. Zahvaljujući ovoj materijalizaciji ova kocka ima karakteristike prirodne, ali i čvrste forme.



> Box Packing: Lighting



Svetlo i senka

Prikazan model je rađen u Rhinu, dimenzija 2x3x7cm. Od iznena svetlosti, koristi se sam point light, u žutoj boji, menja se mu visina i položaj. Takođe sam menja i intenzitet senke. Na prve dve slike, njen intenzitet je 60, a na treću i četvrtu 30.

Svetlost i senka. U ovom procesu istražena karakteristika ambijentnog pakiranja košice postavljajući različite vrste osvetljenja i tipove osvetljenja. Istraženo je kako se osvetljenje odražava, pri čemu su postavili elementi košice simetrično tako da se proširilo osvetljenje dimenzionalno ambijentu.

Pri ovom procesu korišćene su četiri tačkaste svetle koše na različite udaljenosti, boji i jačini osvetljenja za bolju dopadljivost.

Sl. 1.01
Prikaz osvetljenja i senke sa ambijentnim osvetljenjem

Katarina Krunić 22/2016



Osvetljenje: Korišćena su tri tačkaste osvetljenja u različitim bojama, kombinovano je mešanje tri boje i dobijanje novih nijansi u zavisnosti od ugla promatranja objekta.

Sl. 2. Kombinovanje različitih tipova osvetljenja, kako se osvetljenje odražava na površine prostora oko tačkaste svetlosti

Osvetljenje košice u Rhino-u. Kombinovanjem različitog osvetljenja na više načina dobijene su košice drugačijeg tipa. U zavisnosti od tipa osvetljenja, dobijeni su različiti svetlosni efekti, a samim tim i različiti doživljaji istog prostora.

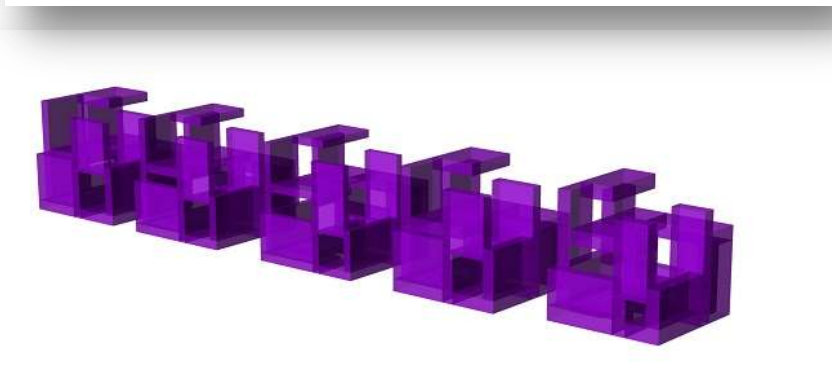
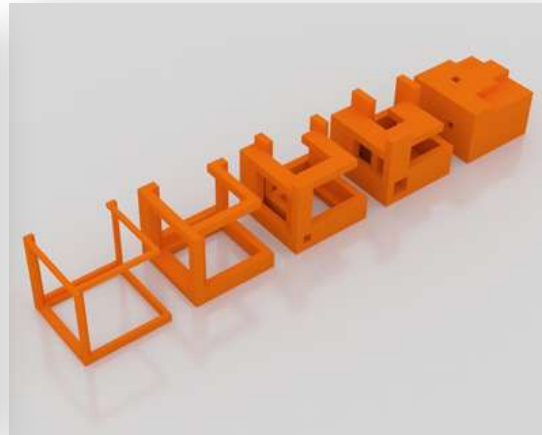
Sl. 1.01
Rectangular light
Sl. 1.02
Bez dodatnog osvetljenja



Sl. 1.03
Kombinacija rectangular light-a i spotlight-a na delu košice

Katarina Krunić 17/2010

> Box Packing: Variations (using the Grasshopper definition)



Grasshopper definicija koncepta box packing

Pomoću grasshoppera moguće je lako dobiti rezultate u ispitivanju koncepta box packing. Manjejeet parametara a,b,c i broja elemenata koji čine kutiju doklepija je uređena.

Laer 8/11/2016

> Box Packing: Architectural object



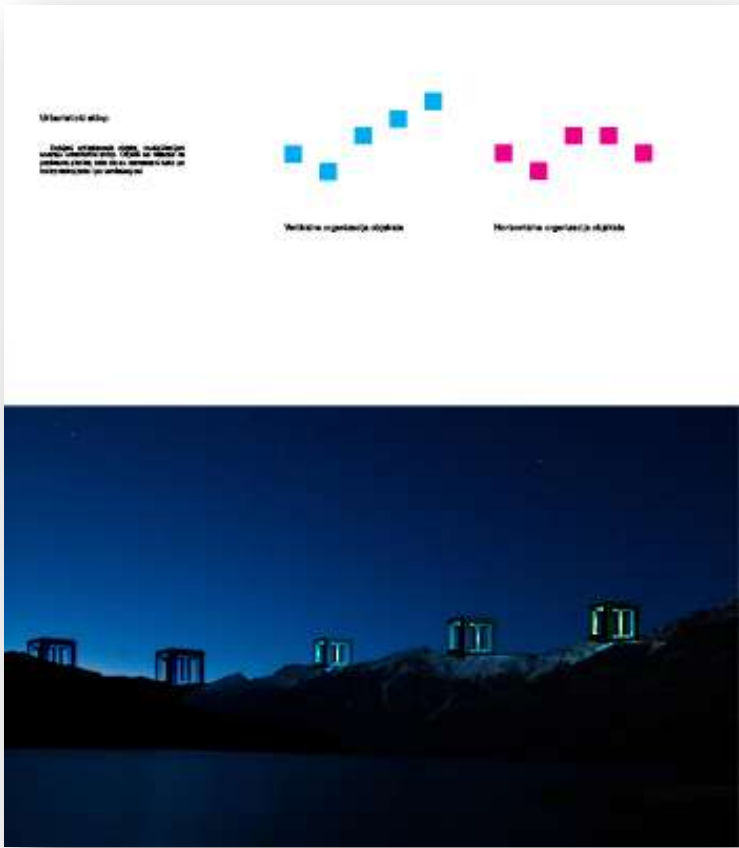
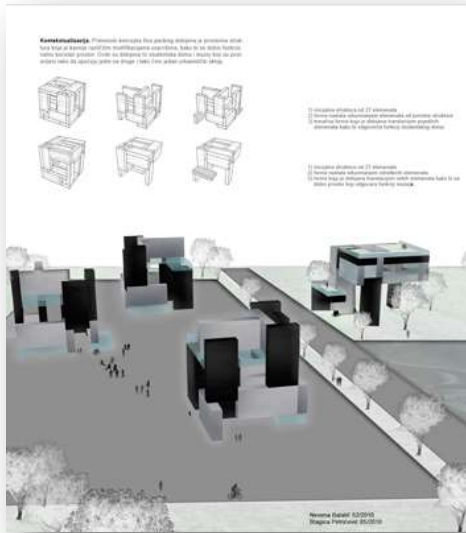
Box packing – konceptualno rešenje koje se ne ograničava arhitektonskog objekta. Najbolji je primer forme box packinga, od strane svetskih arhitekata.



> Box Packing: Analogue model 2



> Box Packing: Urban complex

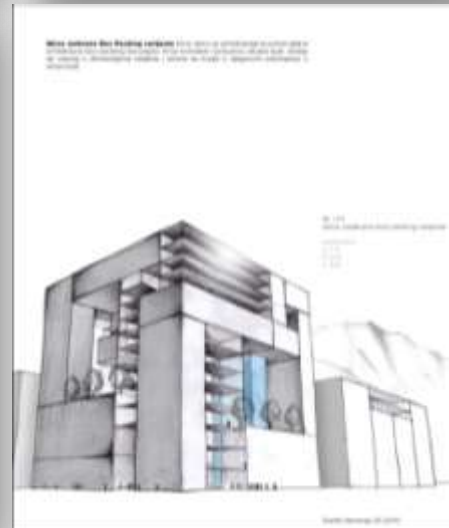
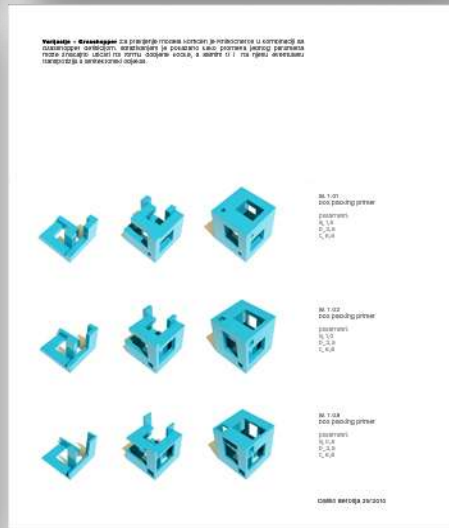
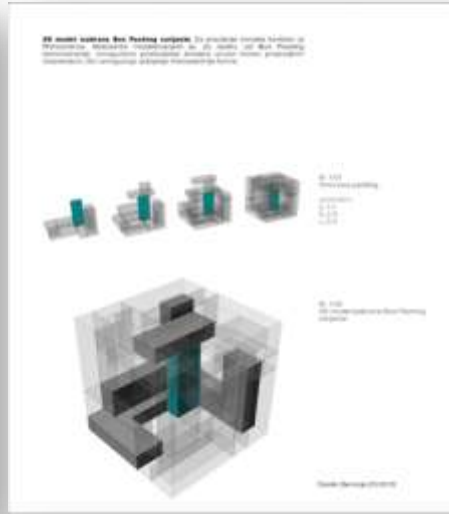
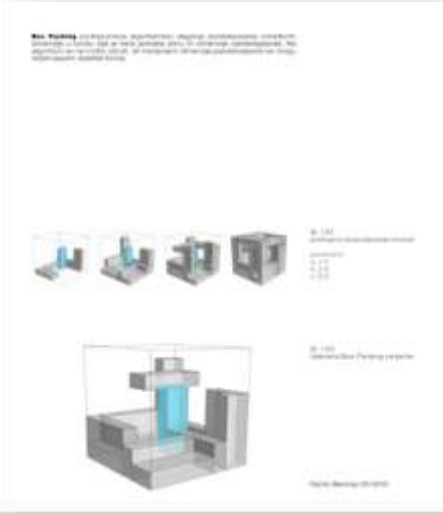


**> 3D Visual Communications:
Box Packing - Students' collections**



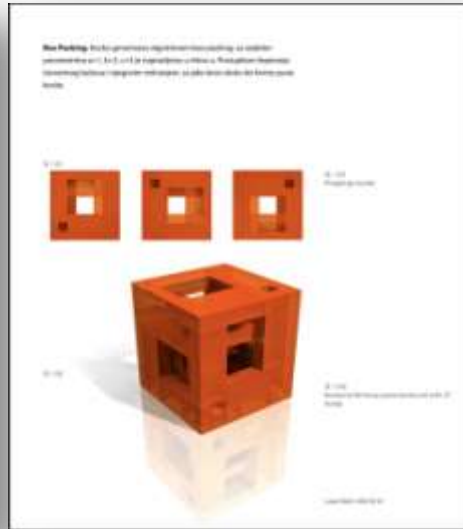
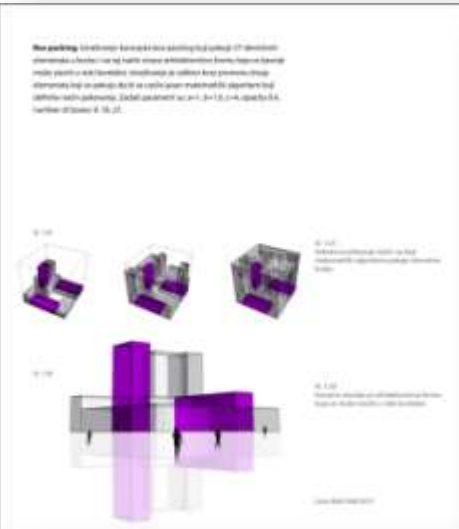
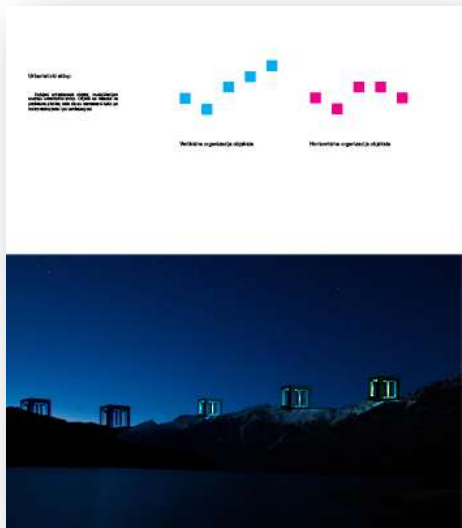
Danilo Beronja, 2010

> collection: student Danilo Beronja



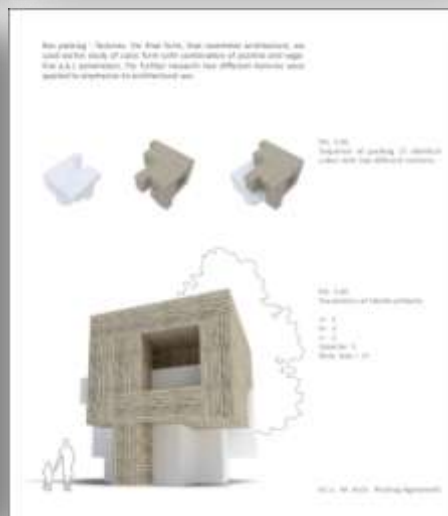
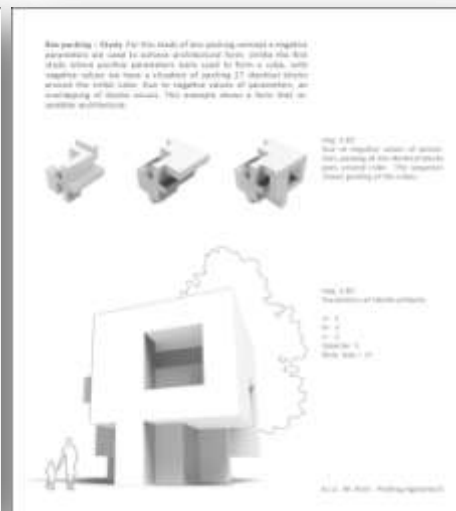
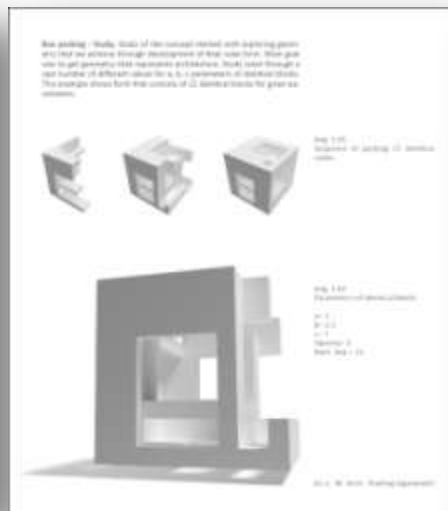
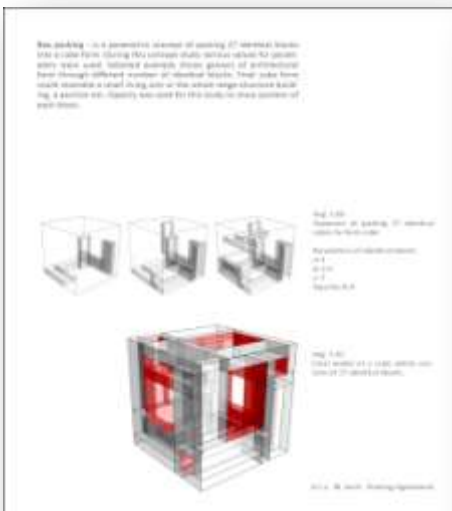


> collection: student Lazar Belic






> collection: Predrag Agatonovic, M.Arch.



**> Preparations for Spring semester 2011/12
The Szilassi Polyhedron**

> Preparation for the spring semester 2011/12
The Szilassi polyhedron



 Wolfram Demonstrations Project

SEARCH TOPICS LATEST ABOUT

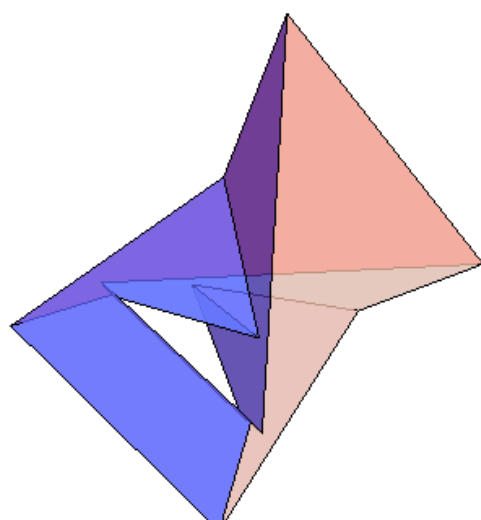
The Parametrized Szilassi Polyhedron

top face of prism

bottom edge of prism

move bottom edge

Szilassi polyhedron
 tetrahedron
 cut out prism
 appended tetrahedra



The following steps construct a seven-faced regular toroid, the Szilassi polyhedron.

