

Biomimic Spaces

Fish, snake, body, rose, cell, skin, canopy, skeleton, termite
Shapes inspired by nature

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Messages

We can already today build sculptural buildings if we use the biological toolbox and mindset of membranes held in shape with arches, poles and inflated with balloon or pillow pressure. These thin membranes can be covered with foam insulation and shotcrete and covered with bricks and a lot of other materials

These biomimic shapes are often much more beautiful than strange “forced” shapes. Somehow the “forced” shapes look forced, heavy, bulky, buckled, clumsy, fat..

We are not claiming that form automatically follows function, but spaces should be shaped around functionality. That is easier to do in clustered dancing volumes than in one single volume

Biomimic shapes makes a lot of sense because they are easy to build, use less material, cover the rooms with less surface, loose less heat, and may often be build at lover cost. These advantages are often lost in expensive moulds wrong sheet materials where a lot of material is wasted, and geometries where space is wasted in conflict with square furniture.

This presentation shows a lot of different biomimic shapes which has their advantages and disadvantages. They can be experiences in the solid surface version and in a glazed skeleton or even skeletons without glazing.

Dancers

This is the most convincing shape for homes

We call them “dancers” because they are standing or dancing and have curves not entirely different from humans.

We like the first ones better because they are interacting in a convincing way, dancing really close and intimately.

The windows are hidden in the cuts in the large shape, and the large windows are situated between the dancing bodies. That is a convincing situation in this particular shape

The geometry is a particularly twisted Richard Serra torqued ellipsis. It can be constructed in almost any material and maybe bricks would be the most beautiful

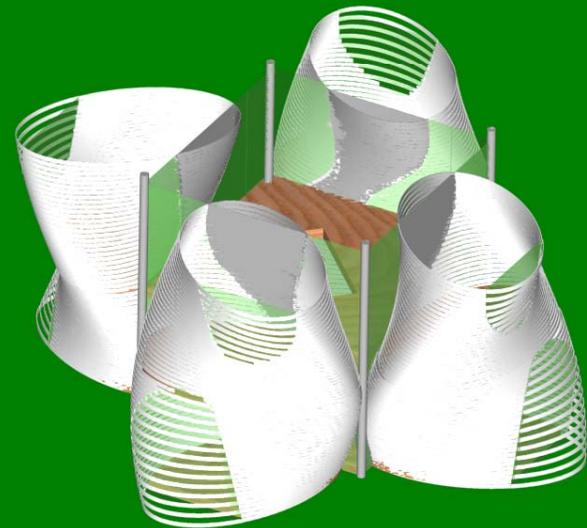
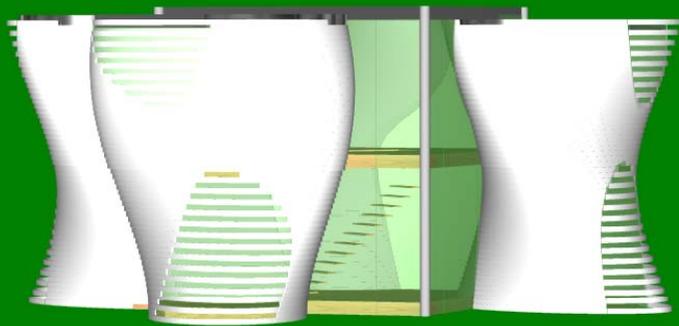
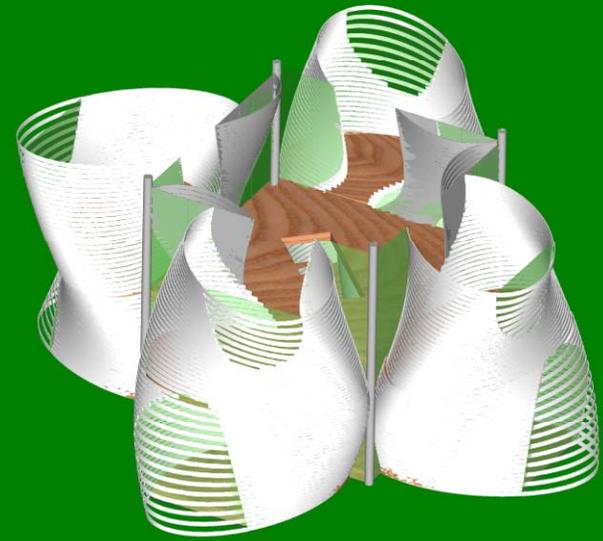
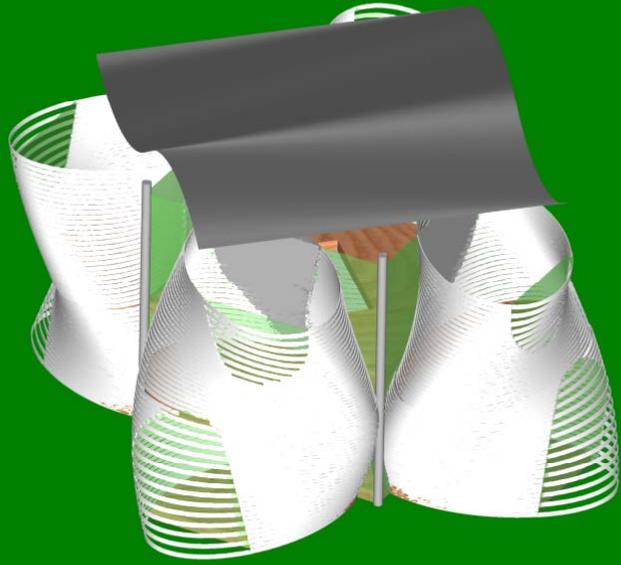
The shape is strong at it is basically an oddly shaped cylinder standing on the ground.

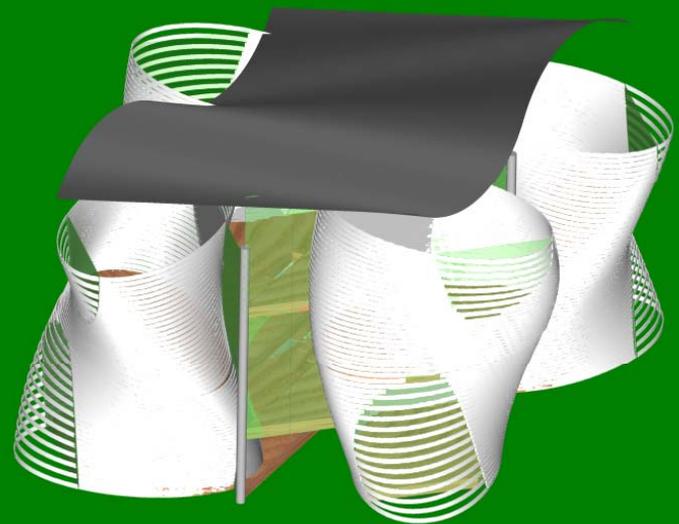
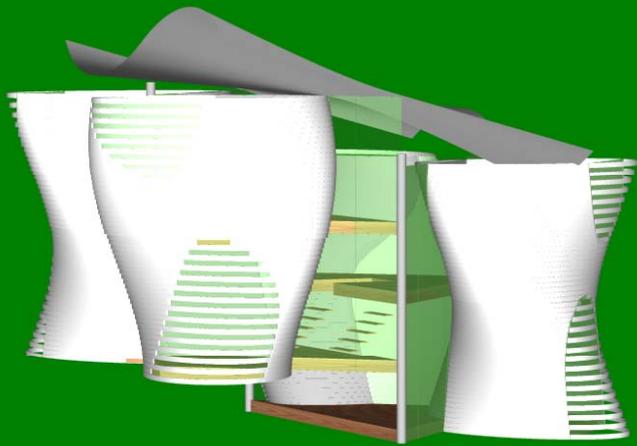
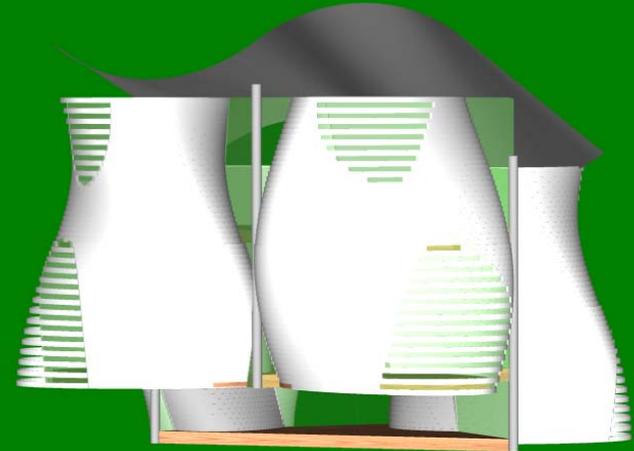
The doors are cut out of the finished shape and slided away or turned around at horizontal hinges.

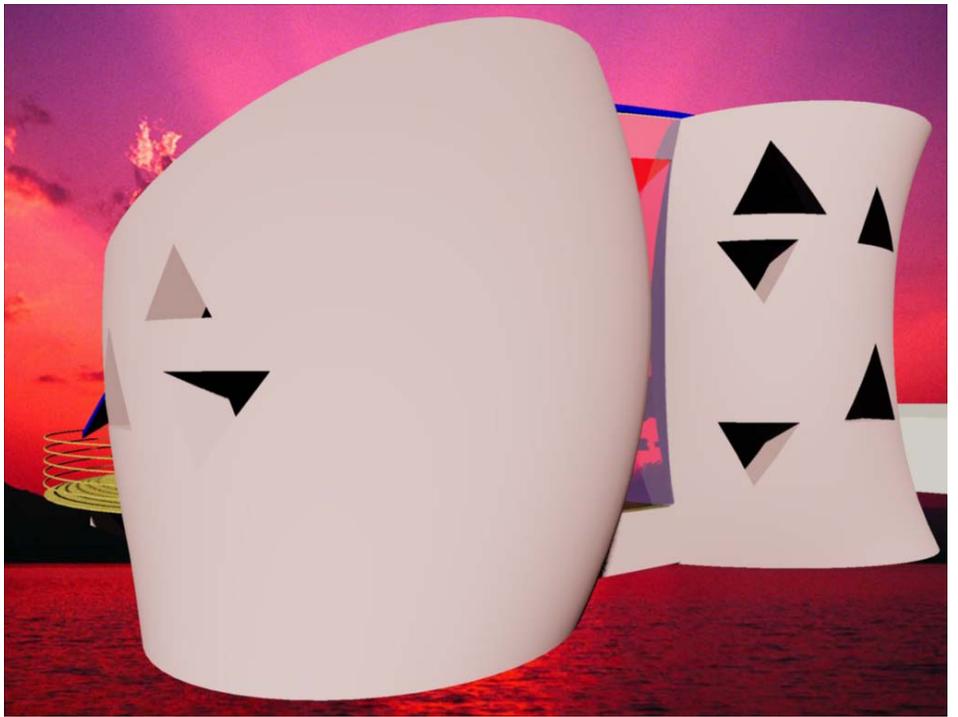
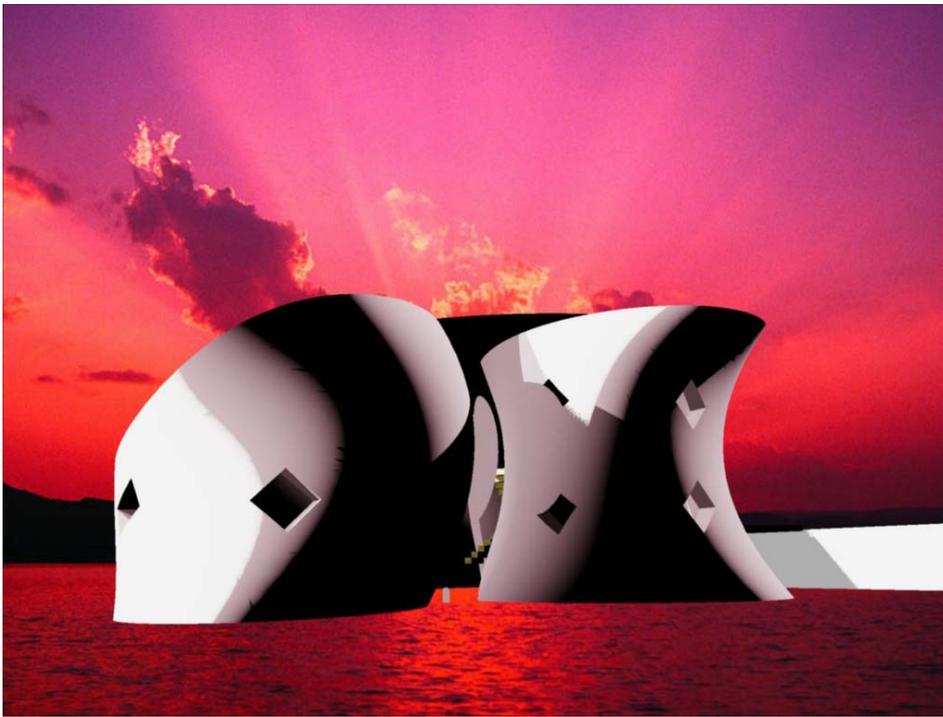
You can not insert partition walls in these structures without a major conflict between the shapes. It is however not necessary to have partition walls because these shapes separates 9 or more spaces.

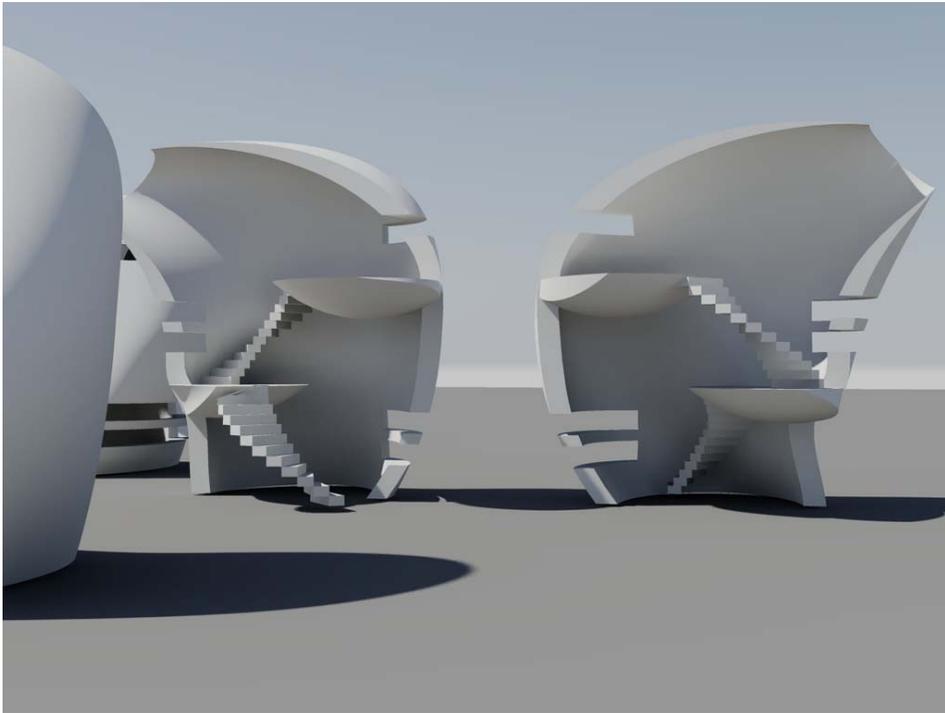
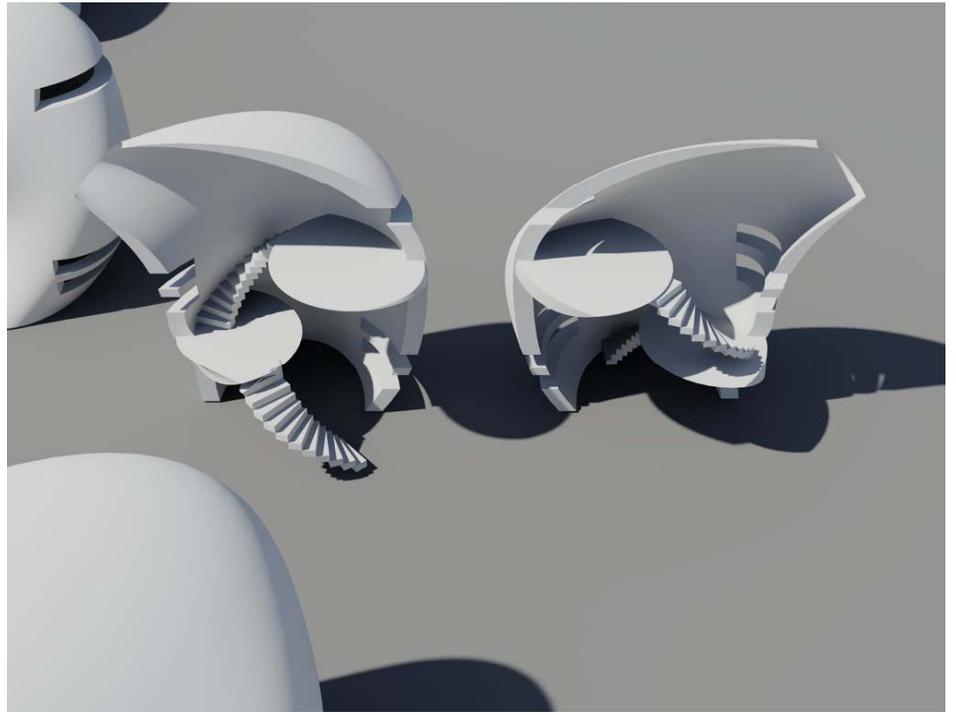
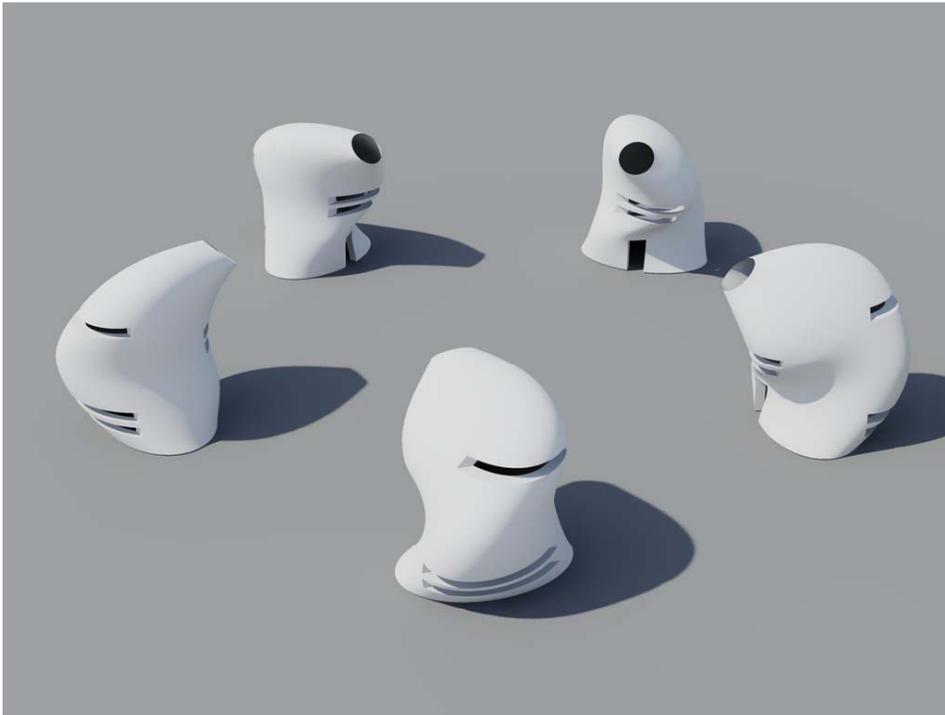
This is one of the very few curved shapes where you can insert decks without penalty.

The Ginger and Fred in Prague and the center hall in Guggenheim Bilbao are in this category while most other Gehry designs are roses.









Rose

Roses are convincing for homes

We call them “roses” because all the walls are like petals

Most of these design have walls made from fragments of Richard Serra’s torqued ellipsis.

They can be build from almost any material

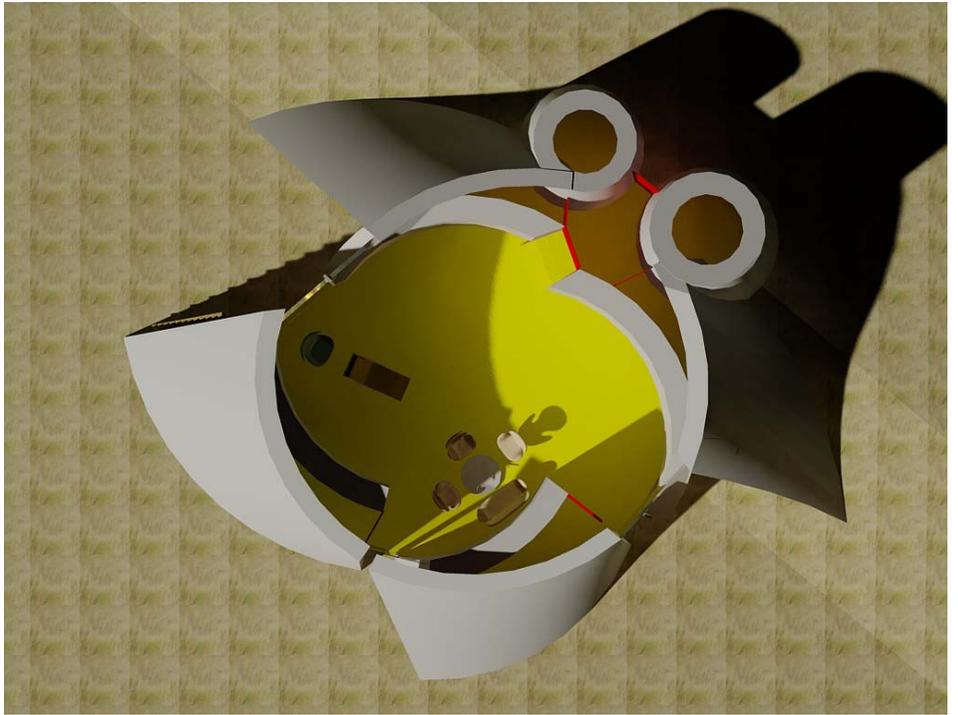
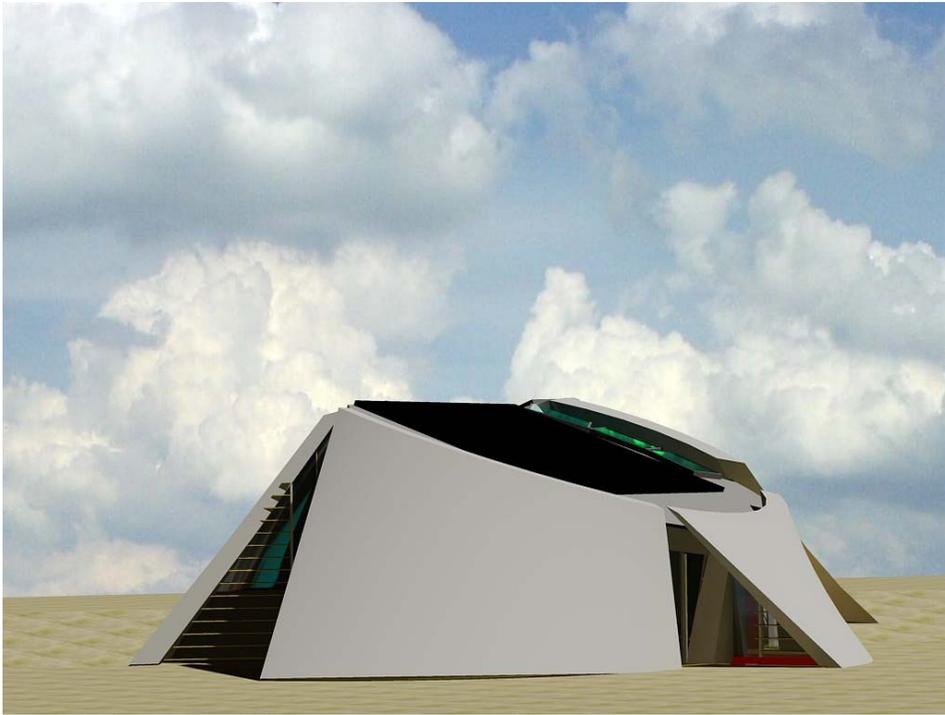
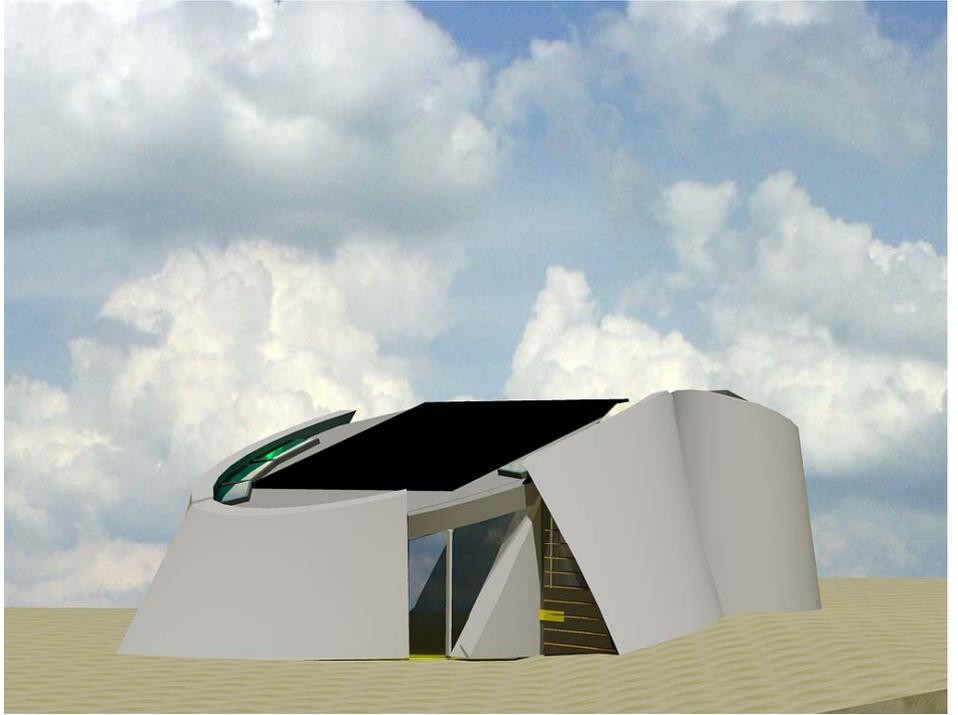
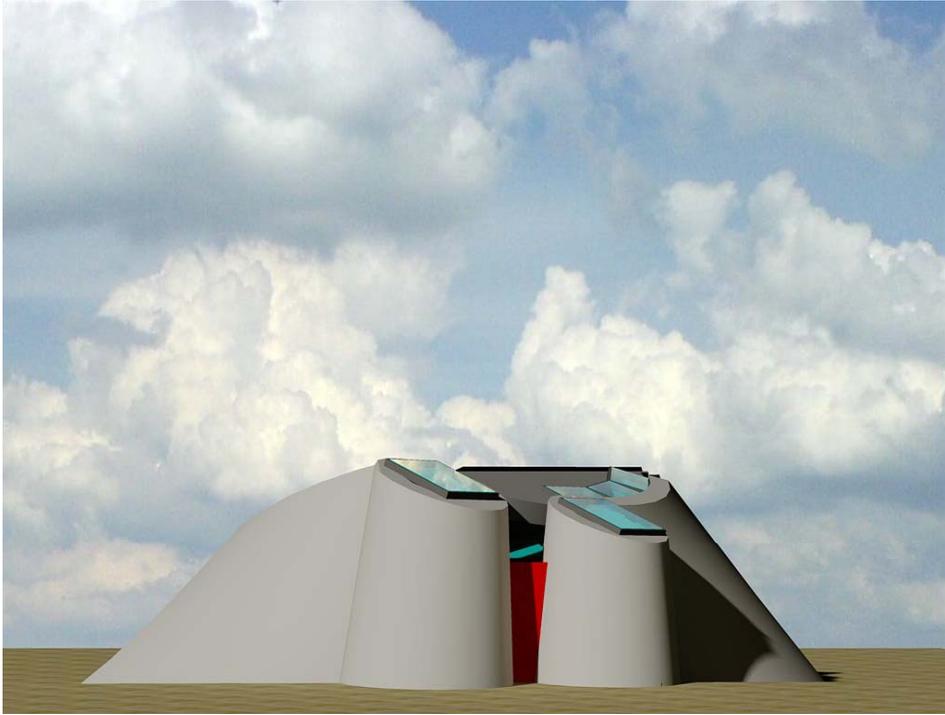
The shape is generated from surfaces ruled by curves at top and bottom. They are strong as they are standing on the ground.

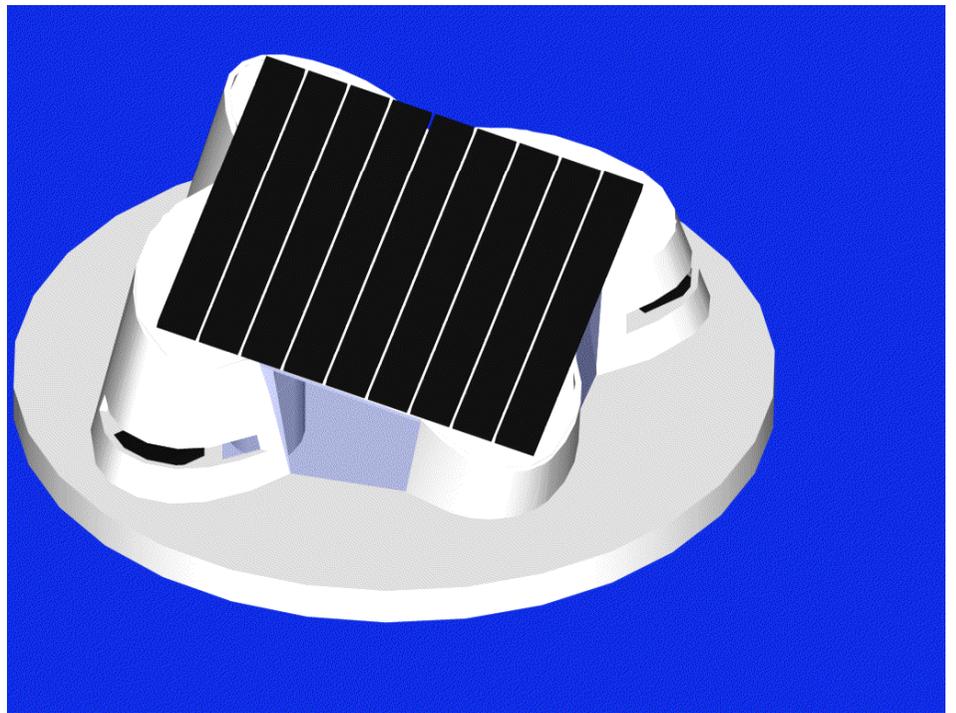
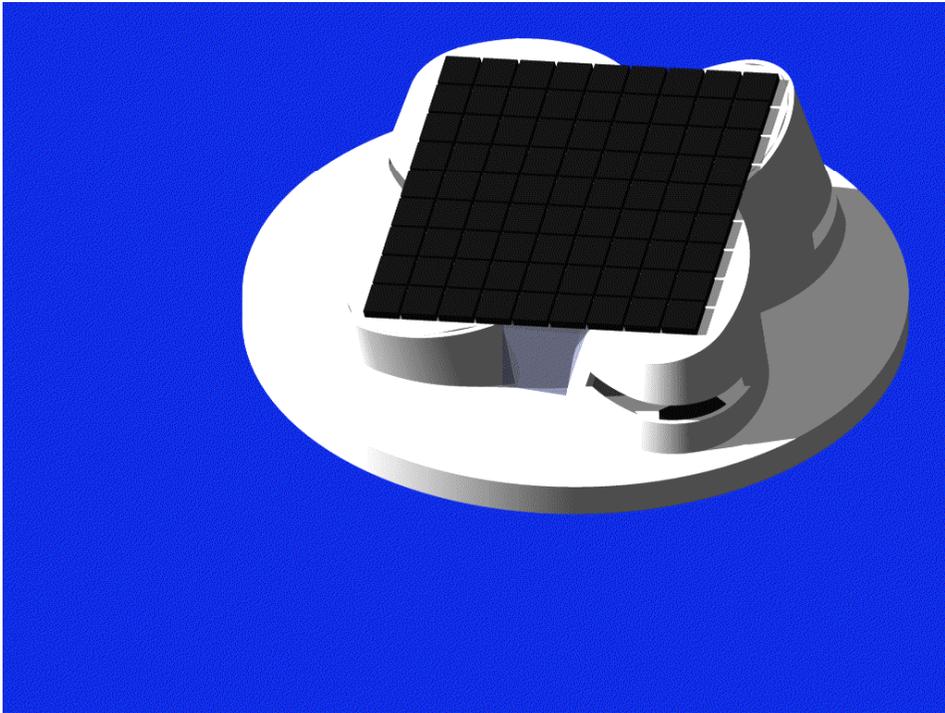
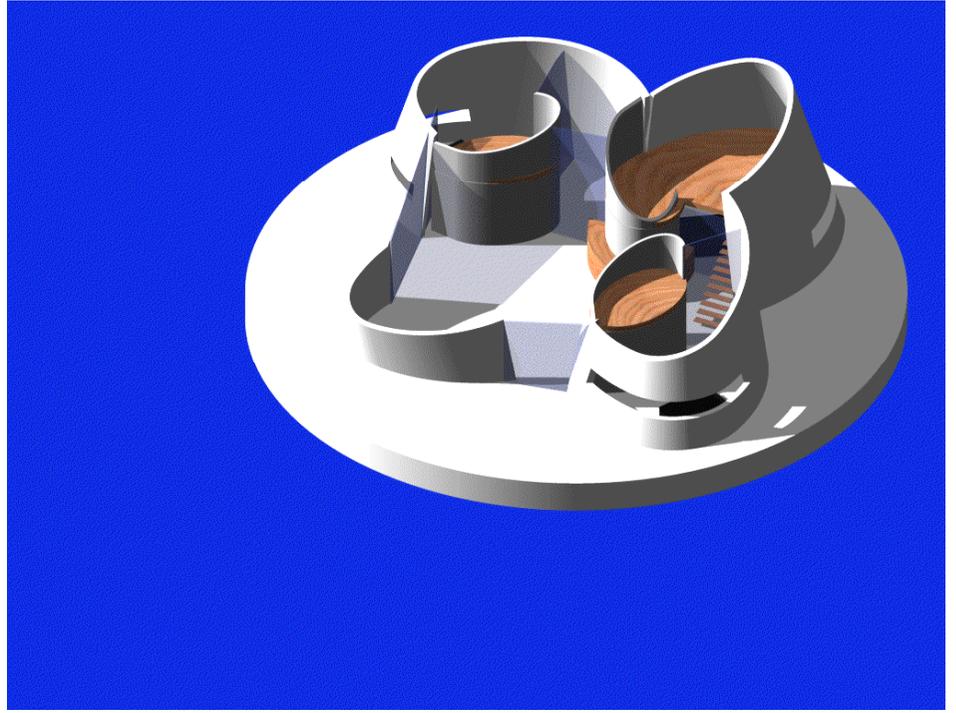
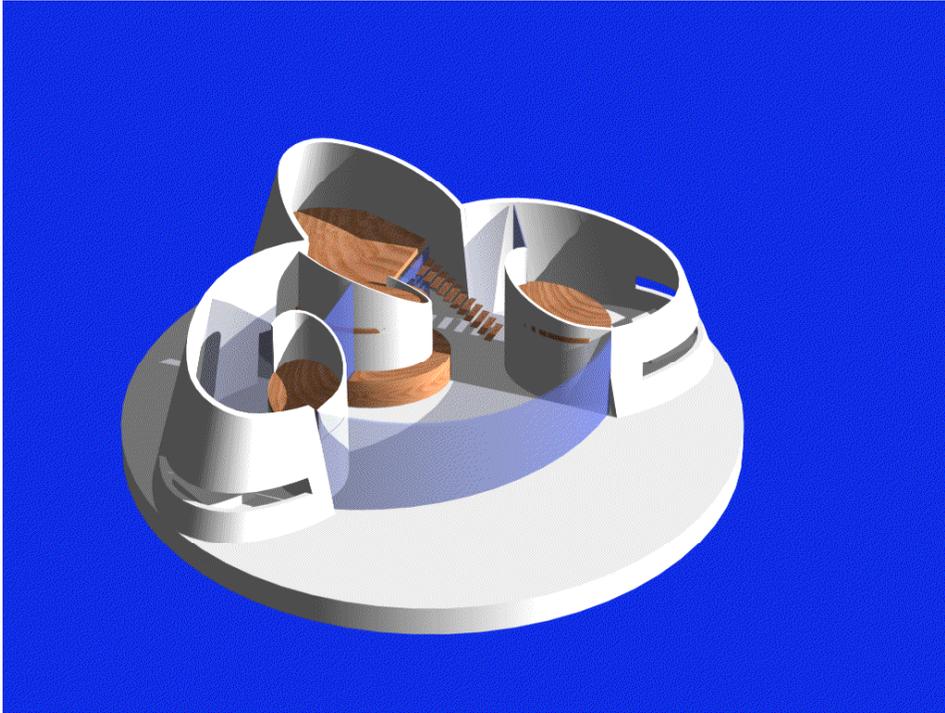
The windows are naturally situated between the petals. The shape should be more like several petals than like on closed torqued ellipsis.

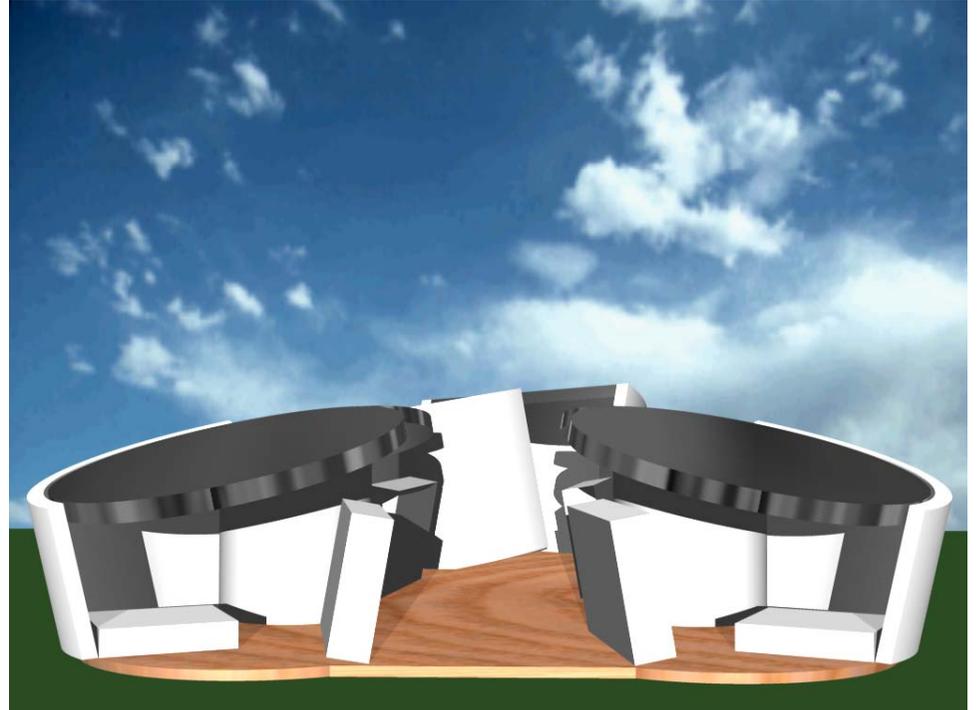
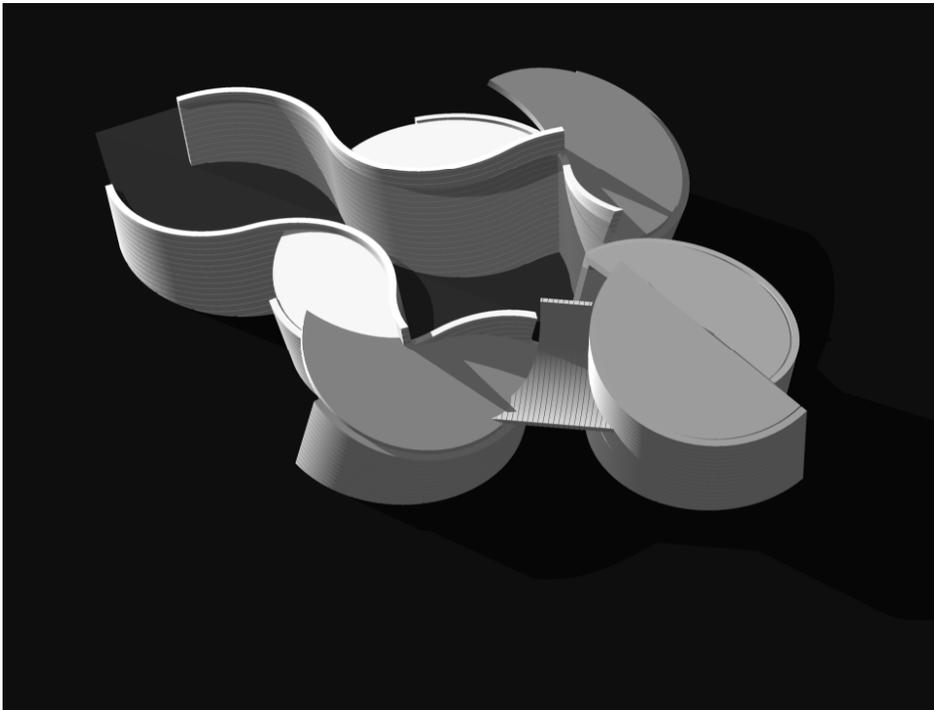
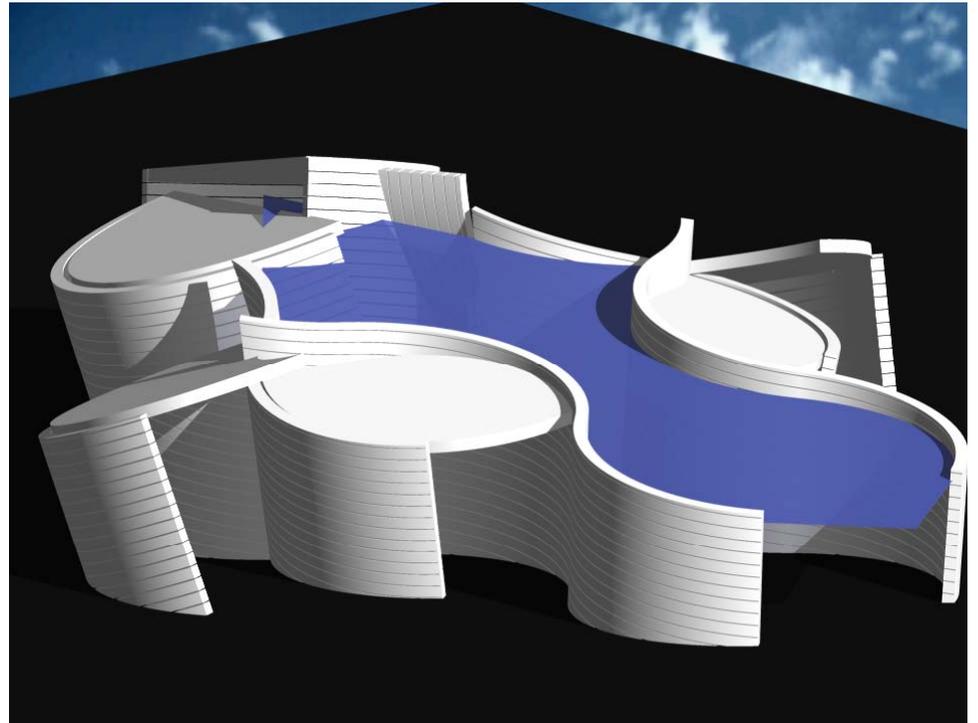
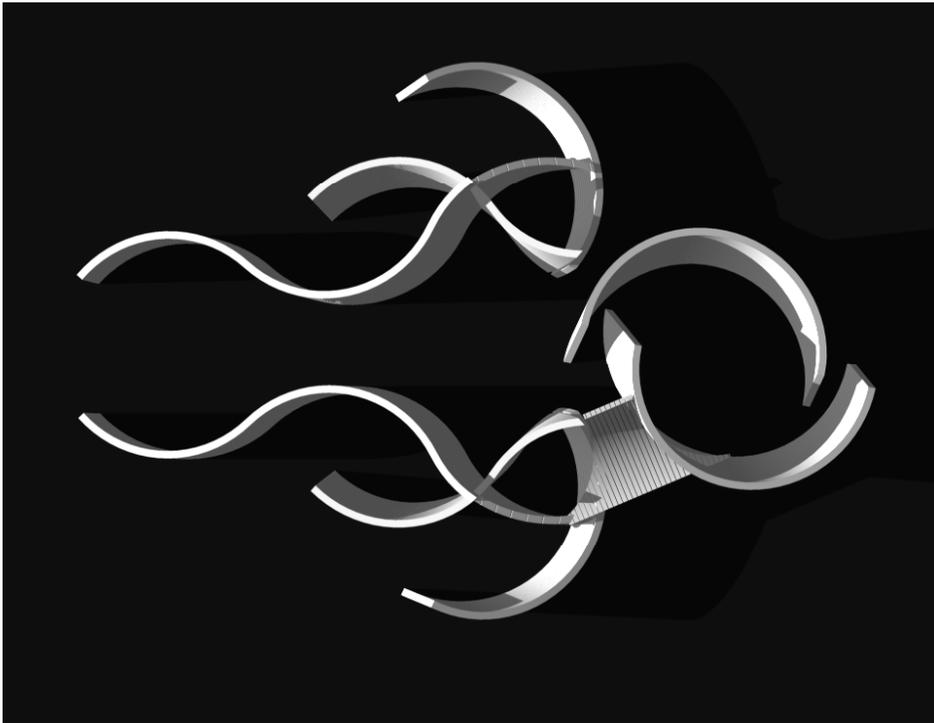
One of challenges with roses are the roof. We have tried a lot of solutions and only two really works:

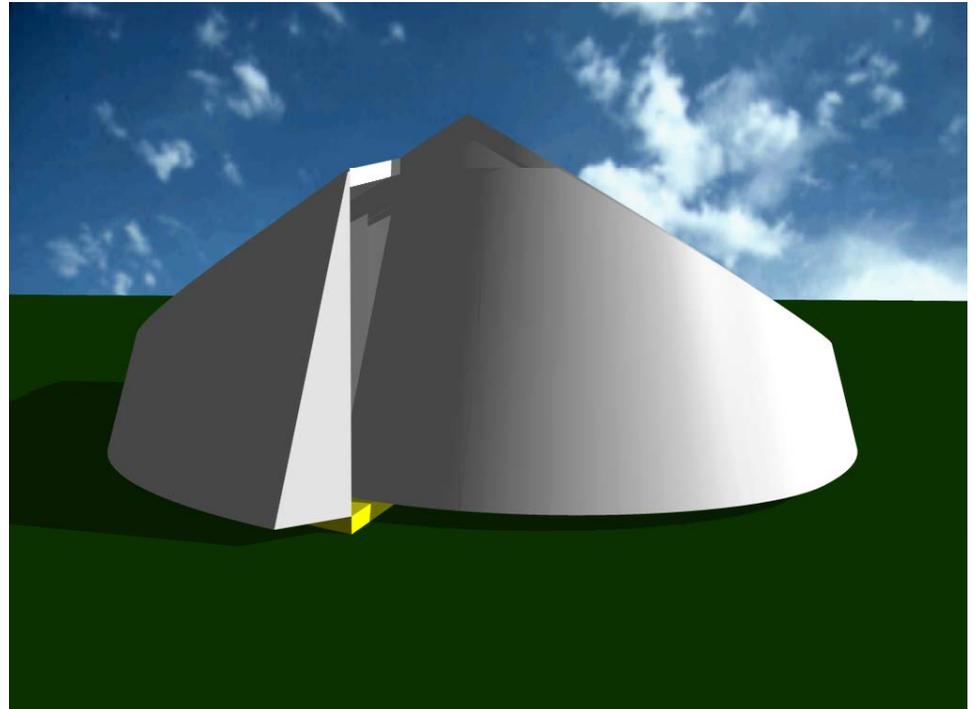
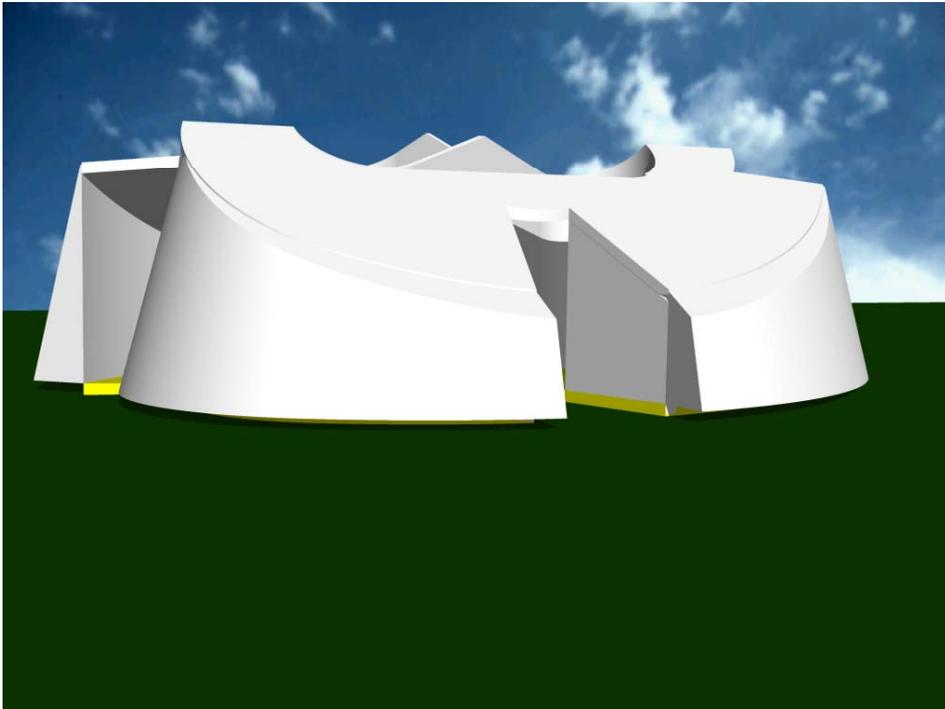
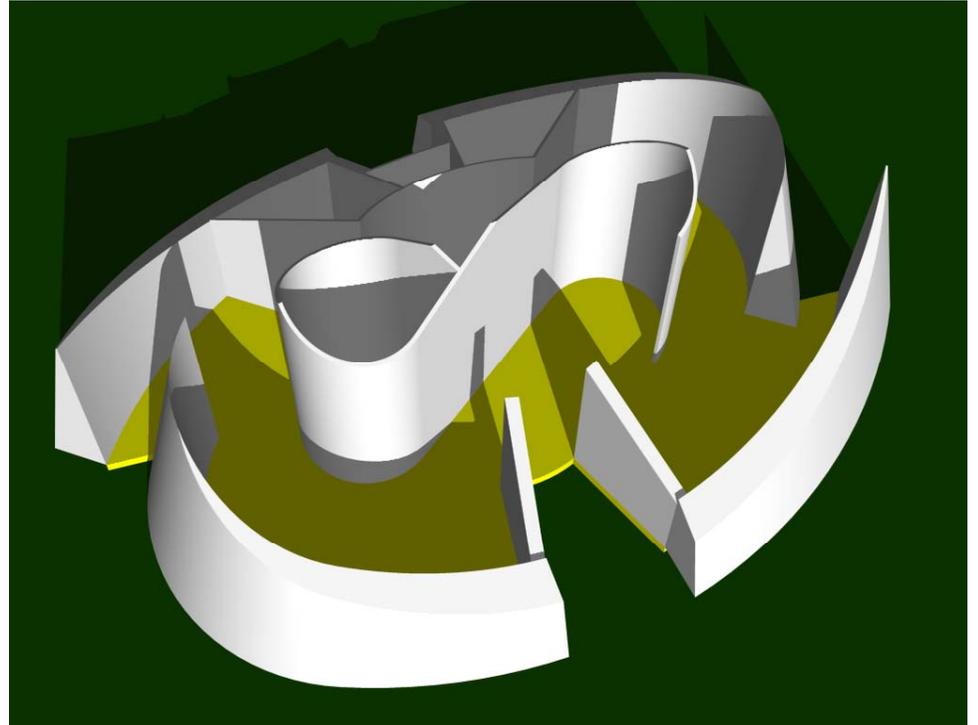
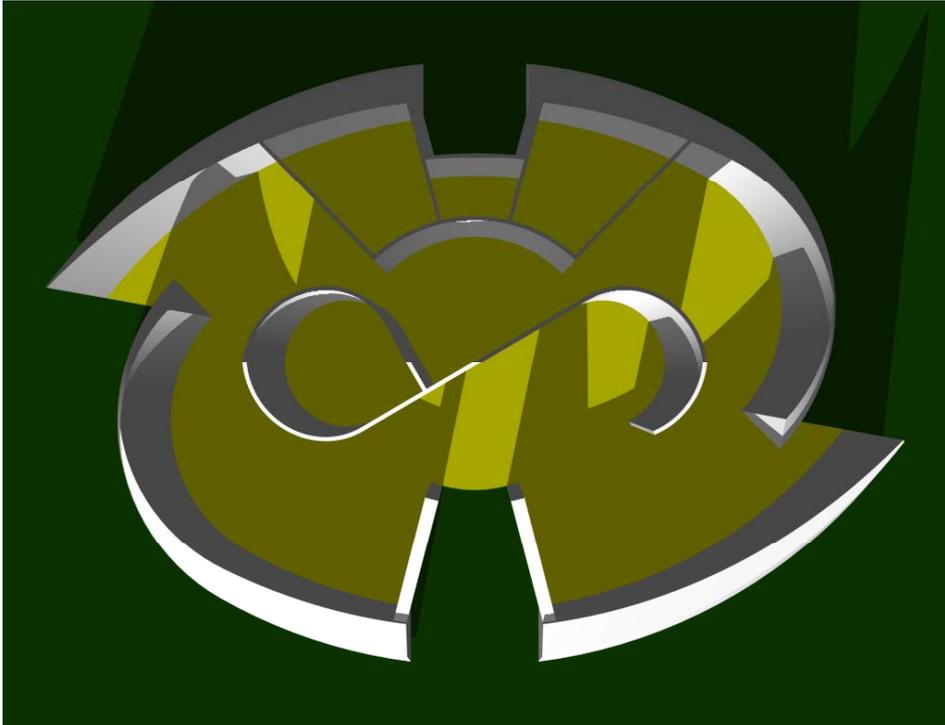
- A roof on each of the rooms and one fitting the space between them
- One roof fitting the periphery of the total volume

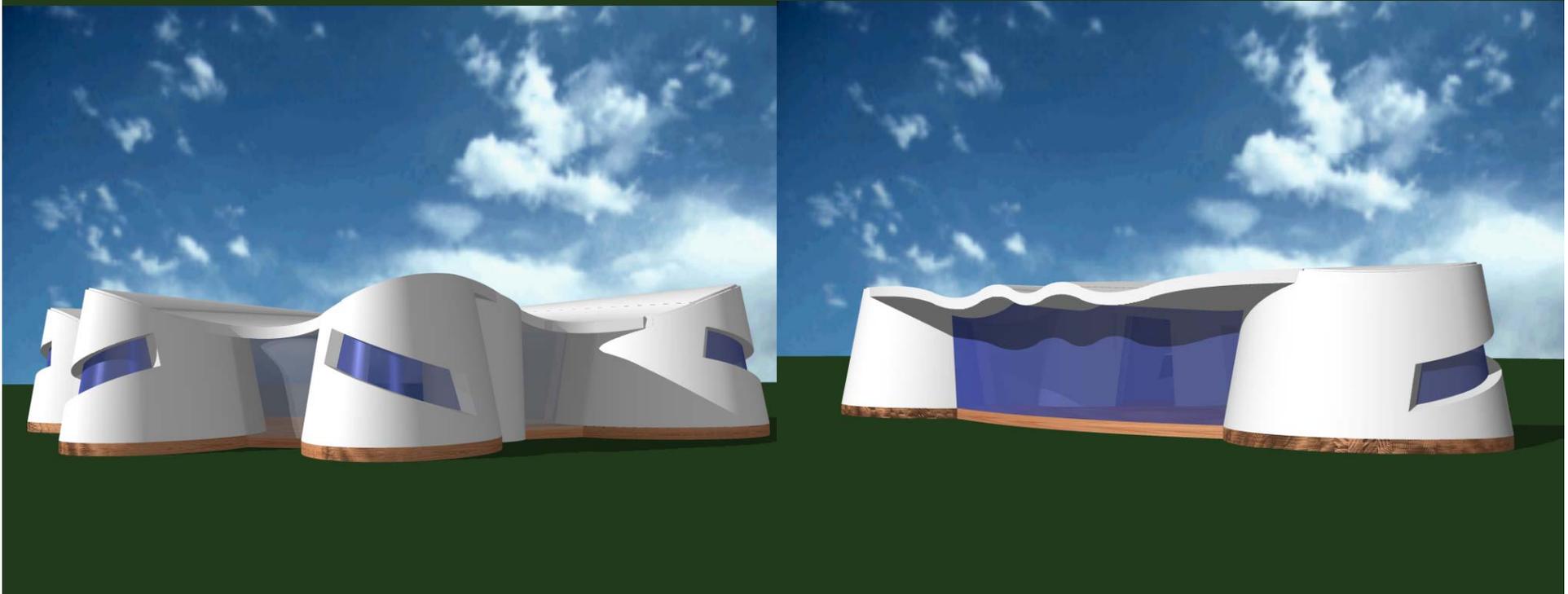
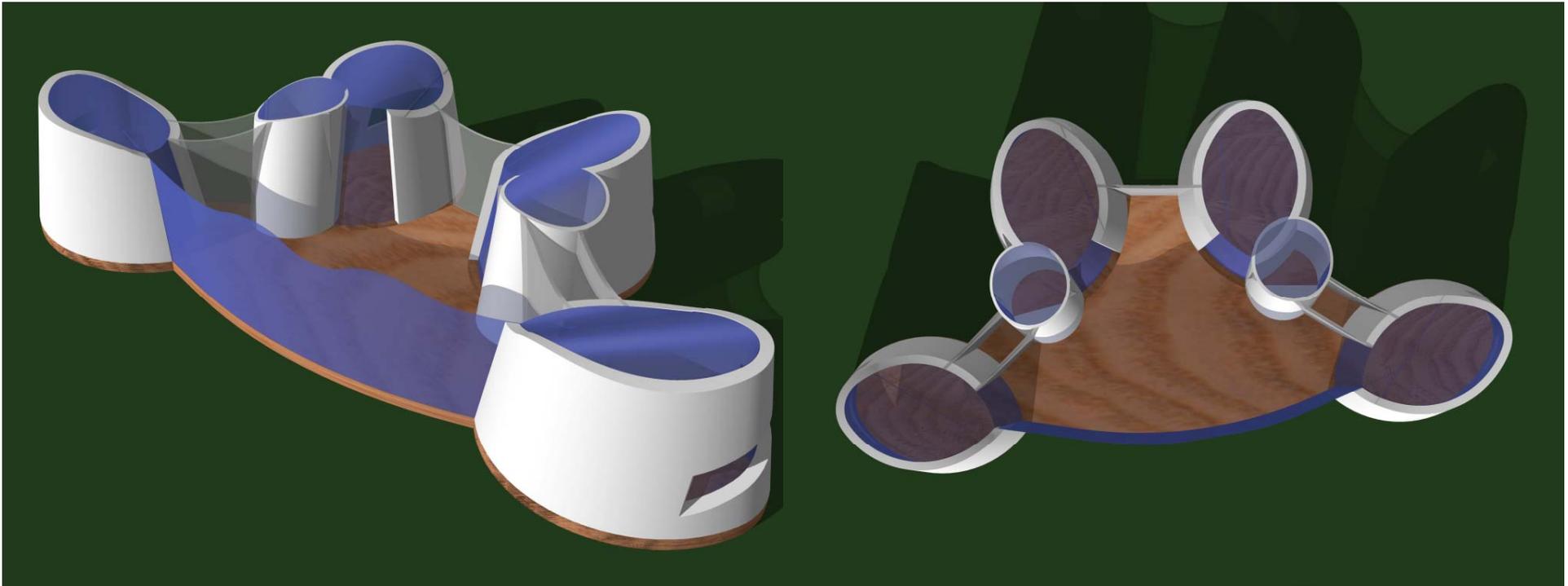
A roof shape with the highest point in the middle and some kind of spherical or conical roof sloping from that center or cascading roofs are preferable.

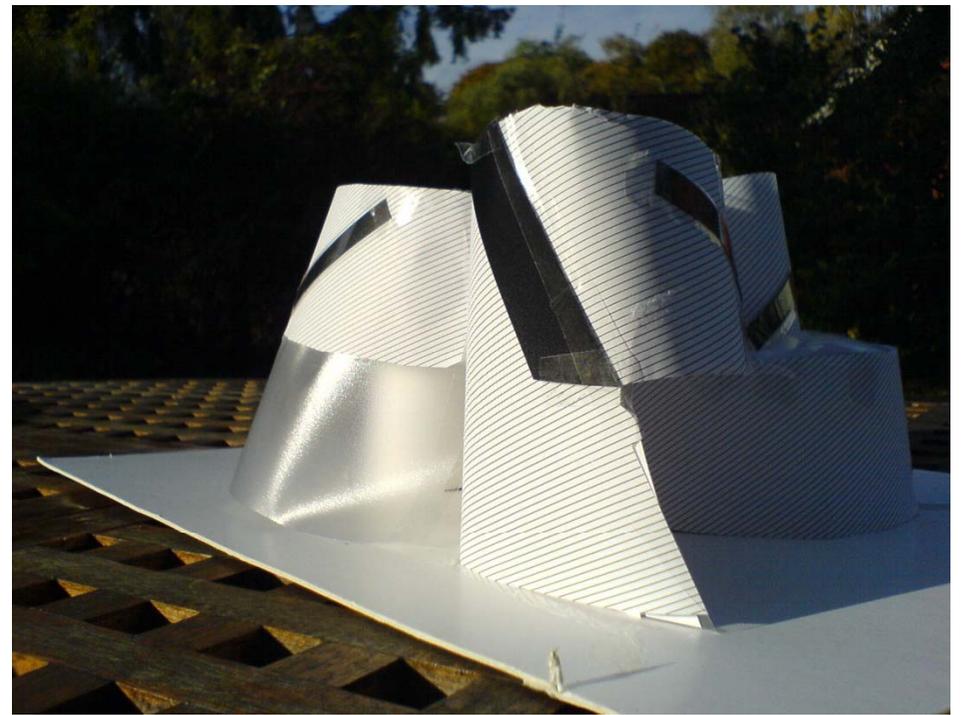
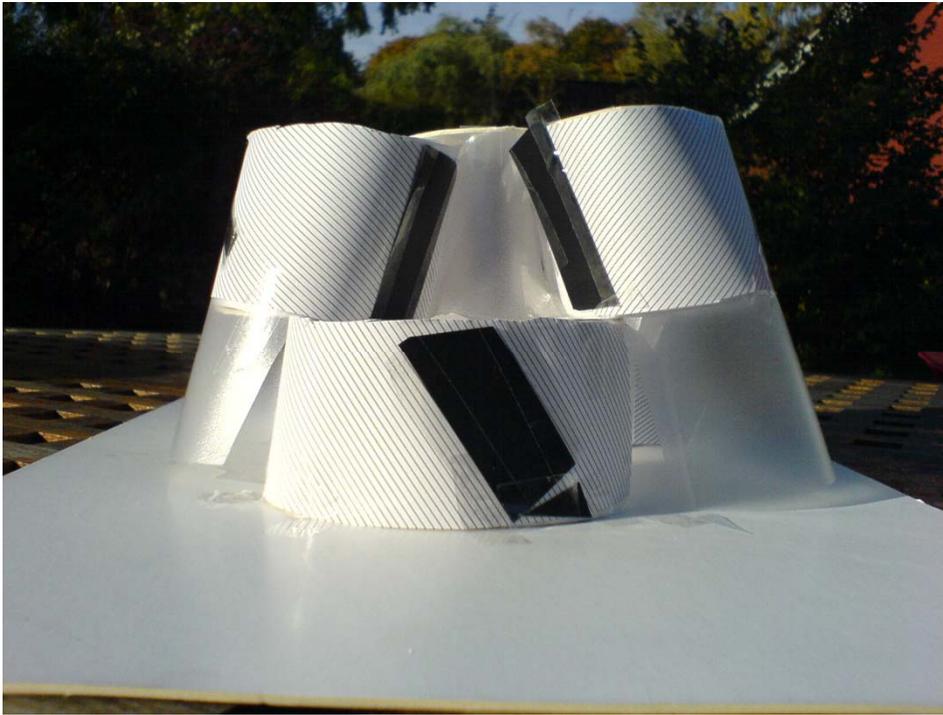
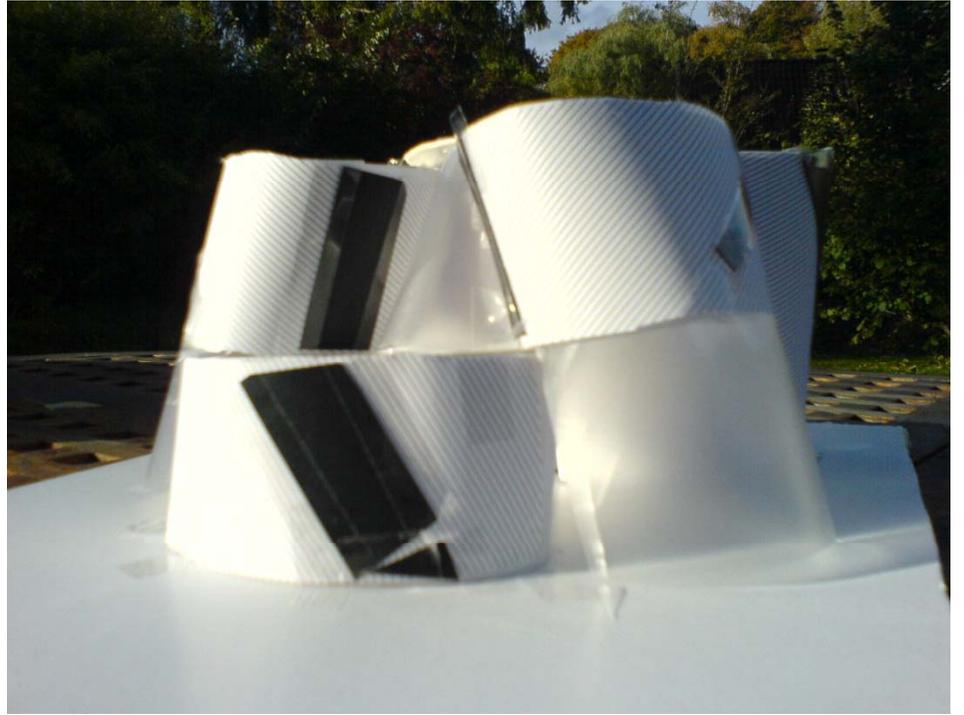


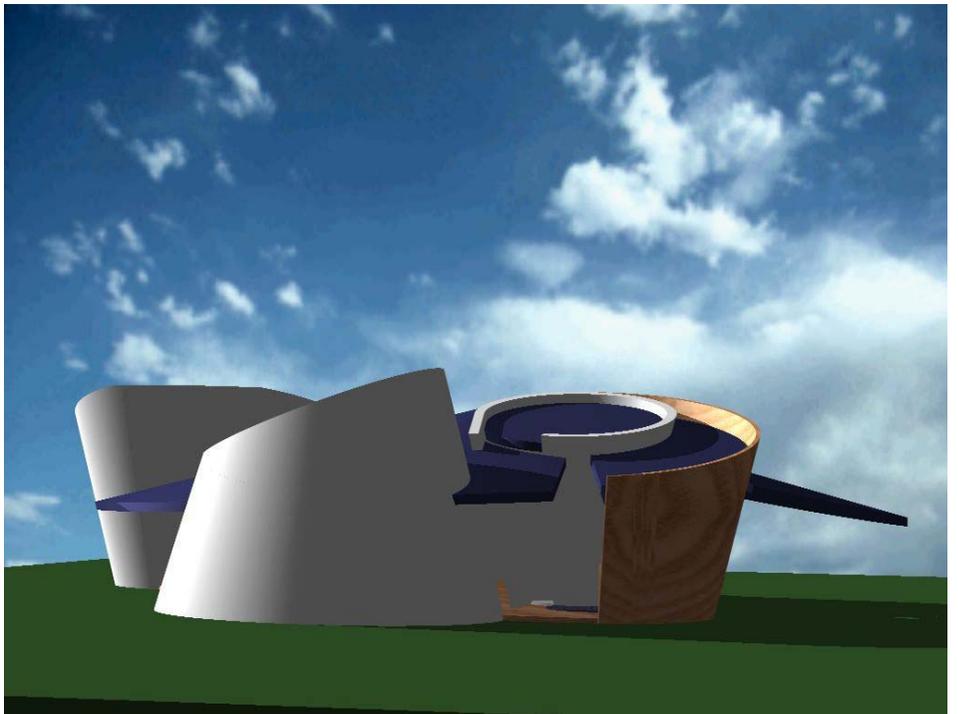
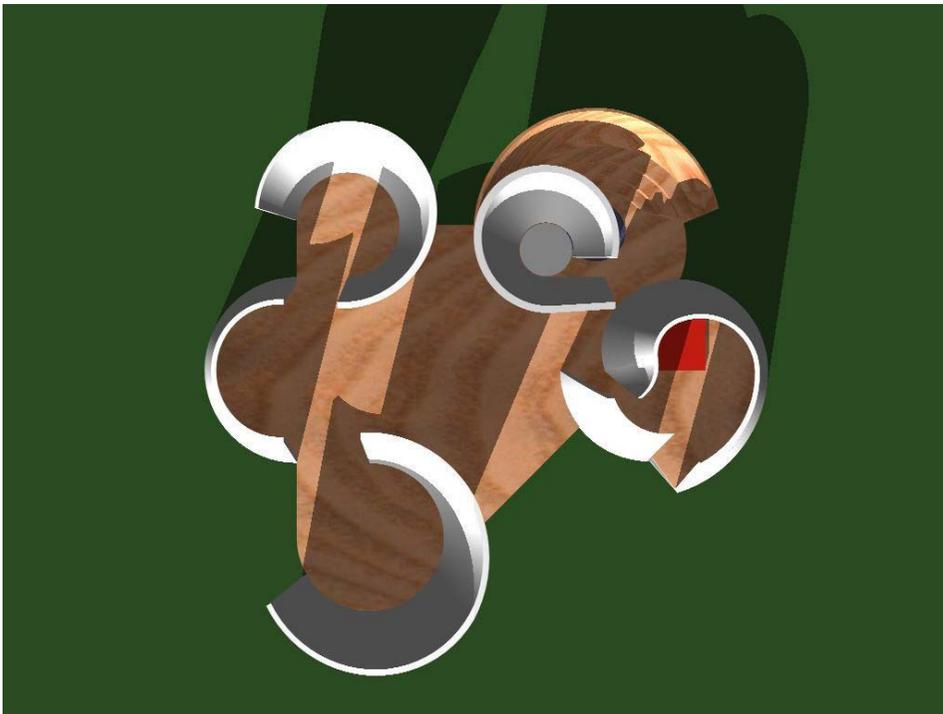
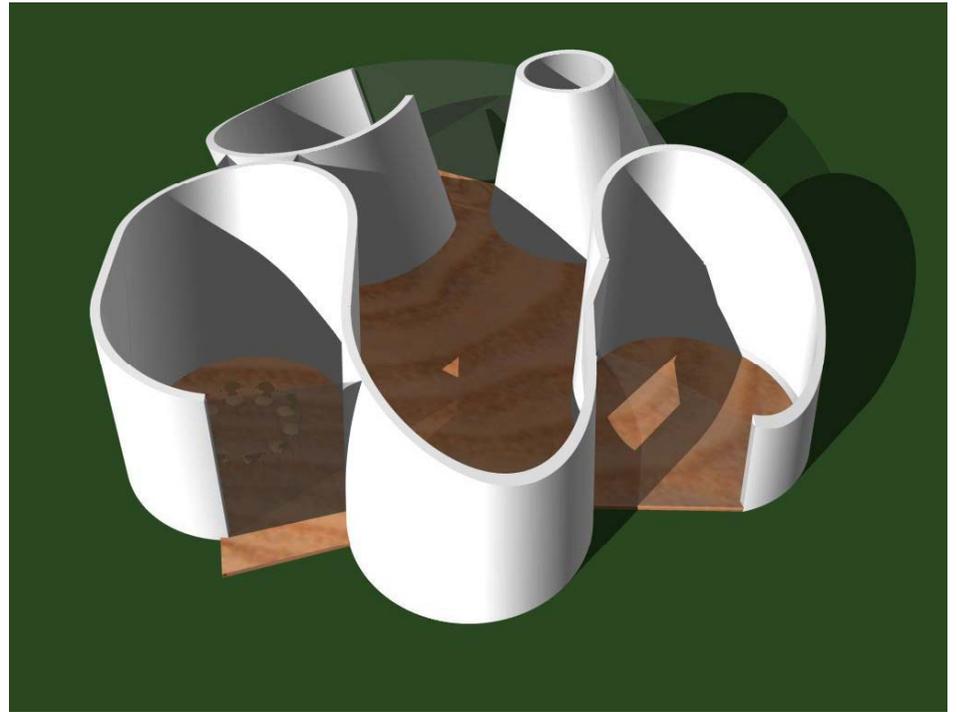
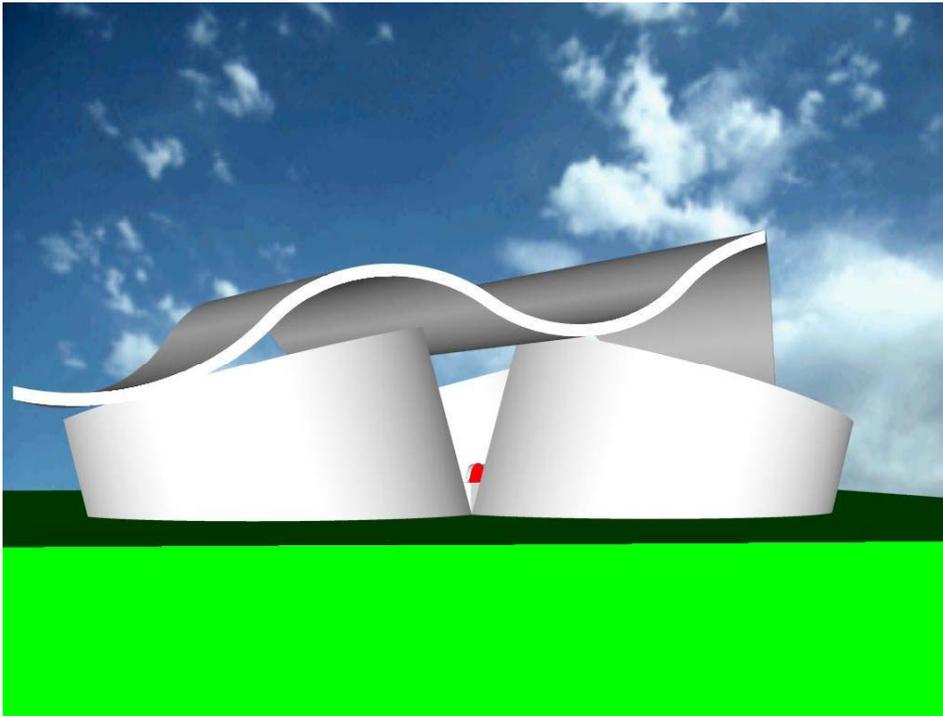


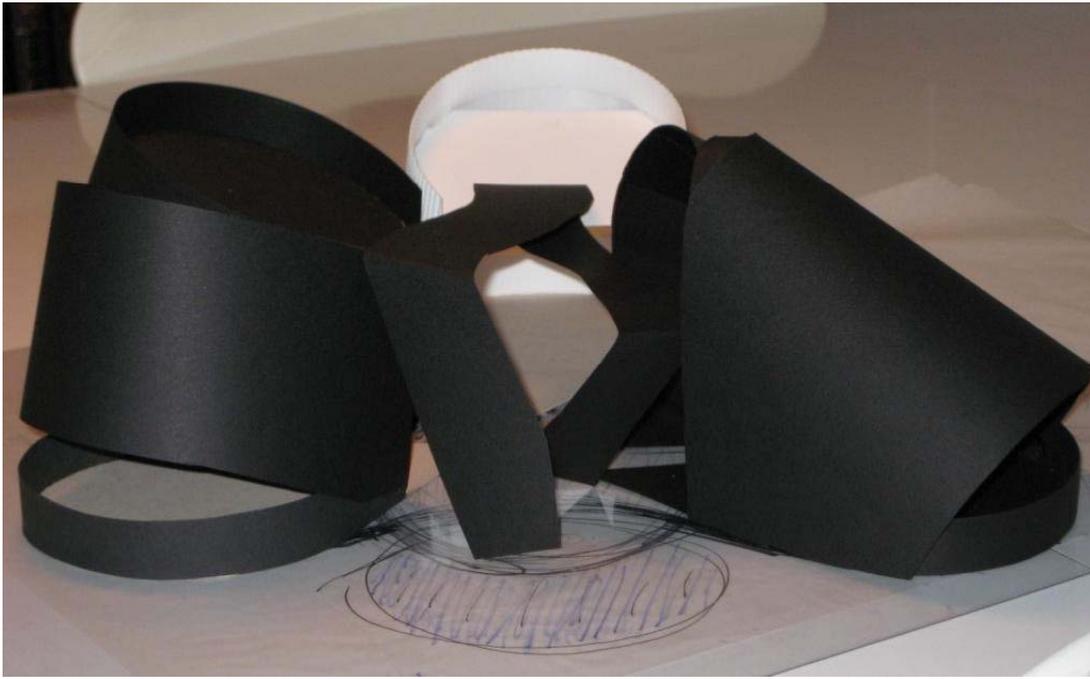


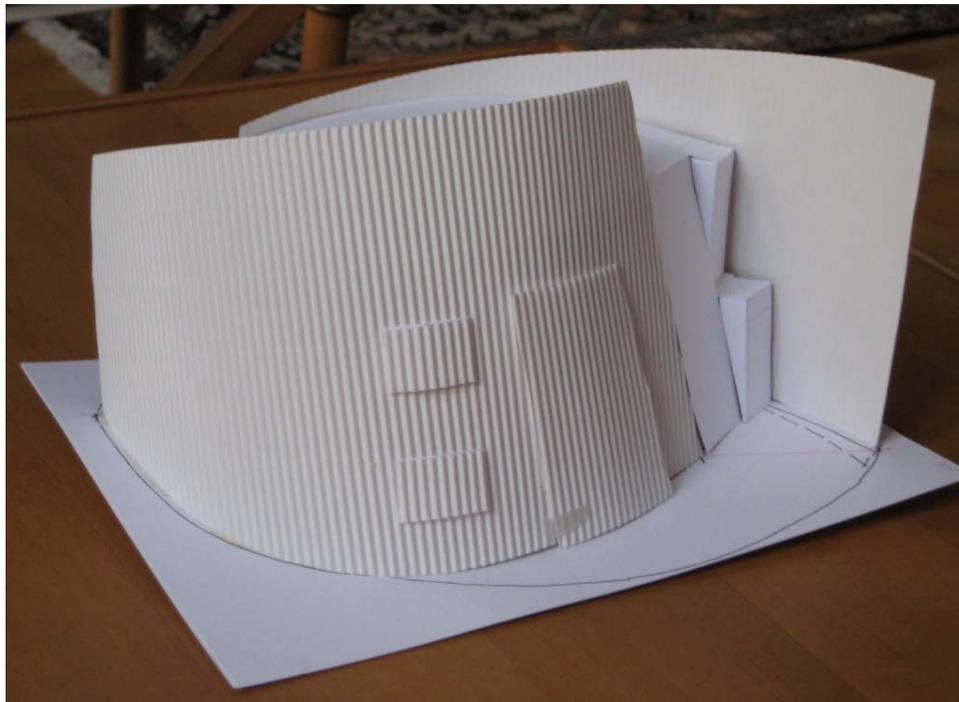
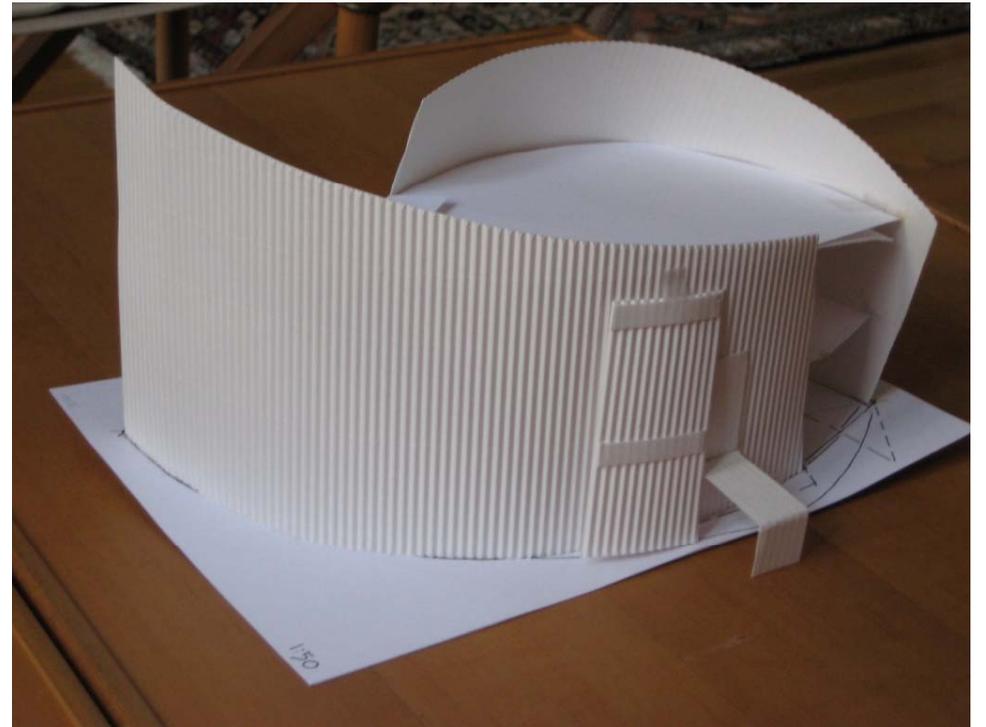


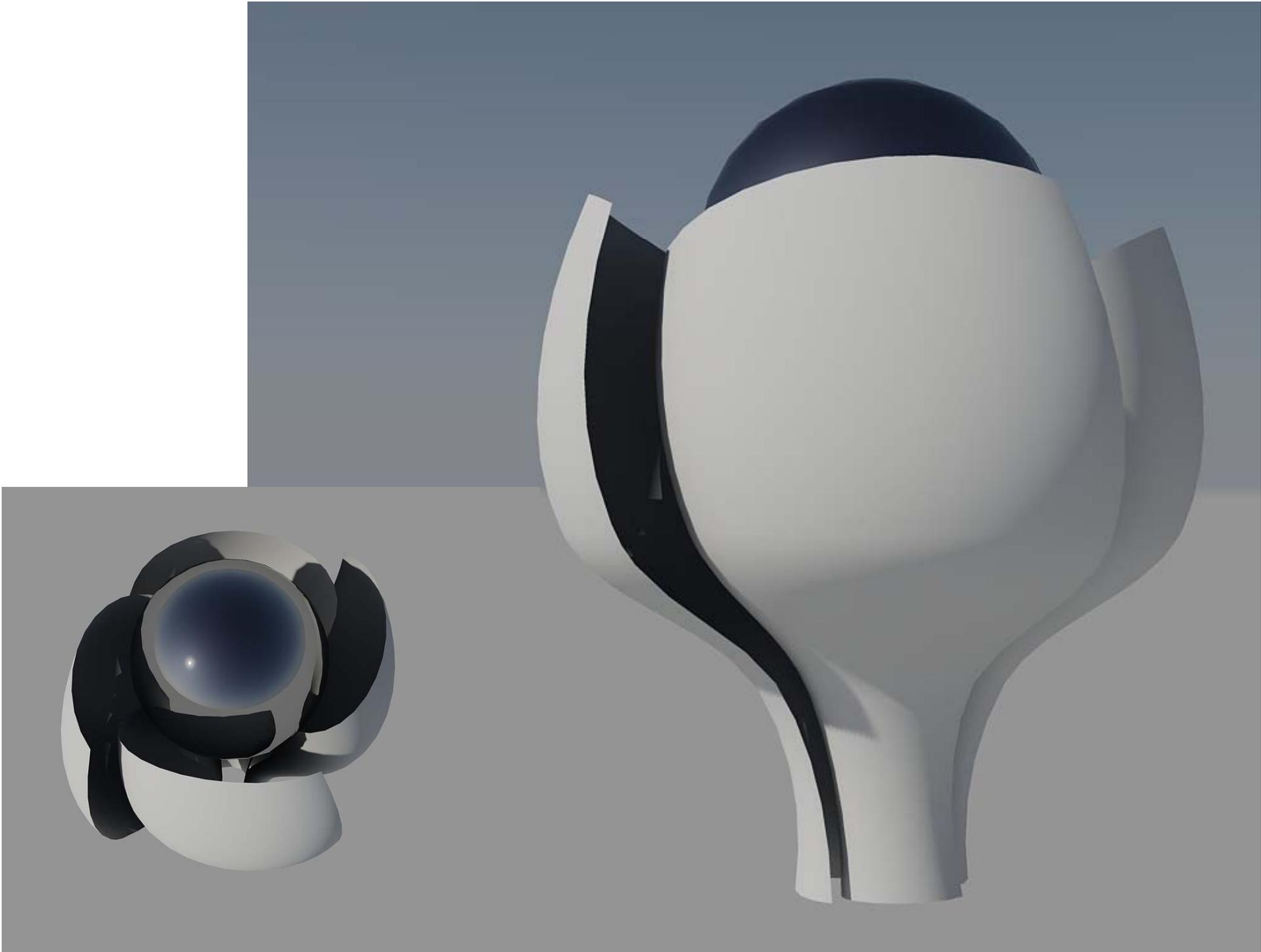


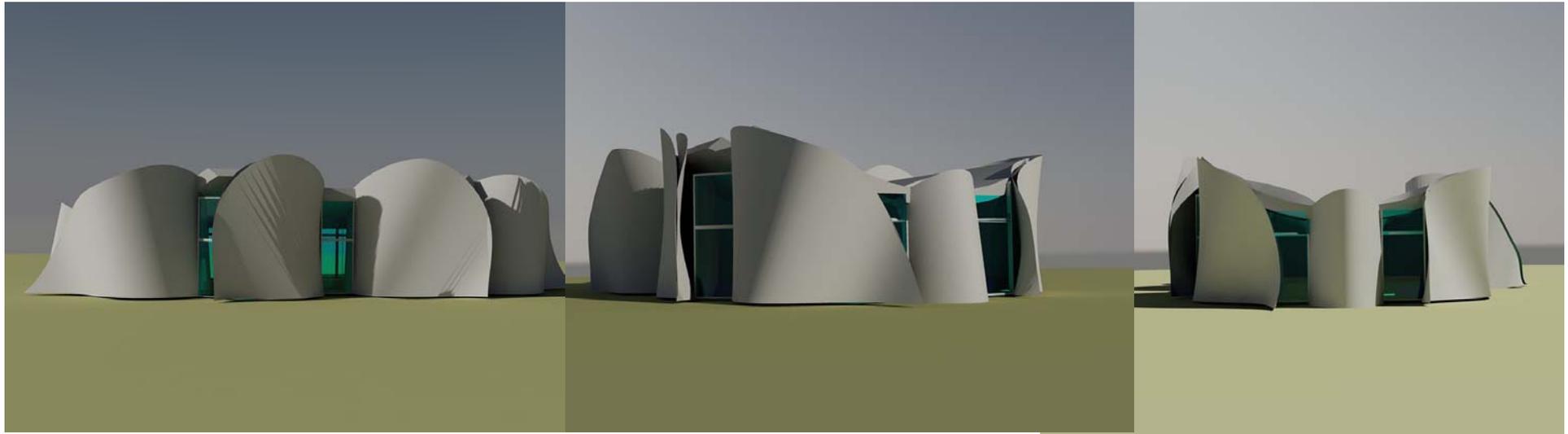






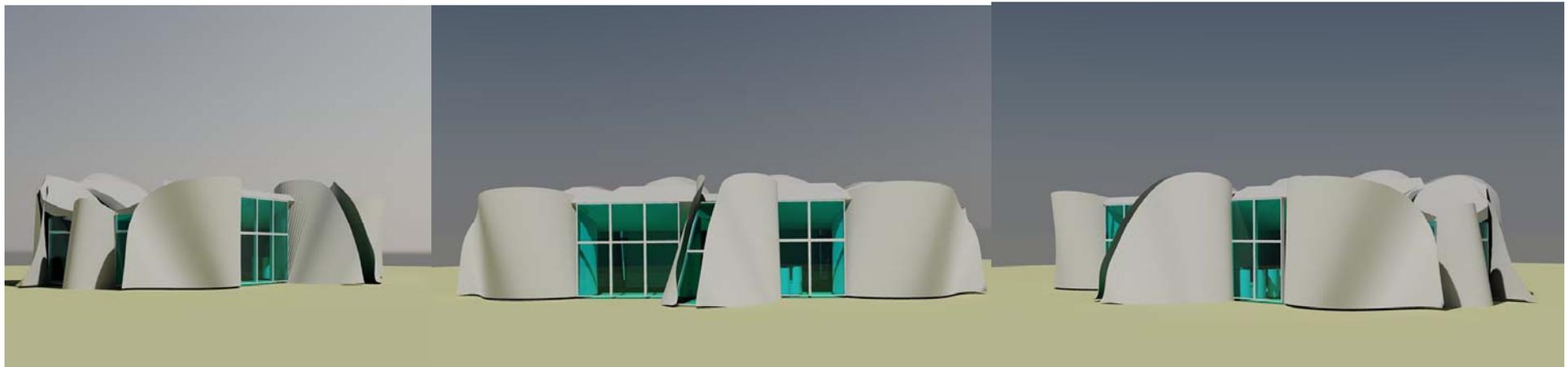






Dancing roses

We call them dancing roses because the two kinds are combined



Snake

We call them snakes, as they are some kind of distorted torus shape

We like the zebra snake the best because the different “snakes” play together, they have an ever changing diameter and the zebra pattern enhances the rather simple shape

I like also like the “Möbius strip” snake at the bottom because it is more snake than any of the others, being curled up and un limited

The snakes are extruded and could be cast on balloons.

The shape is strong due to the relative small radius of all surfaces

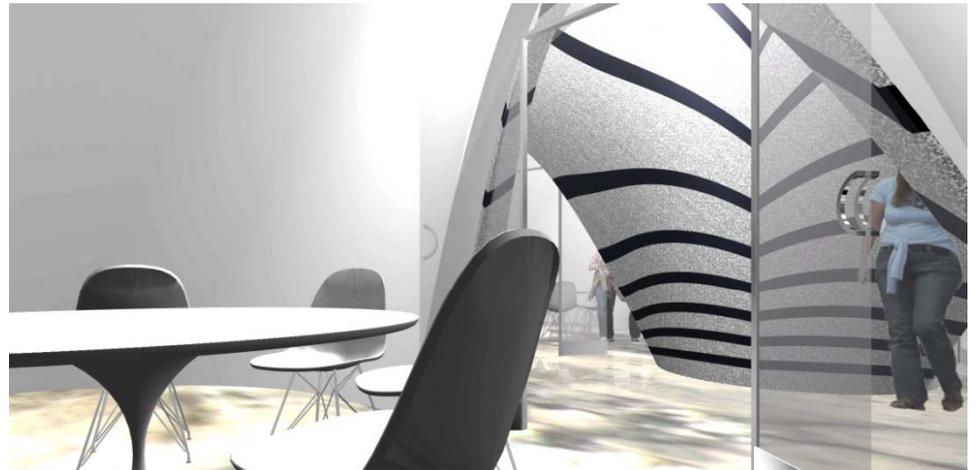
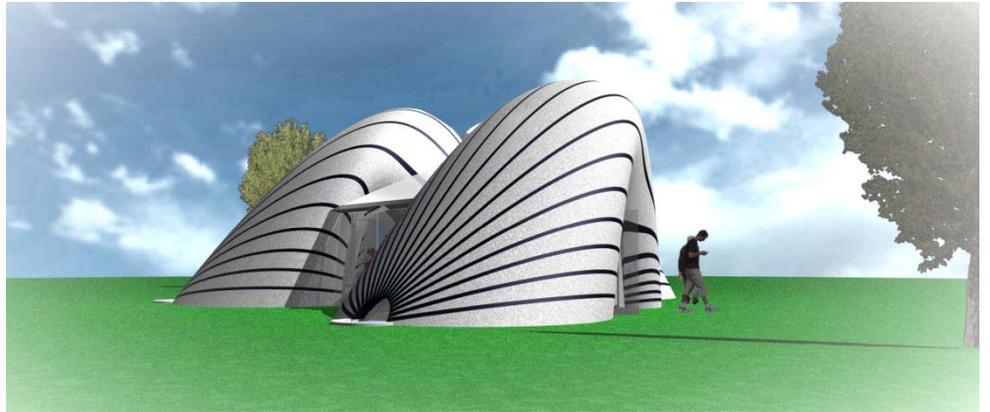
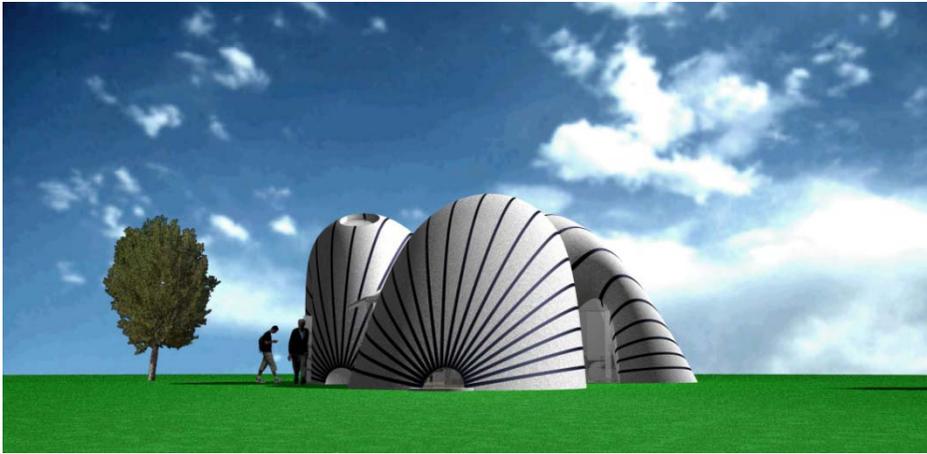
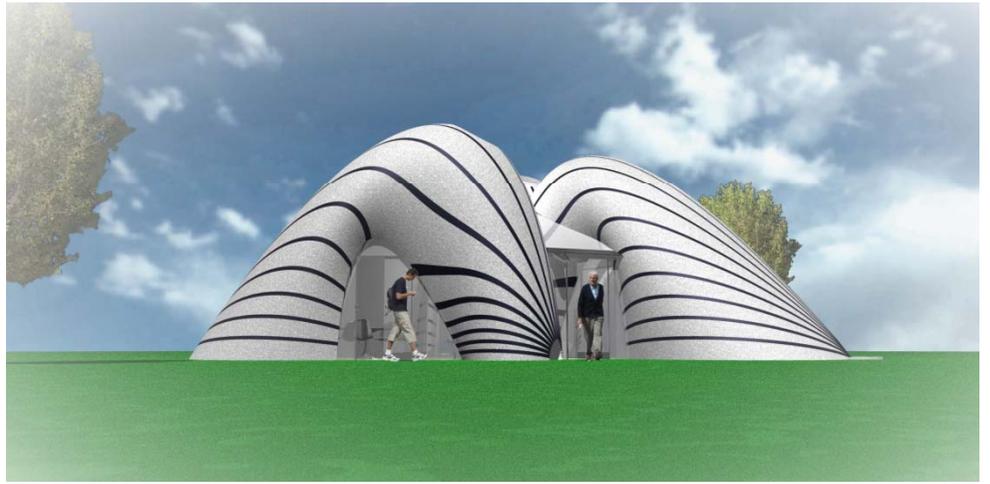
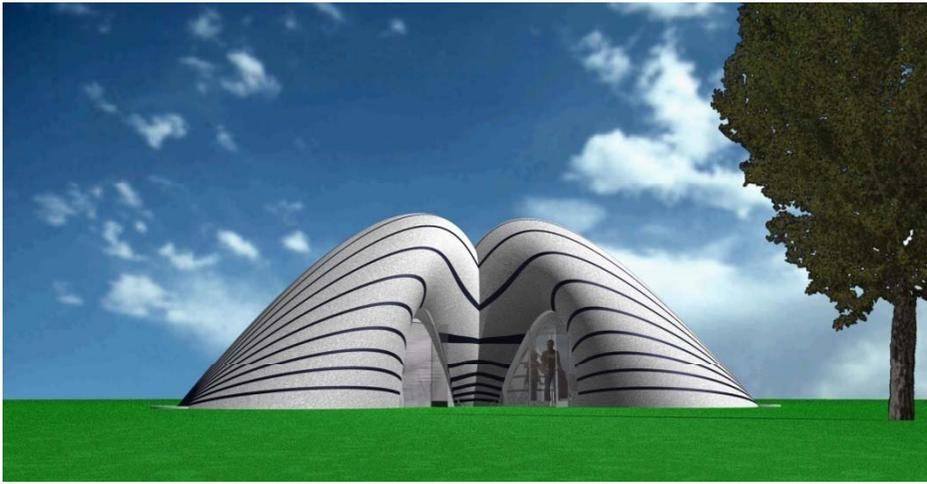
A disadvantage of the “snakes” is that it is very difficult to fit windows into the shape. You can almost only put windows in the concave space below the belly of the snake.

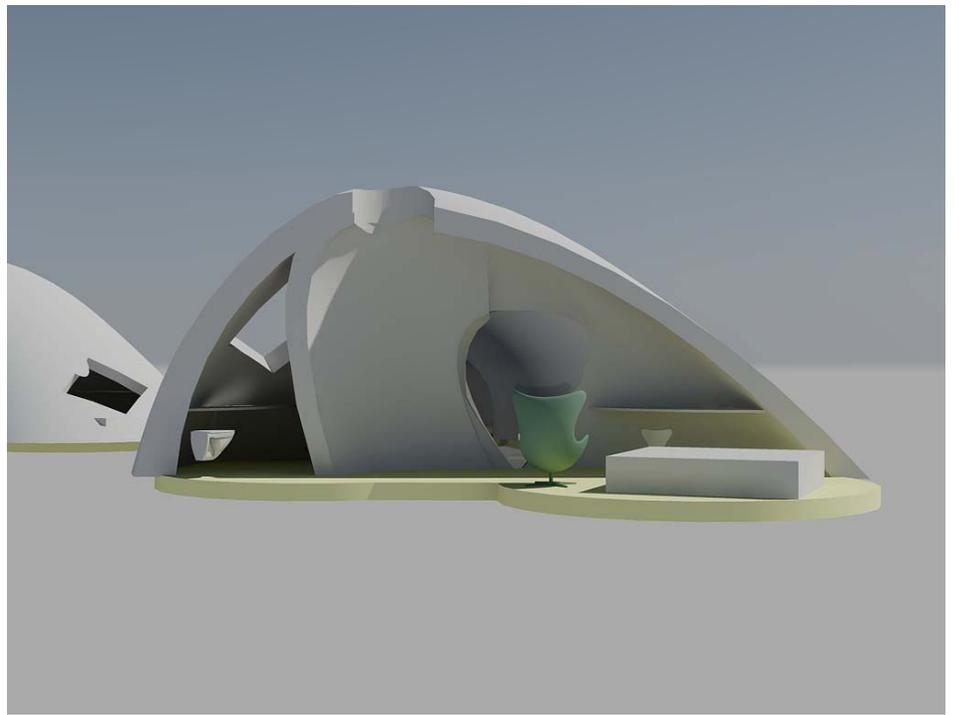
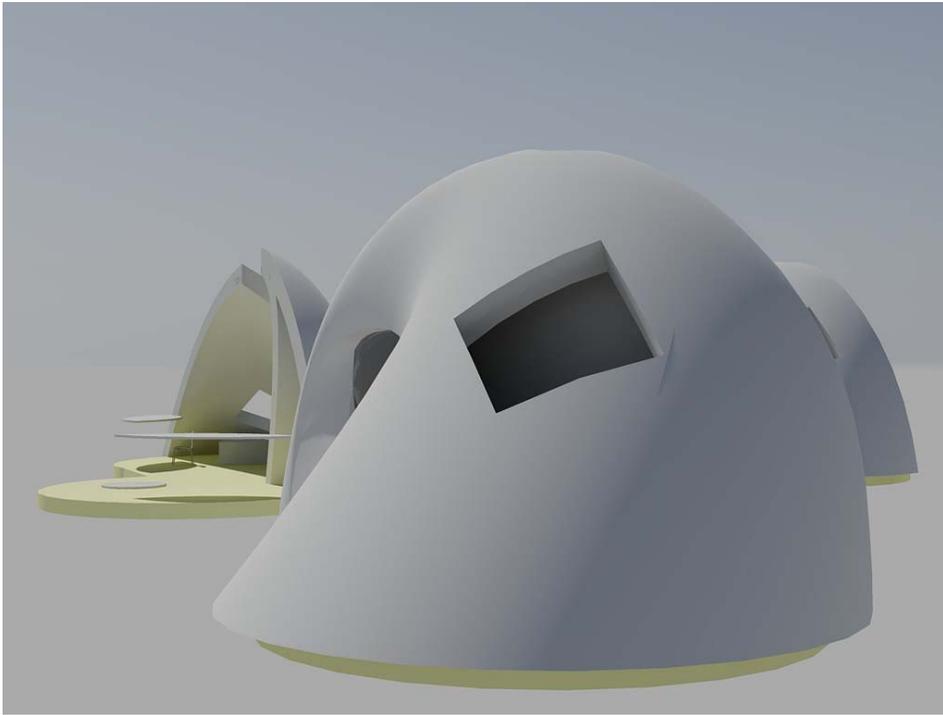
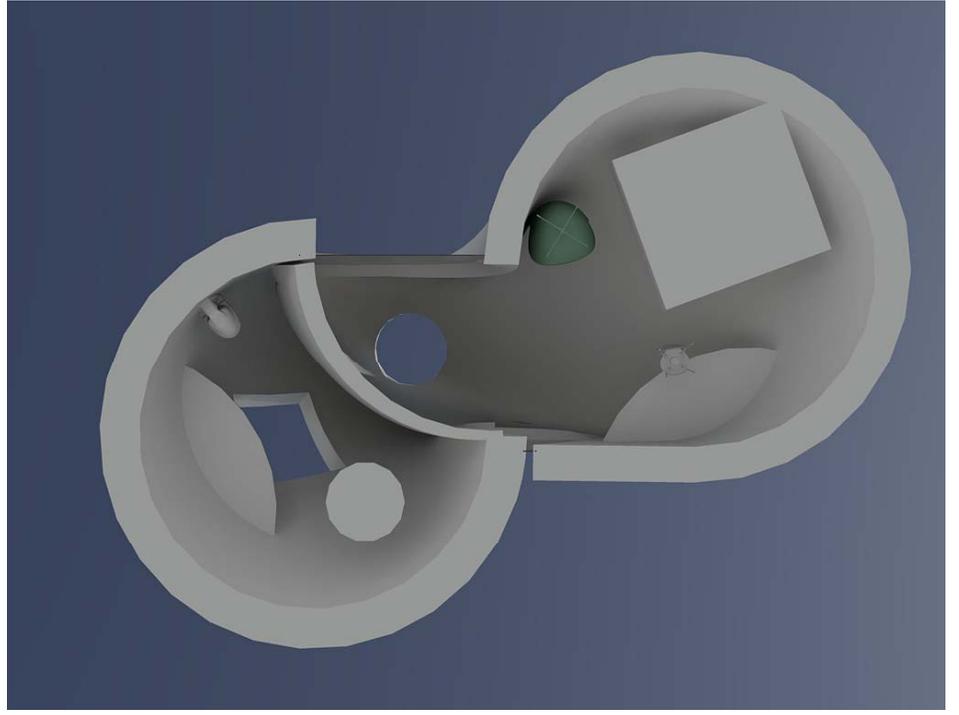
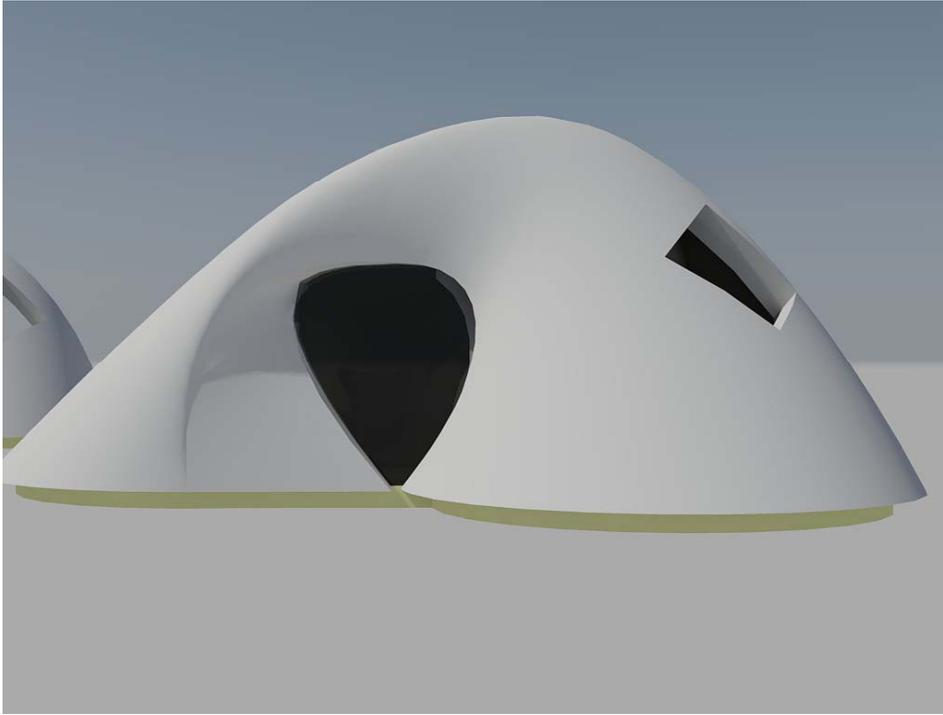
Another challenge is that the spaces tend to become caves with little height at the edges.

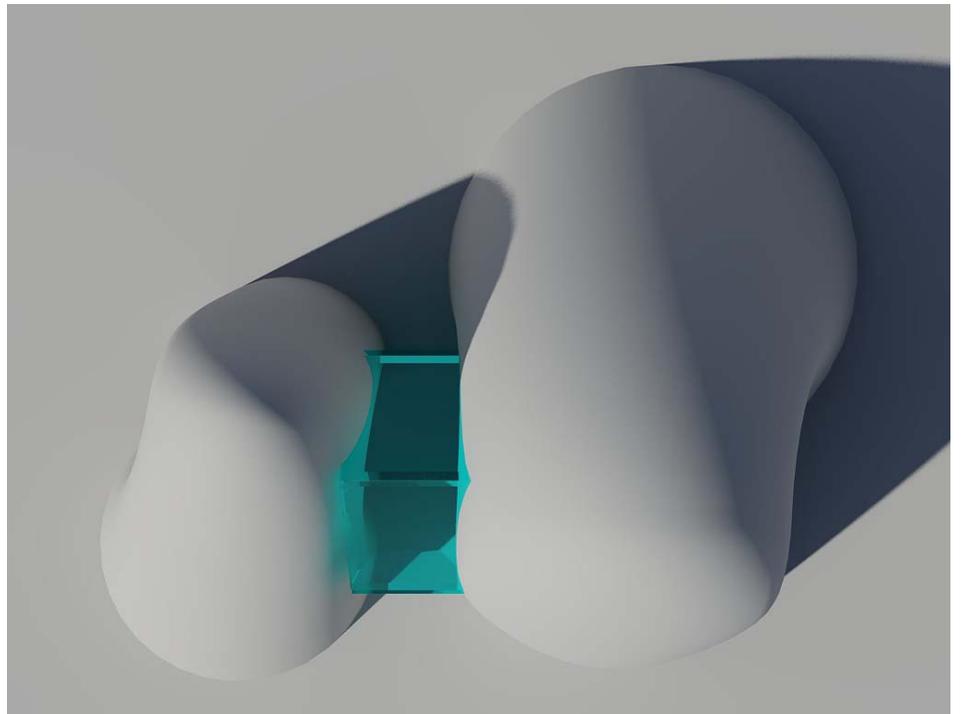
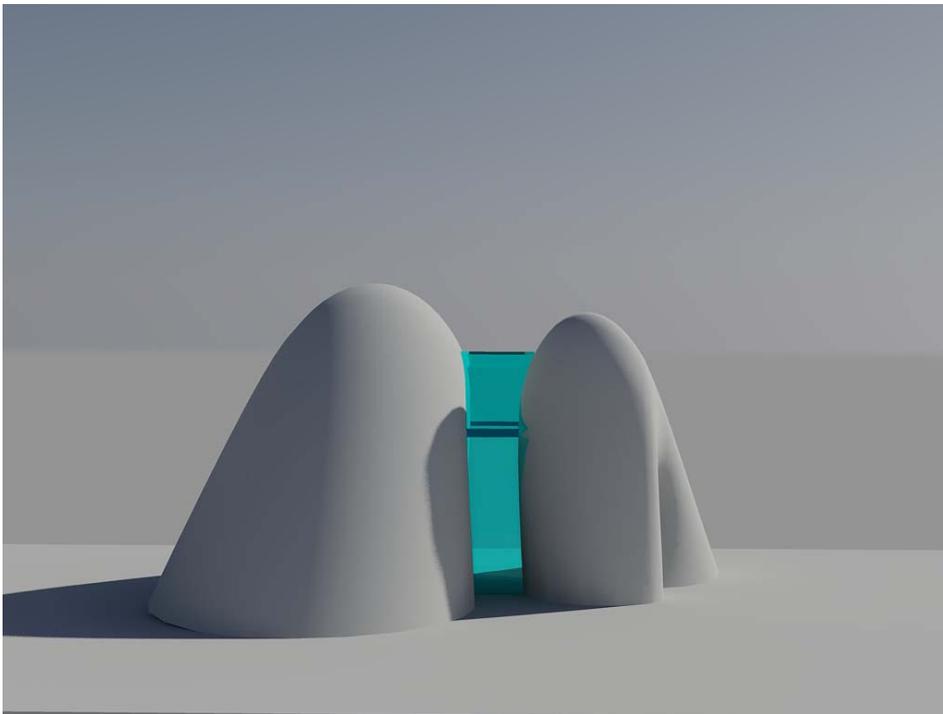
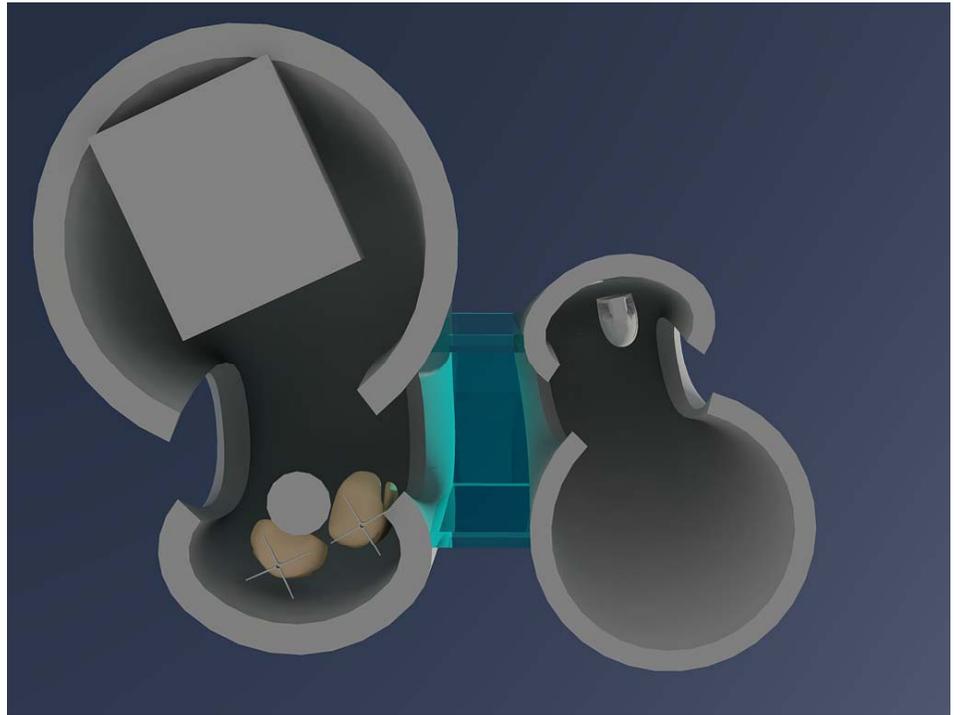
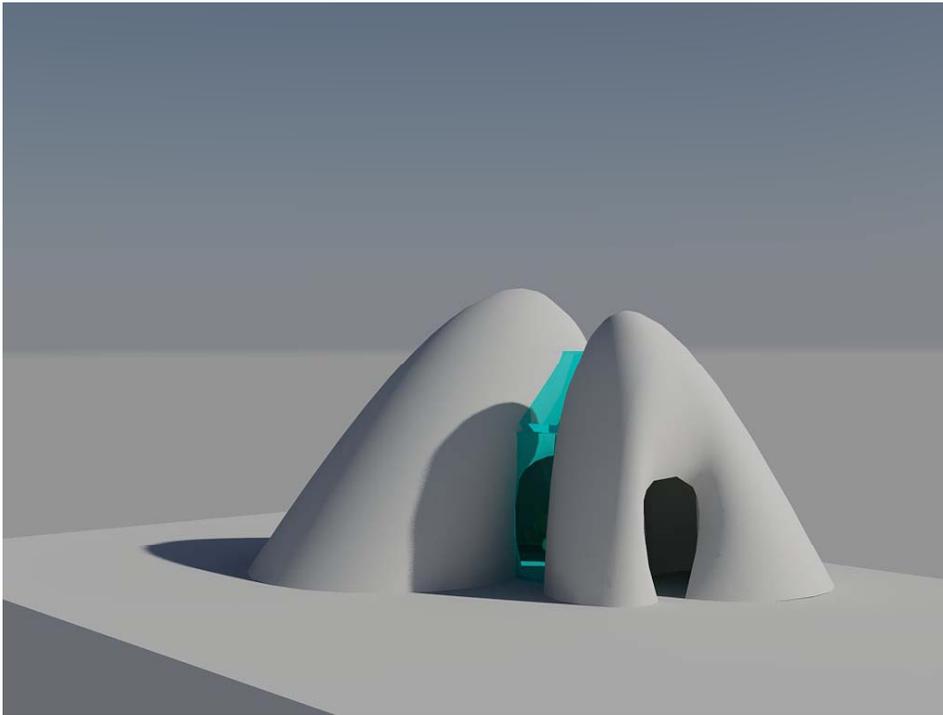
You cannot insert decks in these shapes without difficulties but small platforms are an option.

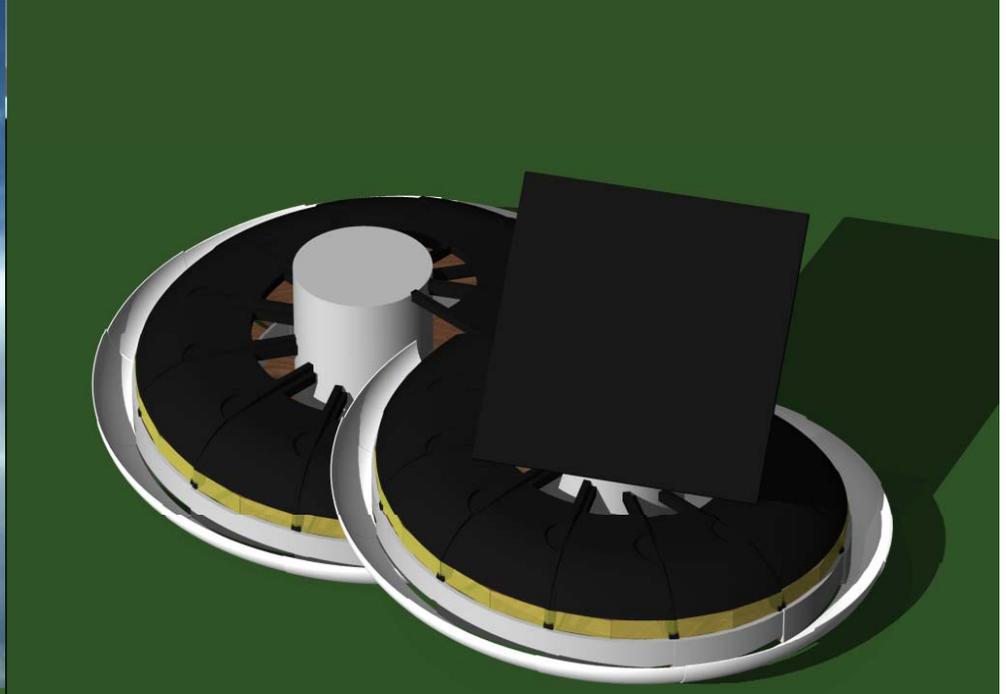
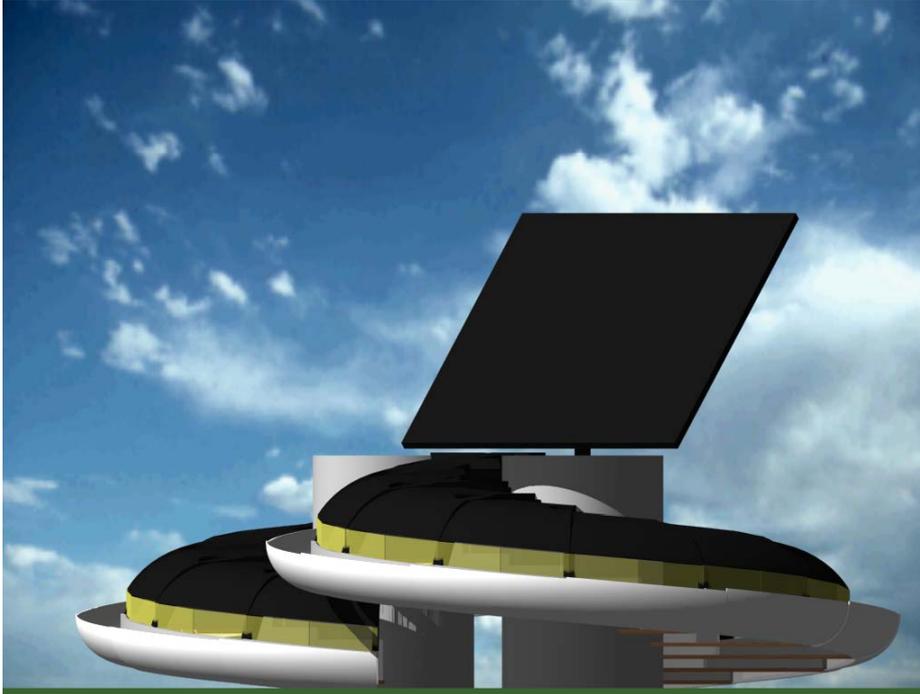
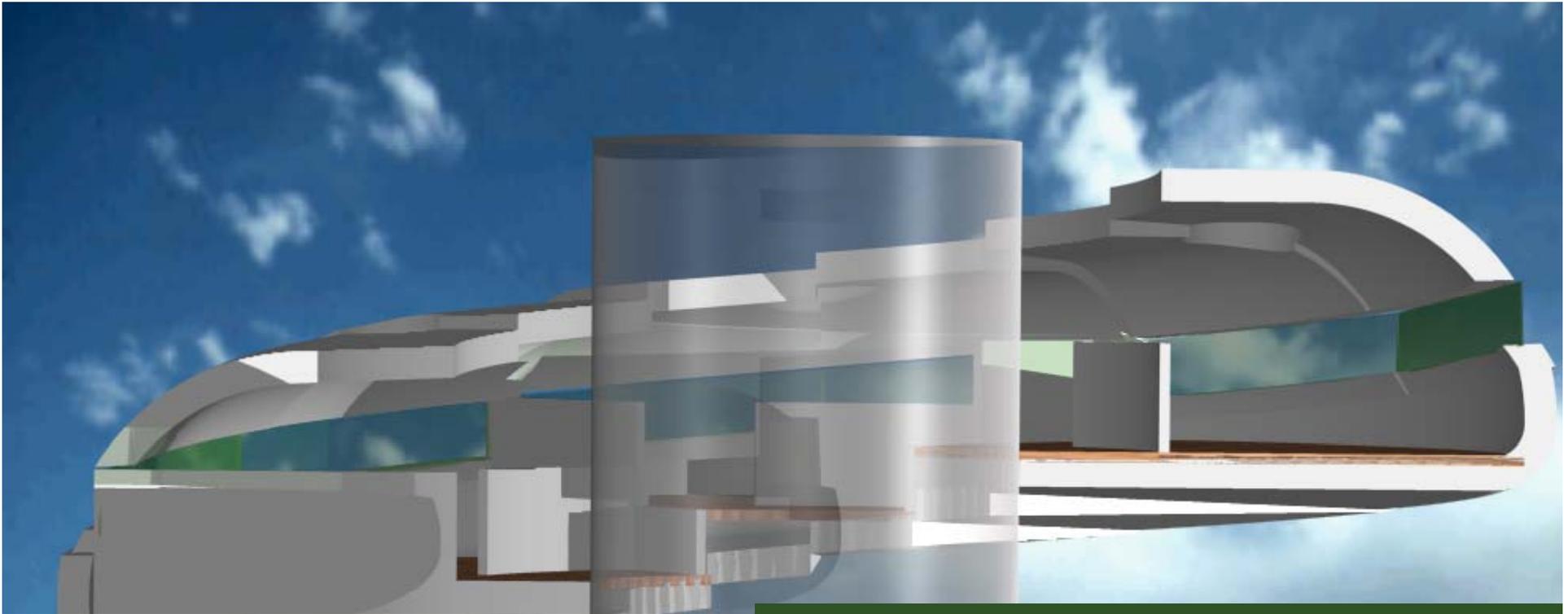
Holes for windows should be very limited

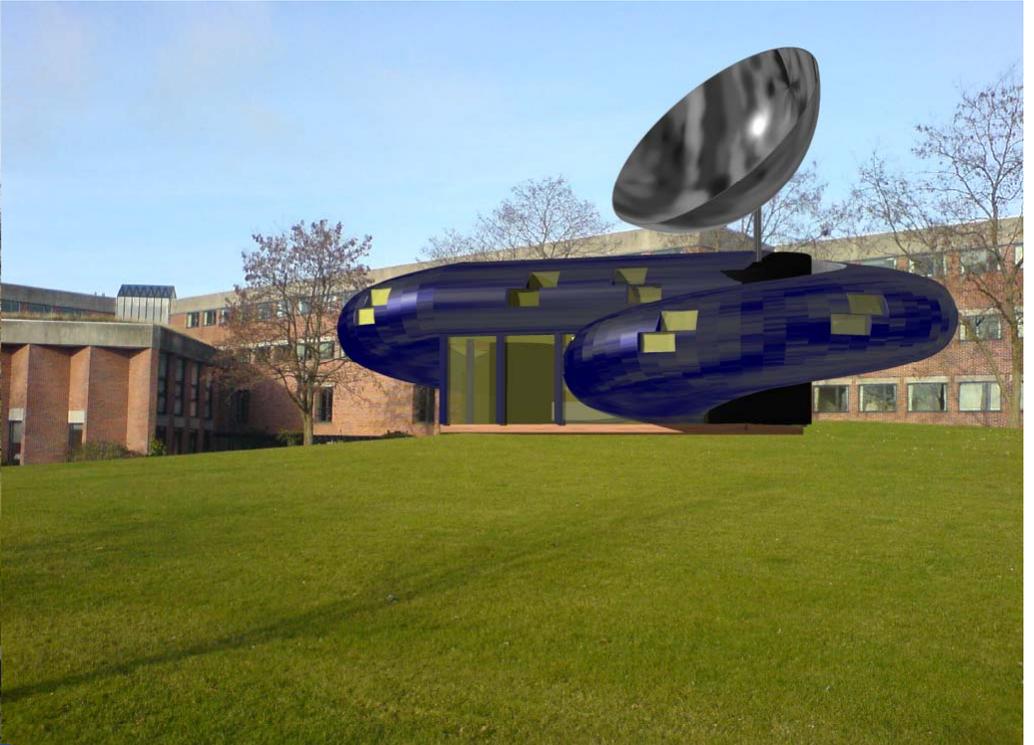
The flat areas of the roof is not so easy to maintain if the constructions are made in concrete.











Cell

We call them “cells” as they are interlaced like cells and soap bubbles

The single cell solution is like a balloon

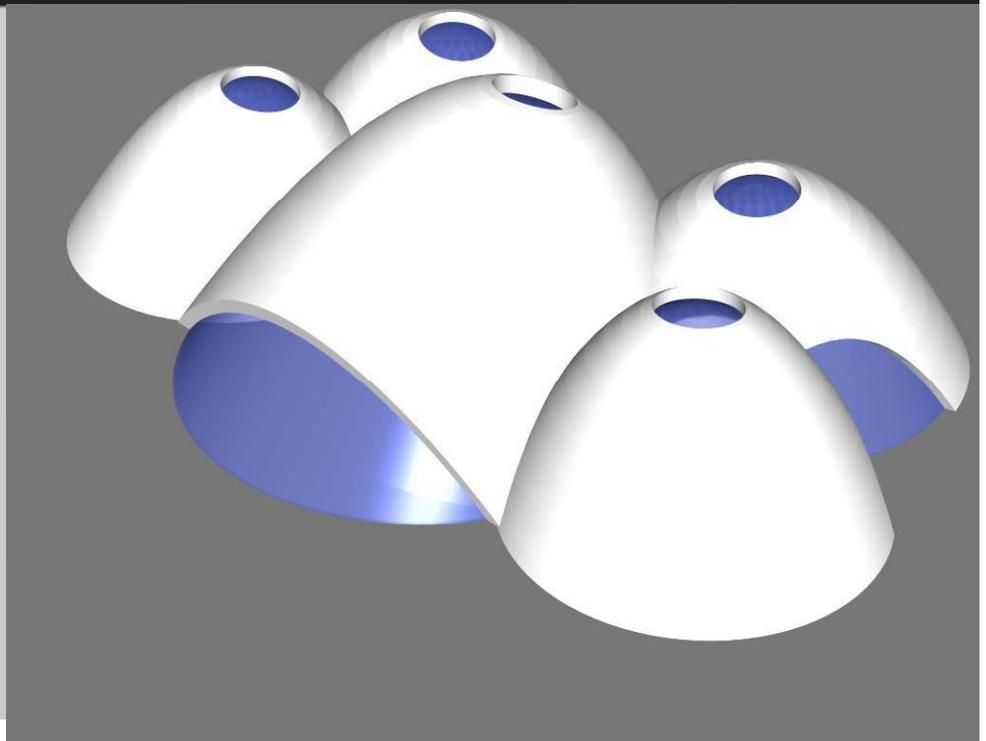
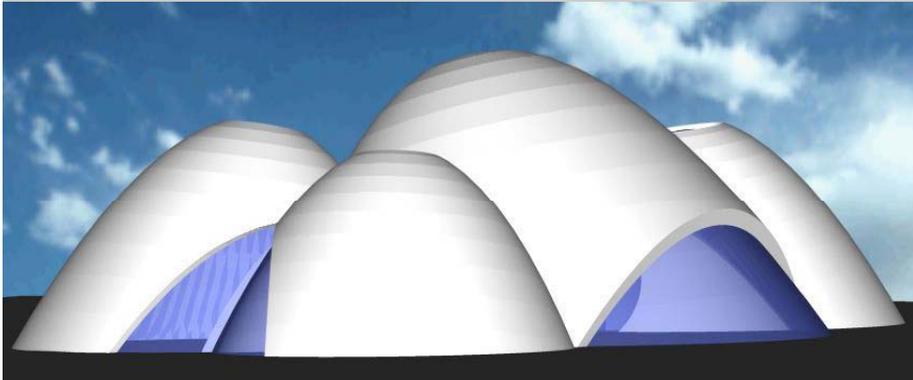
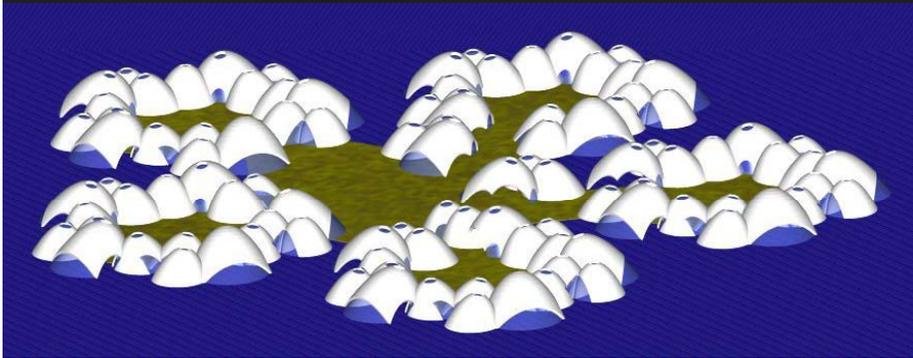
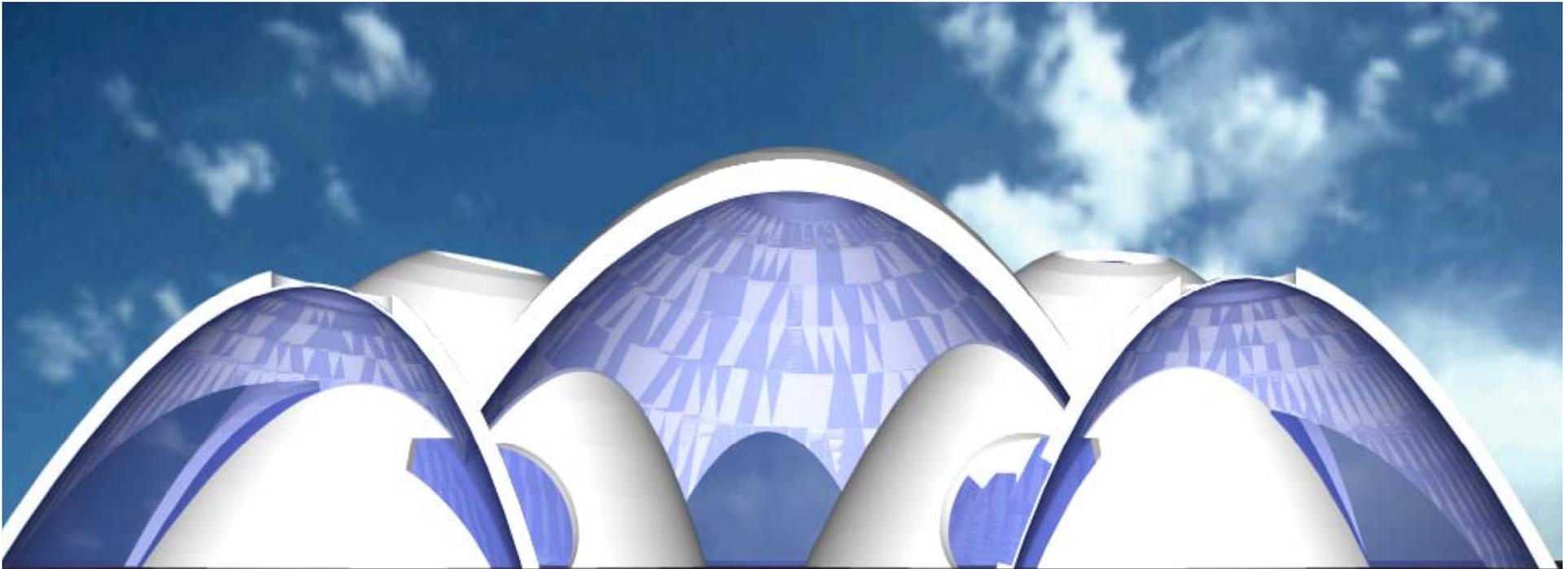
These shapes are easy to build with inflated balloons and they are much nicer interlaced than as single domes.

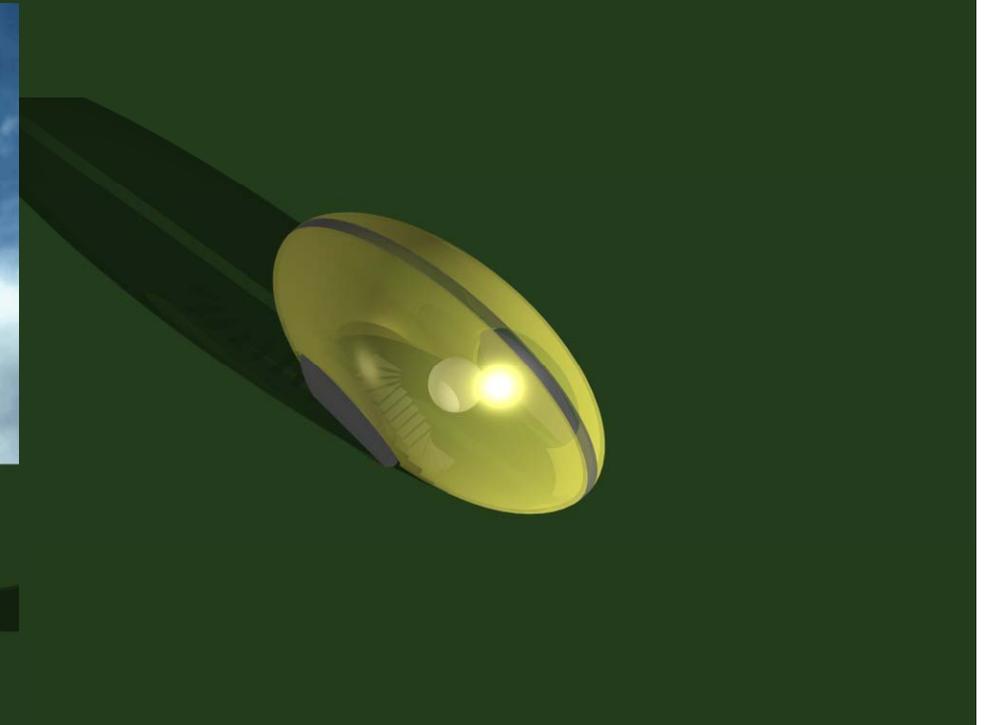
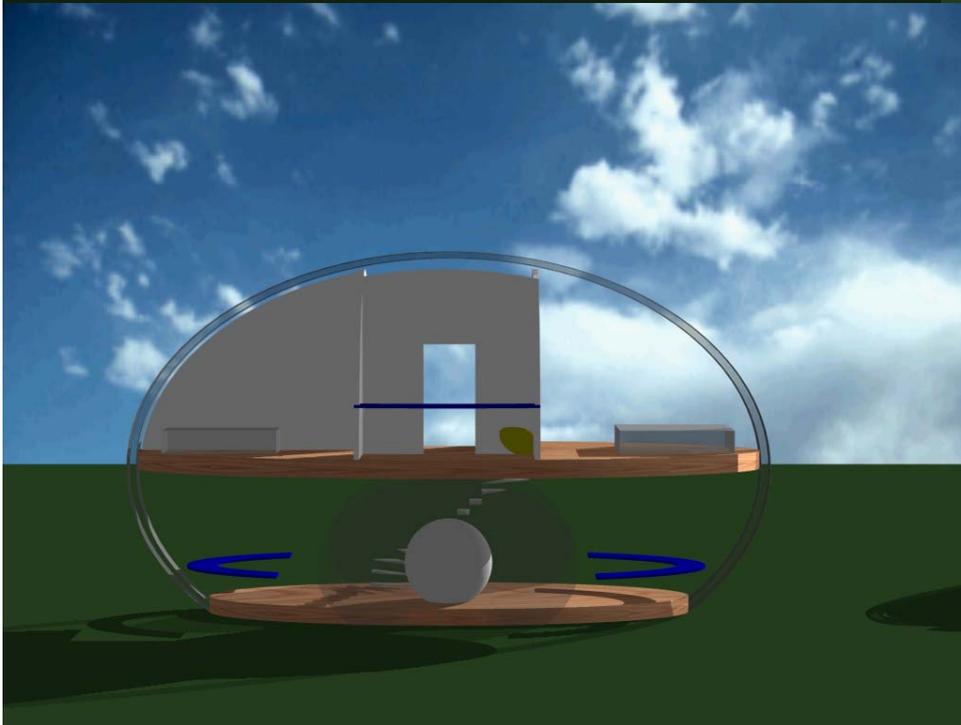
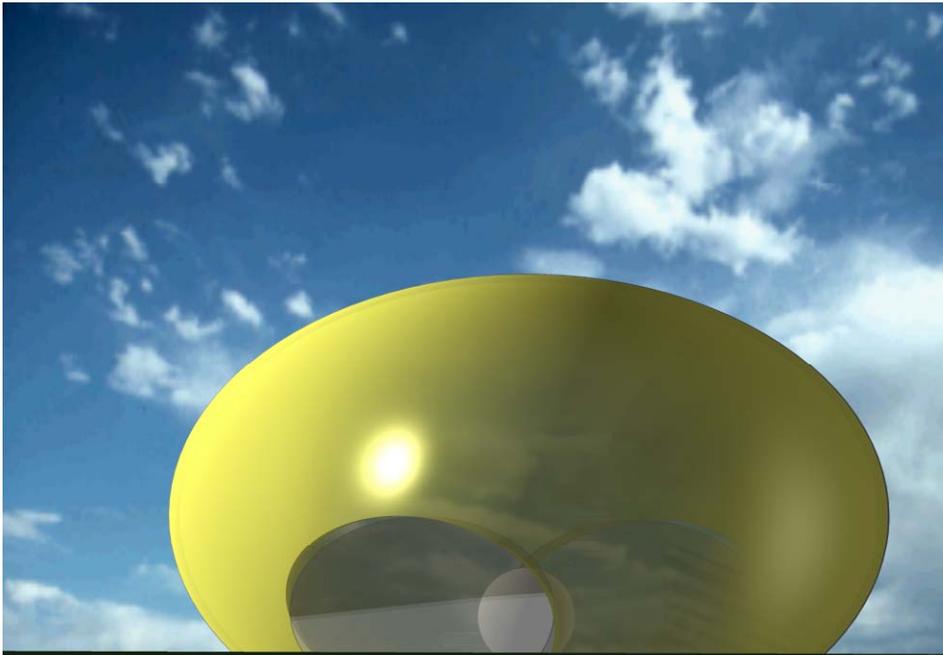
Cells are particularly beautiful when made in some translucent inflatable material like the water cube Olympic stadium in Beijing and Eden project in Wales

The disadvantage of this shape is that it is too much cave like unless they are made in translucent materials

It is difficult to put windows in this shape and windows tend to be wider the lower you get which is not what you want for a view. But that is no problem either with translucent materials

Partition walls have to be curved like the bubbles and that conflicts with most doors





Skin

We call them “skin” because they are a thin suspended layer .

Well, in this case they are actually part of a cylindrical shape but it looks like it is suspended.

The constructions can be made very thin even in large structures if they are “tents”, but if they are made from more conventional constructions and insulated they get rather thick and you should take special care not to lose the lightness.

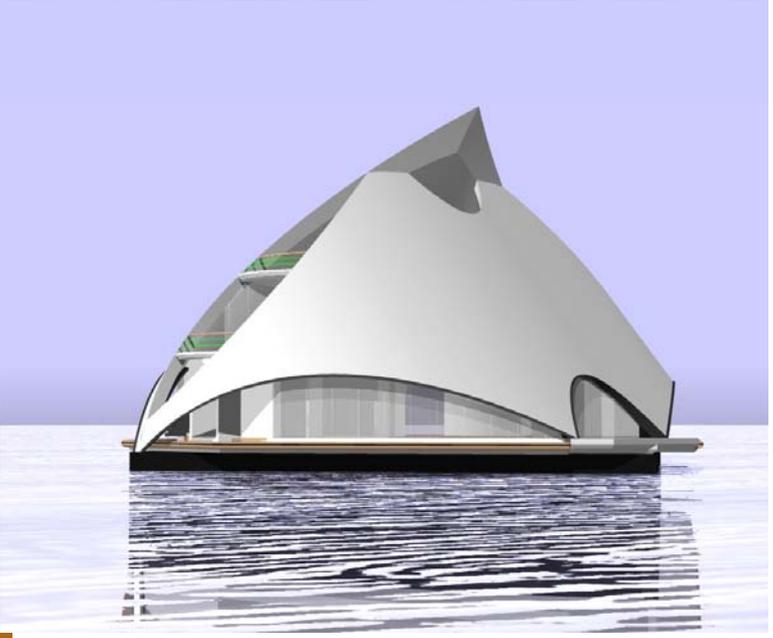
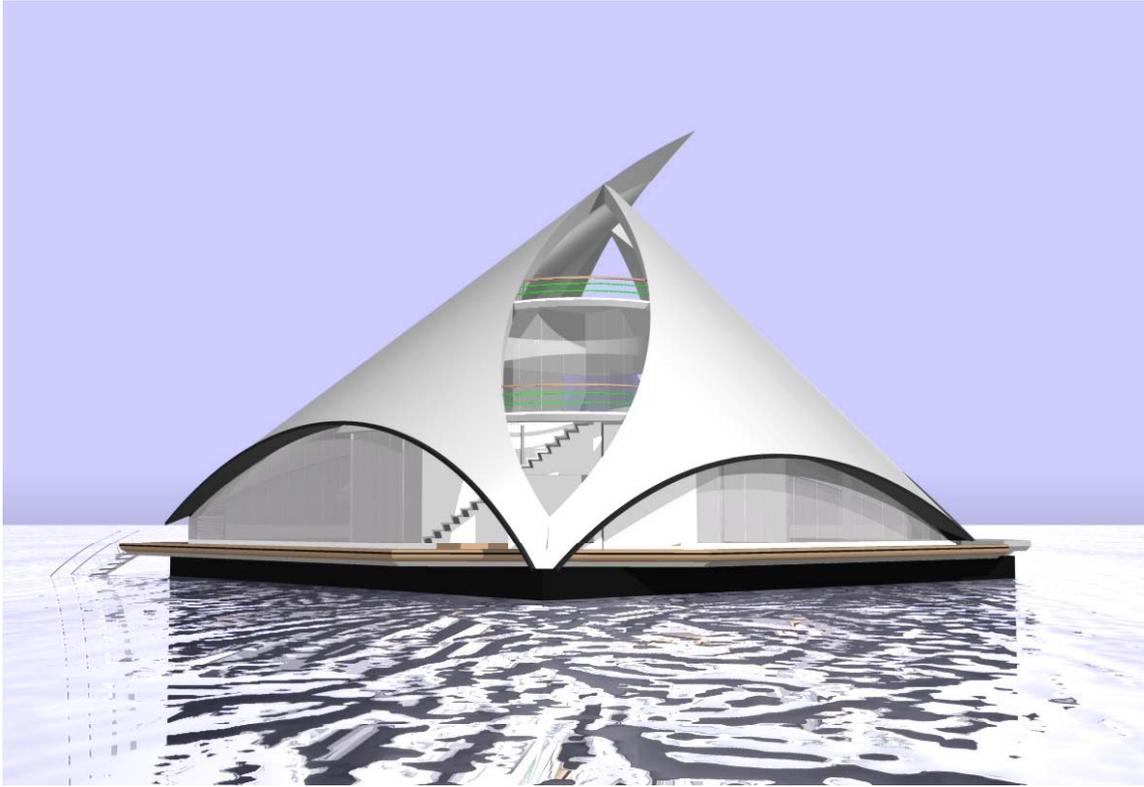
It is easy to put windows in this shape, at least at the ground floor.

The shape is strong but tends to deliver the structural forces in points rather than surfaces

The disadvantage of this shape is the height of the construction in the middle combined with the difficulties in putting deck into this shape.

It is not easy to insert partition walls either. They have to be new sails inside the big ones

Skins are most beautiful when they are slightly translucent



Canopy

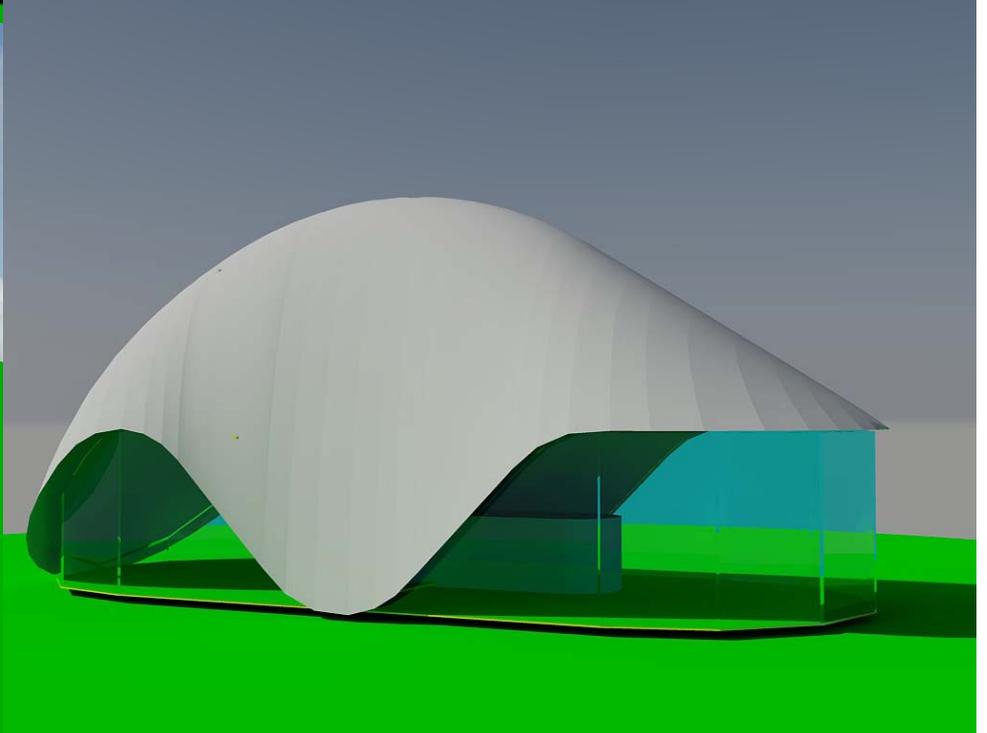
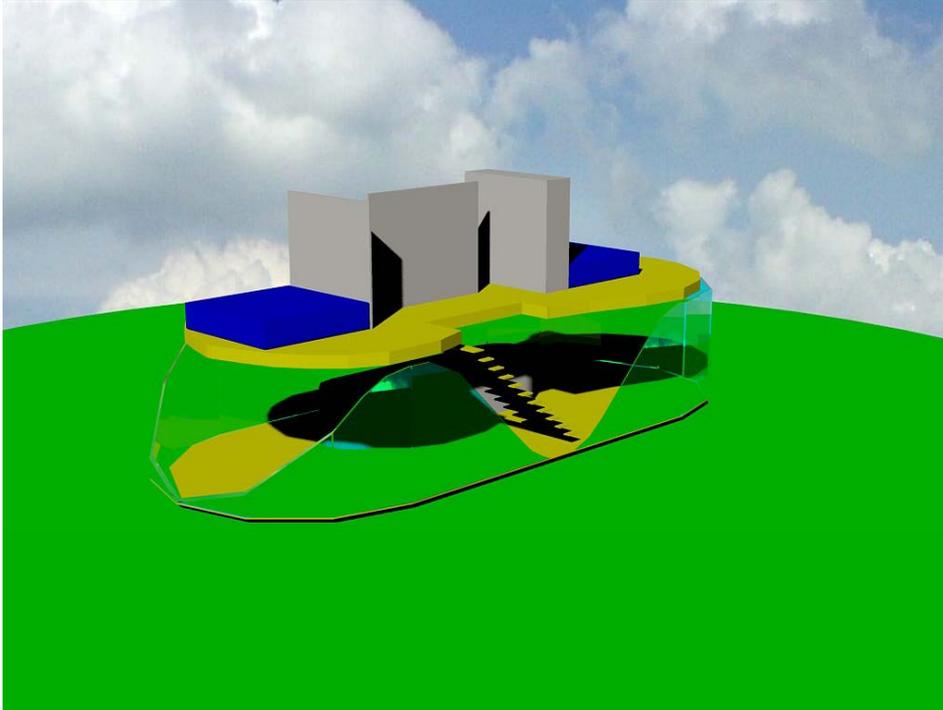
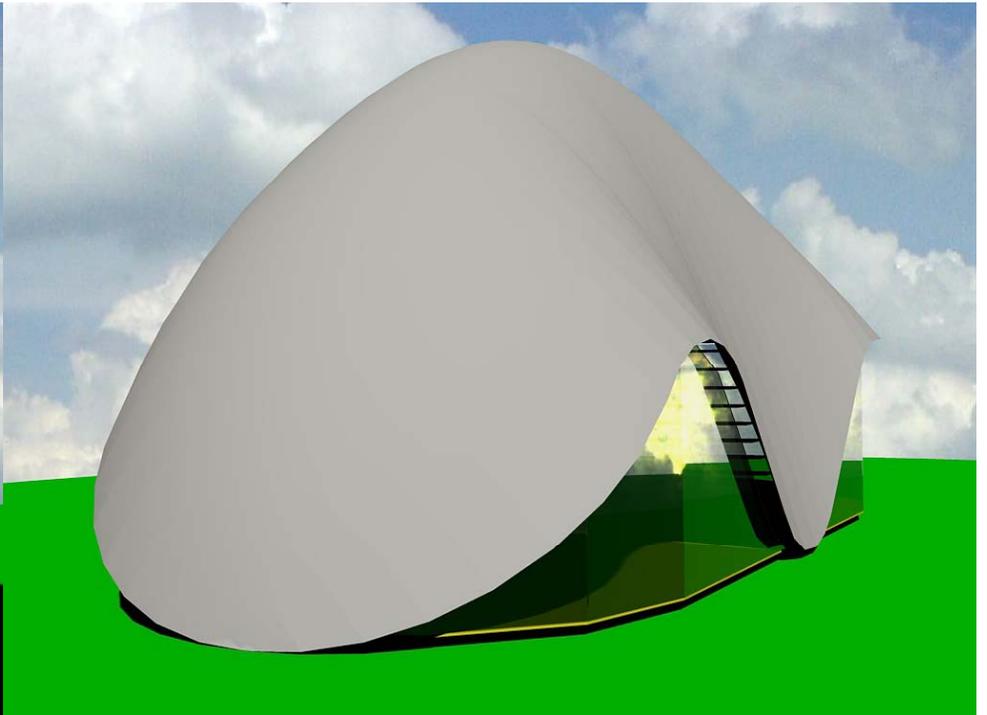
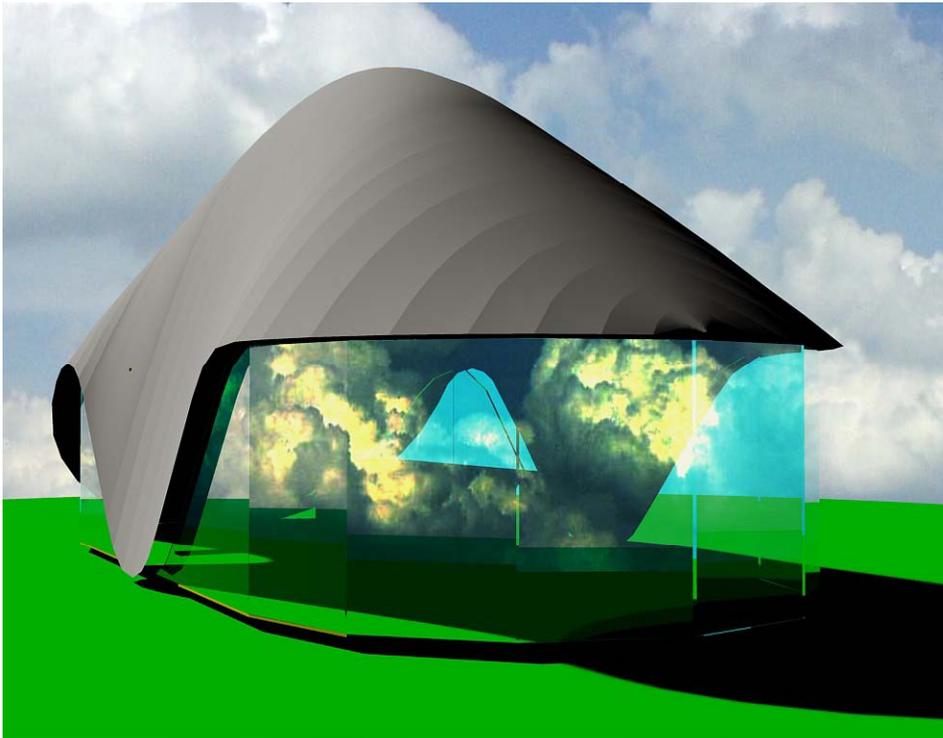
I call them “canopies” because they are like the canopy of tree based on a kind of trunk. In fact they are more often like several canopies on several trunks.

Hadid’s Innsbruck stations, her Olympic stadium in London and many of Candelas shells are in this category.

They tend to leave very large areas for windows and glazing and could not meet our energy targets

It is not easy to insert partition walls or decks in these shapes, but platforms are an option .

We worked on a concept where the deck is inserted as the thickness of the roof.



Fish

We call them fish, because they have a "mouth" and a "tail" and seem to swim or jump in one direction.

We like the jumping dolphin better than the others but i also like when the tail of the fish is turned. That creates momentum.

A fish can be constructed from all the different 3D technologies.

The shape I basically suspended between a number of sharp or rounded arcs. I like the sharp arches better

The disadvantage of the shape is that the interiors tend to become cave like, or like the interior of a mid size airplane without windows.

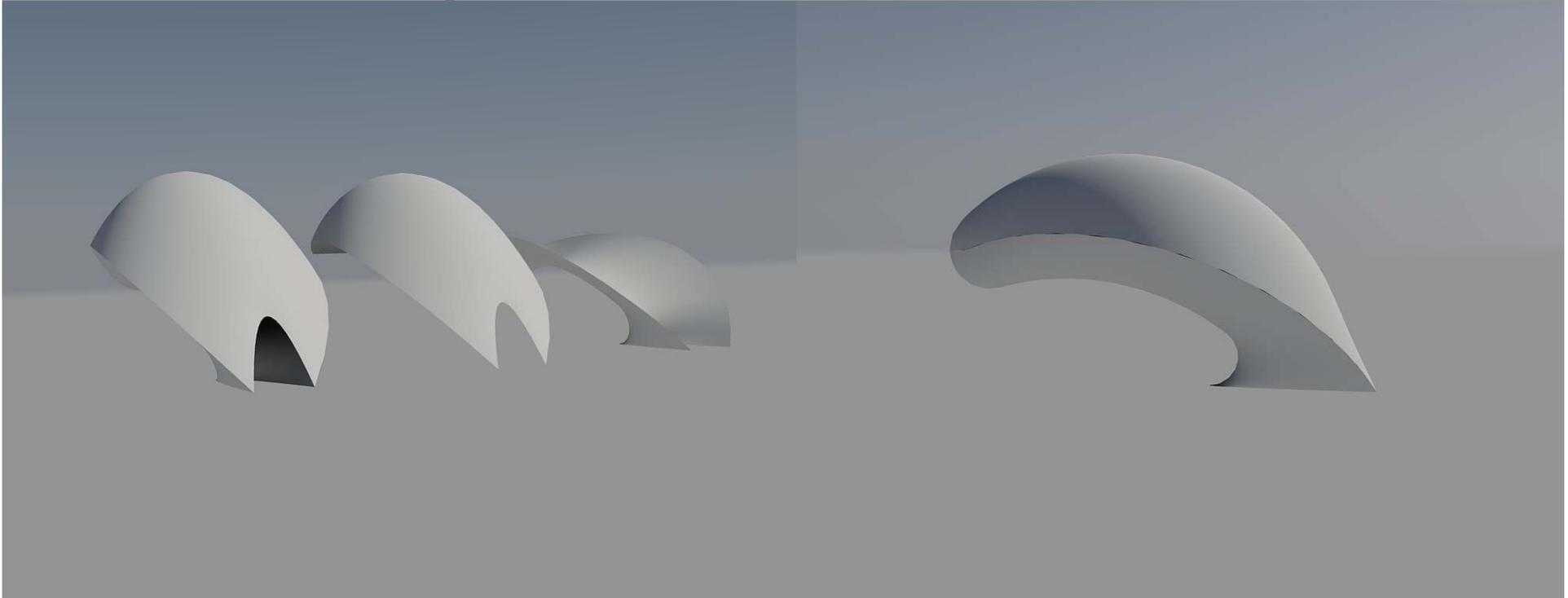
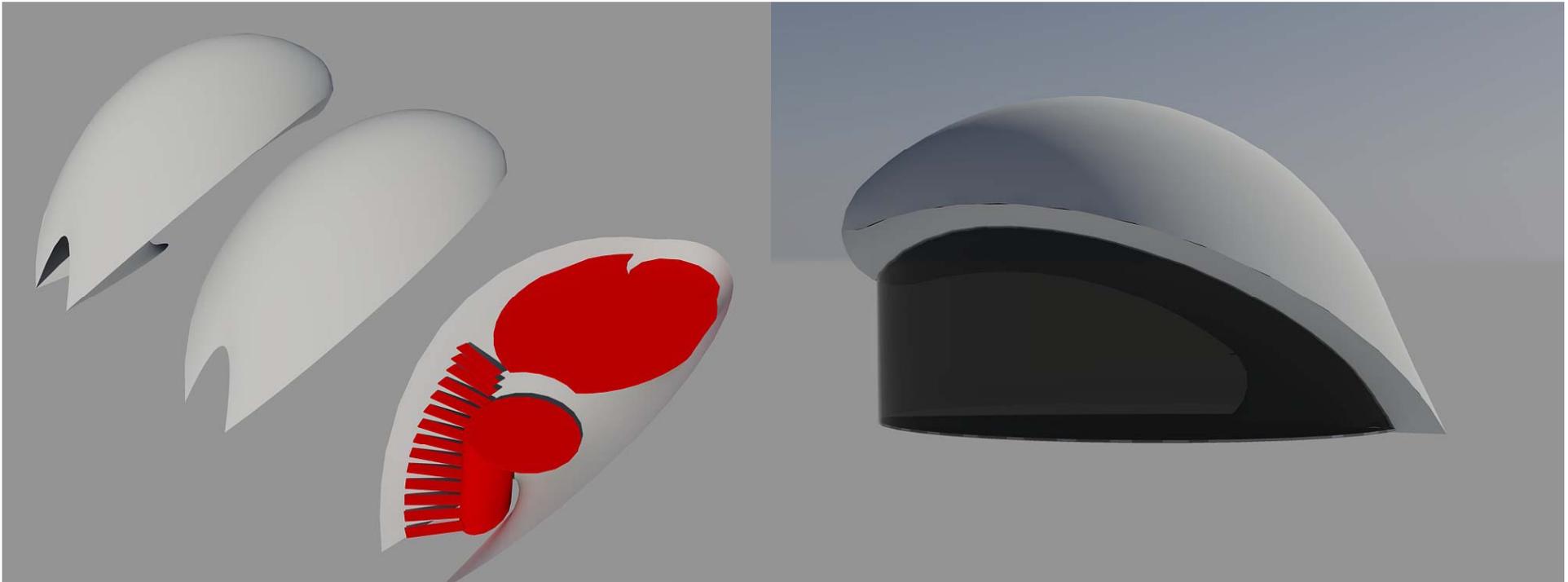
The shape is not necessarily strong as there is a rather flat roof.

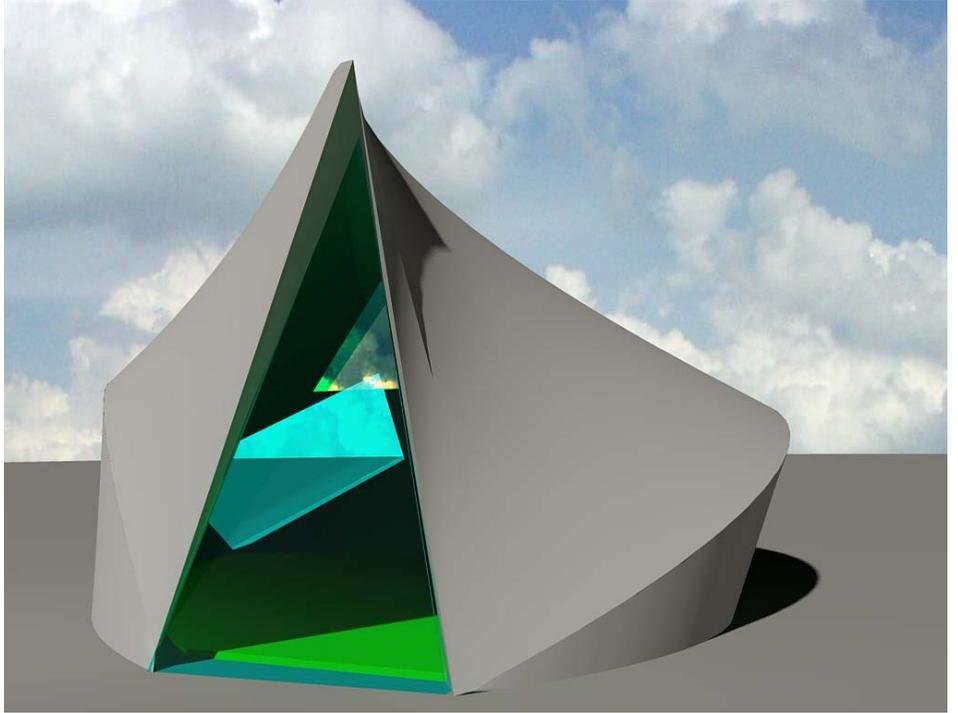
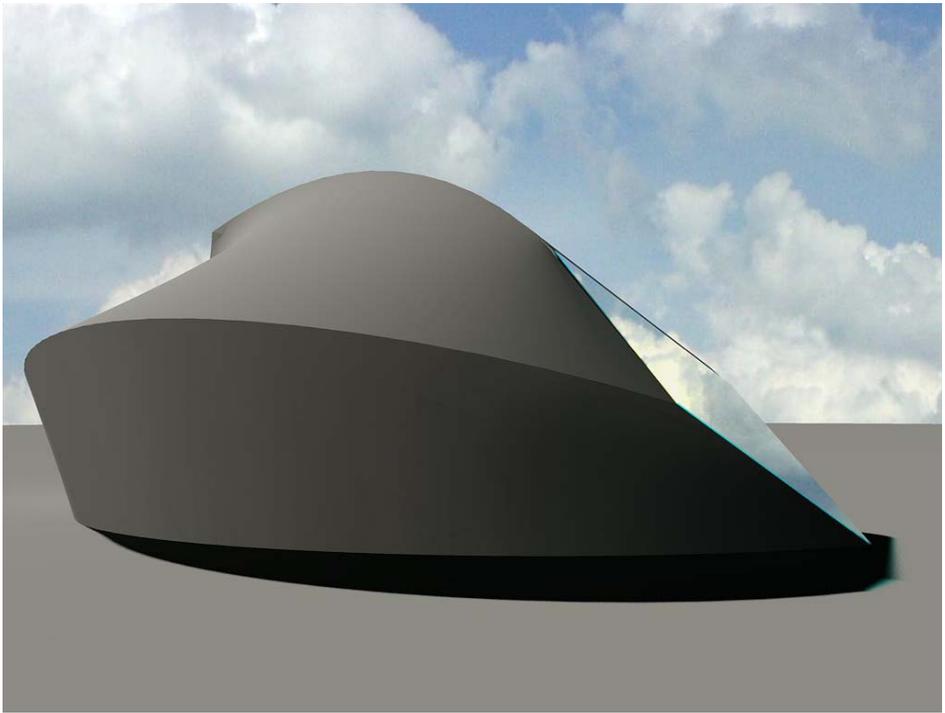
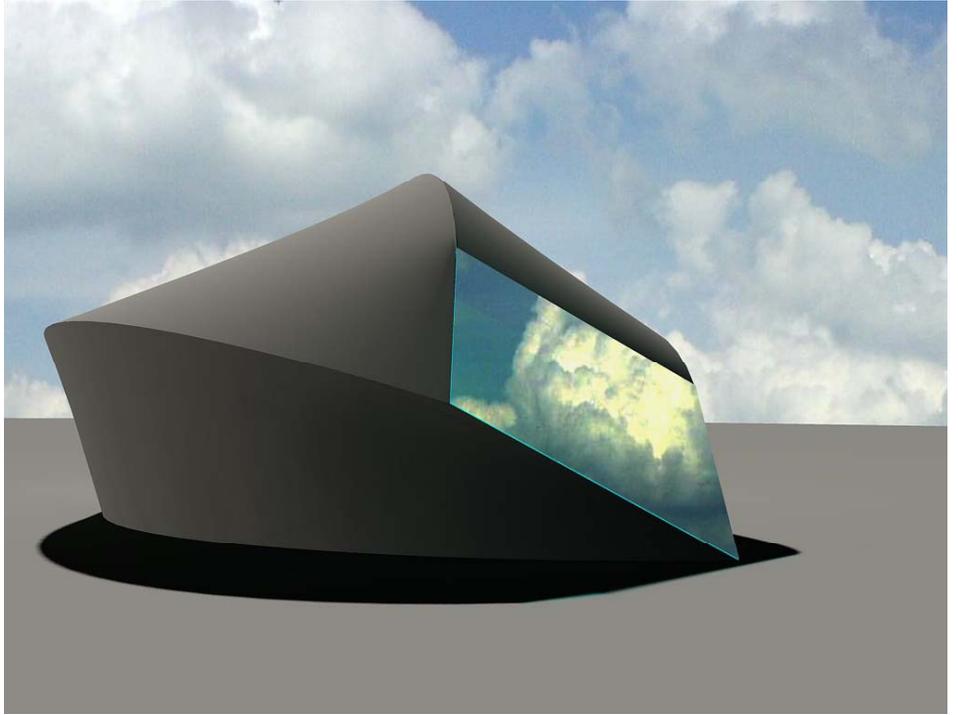
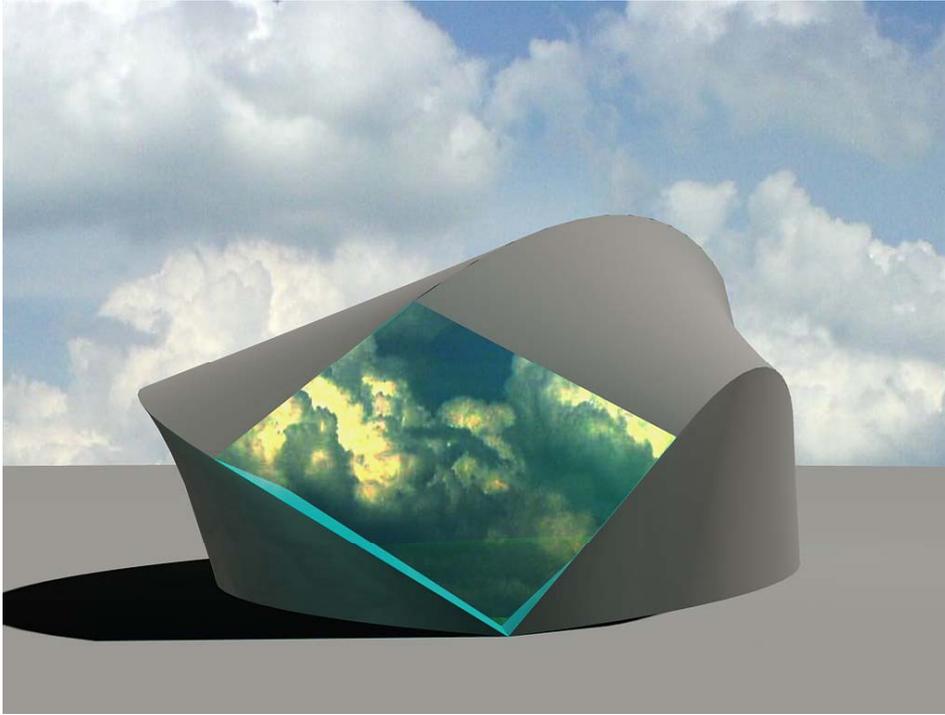
The flat roof creates problems with water and ice.

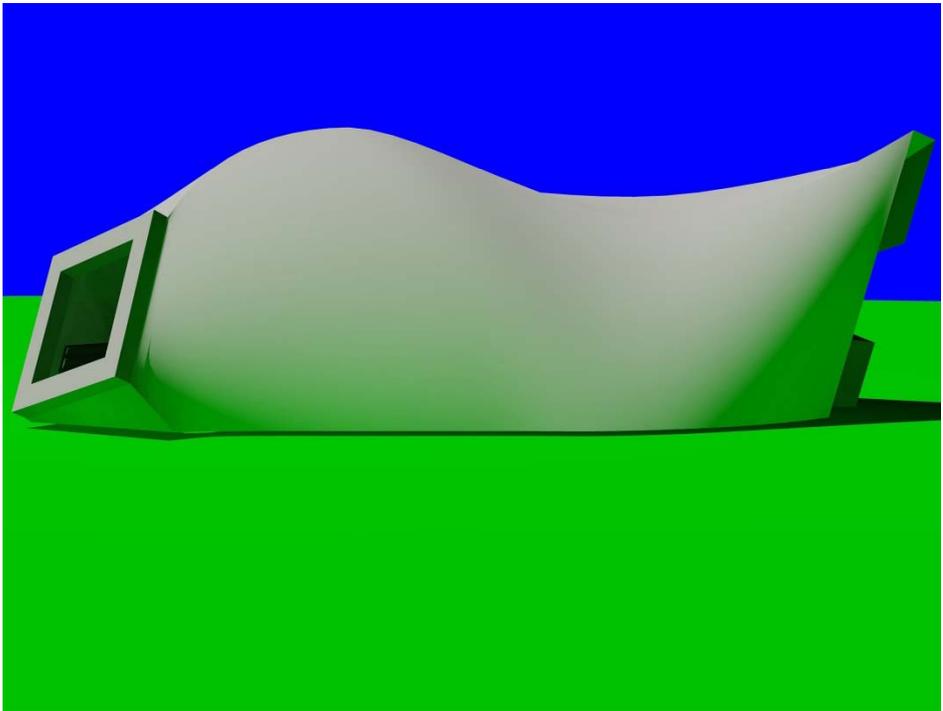
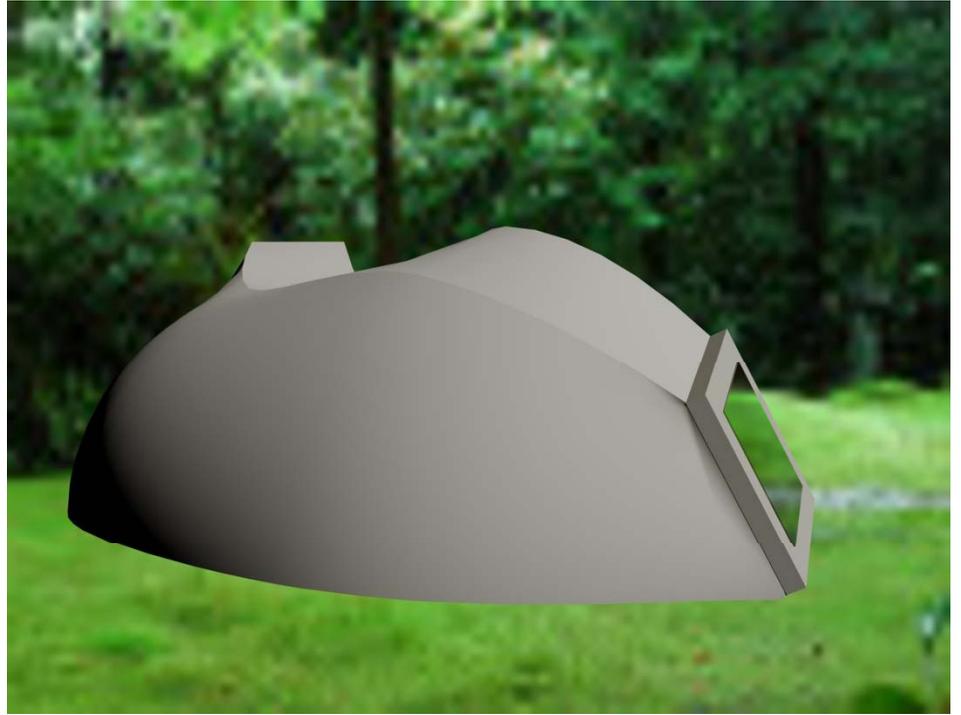
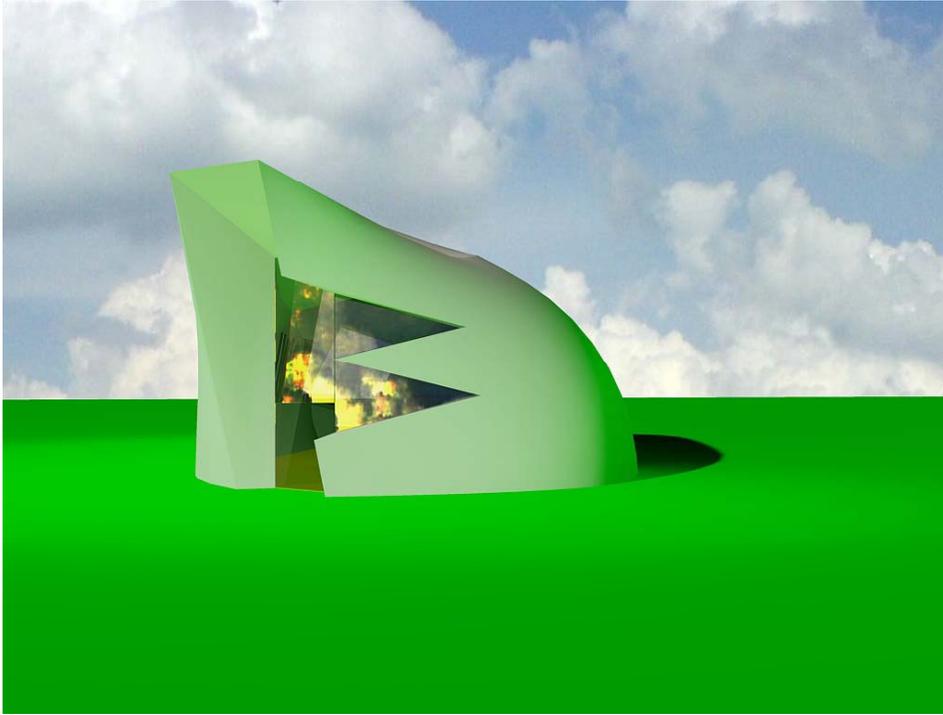
It is difficult to put windows in the fish shape. They tend to be placed in both ends, and that does not create optimal daylight in the rooms

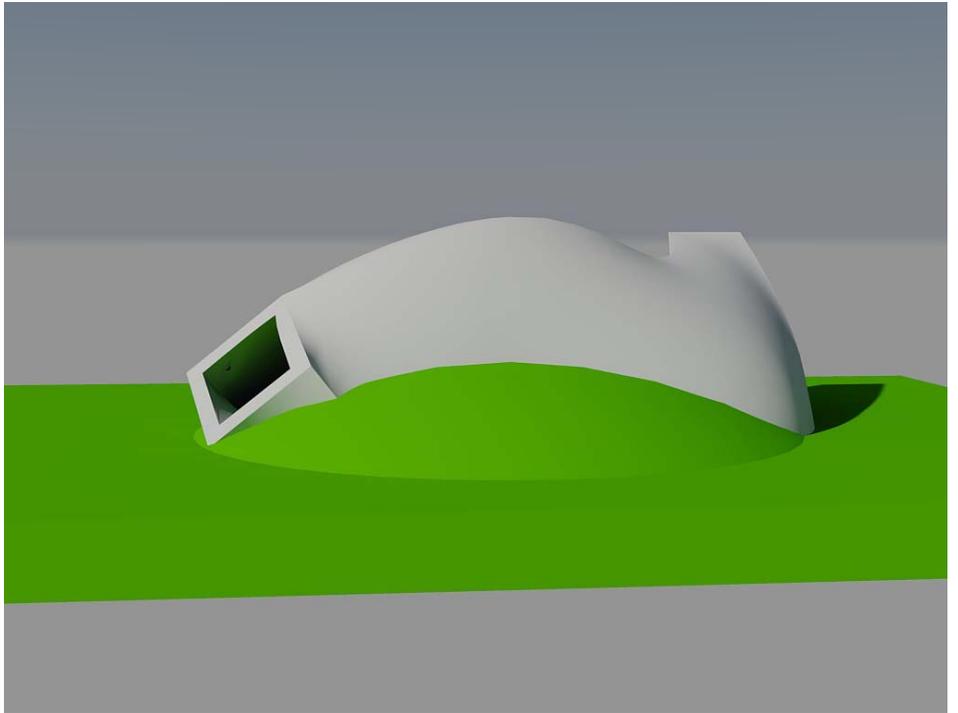
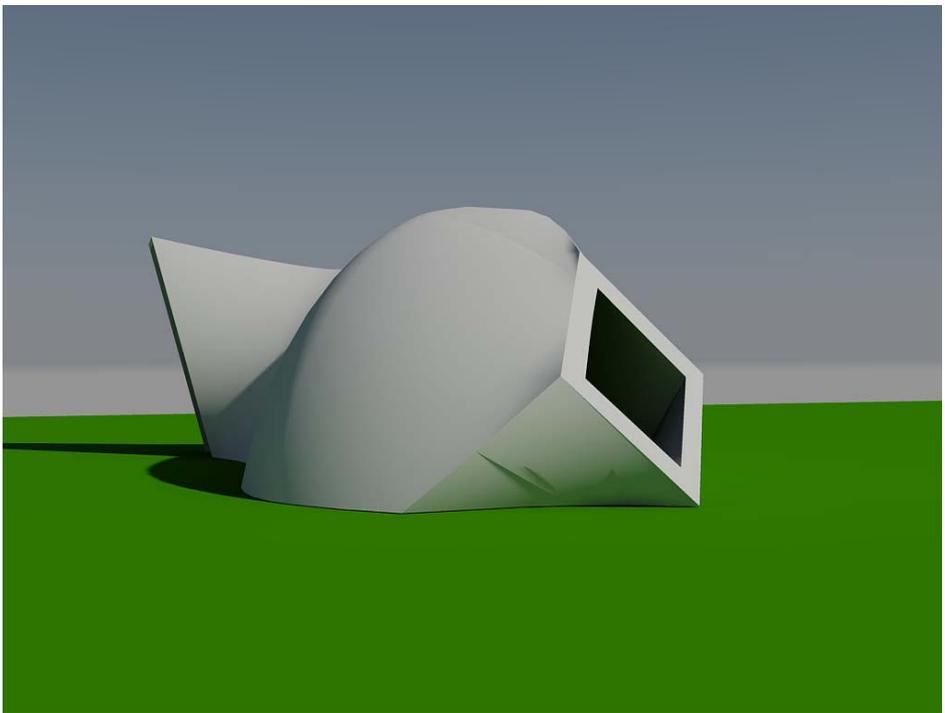
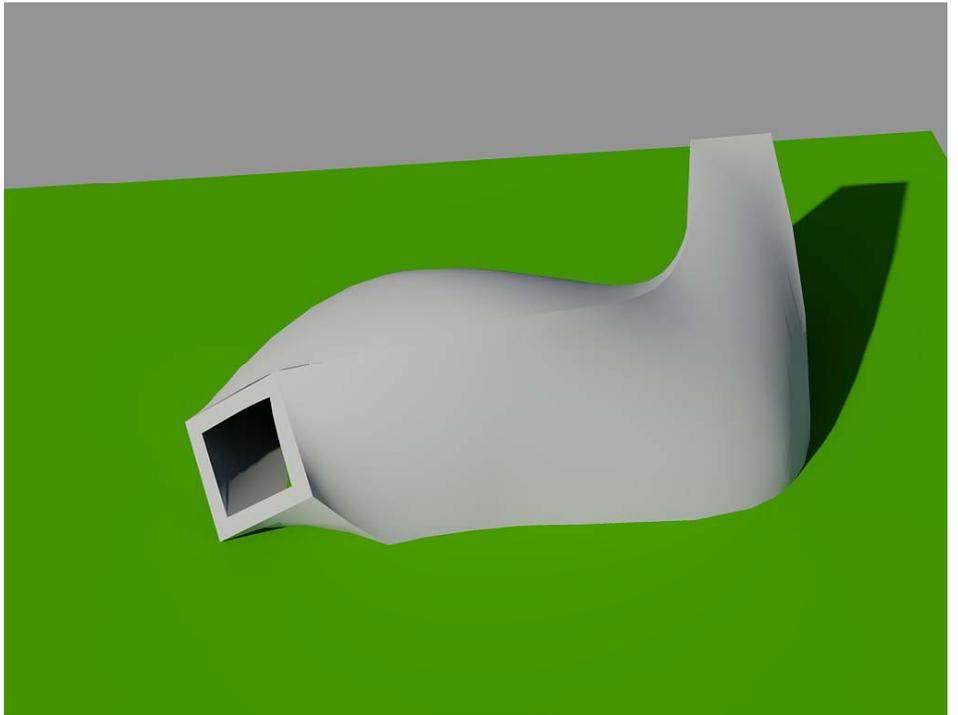
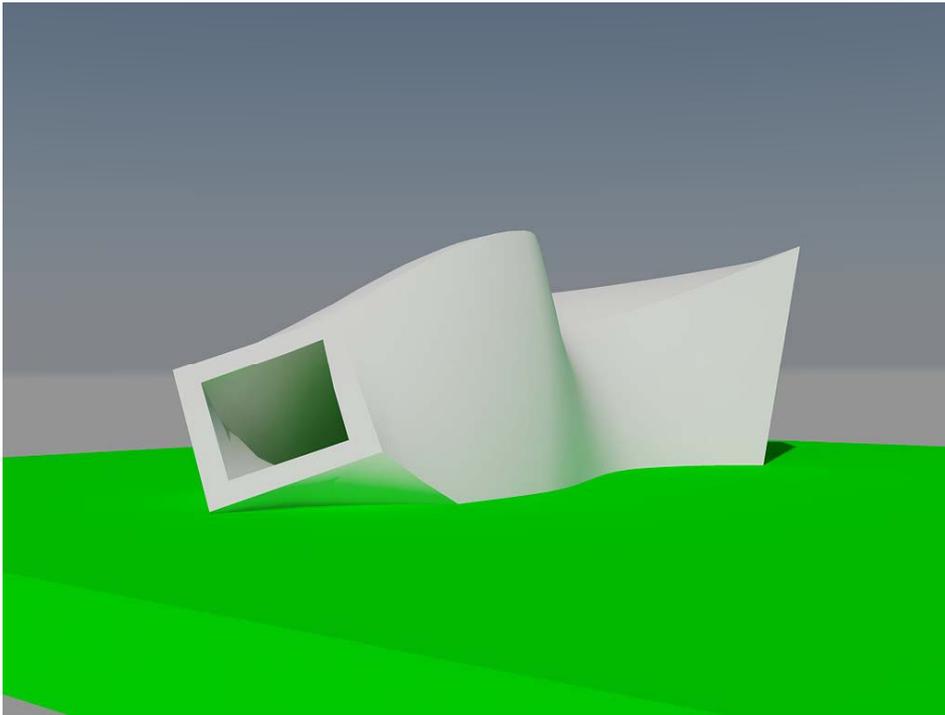
Most large biomimic atrium glazings are fishes. The shape is great in this all glass design

You cannot insert deck or partition walls in this shape which is a major problem because it is so confined. Fishes tend to be a one room design. But you can insert platforms.









Skeleton

We call them “skeletons” because they are only the bones of the previous shapes

Calatrava is the master of skeleton houses.

Skeleton houses have solved the problem of integrating windows in these shapes.

We did not design skeleton houses because they can not meet the low energy targets with present glass technology.

The birds have a very special structures in their bones and skulls which shape rooms like the “dream space” inflatables.

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Termite

We call them “termites” if the surface is carved out and full of complex detailed geometry. The termites make very complicated geometry by adding one grain of sand at a time.

The surprising finding is that we do not need 3D printers for all the other shapes described above. They can be constructed with membranes held in shape with arches, poles and inflated with balloon or pillow pressure. These membranes can be covered with foam insulation and shotcrete.

But the termite shapes are too detailed to use such a technology. Here we finally need a 3D printer and 3D milling technology.

Gaudi, Hunderwasser, the gothic domes of Chartres and Cologne, the facades of the doge palace in Venice need 3D milling robots to be milled out of stone and reproduced

So it is first when we cross the line from architecture to art, from building to decoration, from the large sculpture to the detailed sculpture that we need the accurate 3D technologies.

The message to the architects is that we can already today build sculptural buildings if we use the biological toolbox and mindset of membranes held in shape with arches, poles and inflated with balloon or pillow pressure. These membranes can be covered with foam insulation and shotcrete.



Hybrids

You can combine and compose fish, snake, body, rose, canopy, cell, skin, skeleton and termites in the same building .

Guggenheim Bilbao and EMP in Seattle are a combination of fish, rose and dancers

The specific purpose of the rooms could point in direction of the ideal kind of biomimic space for this activity. Hybrid designs can express the different functionality of the rooms.

Checklist

Honesty

- *Use biomimic structures with skeleton (compression), muscles (tension) fat (inflatons) and skin (membranes)*
- *The interior shapes and spaces should relate to the exterior*
- *Art design should be holistically from detail to entirety*
- *The functionality of the building projects variation into shape*
- *Build continuous shapes in continuous materials*
- *Or triangulate everything in the building system*

Layout

- *Entrance through the canyon or*
- *Entrance up the MD 80 stairs into the belly of the shape*
- *Space between the torque ellipses is as good as within them*
- *The curly maze*
- *Curved facades, stairs and ramps guide you*
- *A succession of sloping ramps/stairs*
- *A deck plan like a Philippine terraced paddy field*
- *Platforms and spaces within spaces*
- *Don't slice spaces with partition walls or decks*

Shapes and spaces

- *Soft organic joyfully dancing shapes and spaces*
- *Inspired by natural biomimic shapes from bodies, flower petals, fish, snakes, cells, skin, skeleton and waves*
- *The clean curves are better than “car wreck” like surfaces*
- *Folded asymmetrically to hit the ground in some 3 points*
- *Dynamically heading in one direction*
- *The artistic triangulation is more inspiring than the uniform*
- *Equality between the transparent and the opaque surfaces*
- *Changing shapes by moveable structures, windows and doors*

Glazing

- *Glaze beneath, above and between the shapes*
- *Glaze the entire roof of the torque ellipses*
- *Glaze between the petals*
- *Windows separating walls and roof make the roof weightless*
- *Tentacle windows growing out of the surface*
- *But never cut large holes for doors/windows*
- *Skylights enhance the mirror effects in the material*
- *Invisible glass enhances the beauty of the curved spaces.*
- *Truly double curved triangulated windows*
- *Small embrasure windows in thick walls*
- *Symphonic patterns of relatively small windows in all sizes*
- *Curtains mediate the borders between walls and voids*
- *Deck plans of triangulated glass surfaces should be curved*
- *Structures filtering light*

The sensation of shapes and spaces are enhanced with:

- *Reflecting and mirroring surfaces enhance shapes*
- *Nano deep color mirror stainless steel (Gehry, Seattle)*
- *White curved walls on dark or transparent background*
- *White and light colors*
- *Direct sunlight and skylights*
- *The depth of greening white glass is beautiful also when dirty*
- *Imperfections in the shapes are very visible and disturbing*
- *Curved patterns on the shapes enhance the perception (Hadid)*
- *Avoid sloping straight lines, they make people sea sick*
- *The curved patterns in the roof creates 3D illusion*
- *Spaces designing acoustics*

Shapes

- *Any durable material goes*
- *Broken tiles are better than square tiles for curved mosaics*
- *Facade shapes and surfaces in the interior next to skylights*
- *Soft surfaces on the opaque interior parts*
- *Playful artistic decorations and sculptures*
- *Greenery conquering the facades, balconies and roofs*

Furniture and installations

- *Free form furniture fitting the building*
- *Move double beds to a loft, they don't fit the curved shapes*
- *Octopus ventilation ducts*

Light

- *Illuminate the interface between floor and curved walls*
- *Theater spotlight*
- *Multimedia light beneath the translucent surface*
- *Dimmed light next to glazing*

Design and communication process

- *3D milled molds and computer cut membranes as drawings*
- *Digital information throughout the process and value chain.*
- *Almost square windows can build double curved glazing*

Energy

- *Switchable mirror glass avoid overheating of glazed spaces*
- *Switchable mirror glass can focus light on PV*
- *Highly insulated membranes have no thermal bridges*
- *Town scale focused solar, waste oxyfuel cogeneration*

Membranes, molds and shells

- *You can produce molds in any shape with 3D milling*
- *The mold can be insulation between plaster surfaces*
- *ETFE is a membrane alternative to glass*
- *Tensile structures with translucent insulation*
- *All membrane shapes can be insulated, fireproofed and transformed into stiff shells by the Monolithic dome concept*
- *Tensile membranes can be composed, combined and include partition walls and columns*
- *Free style Vacuumatics molds can be shaped and re-used*
- *Robots can plaster any surface accurately also without molds*
- *Vacuum injection molding saves materials, weight and molds*
- *Helicopter distribution of light carbon fiber technology house*
- *Highly insulated membranes can float*
- *Floating structures distributed by sea can be produced in a factory without limitations on dimensions*
- *Buildings composed from torque ellipses prefab modules*