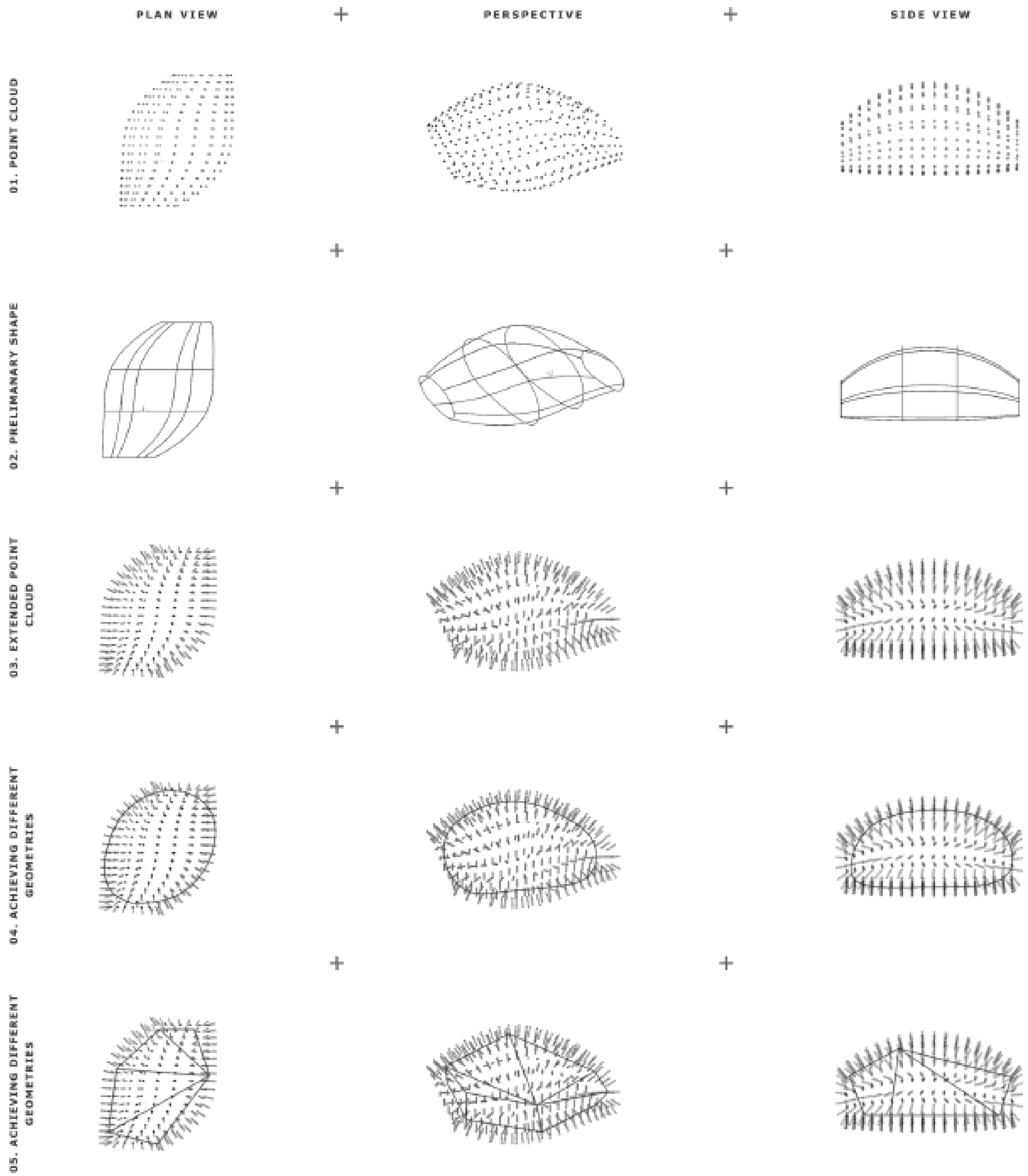


Figure 1-2. Understaning geometry of the pavilion in different ways. First of all as a point cloud, second of all as a set of basic surfaces and then some moves to create the final impression of loosing the fixed geometry

1. Styling Group - Defining the Geometry

Krzysztof Gornicki
1530259

1.3. Different ways of understanding space
Starting from the point of understanding space of the pavilion as set of surfaces we can easily jump into level of main powerlines and finally achieving point cloud as the purest way of definng three dimensional space.

1.4. Extending the geometry
Considering the main idea of the project it seems to be necessary to extend the possible area of the pavilion surfaces. And so point cloud gives a perfect possibility to make the ‘walls’ of the project three dimensional. Now the form is not defined with high precision, but just constrained by point cloud, which allows to choose preferable geometry.

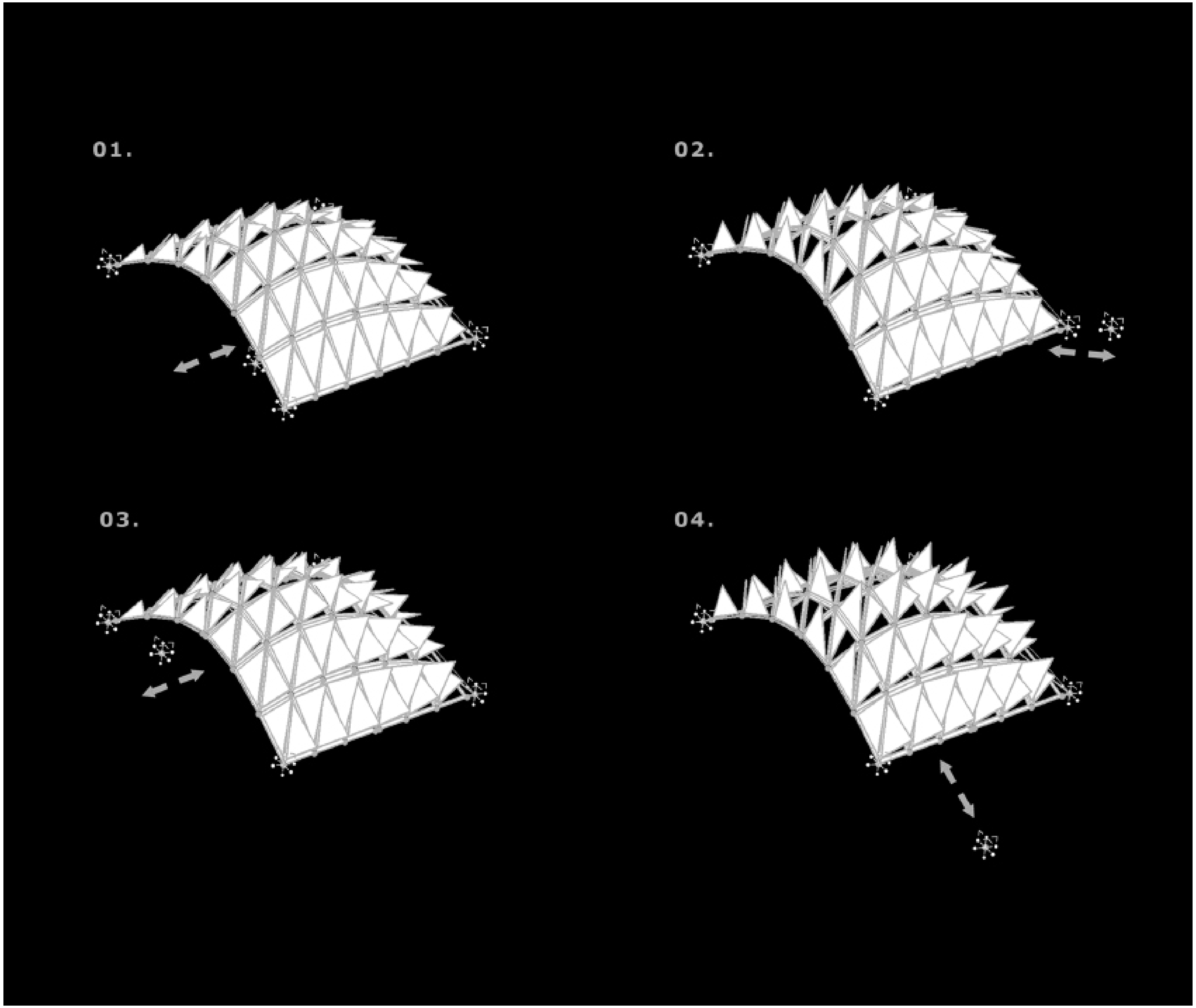


Figure 1-3. This image shows potential behaviour of the surface which can be applied to the project

Styling group - adaptivity

Agata Kycia
1520275

The picture on the left shows how the skin of the project could perform. This was the first attempt to build a simple parametric model where the triangular components react in a certain way according for instance to the sunlight conditions.
In that simple model the components simply react do the distance to one point that can be moved around, but what you can already see is how they behave in a larger group on a bigger surface. Since their rotation axises are differentiated, the component create more complex pattern enriching the existing form.

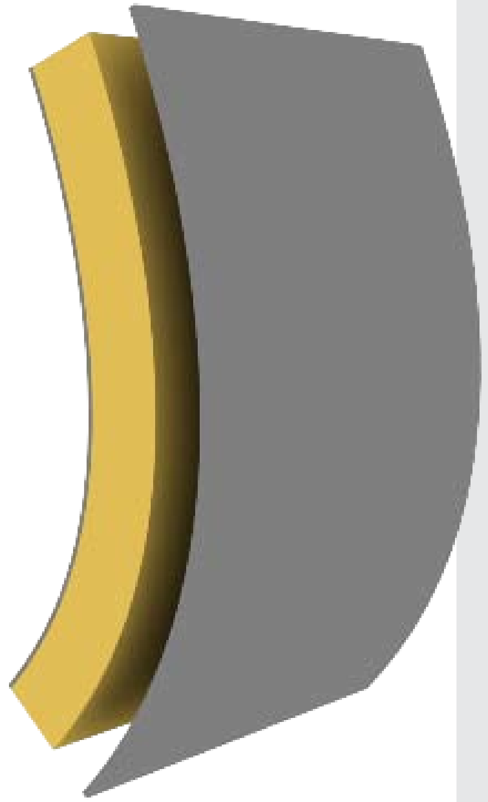


Figure 1-5. skin build-up, enough insulation to keep heat or cold inside.

Figure 1-3. bla bla

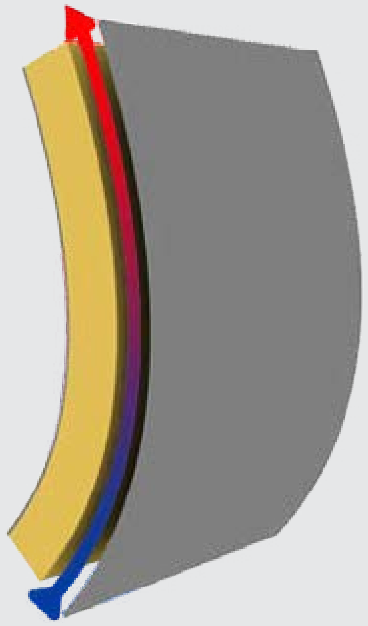


Figure 1-4. making use of natural ventilation

Figure 1-4. blablabla

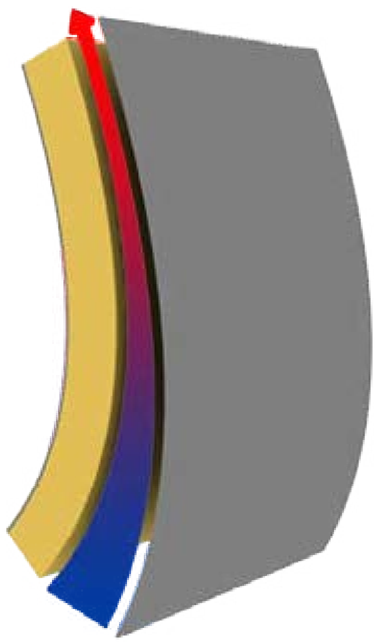


Figure 1-3. playing with the airflow

Figure 1-5. blablabla

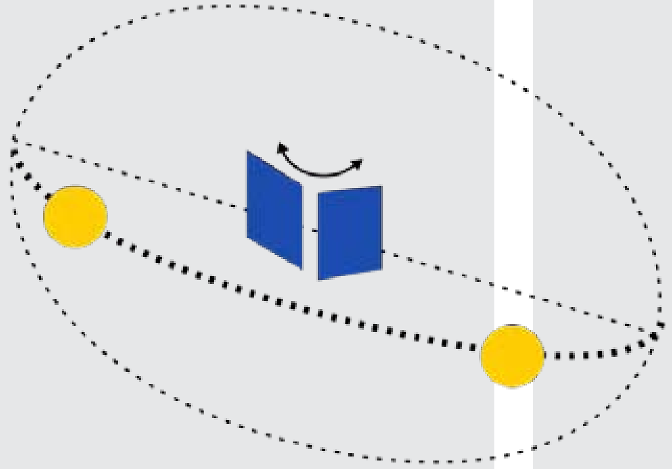


Figure 1-2. using solar energy

Figure 1-6. blablabla

1.4. skin build-up

A normal concrete construction stores some of its heat in the concrete. A lightweight structure doesn't have this possibility and therefore either needs a thick layer of insulation and/or multiple layers. The thick layer will keep the temperature stable and the layers will reduce the effects of absorption of solar energy.

A suggestion would be to add a 50mm cavity and 100mm of insulation material.

1.5. make use of natural ventilation

The cavity can be used to generate an airflow. The sun heats up the air in the cavity and it will rise, creating a flow. This can be used to 'pull' out the used air within the building. And thereby creating a nice natural ventilation.

1.6. playing with the airflow

This effect can be increased by changing the size of the cavity. By increasing it the airspeed will rise. By doing so the amount of air taken out of the building will also become more. This might be helpful if the amount of people within the building increases, but in a normal situation not the same amount of ventilation is required. For example to save energy on heating, since less heat is lost on ventilation.

1.7. Using solar Energy

From an estimate of 6 computers (300W) and 5 beamers (300W) can be concluded that solar panels will not be sufficient.

Situated in front of bouwkunde also wind is not a valid solution, since there is not enough for a wind turbine.

What could be done is power the building services (light, ventilation, heating) on solar power, this way the building is energy neutral. Using flexible solar panels (developed in Delft) we could integrate this within the skin. And maybe follow the sun (for optimal result).

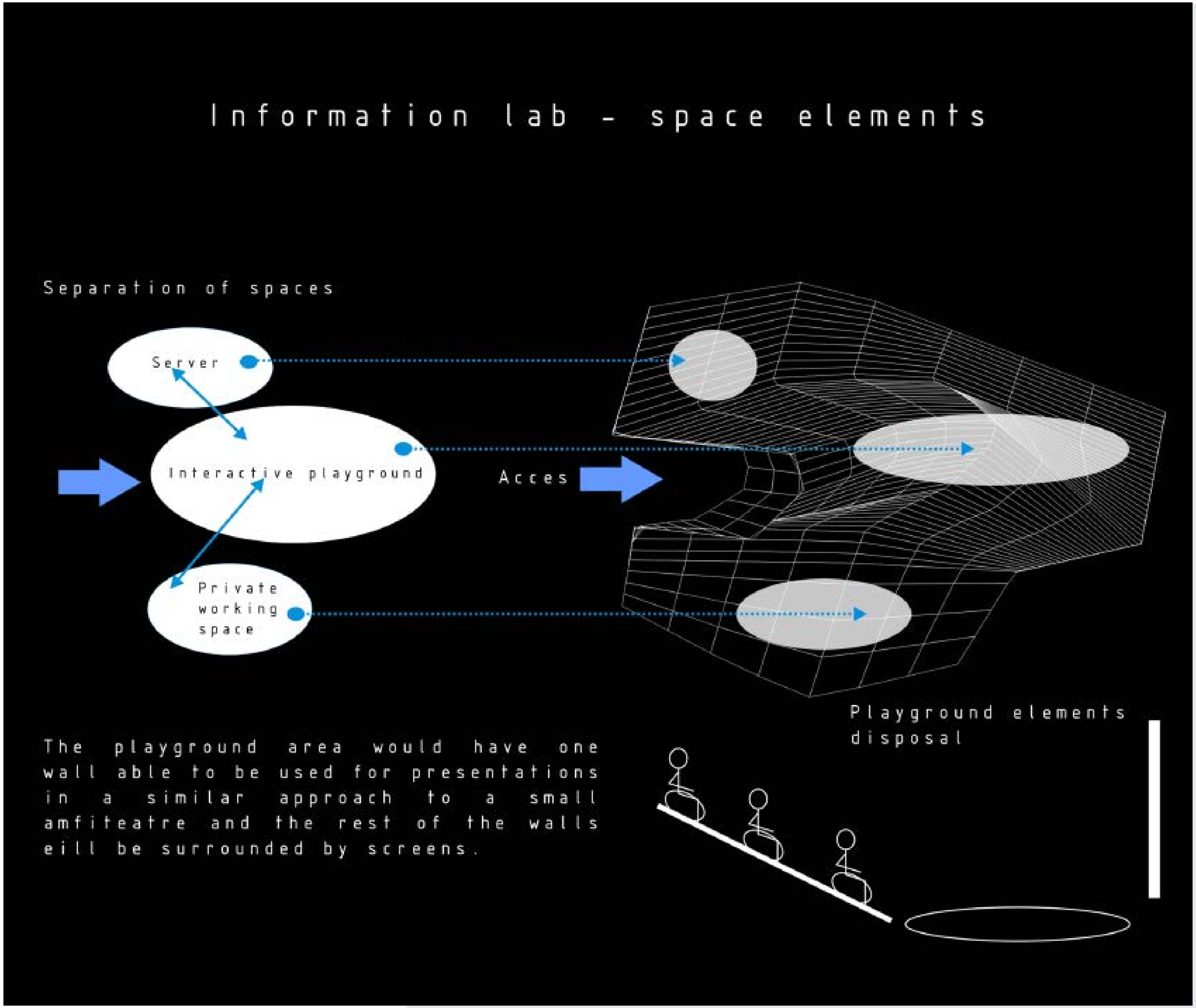


Figure 1-2. This image shows the proposal for space usage and distribution inside the pavilion.

Figure 1-1. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Information lab

Space elements

Silvia Roxana Palfi
1535269

The playground area would have one wall able to be used for presentations in a similar approach to a small amfitheatre, the rest of the walls being used as projection screens. The environment created would provide a three dimensional space of presentation and observation.

The upper part of the shell will be realized from spaces that can allow light to penetrate the shell or to send information towards the exterior. The flow of information between the interior and the exterior will be realized through the means of leds. This would provide an active and interactive discourse between the pavilion, its users and the people that see it from the exterior.

Information lab

Lighting and information

Silvia Roxana Palfi
1535269

The lighting and exchange of informatio iside the I web will be realized using led technology. The flows of linformation can be direct or interweaving, following the major lines of the proposed shape.

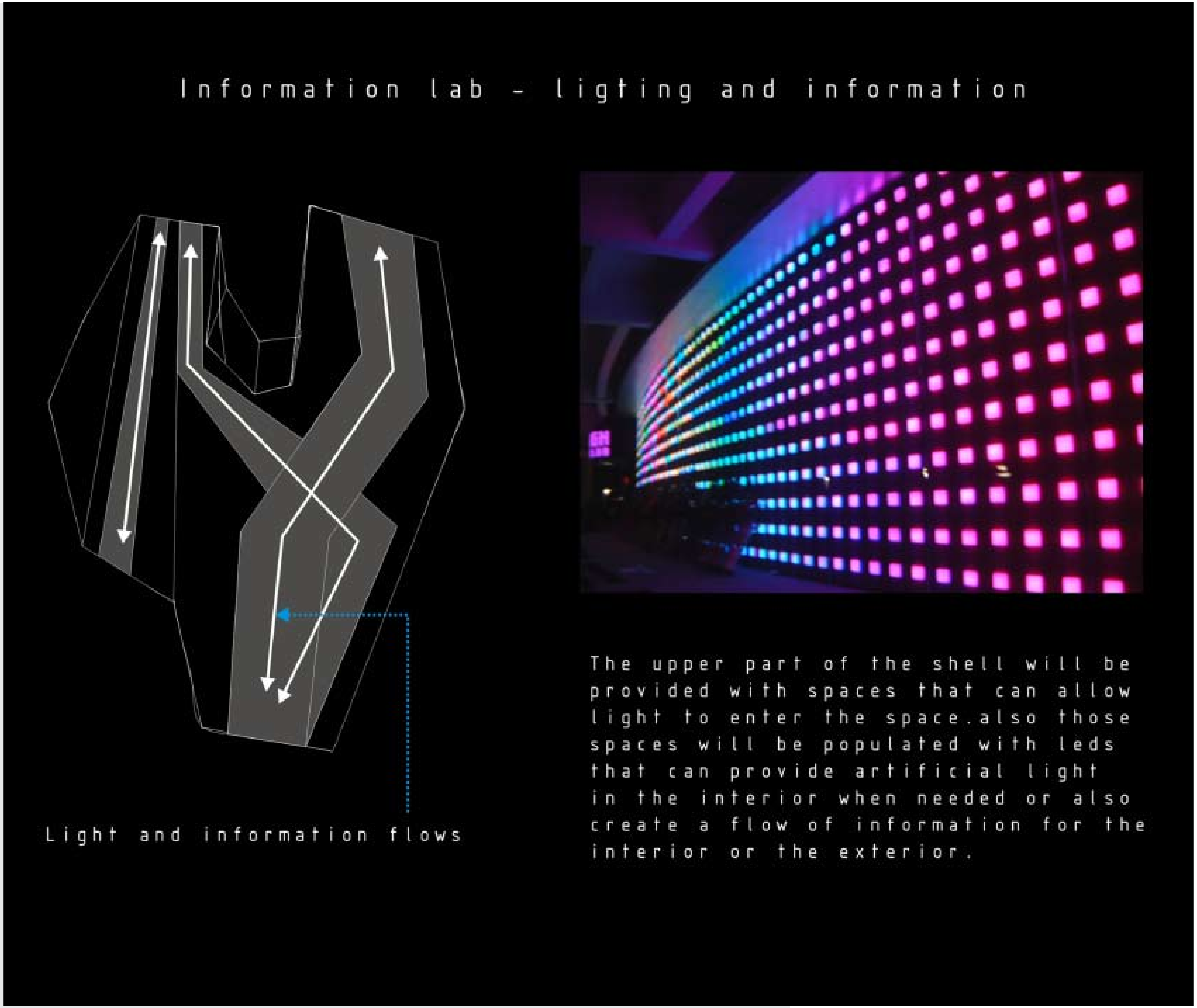


Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exerc consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-3. The image above is a visual description of the led concept and the way of implementing it in te project

1. Mechanical, Electrical, Plumbing

Harikrishnan Sasidharan
1541994

1.1. Exploring Systems.
This stage was used to develop new ideas to be aplied in the purview of MEP design. Two of the thrust areas of exploration in addition to the requirements were sustainability and responsive spatial volumes

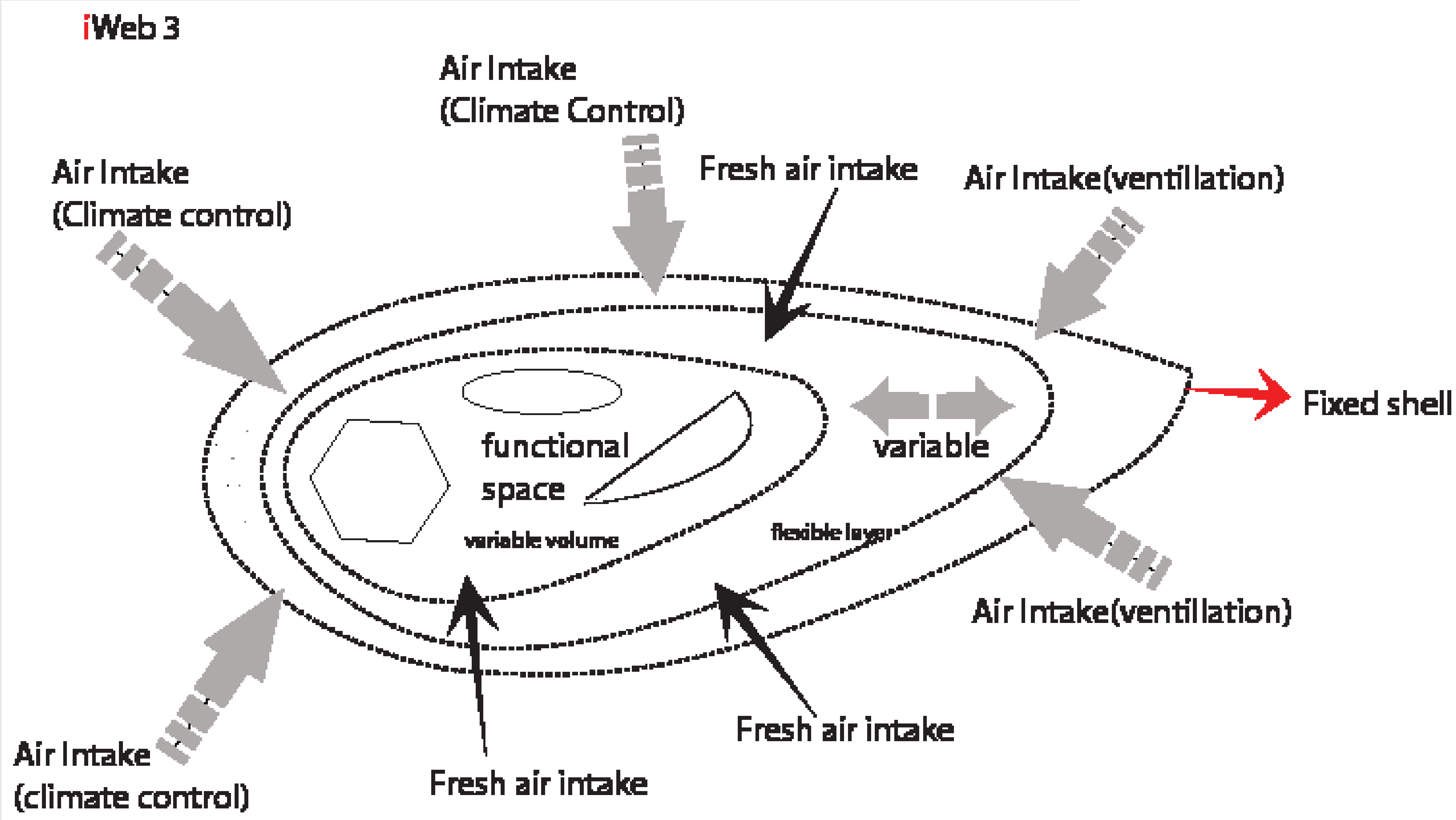
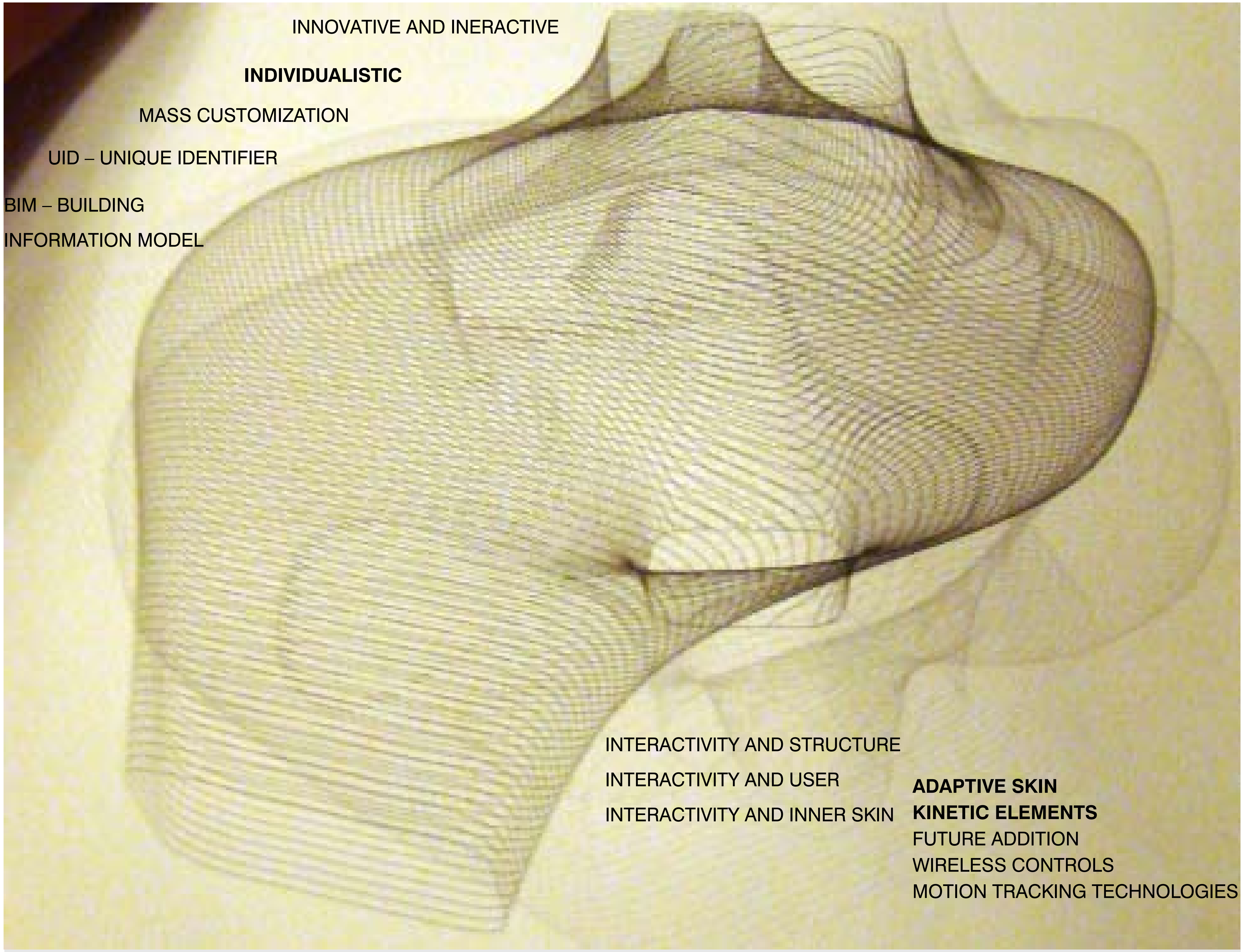


Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-1. Figure showing the use of variable spatial solutions for saving the air volume according to uasge.



1.2. Fluid spaces

Analyzing the program and vocabulary into a fluid space. Space that offers flexibility. And that is most directly translated to the flow of smooth curves. Intermingling spaces and changing shapes as per the need.

Idea competition

Inner and outer space

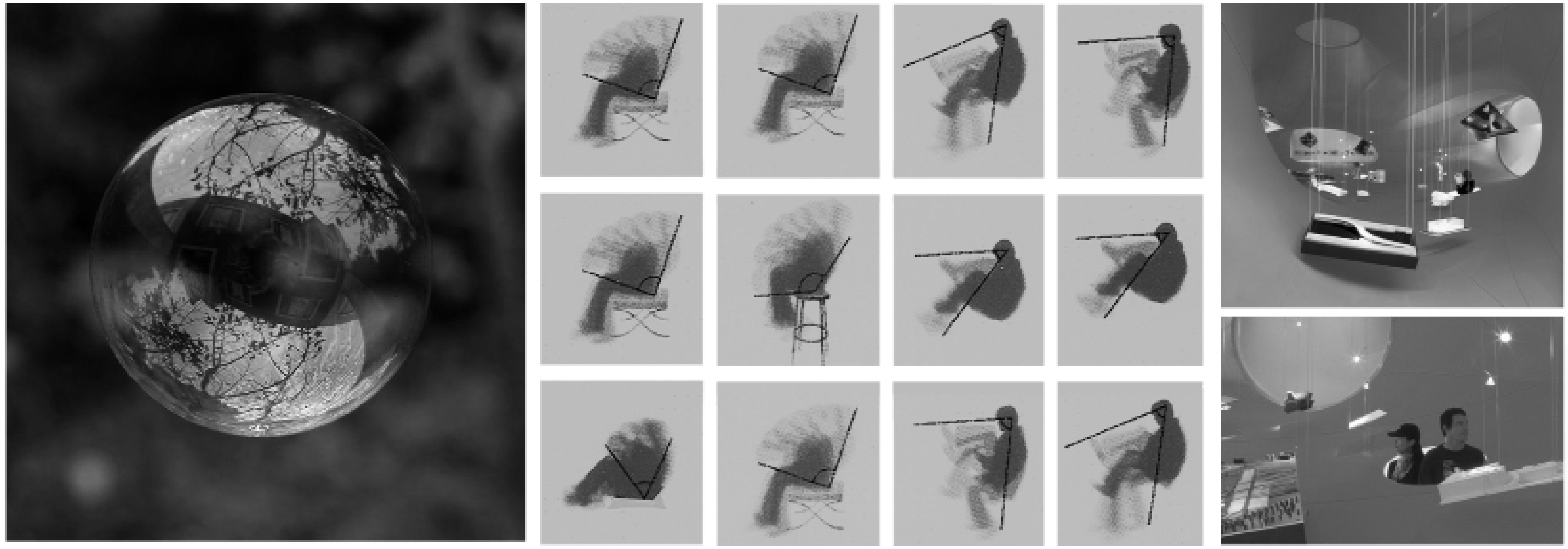
Junjie Yan   1530607

1.1 Concept

The A soap bubble is a very thin film of soap water that forms a sphere with an iridescent surface. Soap bubbles usually last for only a few moments before bursting, either on their own or on contact with another object. The two-sides tension on the surface dicided the shape.

Human behavior can adapted to the environment for different conditions. A pavillion can provide multiple functions by creating different space usage.

One surface can create both inner and outer space. which can be used for different functions.



QUALITY 1
BY USING THE LEAST MATERIAL CAN CREATE A LARGEST SPACE WHICH PROVIDE BOTH INTERIOR SPACE AND OPEN SPACE.

QUALITY 2
THE STRUCTURE AND MANUFACTORY OF THE MINIMAL SURFACE CAN BE MUCH MORE EFFICIENT AND EASIER TO CALCULATE.

QUALITY 3
THE OPEN SPACE AND INTERIOR SPACE CAN PROVIDE LOTS OF POSIBILITIES.

Figure 1-1. The images show that the way of create a surface dicide the usage possibilities , which can be adapted by the human’s behavior.

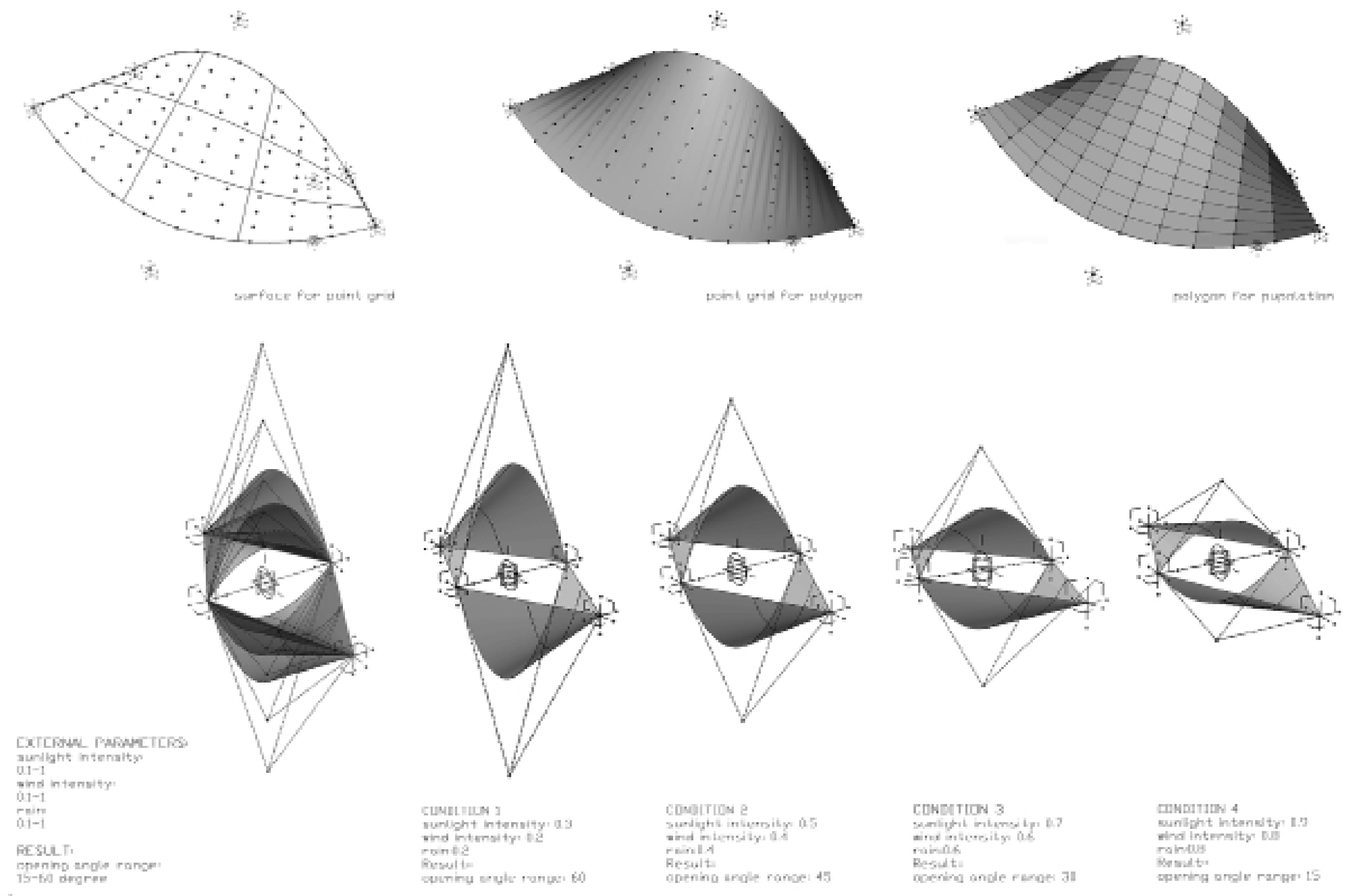
Idea competition

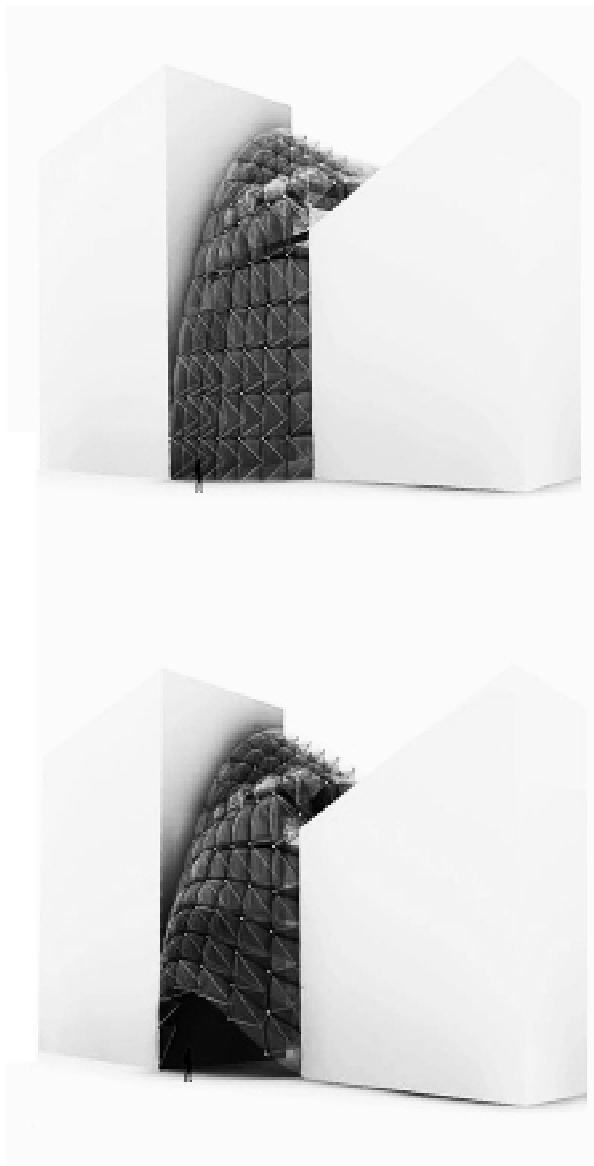
Adaptive skin

Junjie Yan   1530607

1.3 Adaptive skin

To assemble the geometry by the most efficient way and also make it has the potential of interaction, we can develope a method which makes the assemble logic as simple as possible(e.g. only one detail in each component) and also allows the possibility to reassemble it. by using the milling machine and 3d print technics, we can easily achieve the whole building by design a single component which can be connect to itself and buildup a complex system.





EFFICIENT

CAN THIS TEMPORARY PAVILION BE EFFICIENTLY,ECONOMICALLY,ECOLOGICALLY AND AESTHETICALLY?

RE-ASSEMBLE

CAN WE DESIGN AN SUSTAINABLE AND FIEXIBLE STRUCTURL SYSTEM,WHICH CAN BE RE-ASSEMBLED IN DIFFERENT CONTEXT?

POSSIBILITIES

CAN THIS PAVILION ALSO BE ABLE TO TRANSFORM EFFICIENTLY TO ADAPT TO DIFFERENT PROGRAM OVER A PERIOD OF TIME ON THE SAME SITE?

Figure 1-3. The images shows the adaptive skin in a environment, and how it respond to the parameters in the scene.

1. Bodycheck 2
Group C - Styling

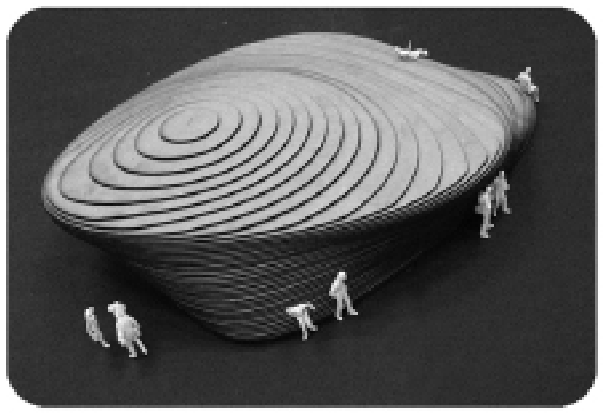
Junjie Yan - 1530607
Urvi Sheth - 1531174
Harikrishnan Sasidharan - 1541994
Kwok Tung-Chun - 1535226
Krzysztof Gornicki - 1530259

form-finding process

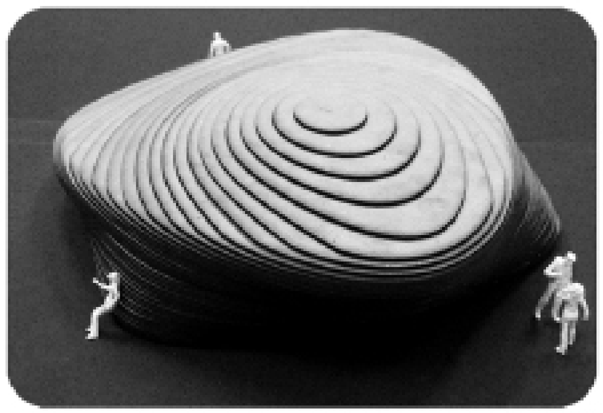
choosing form

1.1. Form Finding
The exercise to design the pavillion started with the form finding exercises. The physical realization was providing more possibilities and solutions to be explored ina very short time. The physical tension and articulation provided by the combination of tensile fabric and the compressive wire frame helped in arriving at the real design. The idea of power line was fully utilized in the design process.

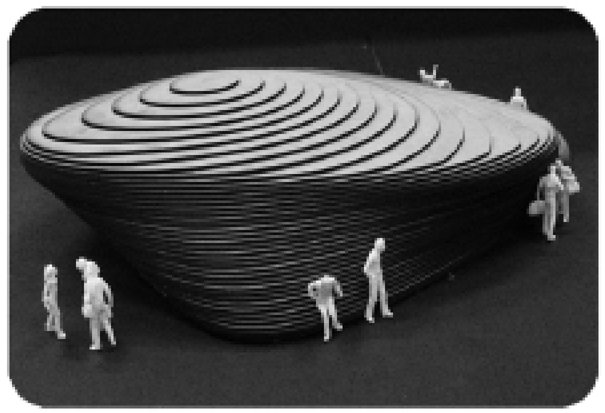
1.2. Digital Fabriction
The digital fabrication using laser cuting as a means helped in translating the combination of the physical and digital model into a solid state structure which was used for further exploration of zoning and space utilization.



perspective from east



perspective from northeast



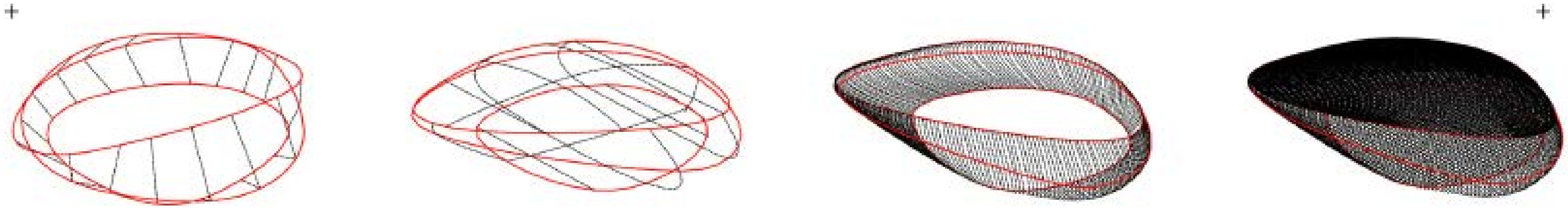
perspective from west

Figure 1-1. Prelliminary models made of thights and wires - form analysis

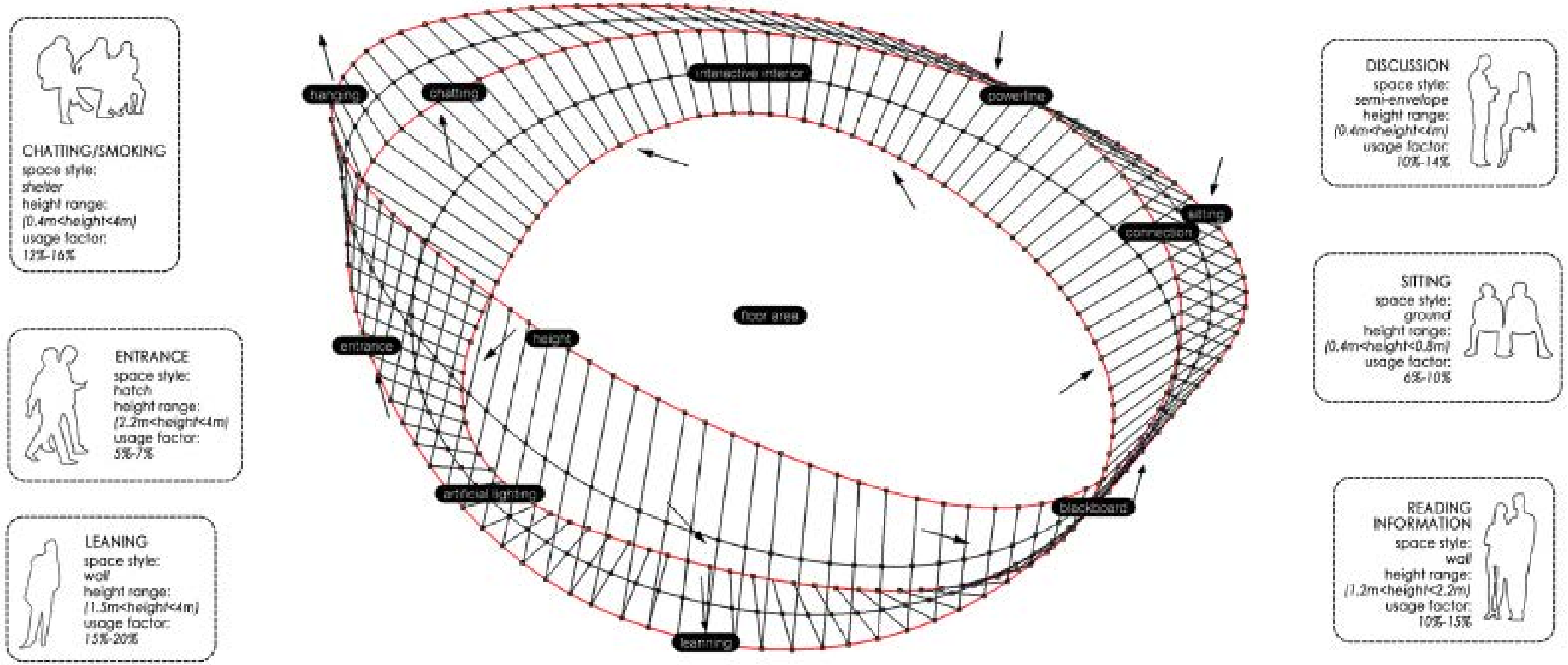
Figure 1-2. Model of the fisrt iteration of the group project

1. Bodycheck 2
Group C - Styling

Junjie Yan - 1530607



powerline transformation process



powerline defination based on human scale

Figure 1-3. The render showing the segrgation of functions in the pavillio design.

1.3. Function and Form

The design design process involved the play of a creative competition between the functional aspects, aesthetics and the unifying charcter of the building. This led to the creation of a parameric form finding exercise leading to the generation of final frm for the idea phase.

1.4. The Functions

The pavillion is conceived as a series of intertwining functions often intermingling even in the physical context.

1. Bodycheck 2
Group C - Styling

Junjie Yan - 1530607
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1.5. Design Phase
The design shows the development in stages of the design to form the pavillion. The functional requirements like light ventillation and attenuation of the space paly a great part in defining the space. Triangulation is used as the methode to define the articulation of surface and also as the integral unit for spatial orientation.

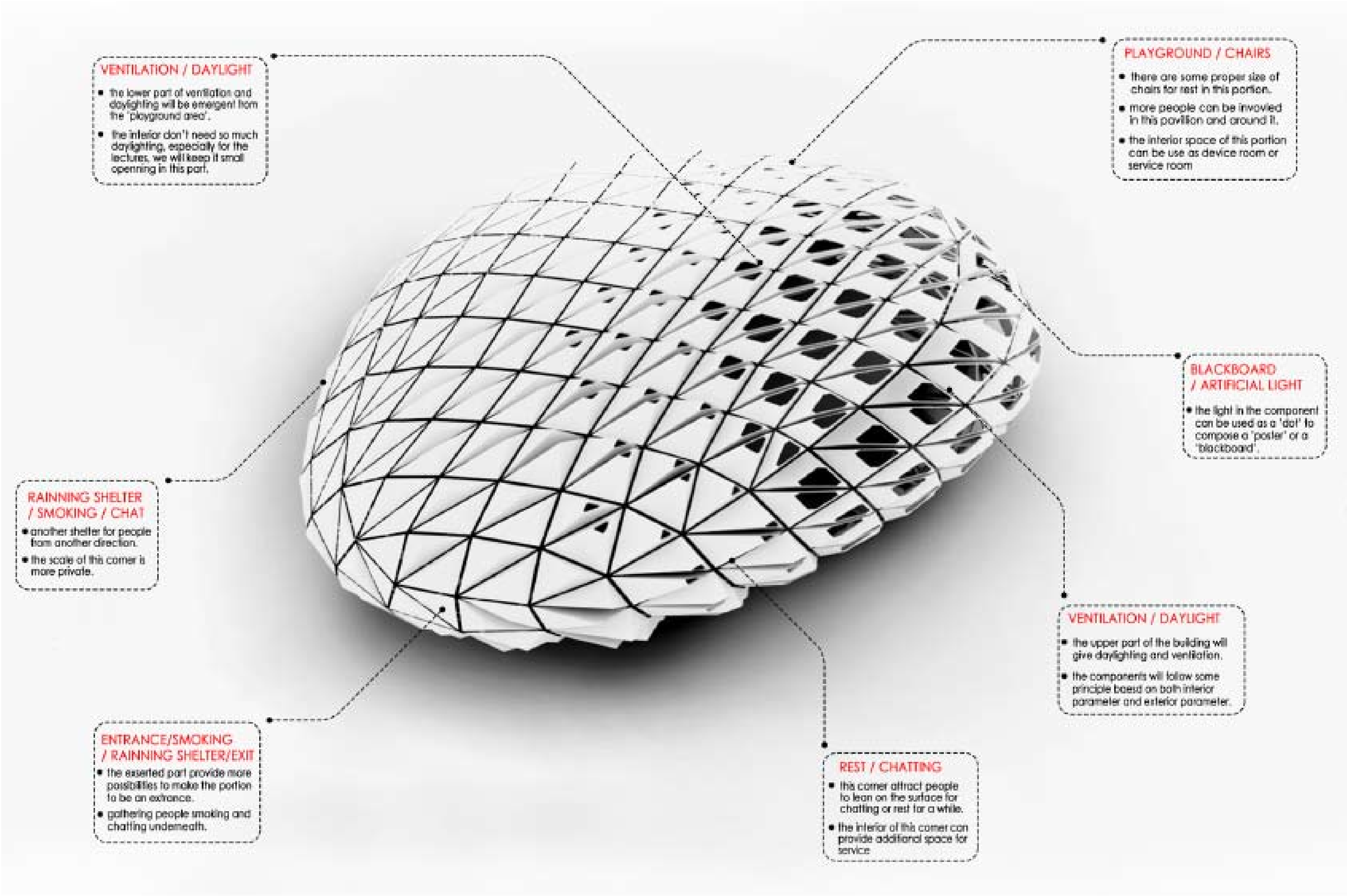


Figure 1-4. The render showing the articulation of functions in the triangulated scabrous pavilion.

Bodycheck 2 Group C - Styling

Krzysztof Gornicki - 1530259

1.7. Functional

The various sections depict the variable sections which corrspond to the various components. It is also dependent on structural requirements as the thickness is primarily dependent on it. The design requires carefull calcualation phases to arrive t an optimum solution

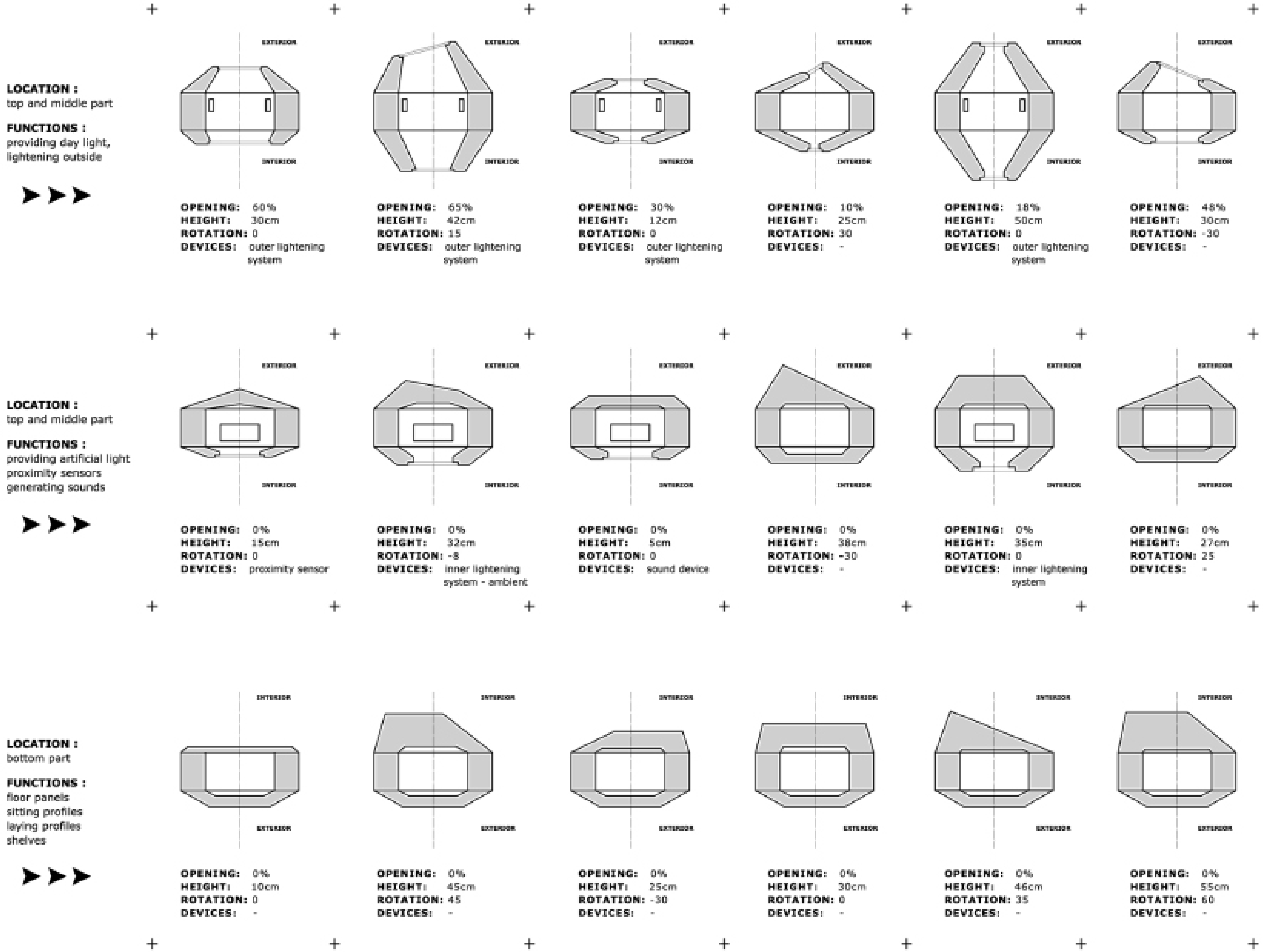
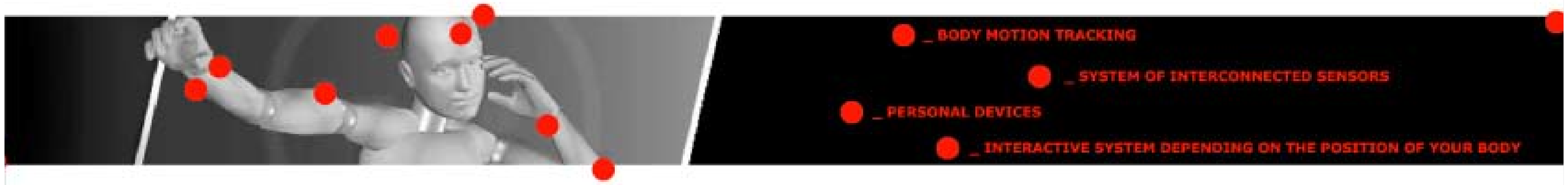
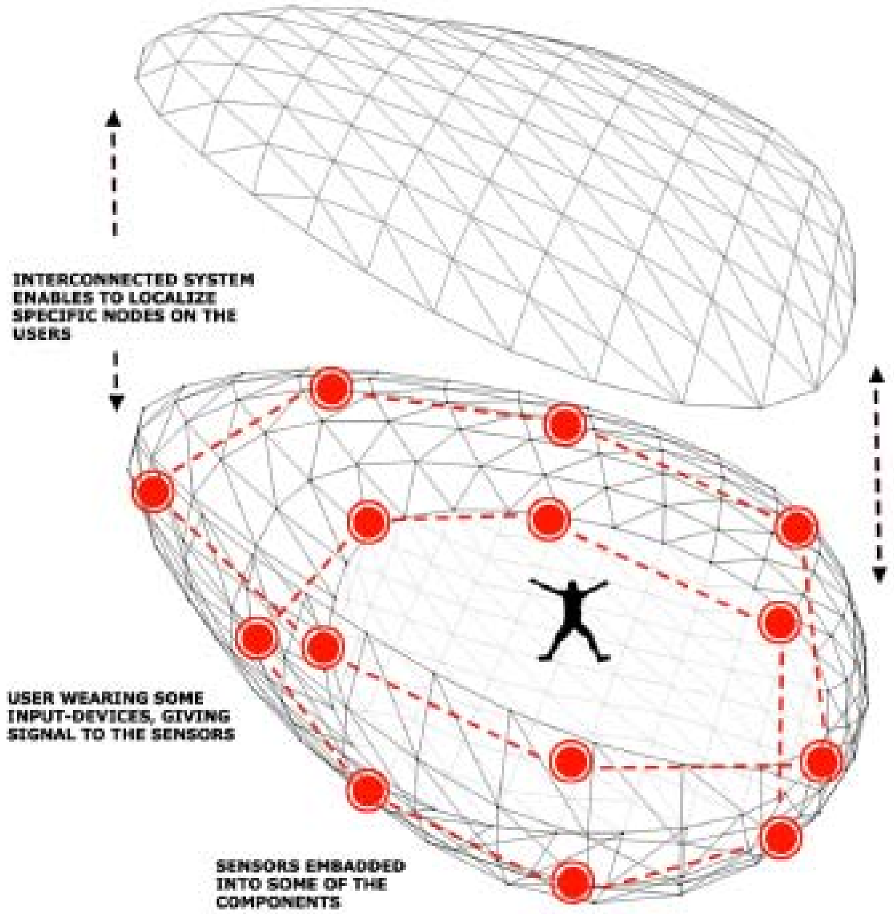


Figure 1-6. Render showing the various sections of the variable component with respect to functional variation..

Bodycheck 2
Group C - Interac-tivity

Krzysztof Gornicki - 1530259
Urvi Sheth - 1531174





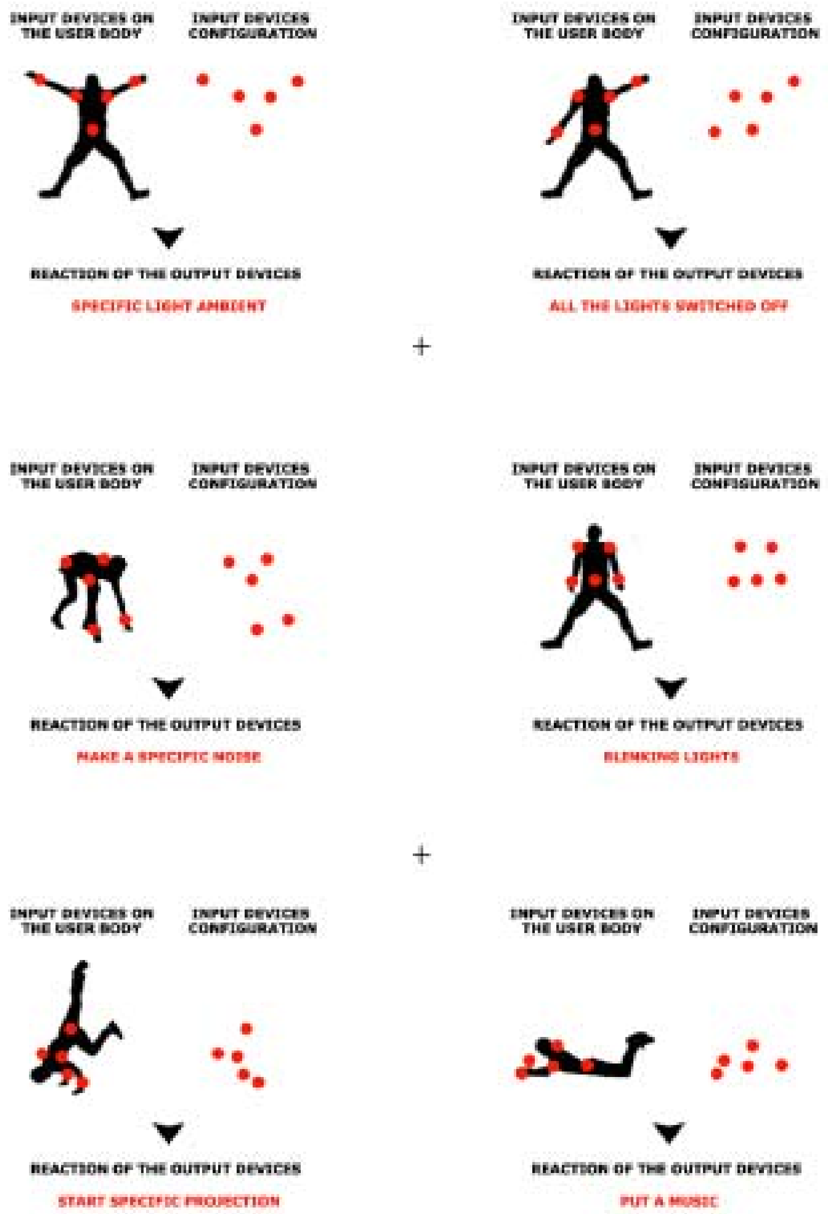


Figure 1-13. Render showing the idea of body motion tracking

1.9. Body Motion Tracking

The design acts a s an articulated and enhanced perception for the user about the space which he occupies

Bodycheck 2 Group C - Structural Analysis

Krzysztof Gornicki - 1530259

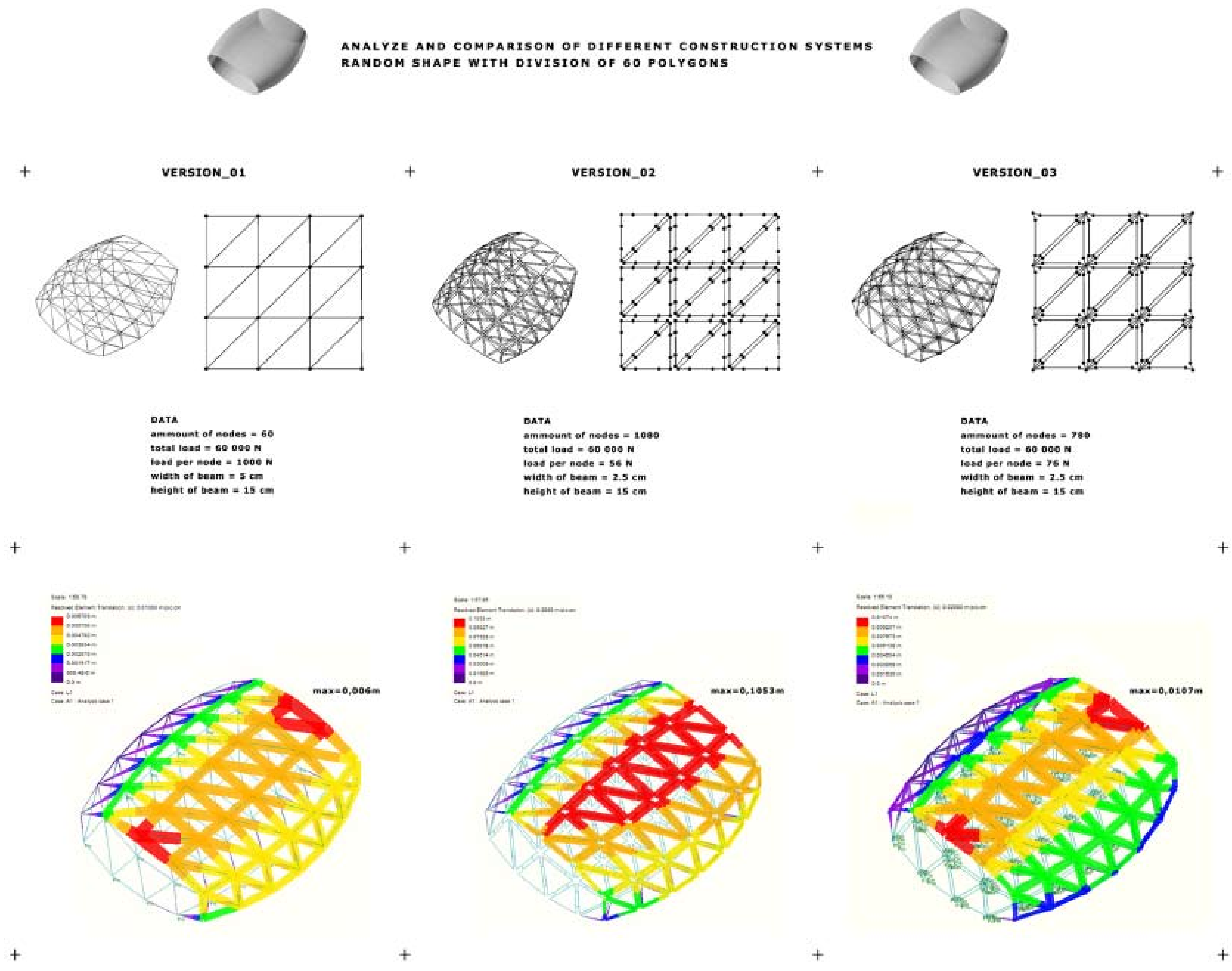


Figure 1-14. Render showing the variations in structure with respect to the various structural solutions

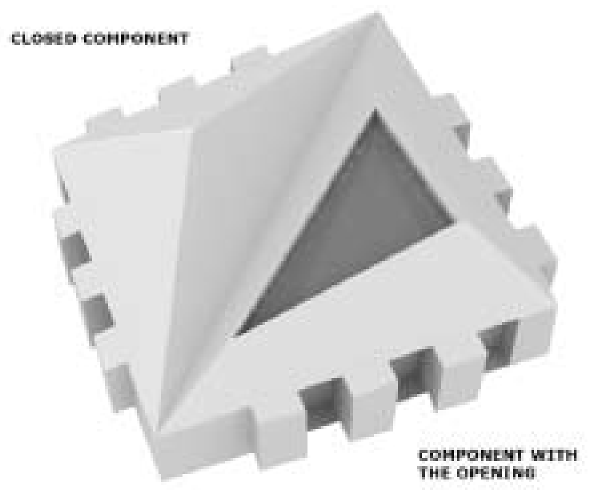
Bodycheck 2 Group C - Manufacturing

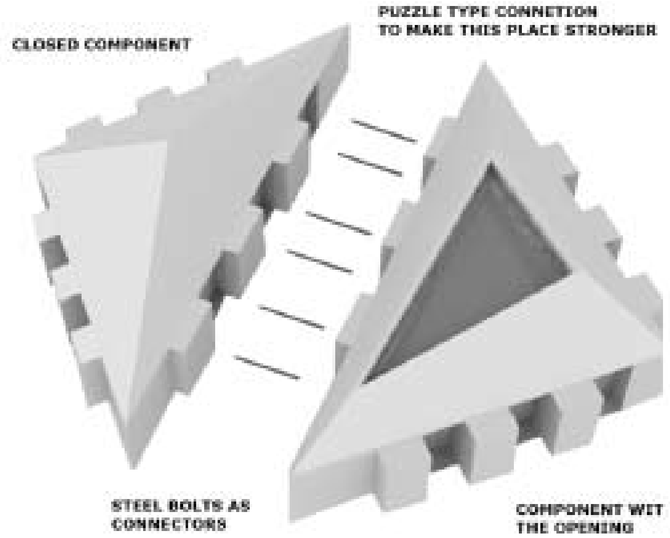
Kwok Tung-Chun - 1535226

1.12. Milling the 3D

The structural connections were designed to be milled in a 3D miling machine. The interlocking system helps in providing a close connection. It also helps in breking the shear forces acting along the faces of the component.

Materials of component:





Translucent plastic glass:
Even light emission,
optical clarity, durable,
low ebergy consumption,
low heat generation.

Fiberglass:
High strength/weight ratio,
insulating, translucent,
easy to repair,
can be applied directly to backing,
drapable.

TEXACO Pet rol Stat ions
(E17 bet ween Ant werp and Gent)
Architect: Bontinck Architecture and Engineering
The blocks were coated with polyurea, an especially for this project by Nedcam developed concept for the building industry. The concept has gained approval for all applicable regulations and safety standards. The 3D-skin surface is 9000 m2 in total
EPS/PU-paste system in parts or up to 25 meter in 1 piece
- Building package in 3D machined MDF- or Styropor-blocks on a MDF support frame

Figure 1-24. The details for the milling process.

Bodycheck 2 Group C - Manufacturing

Kwok Tung-Chun - 1535226

1.13. Integration
The component follows a hexagonal node connection which overlaps with the adjacent component along the face. THis helps in transfering the shear forces and uses less material to reduce the bending moments along the span of the section. The larger face of the cross section is also oriented along the line of action of bending moment.

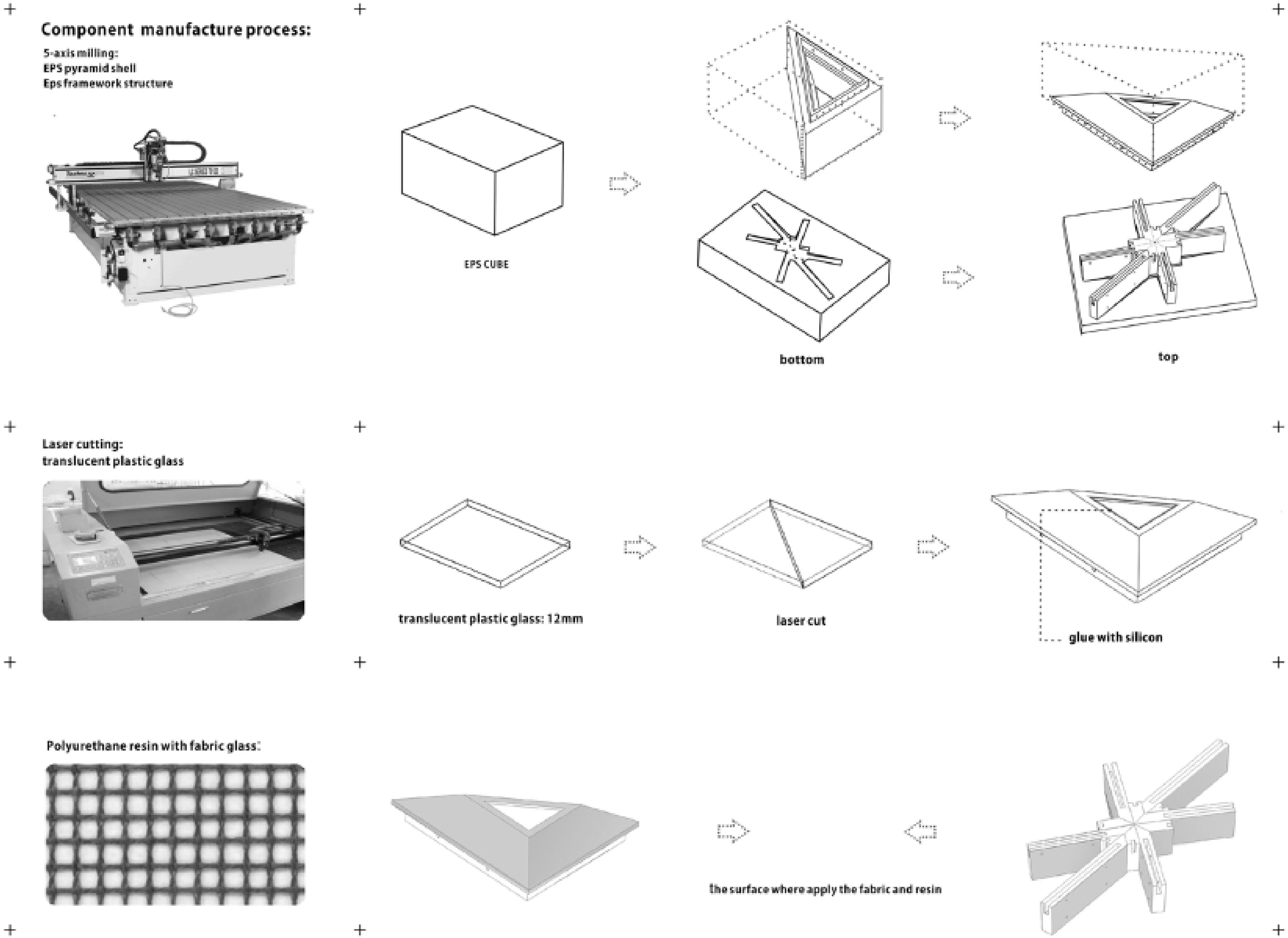


Figure 1-25. Images showim-ng the various materials and structural details to be used for manufacturing the component.

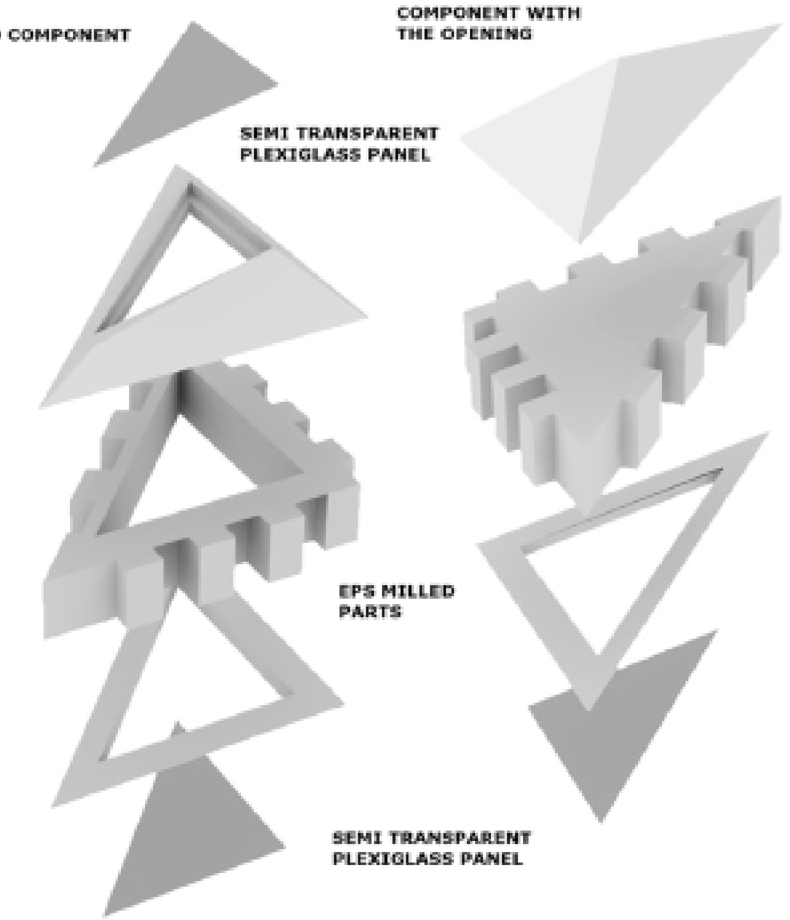
Bodycheck 2 Group C - Manufacturing

Harikrishnan Sasidharan - 1541994
Krzysztof Gornicki - 1530259

1.14. Numbers

The nos give the estimates for the components required for lighting, ventillation and maintenance of services.It is dvel-oped as a system to apply as a series of facts to be used in the development of the design further.

Total Usable area = 130.44 SqM
Surface Area = 328SqM
Total Volume = 354Cum
Total no of components = 484
Top Surface = 98
Middle Surface = 280
Bottom Surface = 106
Lighting
Total Nodal Luminaries= 154
Drainage
Nodal plugs(Vulcanized Rubber) = 379 Nos
Drain Channels(Neoprene) = 346 Nos
Heating/Ventillation
Peltier Heater = 130 Nos
Heat exchanger = 1 No
Electrical
Length of flexible cable duct = 1724 Mtrs



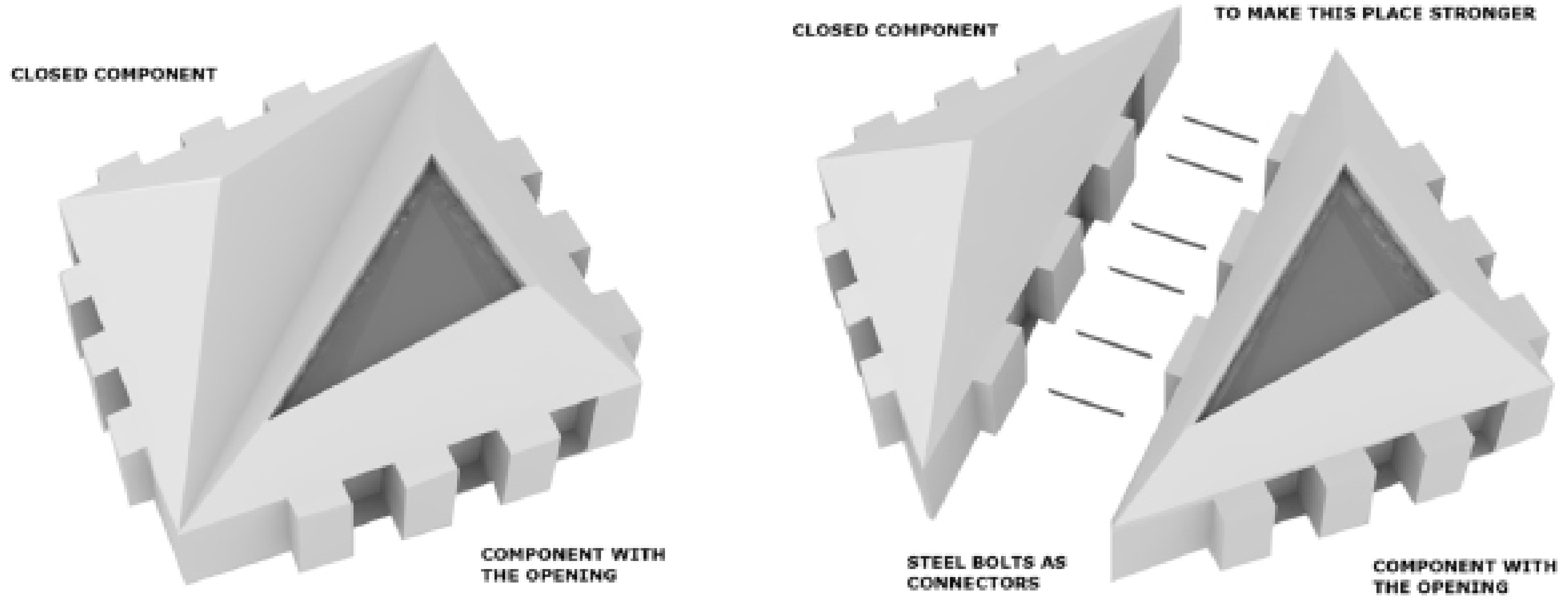
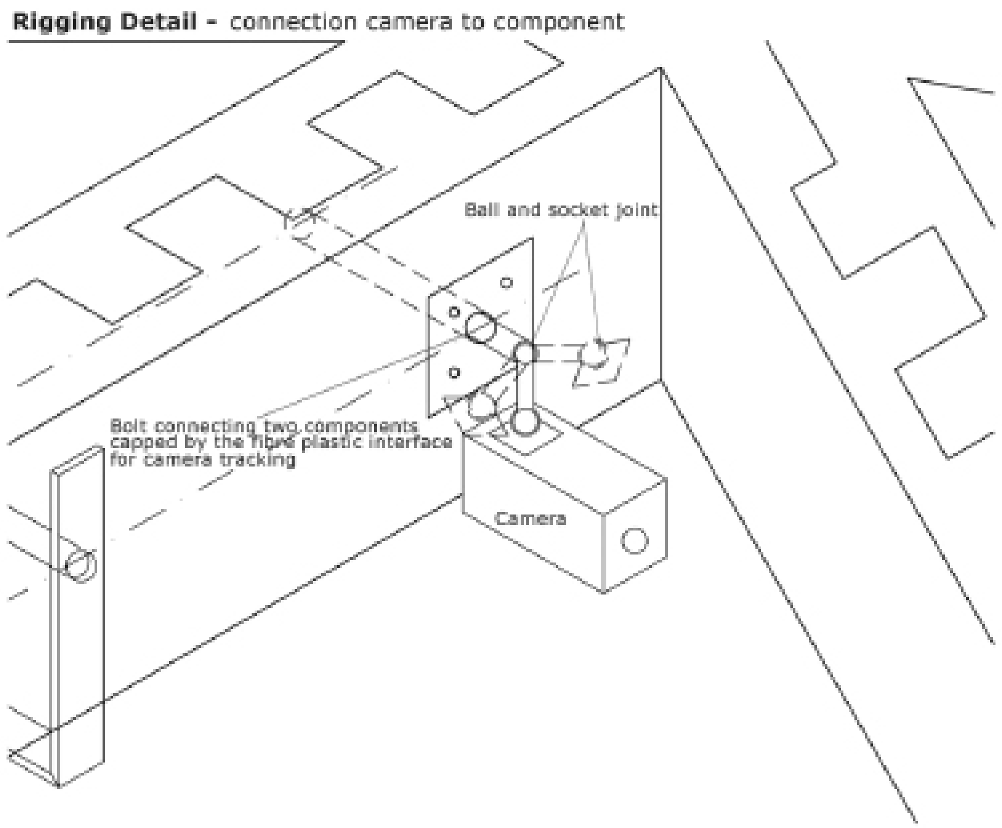


Figure 1-26. This nos required for the maintenace of services in the building

Figure 1-27. Exploded views of components showing the assembly logic.

Bodycheck 2 Group C - Manufacturing

Urvi Sheth - 1531174



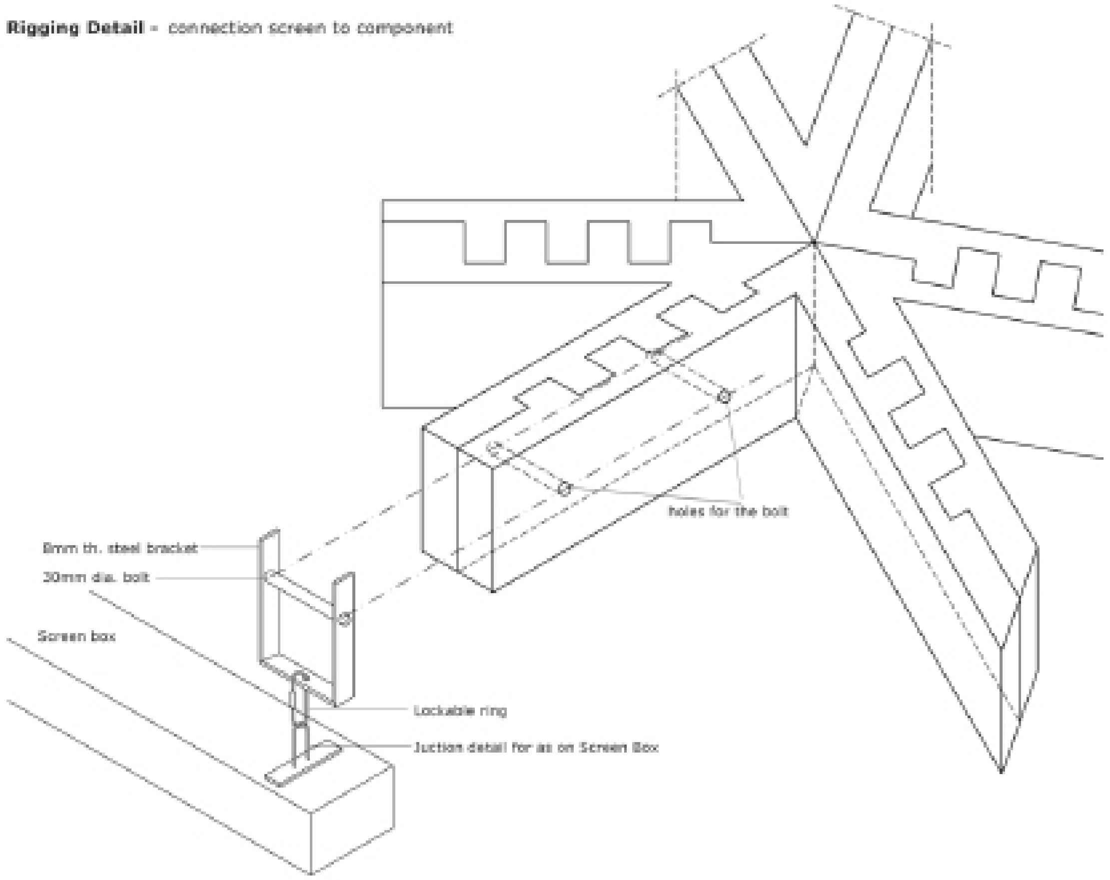


Figure 1-28. File showing shop drawings for the manufacturing process.

1. Bodycheck02
/ group D
/ MEP

Erwin van Osch
1257757

Figure 1-23. Showing the position of the functions within the component

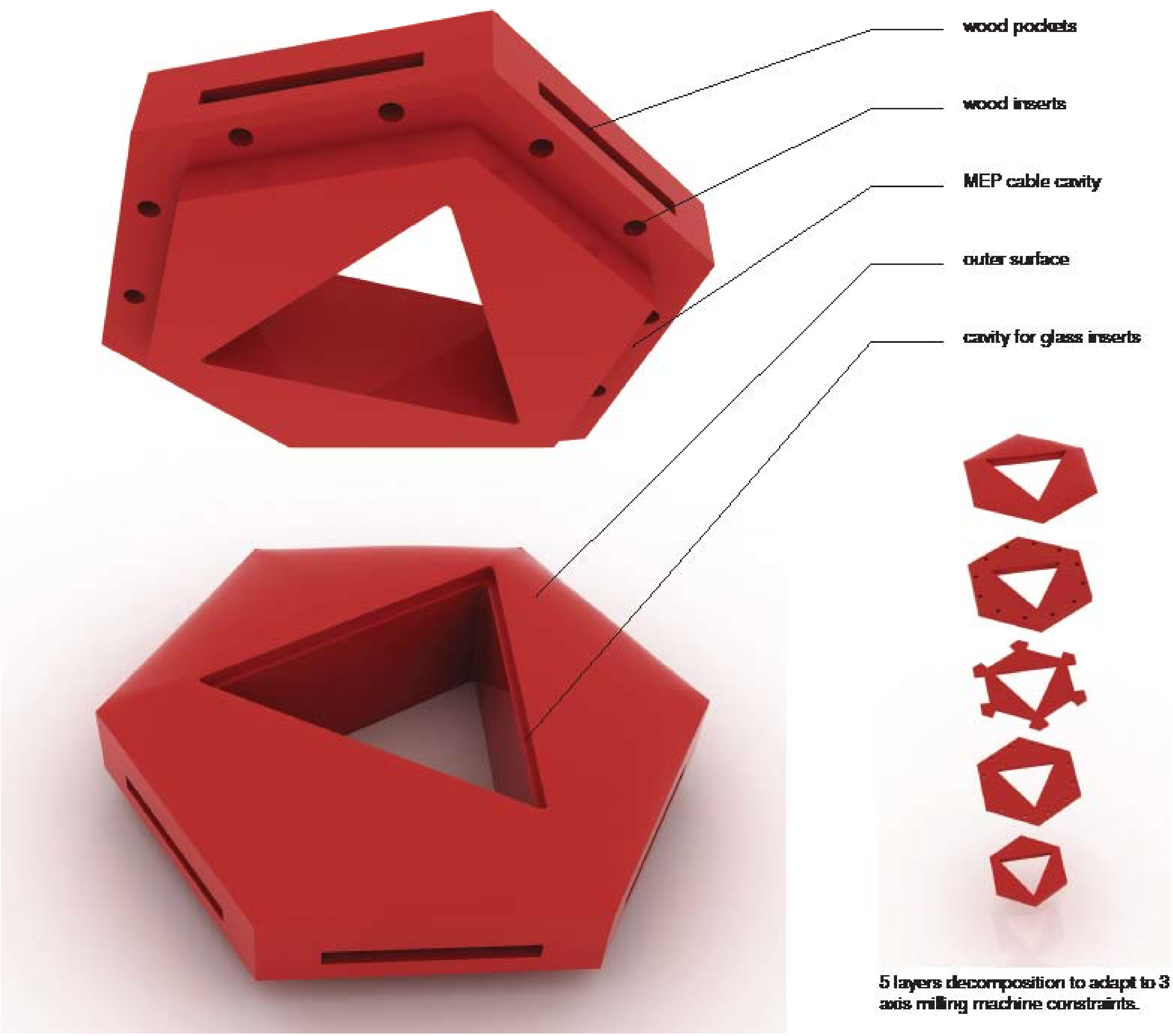


Figure 1-6. The proposed prototype is to be milled in 5 steps to cope with the constraints of the CNC 3-axis milling machine.

2. Prototype, 3-D modeling.

Aurelie Hsiao
1541951

Kwok-Tung Chun
1535226

2.1. Prototype logic.
According to the component logic developed by Group 1, we developed the model to fit TU Delft CNC Milling machine constraints. We chose to mill the triangle-opening component type. It includes the cavity for the glass element, the wood pockets for the connection in between components, the wood inserts and the MEP cable cavity.

2.2. CNC Milling machine constraints.
The three axis are X, Y and Z, this means the milling tool is fitted perpendicular to the XY-plane and can move in the X and Y directions as well as up and down (Z direction). The maximum travel in the X, Y and Z direction are 1200mm, 800mm and 150mm. The 3-axis milling machines are controlled by files in a specific format. The Isel machines are controlled by Isel_NCP files. Several programs are able to create NCP-files. We used Rhino (Rhinoceros) with a MadCam plugin. The MadCam plugin calculates and creates the toolpaths and processes this information into a NCP-file.

The first step we had to do is select the solids and/or surfaces to prepare them for toolpath calculation. For different procedures we can use different cutters. A curved surface will have the best finish with a cutter with a ball end. A flat surface will have a better finish with a flat end cutter. The best finished result for surfaces will be achieved with bigger cutter radii, however a bigger cutter radius might sometimes be impossible because of narrow spaces that need to be detailed as well. Here we used a 6 cm long and 1.2 mm diameter flat end driller.

The next step was to select the actual areas to be milled. We chose to also enclose the cutter radius for a smooth finish near the box edge. The problem however is the position of the box in relation to the origin. So we had to move the box and the solids and/or surfaces in a way that the desired start-point will be the origin (0,0,0). After moving the box and the solids and/or surfaces we had to rebuilt the box.

The third step is to define the toolpath. We first proceeded to the roughing, the z-level finishing, and then the pocketting. Roughing is a fast way of milling the basic shape. It takes

3. Prototype, 3-axis milling machine.

Aurelie Hsiao
1541951

Kwok-Tung Chun
1535226

away excess material before finishing. The maximum 'Step-Down' and the maximum 'StepOver' were set to the value 5. The 'Stock To Leave' was set between value 2 and 3. Z-level finishing is ideal for near perpendicular surfaces. By making small steps down the near perpendicular surfaces have a smooth finish.

3.1 Milling strategy.
Because of the 3 axis milling machine constraints, we decided to separate the milling process into 5 layers, so that the pockets or space for inserts can be successfully milled. Each of the layers need to have a flat bottom, to avoid any negative mould. The driller size and length used defined also the height of each layers: to be able to mill 90 degrees angles, we need to keep the height of the layer under 6 cm, otherwise, the maximum angle would have been 80 degrees. Each inner corners need also to adapt to the 6mm radius fillet triggered by the use of a 1.2 cm diameter driller. Beside the very low density foam material we used, the final result of the top layer milling prototype was beyond our expectation.

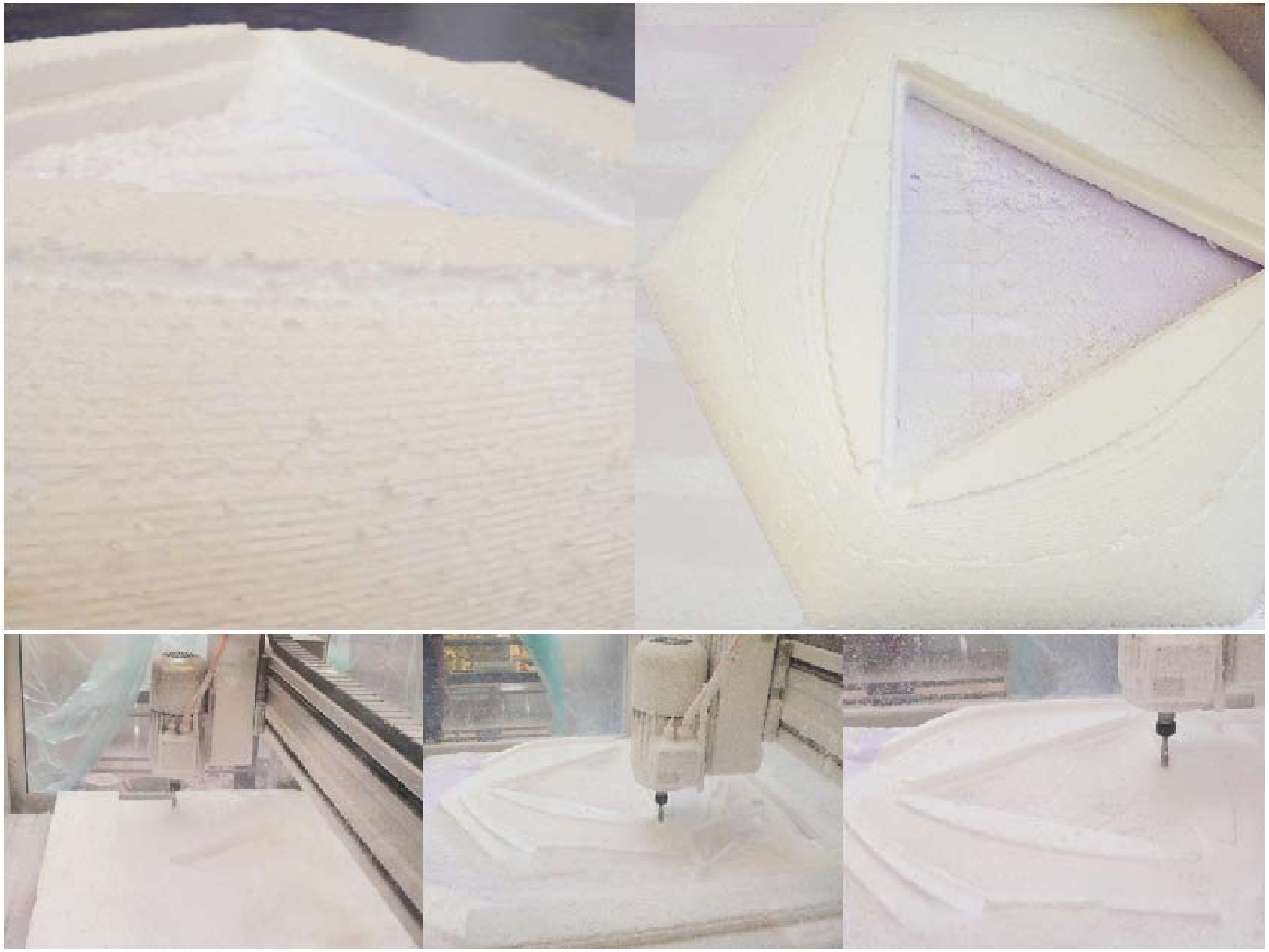


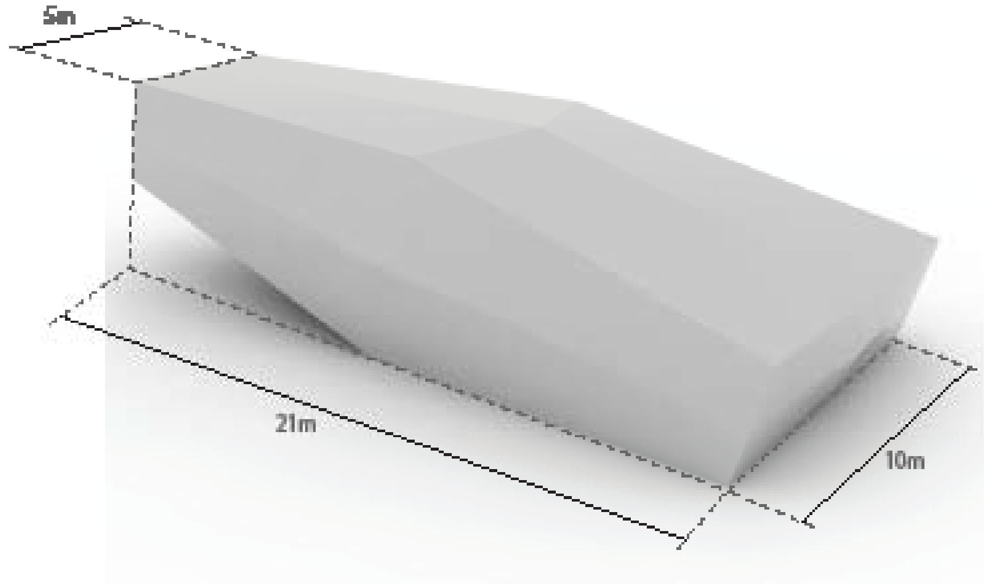
Figure 1-7. The milling process of the top layer of the prototype was achieved within 6 hours. The result exceeded our expectations.

Bodycheck 3
Structure

Shape Analysis

Soran Park 1530801

Shape analysis
With very initial version of shape and without tesselation on the model we had to analyze shape to feedback about optimization the shape in the aspect of structure. At this moment, the wire frame model was not perfect, so in several parts, some elements are broken in GSA calculation. However, at least we can see huge deformation in cantilever part.



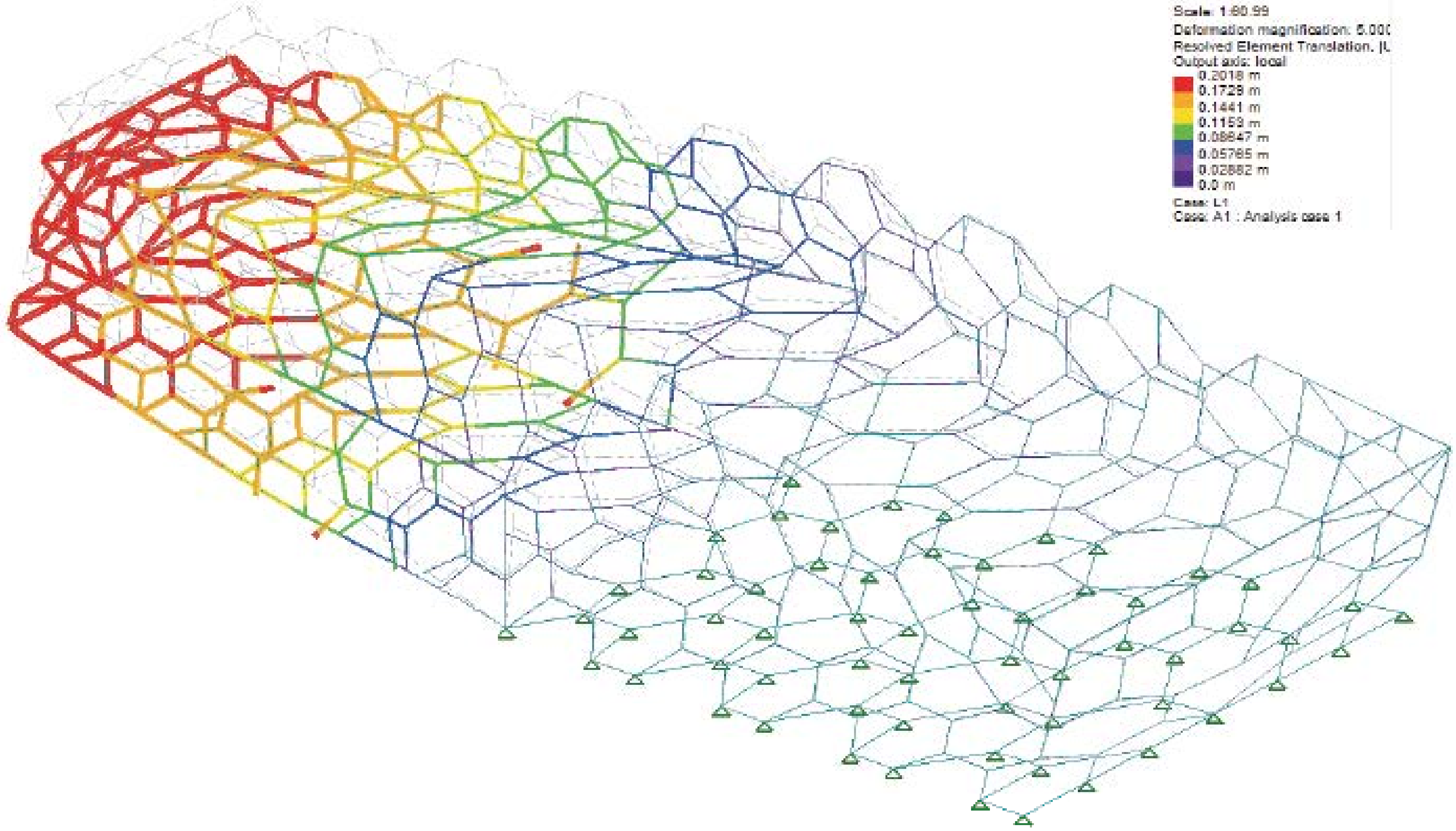


Figure 1-1. This image is showing the rough size of pavilion and wire frame analysis of very fist shape in GSA.

Interlocking System

Soran Park 1530801

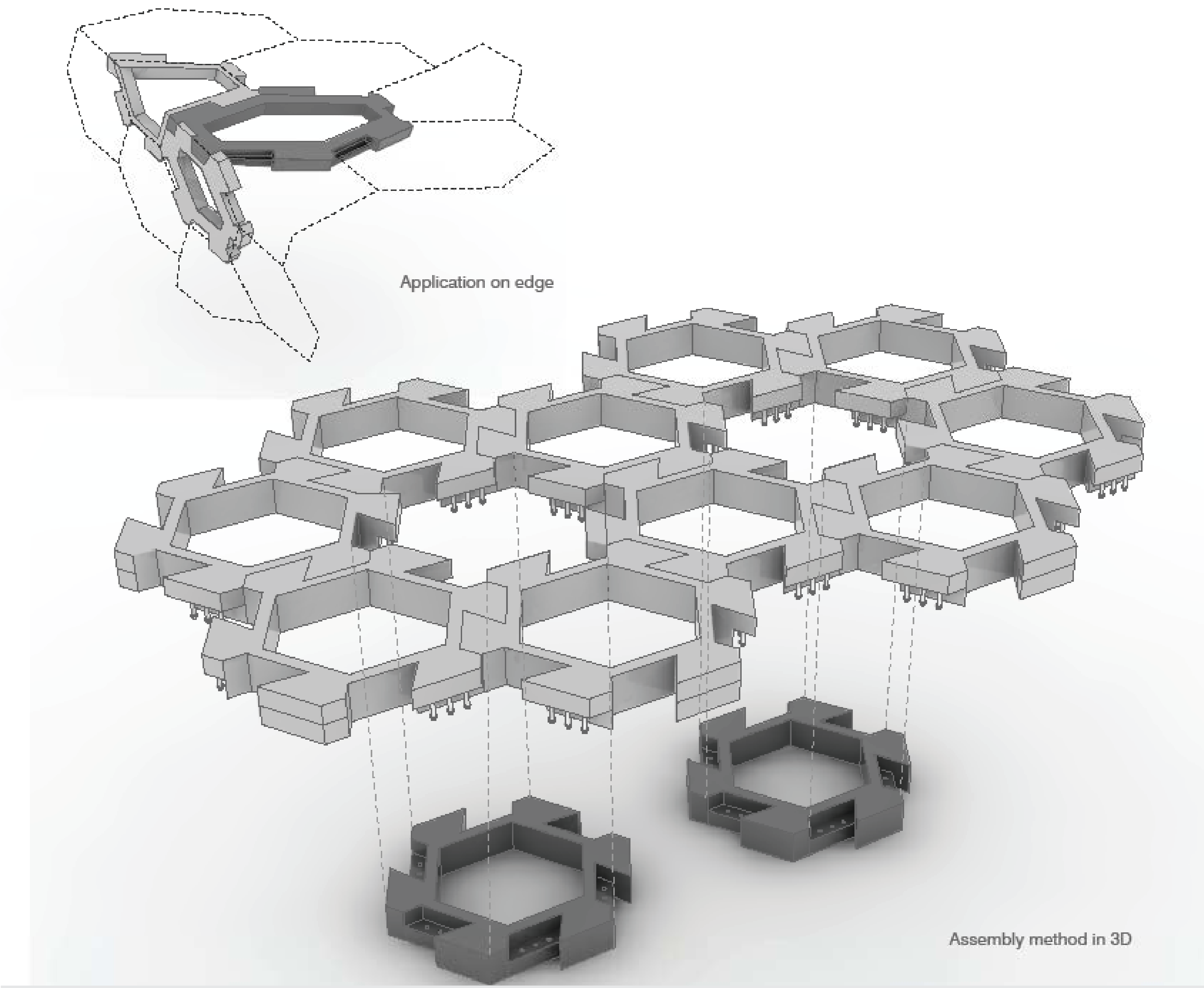
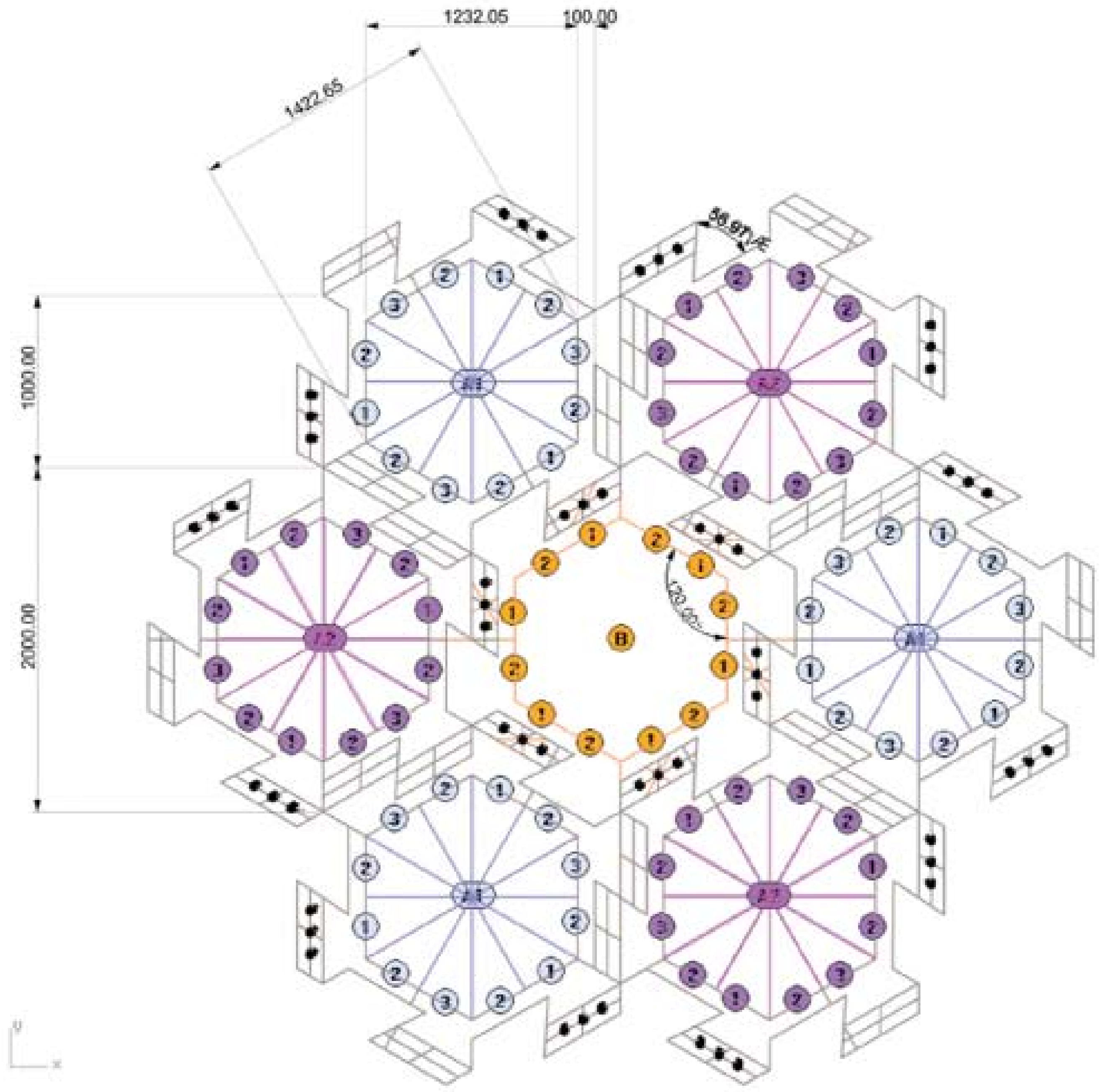


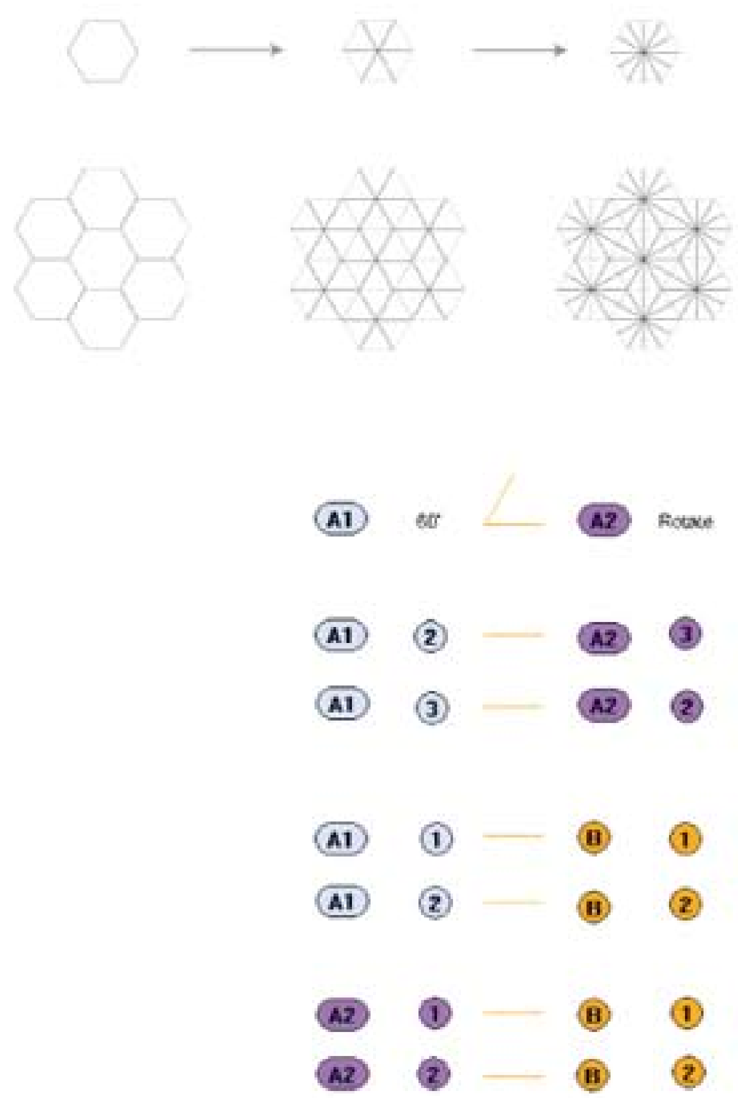
Figure 1-4. This render shows interlocking system in 3d. The image on top shows application on edge.

Application in 3d
This interlocking system has to be considered carefully in the aspect of fabrication. To make it sure whether this system is working or not, application on curvature and edge was demanded.

Matching Logic

Mingyu Seol 1535234





Matching logic
In order to populate component having interlocking system, one component is divided into 12 parts. There can be three type of small parts. By combining these parts, we can get three kinds of component which are rotated by 60 degree.

Figure 1-6. This drawing presents the logic to populate interlocking system.

Bodycheck 3
Structure

Material and Detail

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Material
The principal of the structure is basically sandwich panel. Inside material is EPS for creating shape and only outside material is working as structure. For the outside material, several materials were considered with its properties- carbonfiber, glass fiber, Polyurea coating. Glass fiber was picked as proper material finally.

Connection detail
Every bolt is inserted in component in factory with RTM method in both cases of glass connection and connection between components.

Carbonfibers
Weaved carbonfiber, omnidirectional.
Tensile strength:

- Handlayered, no pressure. 3,000,000 psi
- Handlayered 1BAR negative pressure 10,000,000 psi

Glassfibers

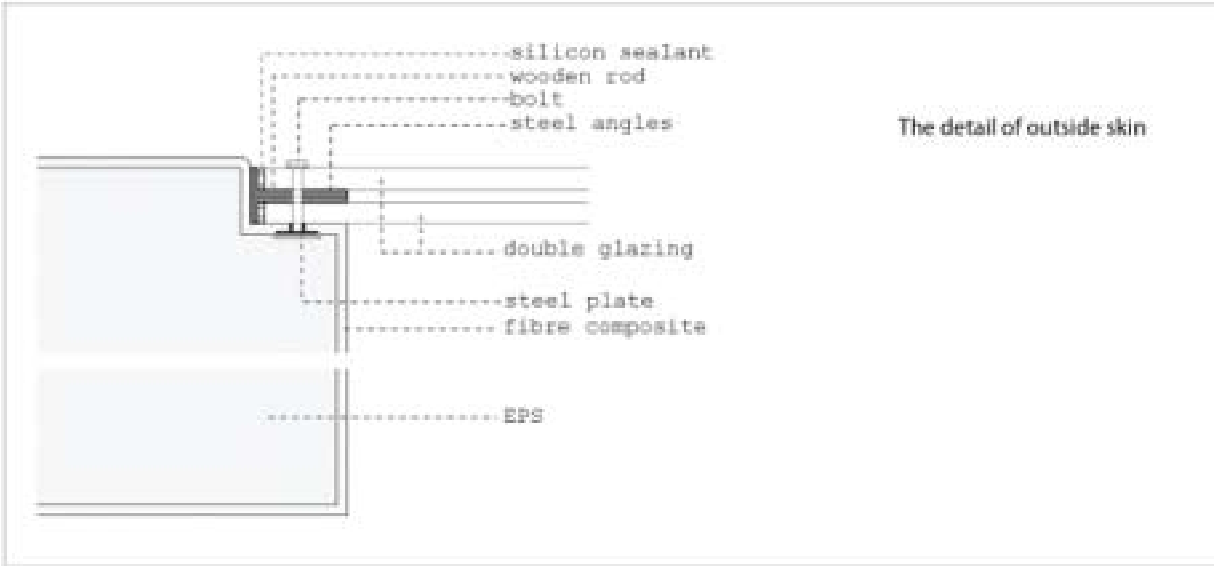
- Flexural strength 16,000 to 32,000 psi
- Tensile strength 9,000 to 18,000 psi
- Elongation 1 to 2,5 %
- Compressive strength 15,000 to 25,000 psi

Polyurea coating (per mm thickness)

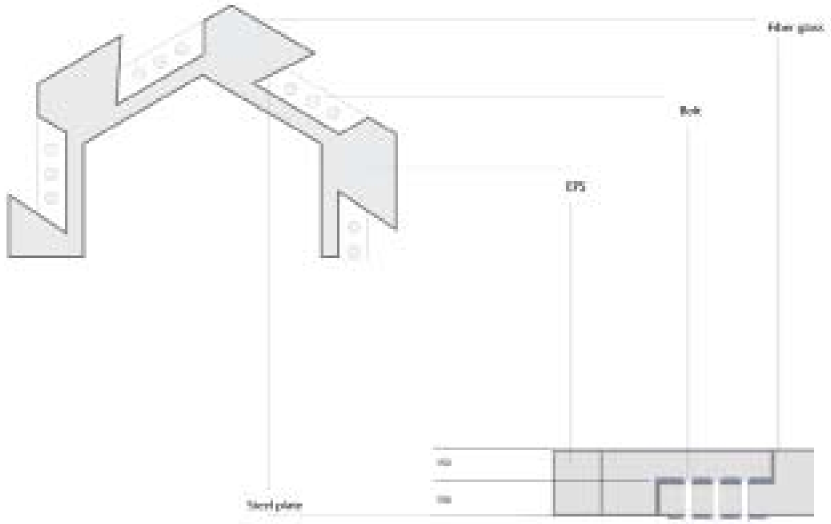
- Tensile strength 1,300 psi

Ref. Steel property

- G10100 Hot Rolled
- Yield strength 26,000 psi
- Tensile strength 47,000 psi



The detail of outside skin



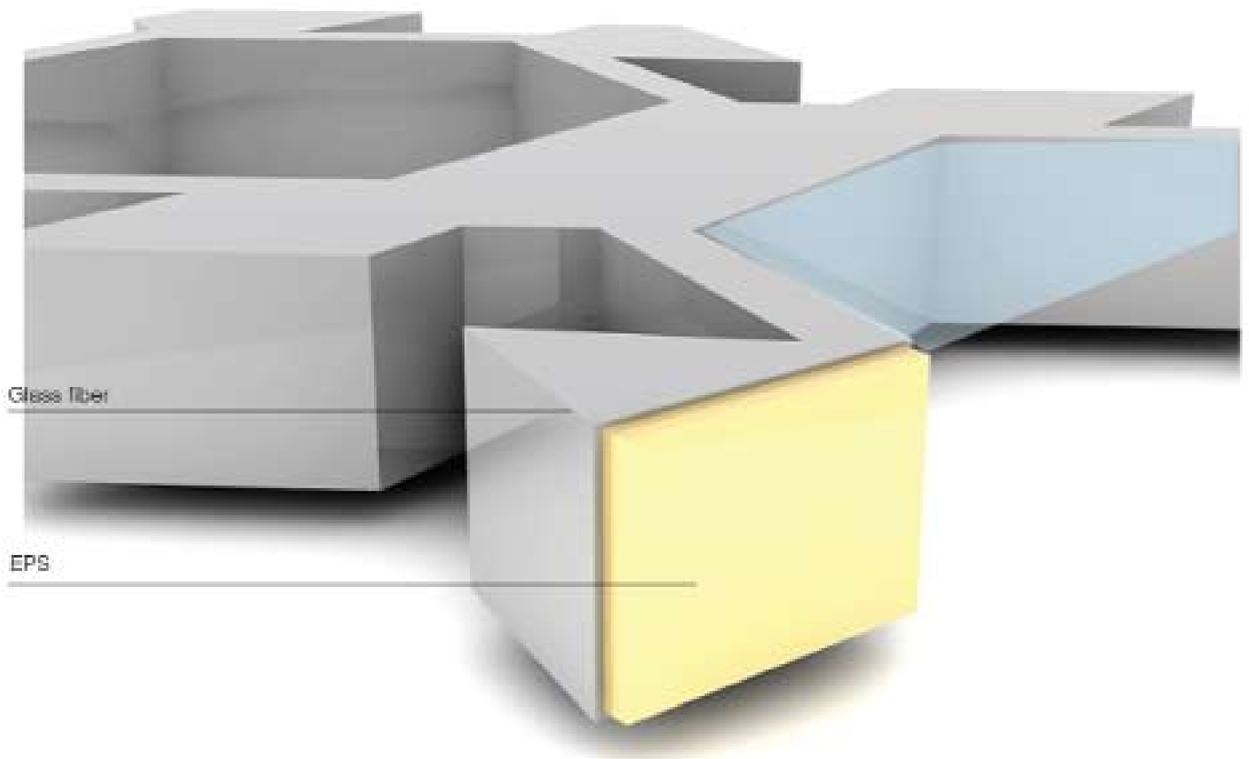


Figure 1-7. This image is showing material properties of structure and detail of connection of glass and components.

1. Assembly order - from bottom to top

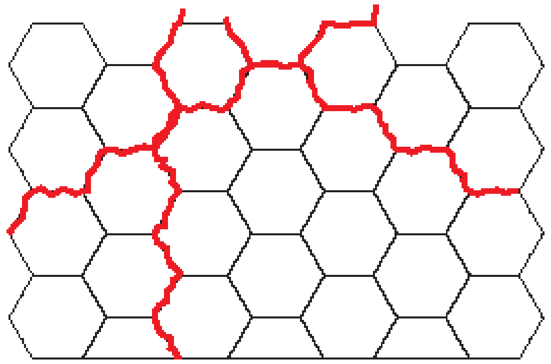
Analysis of

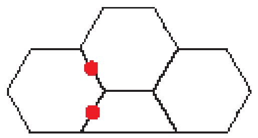
Aurelie Hsiao
1541951

Kwok-Tung Chun
1535226

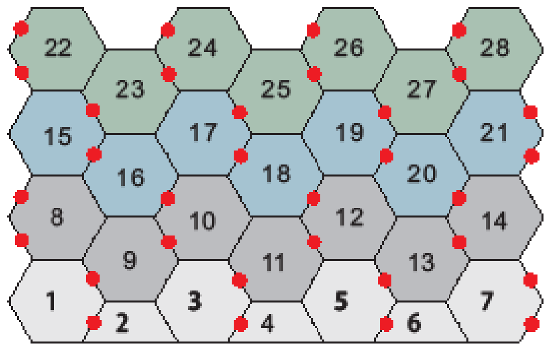
1.1. Balls.
Since the clip connection can not load the shear force, we insert balls into the connection face between components. The balls are a kind of good dual to conteracting shear force. But the problem is how an assembly logic be able to put the balls in correct position .

1.2. Assembly order.
We invent two different logics to insert the balls during assembling, one is assemble the components one by one, another is layer by layer. Both logics are assemble from bottom to top. One by one means you can accumulate the components consecutively and also the balls. And layer by layer means you have to assemble a ring of component frist, and the accumulate on lower one. This way of assembling be able to insert more balls, hence the shear force conteracting is better than perious one, but the problem is you have to have something to hang or hold the componont when your assembling.

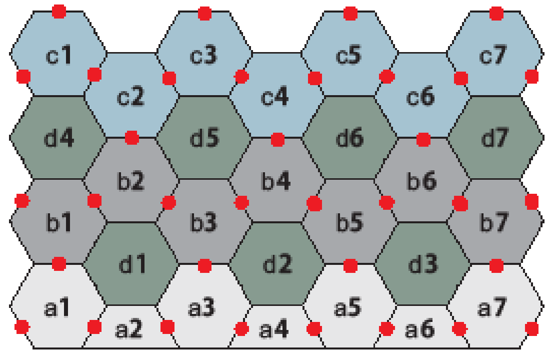


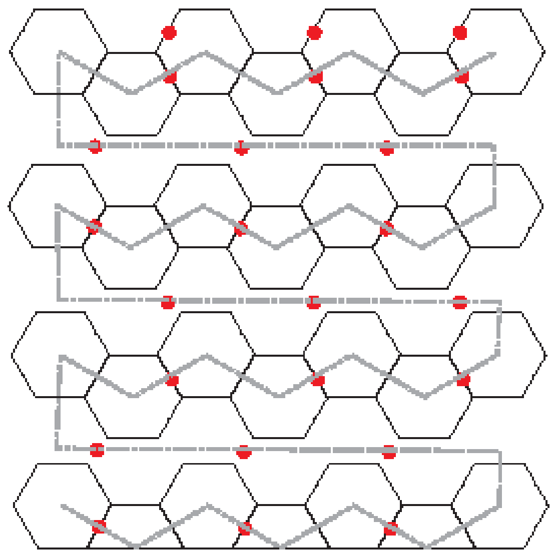


Assemble one by one:



Assemble layer by layer:





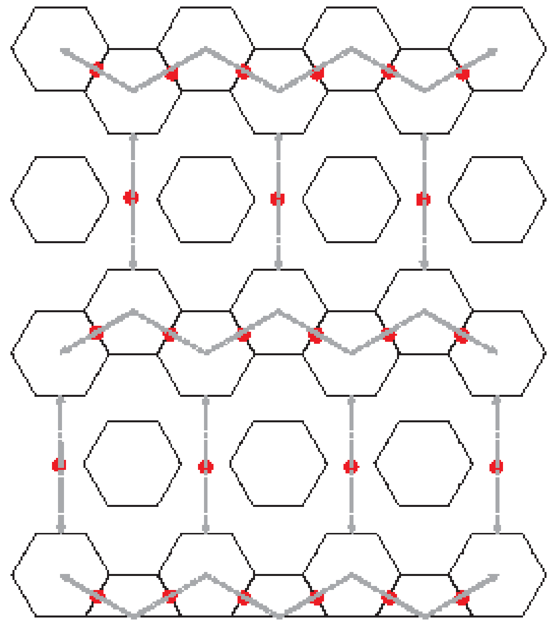


Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.
Figure 1-1. This diagram shows the different between these two kind of assembly logic

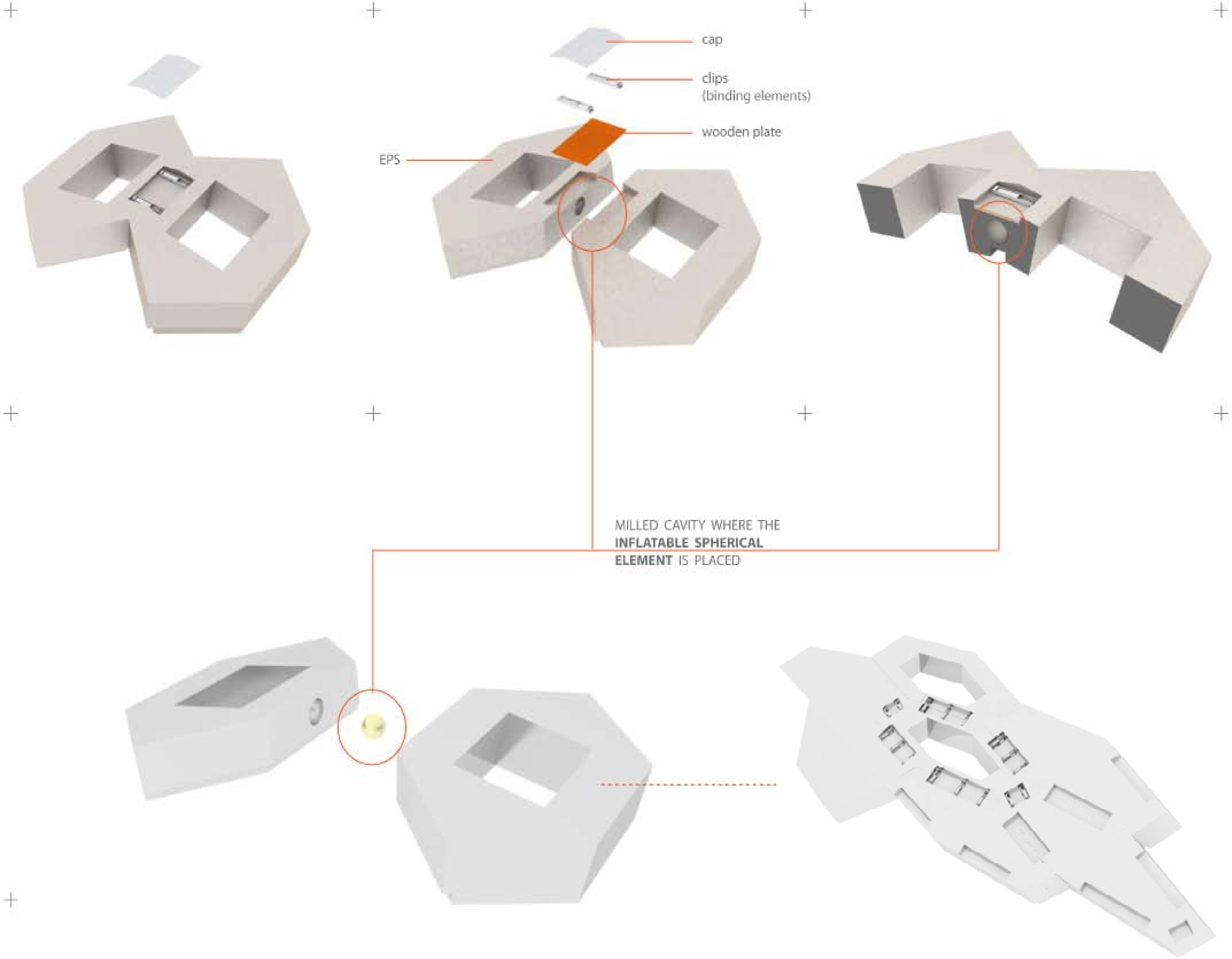


Figure 1-9. Connection between two components: clips for the compression and tensile forces, spherical inflatable element at the interface for the tensile forces.

Figure 1-1. This spherical inflatable element placed in the component. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. Bodycheck05 Farication / Materialization.

Clip

Melina Mezari
1535293

1.13. Clip cavity.
In order the clip to be applied on a flat surface, a cavity is milled on both interior and exterior surface of the component. The wooden plate is palced in the cavity and sprayed afterwards. The lenght of the cavity includes all the clips per edge, but this is going to change so as the cavity-clip combination to be more discreet.
A cap for the cavity is proposed, to protect from water penetration and accumulation.

1.14. Shear forces.
The clip itself is not enough for the connection between the components. The shear forces have to be taken into account also during the design process. The idea is to put a single element on the interface of the components. The spherical shape is appropriate for the case. The persistent problem concerning the ball, is the way and the time it is placed between the two components. A restriction for this is the assembly logic that is developed. The only way the sphere to be placed before the assembly of the parts, is by using an element, that is inflated after the locking of the components. More specifically, such an iflatable element is found in stock and is a high-pressure structural element. The exterior material is a proprietary 7-layer laminate which includes a puncture-resistant layer, a barrier film, and a urethane layer. The laminate material is cut to size and welded around the seam using RF welding. Typically the elements are inflated with nitrogen because nitrogen molecules are relatively large, so the gas escapes from the elements slowly. Pressures up to 2,500psi are possible, as are curved shapes and elements with hinges.
This element can be used as support for temporary structures like tents, or used inside any item that needs to be rigid.

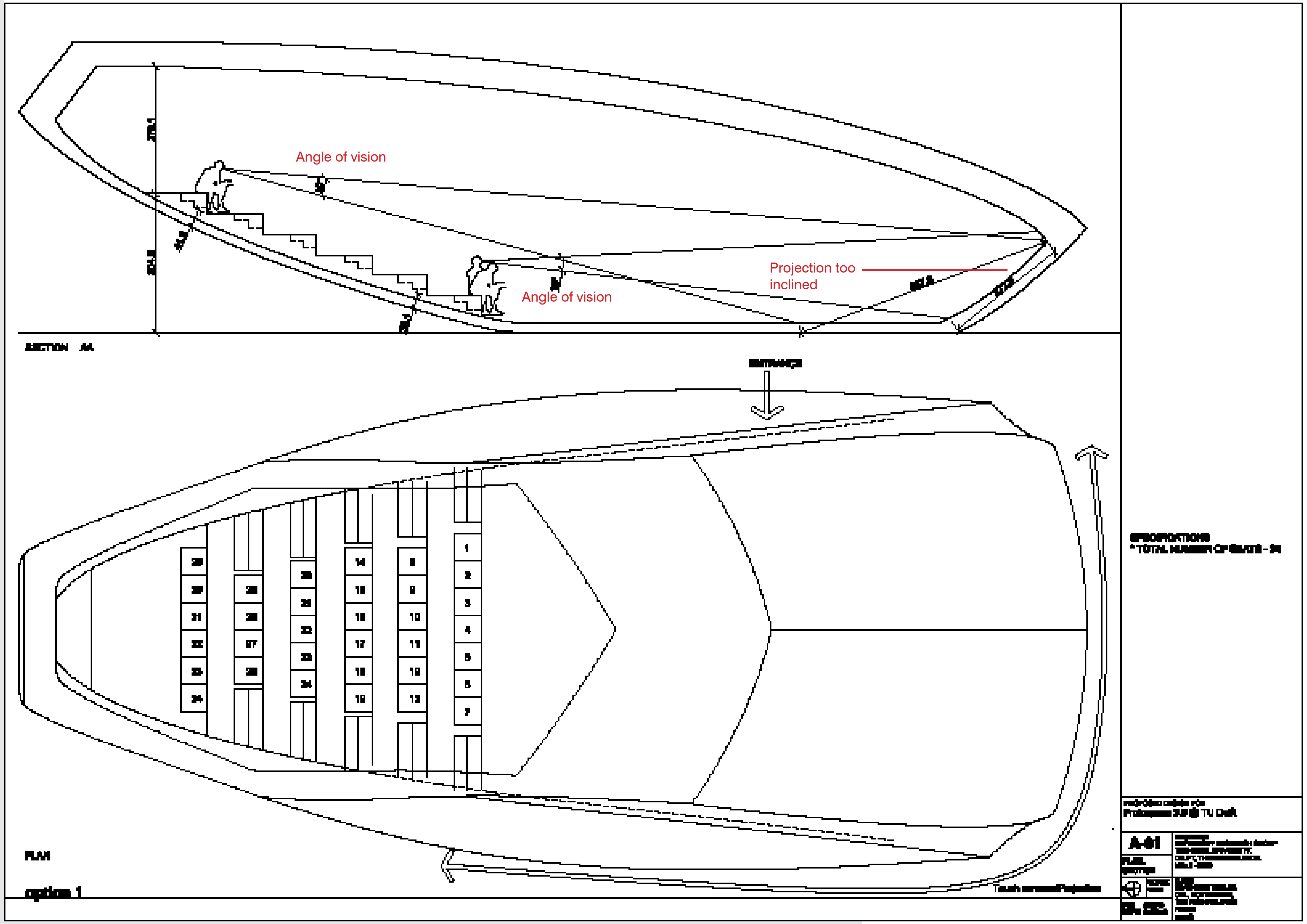
(**https://www.inventables.com/technologies/high-pressure-structural-elements**)

1. Bodycheck 05

Interaction Design

Lecture Scenario

Urvi Sheth 1531174



1.4. Options to for the lecture scenario

To begin with the standard method of stepped seating is adapted. This concluded of maximum number of people to be considered for the design of the Protospace 3.0. Taking this as basis various options were worked out further.

Figure 1-2.

Figure 1-5. Plan and section showing standard seating arrangement for lecture scenario

1. Bodycheck 05

Interaction Design

Lecture Scenario

Urvi Sheth 1531174

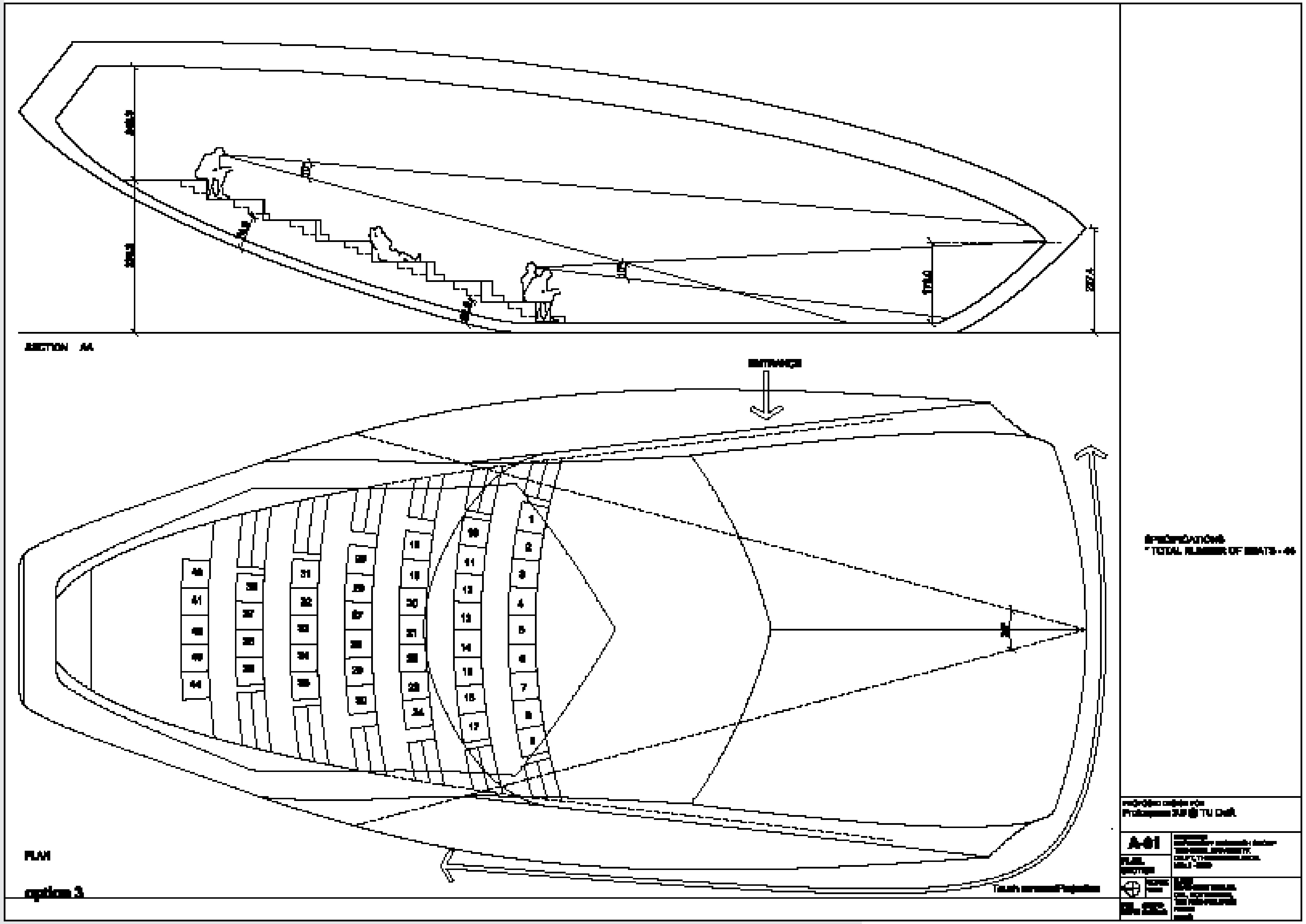


Figure 1-2.

Figure 1-7. Plan and section showing standard seating arrangement for lecture scenario

1. Bodycheck 05

Interaction Design

Furnitures

Jonas PS Sin 1535102
Urvi Sheth 1531174

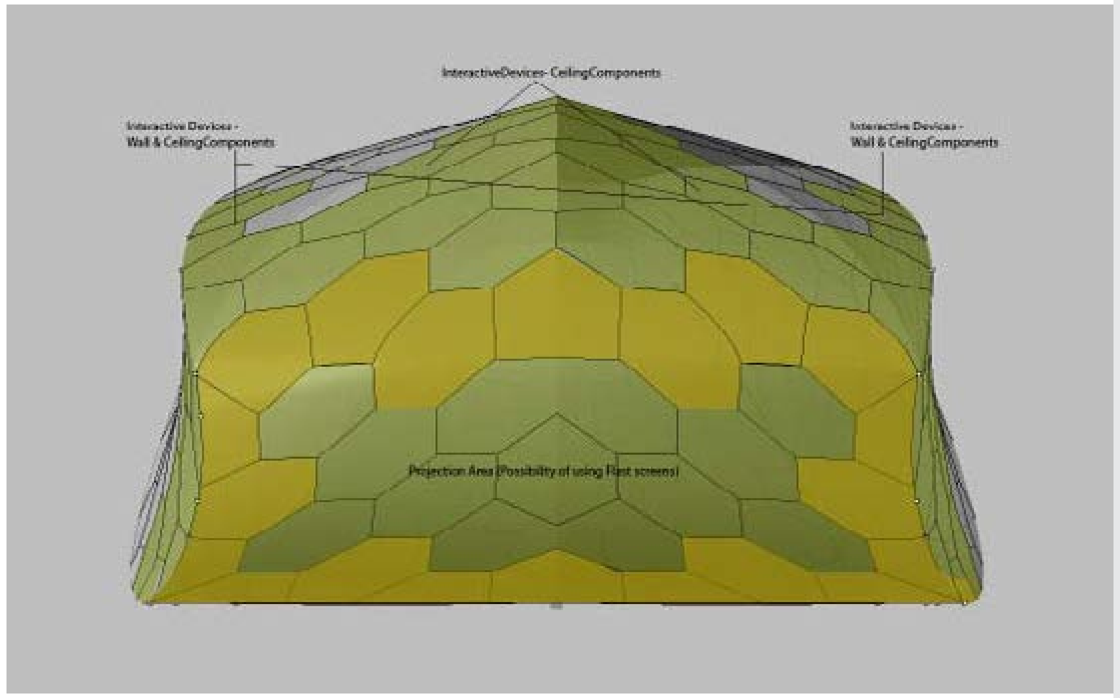


Figure 1-24. Rear view

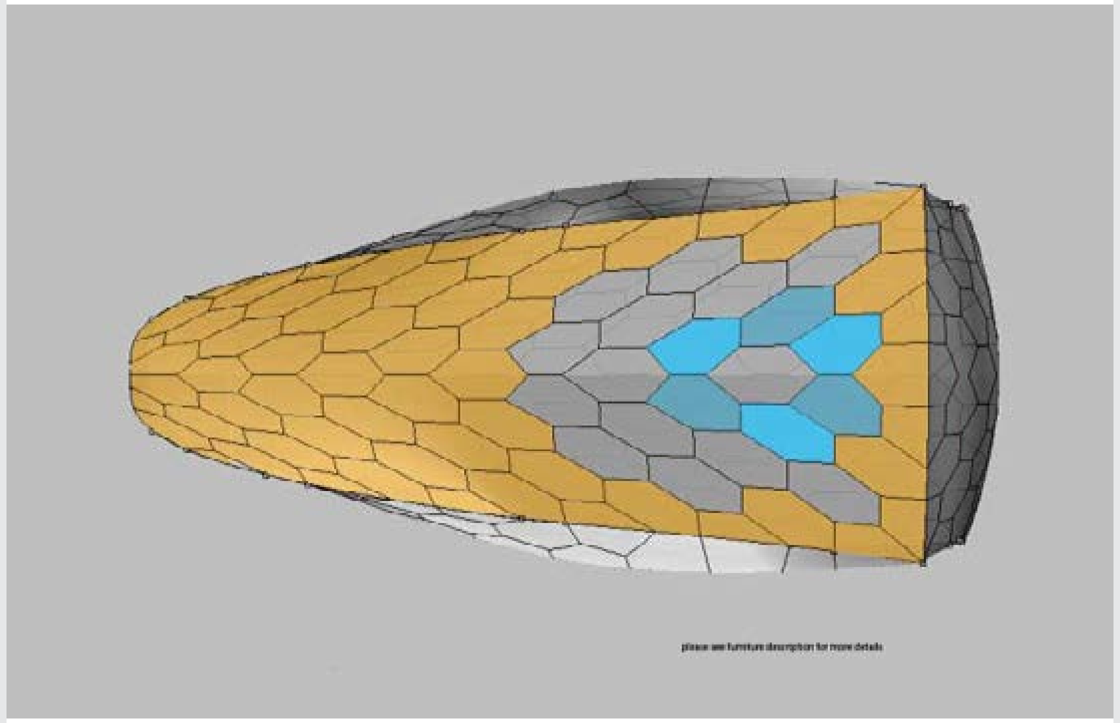


Figure 1-25. Floor plan view

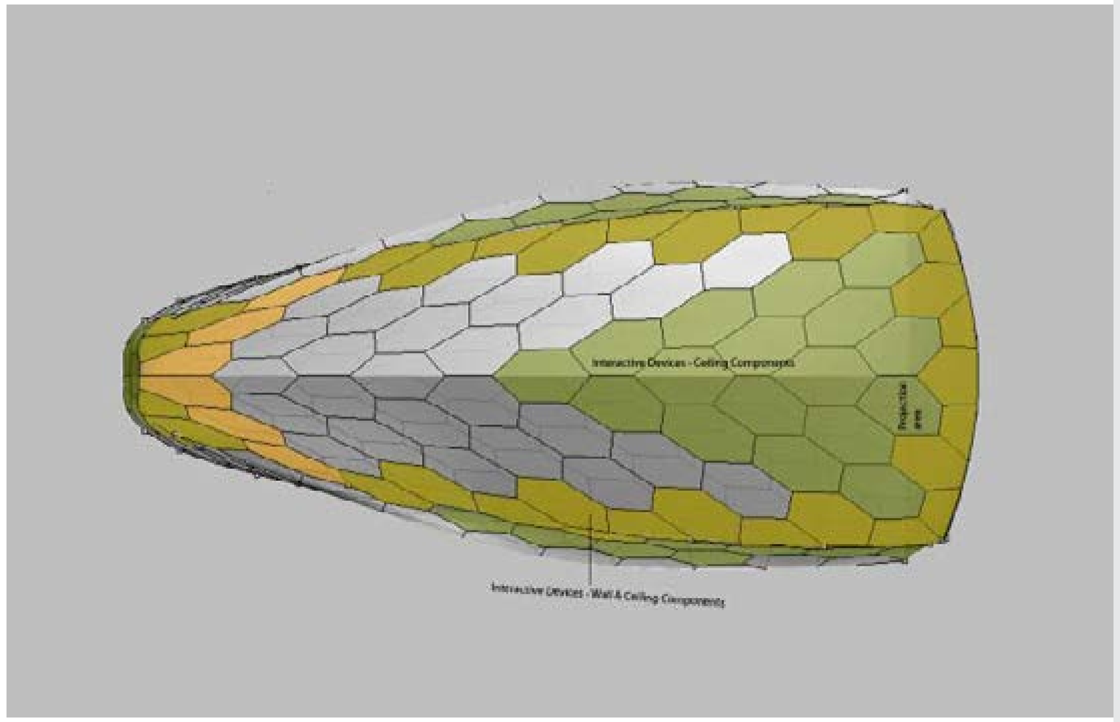


Figure 1-26. Top view

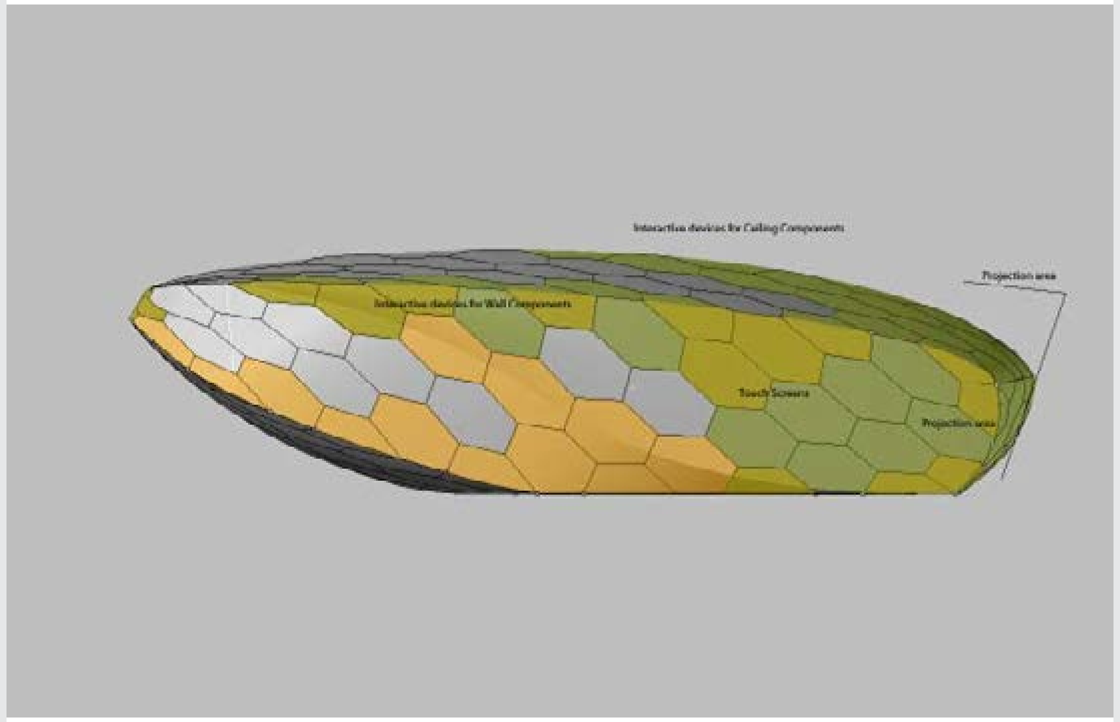


Figure 1-1. Visualisation of interior skin as guest

Figure 1-27. Side biew

1.18. Position of the furniture

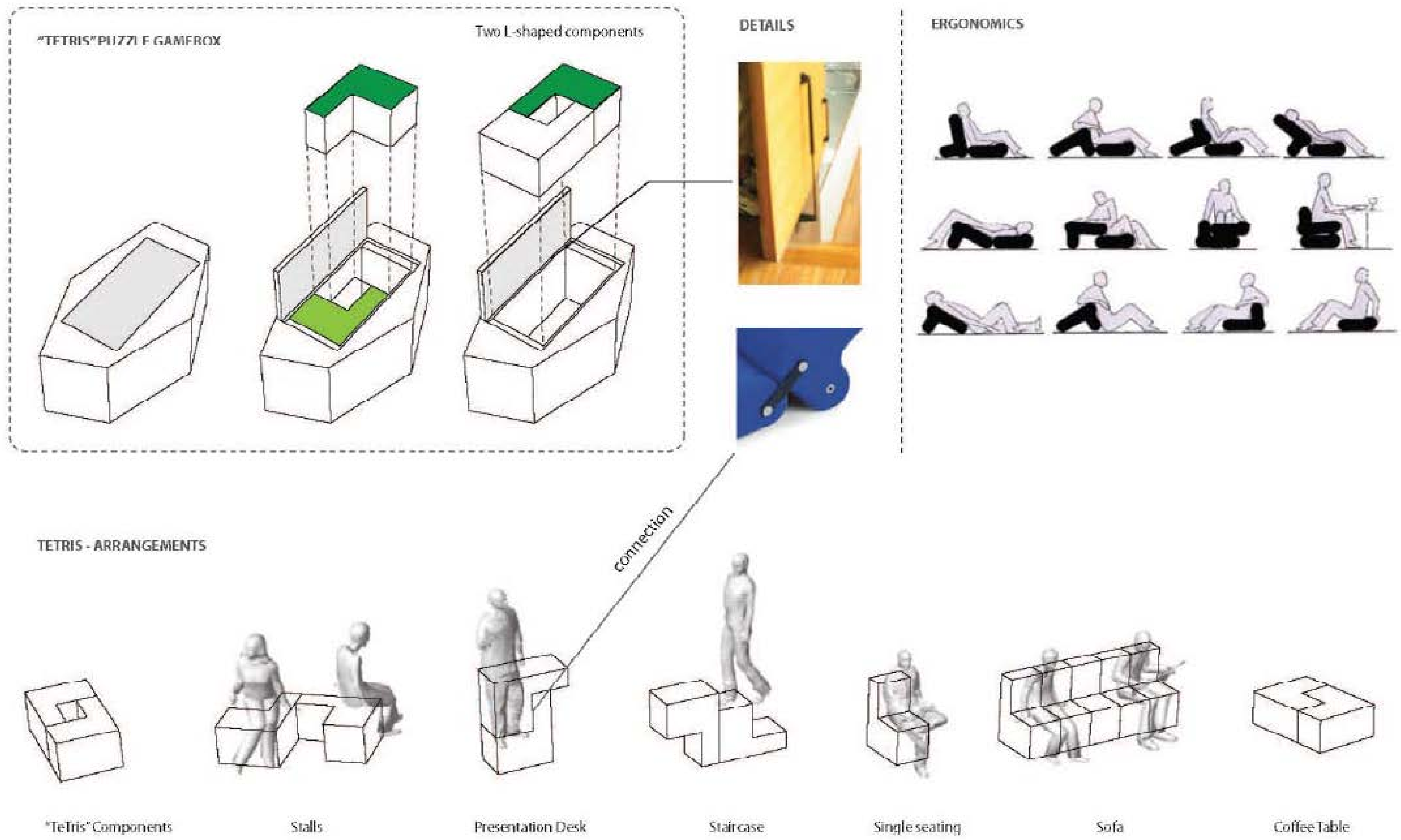
The position of the interactive devices, furniture, apertures and structural parts are clearly defined on every component. Some of the components are multi-purposed.

1. Bodycheck 05

Interaction Design

Furnitures

Jonas PS Sin 1535102



1.19. Furniture development

The shape of the furniture are developed into a generic L-shape component, which is made out of EPS material. The L-shape components are able to rotate itself and combine with another component to create different type of furniture for different purposes, based on the ergonomic function of the human body, the following type of arrangement is possible: stalls, presentation desk, staircase, single seating, sofa, coffee table, etc.

Figure 1-2.

Figure 1-28. L-shaped component that can be placed differently to form different furnitures based on ergonomics.

Bodycheck 2

Styling group Generating components

Krzysztof Gornicki - 1530259

This is the newer version of the six components for fabrication. The places for clips are modelled in a way to leave space fotr the flat wooden parts. For the request of the interactivity group, I modelled also cuttings for the cables to be able to wire the components and connect to the sensor / actuator devices.

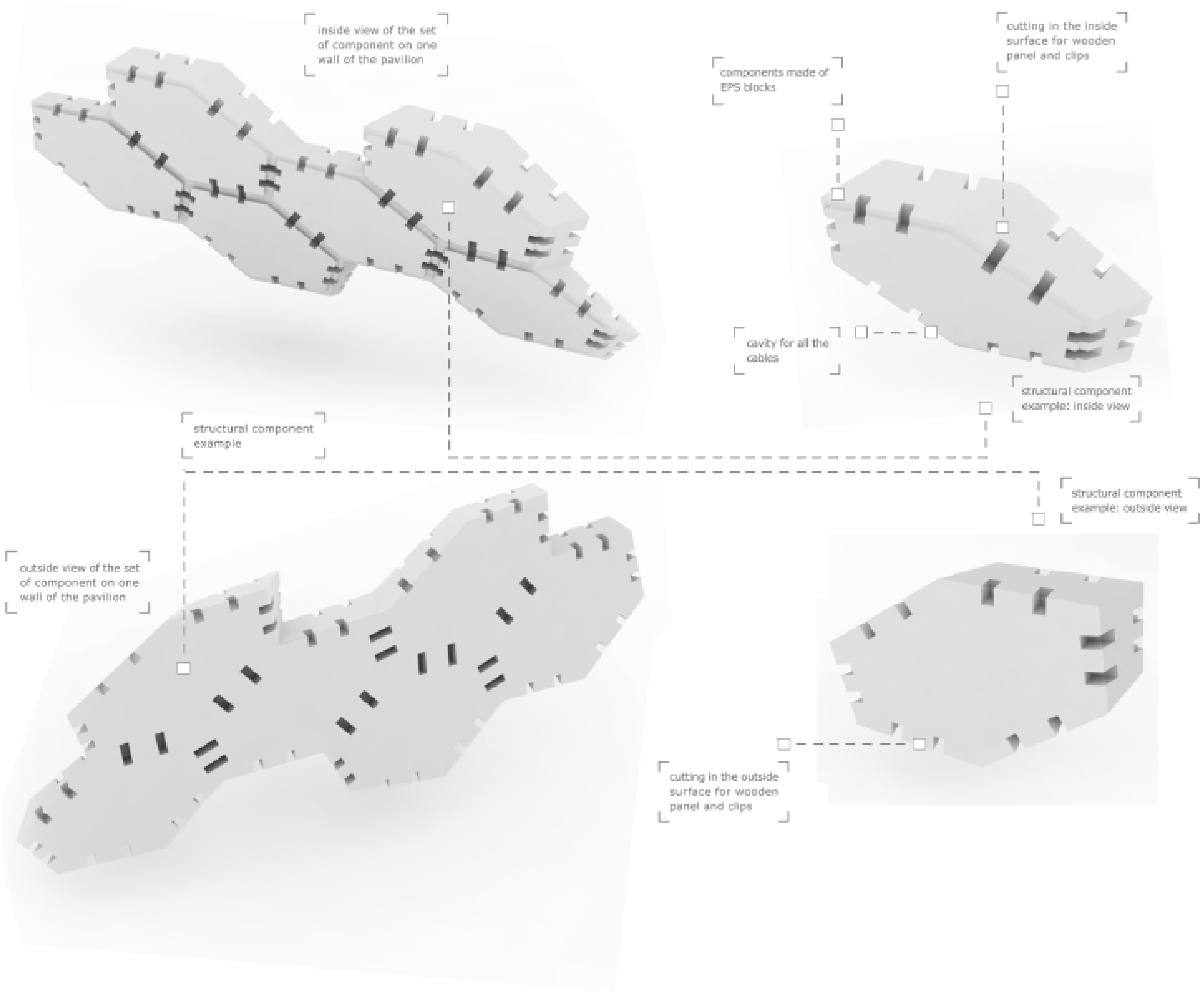


Figure 1-9. First attempt to generate a methodology for milled components

1. F2F manufacturing file.

Aurelie Hsiao
1541951
Kwok-Tung Chun
1535226

Fablab group extra contribution

Aurelie	component 1 EPS connections , hole for metal pipe
Kwok	component 3 interactive panel cap, 2 Eps connection
Gustavo	component 6 EPS connections , hole for metal pipe
Melina	component 2, 6 rubber cavities , 3 join edges , 1 eps connection

6 components.
The milled prototype consists of 6 components chosen from a part of the pavilion proposal. The file preparation for the milling work includes for each component the main EPS block with MEP cable cavities, wood plates cavities, nitrogen spheres cavities and rubber cavities. As for the connection parts, it includes the wooden plates, with the corresponding perforated holes for the metal rods of the clip system

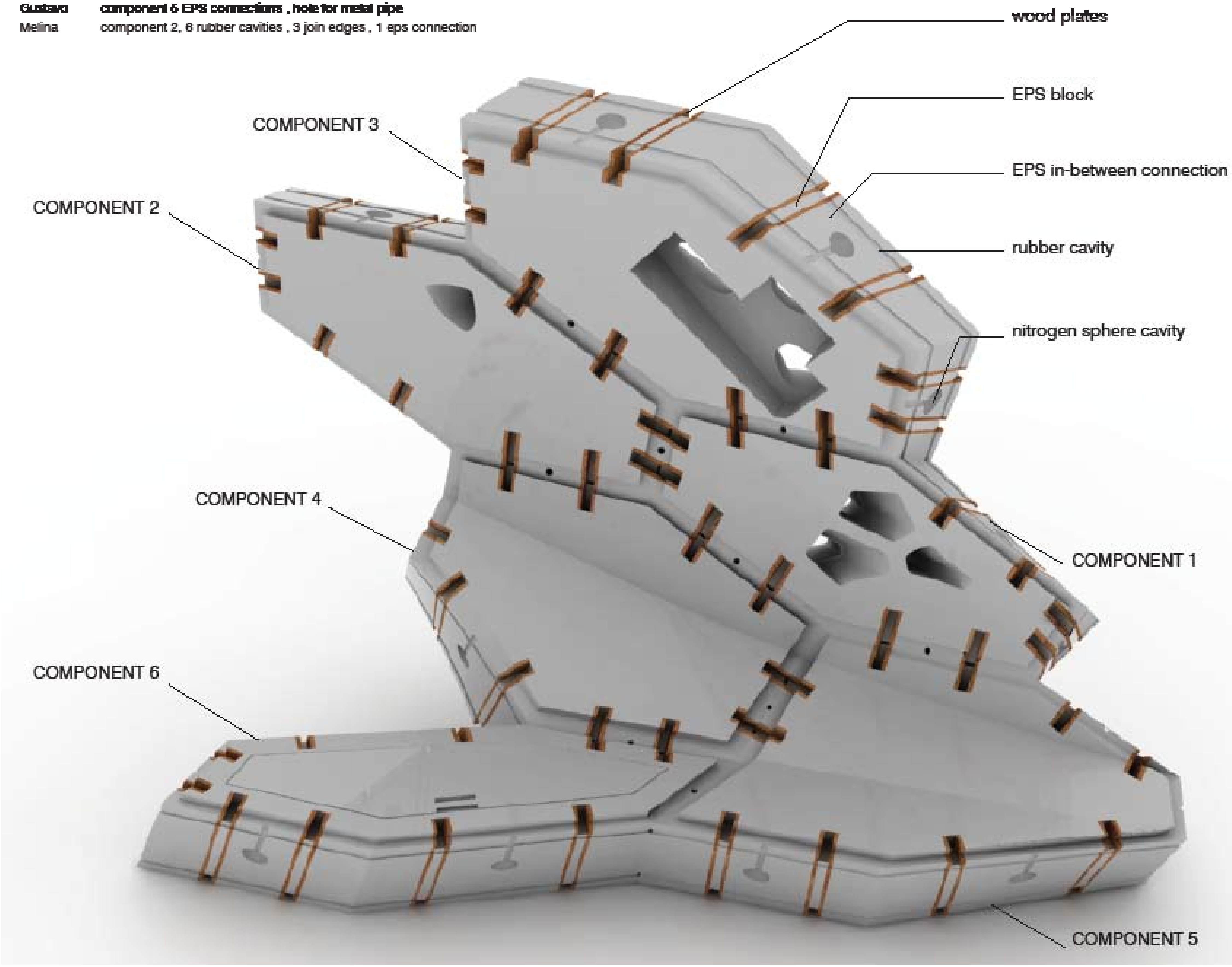


Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exer Figure 1-3. This render shows the final F2F manufacturing file, including the EPS blocks, wood plates and in-between EPS connections, consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Aurelie & Kwok component 1, 2, 3, 4, 5, 6 wooden plates + clip metal pipe

Figure 1-7. The wood plates perforated with holes for the metal pipe of the clip, and with cavities for the rubbers and MEP cable space. Figure 1-1. This render shows that... Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. F2F manufacturing file.

Aurelie Hsiao
1541951
Kwok-Tung Chun
1535226

67 wooden plates.
The generation of the wooden plates is a delicate operation, for this reason, we developed a grasshoper definition.
The strategy is to keep a constant thickness of 2 cm, corresponding to the thickness of the material used. Consequently, we can reduce the milling work by only applying it to the edges of the plates.

1. Bodycheck 06

Interaction Design

Furnitures

Jonas PS Sin 1535102

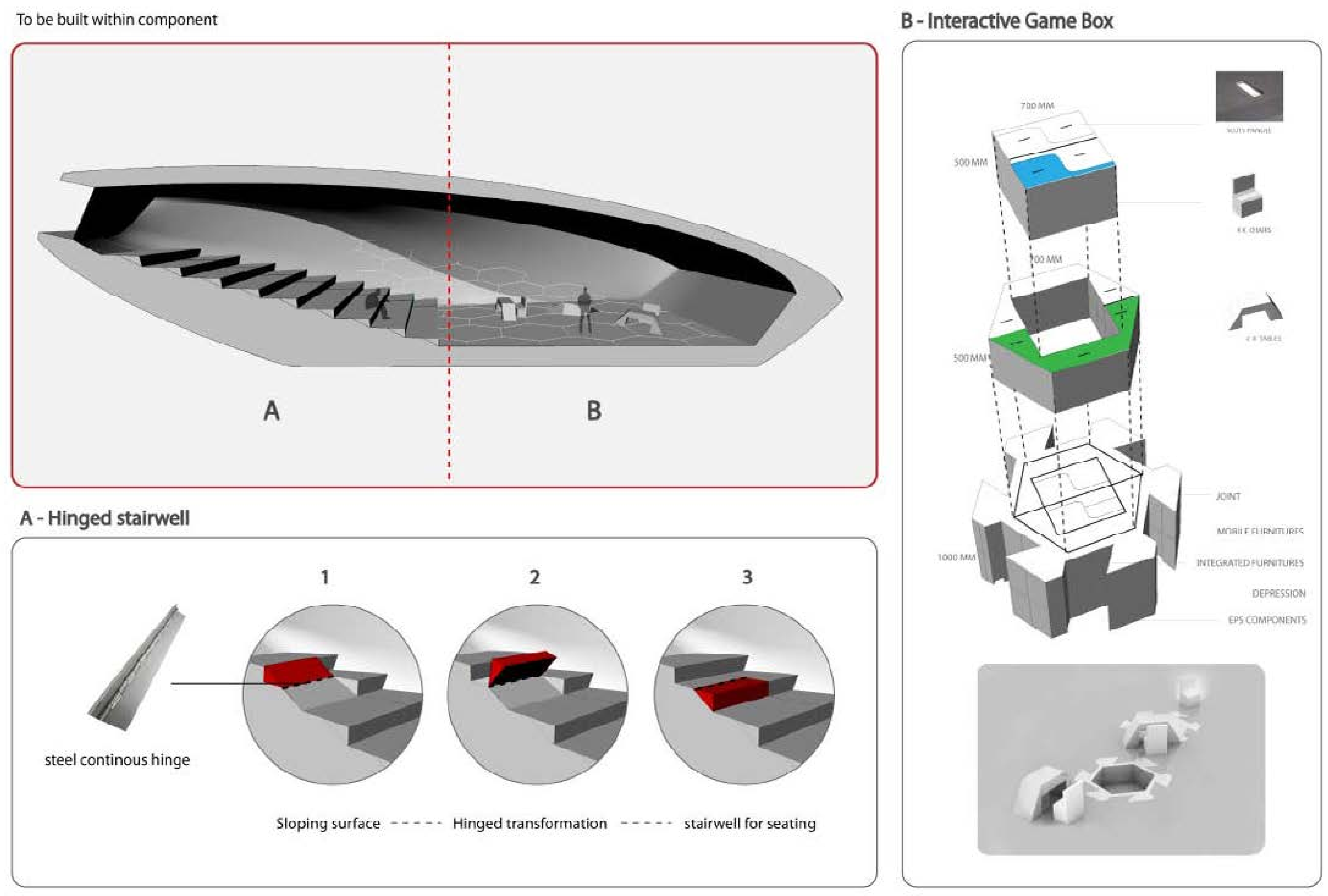


Figure 1-8. The diagrams show the design of the furniture, the hinged staircase and the interactive game box.

1.2. Hinged stairwell

In order to transform the sloping area from a lecture scenario (which requires lecture seatings) to a exhibition scenario (which requires a flat/ smooth surface), a built in hinged stairwell option had been developed to explore the potential of the EPS materials and steel hinges to create fast changing transformable mechanism.

1.3. Interactive GameBox

To use the necessary structural thickness of the EPS component, the standard furniture such as tables and chairs are integrated into the hexagonal shape. The furitures can be taken out easily from the hole of the EPS block, which fits perfectly back into the component when it is not in use. The advantages of this design, is that it create a multi-purposed component that allows efficient use of material and mobilability of the furniture. In this case, each components contain of

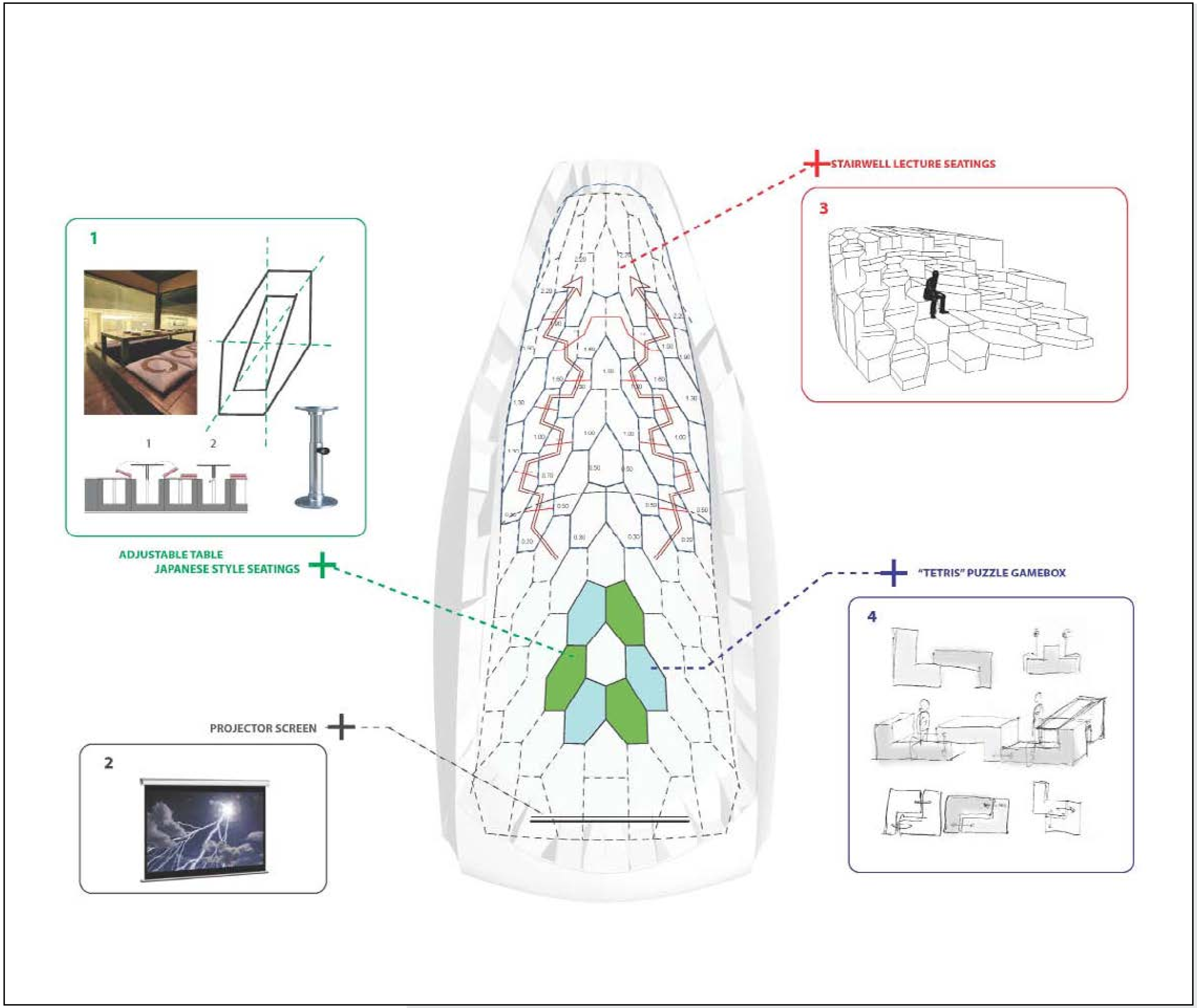


Figure 1-9. The images show different type of furnitures are located within the interior.

1. Bodycheck 06

Interaction Design

Furnitures

Jonas PS Sin 1535102
Vissarion Naoum 1535196

1.7. Spatial arrangement

The interior space of the Protospace are articulated with 2 typologies of furniture. There are 6 puzzle gamebox in total, which are located at the center of the protospace. Another type of the gamebox is inspired by the Japanese style seating within a modern Japanese restaurant. The users are seating on the floor and put their legs into the depressed area of the floor. In order for the table to the transformable and flexible to adapt to different scenario, adjustable aluminium pipe is integrated beneath the table, which allows the furniture to be interactive to the users and scenarios.

In order to form a cascading stairwell on the sloping part of the building, the lecture seating are create by altering the thickness of each components perpendicular to the horizontal floor plan.

1.8. Position of the furniture

The position of the interactive devices, furniture, apertures and structural parts are clearly defined on every component. Some of the components are multi-purposed.

1. Bodycheck 05

Interaction Design

Furnitures

Jonas PS Sin 1535102

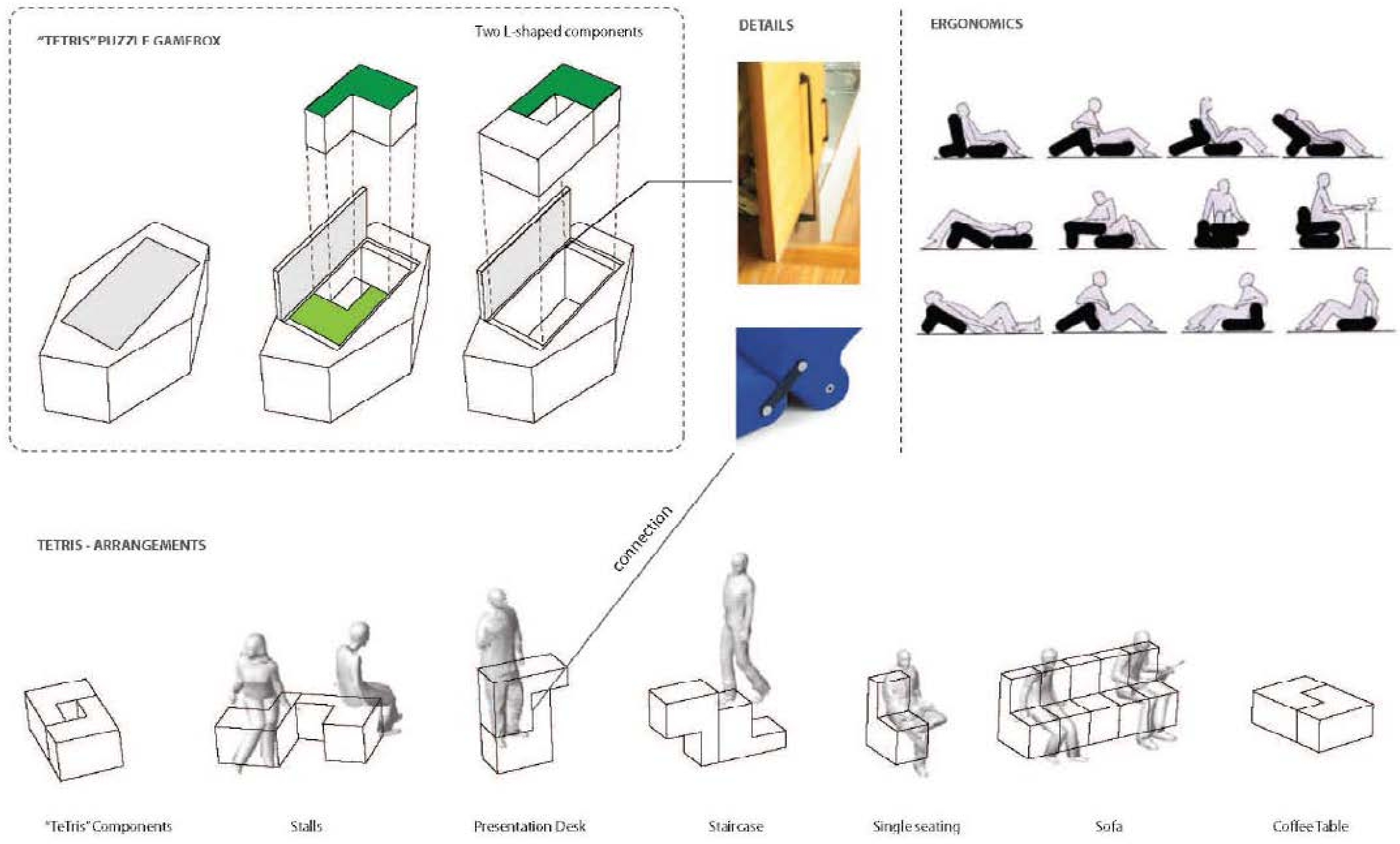


Figure 1-10. L-shaped component that can be placed differently to form different furnitures based on ergonomics.

1.9. Furniture development

The shape of the furniture are developed into a generic L-shape component, which is made out of EPS material. The L-shape components are able to rotate itself and combine with another component to create different type of furniture for different purposes, based on the ergonomic function of the human body, the following type of arrangement is possible: stalls, presentation desk, staircase, single seating, sofa, coffee table, etc.

1. Bodycheck 06

Interaction Design

Furnitures

Jonas PS Sin	1535102
Vissarion Naoum	1535196
Urvi Sheth	1531174

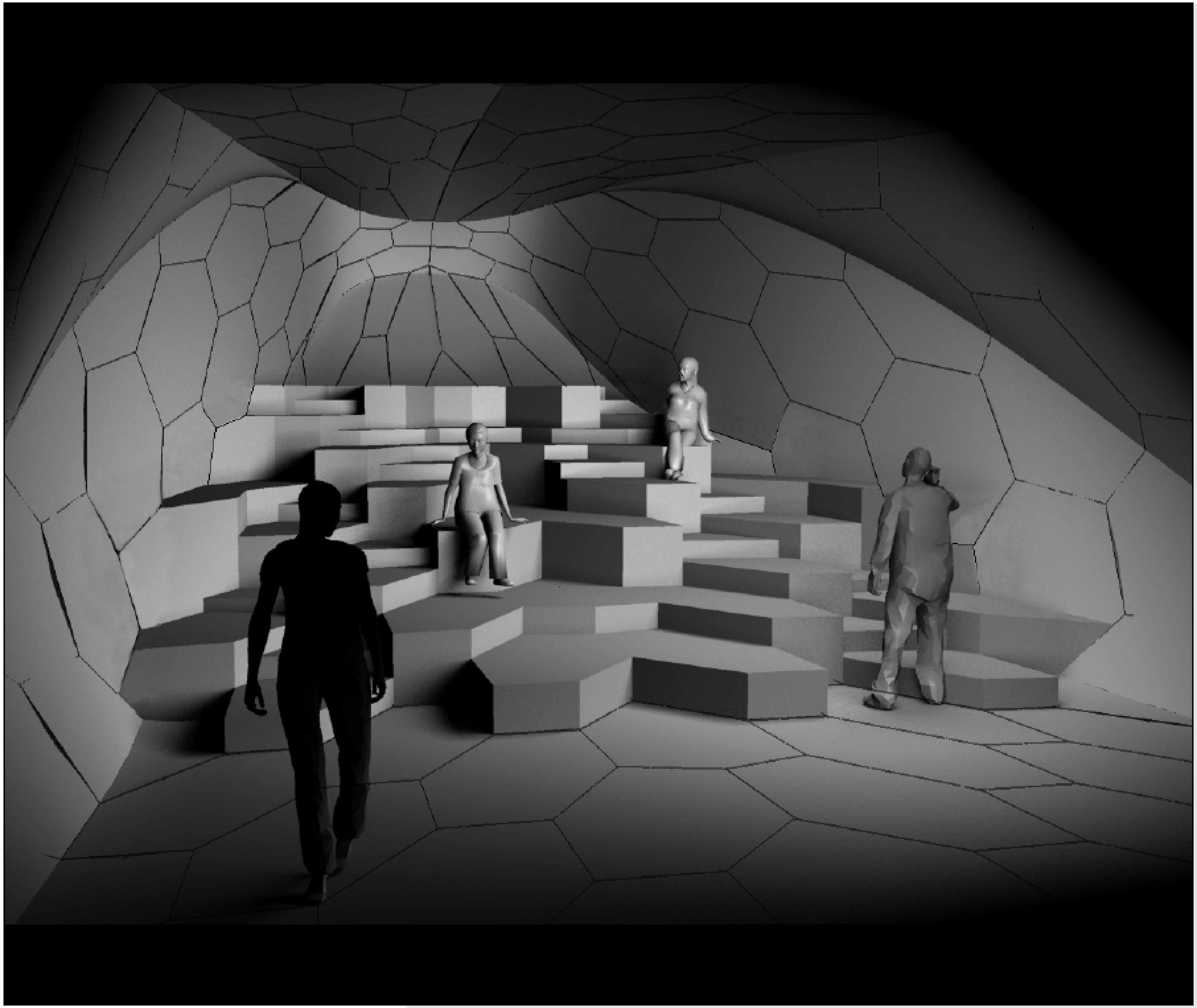


Figure 1-11. This render shows the staircase design created by different sizes of components.

1.10. Lecture Staircase design

In order to form a cascading stairwell on the sloping part of the building, the lecture seating are create by altering the thickness of each components perpendicular to the horizontal floor plan. This proposal was not particularly favorable due to the fact that it is not aesthetically matching with the internal double curved surface and might potentially create structural problems. Further development of the staircase should be carried out together with the stylist and structural specialist as a interdiscipary design process

1. Bodycheck 06

Interaction Design

Furnitures

Jonas PS Sin 1535102

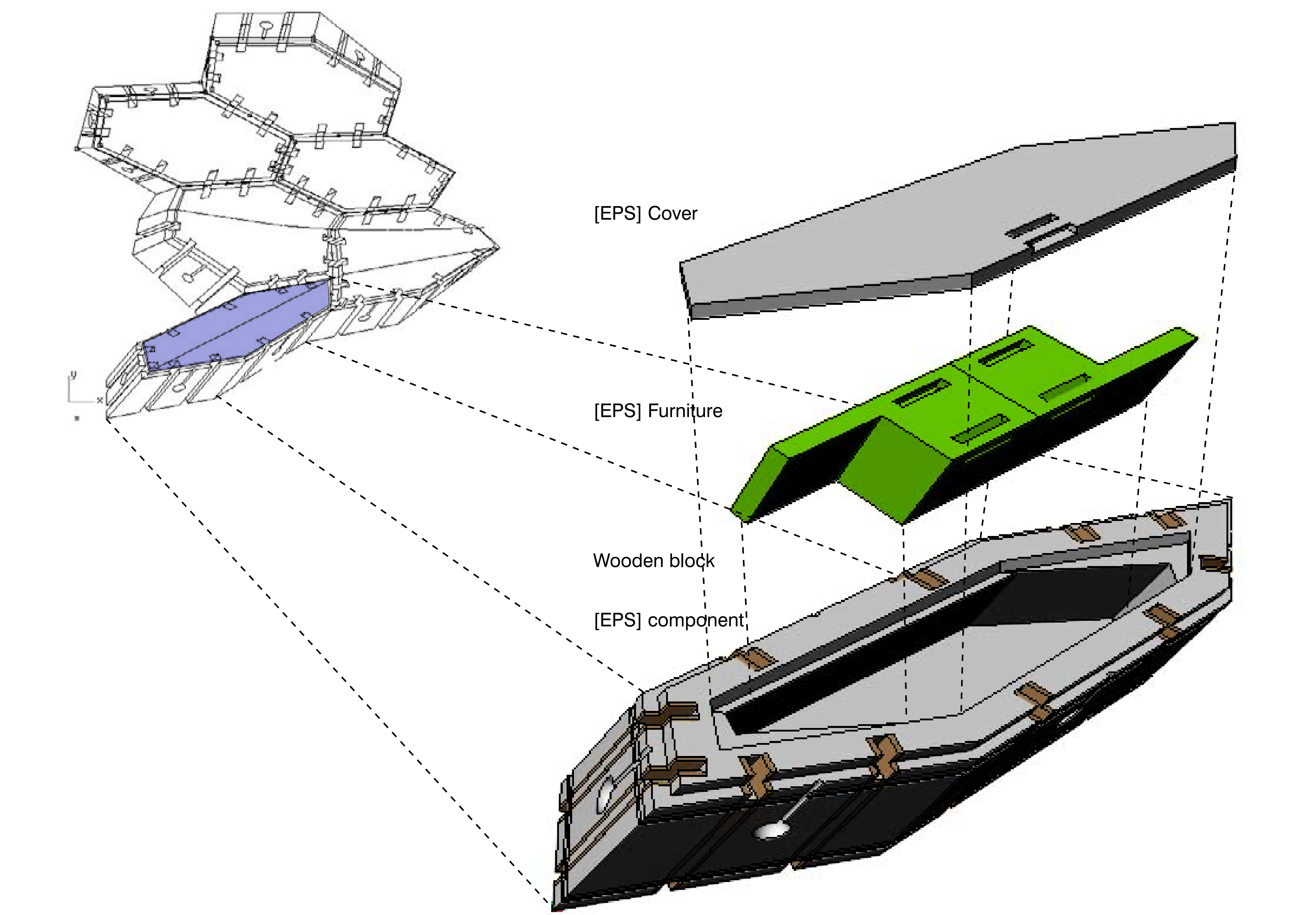


Figure 1-12. The render shows the axometric view of the furniture component.

1.11. File to factory component

At the end of the project, we have selected 6 components to fabricate as a prototype. The furniture design was one of the component to be included to the prototype. The entire component will bemade out of EPS material and fabricate in Havadi using 5 axis milling machine. The connection between each component is joint together using clip both outside and inside of the structure. There are 4 separate pieces that required to be milled; the EPS cover, the EPS Furniture, the wooden block for connection and the main EPS hexagonal component.

1. Bodycheck 06

Interaction Design

Furnitures

Jonas PS Sin 1535102

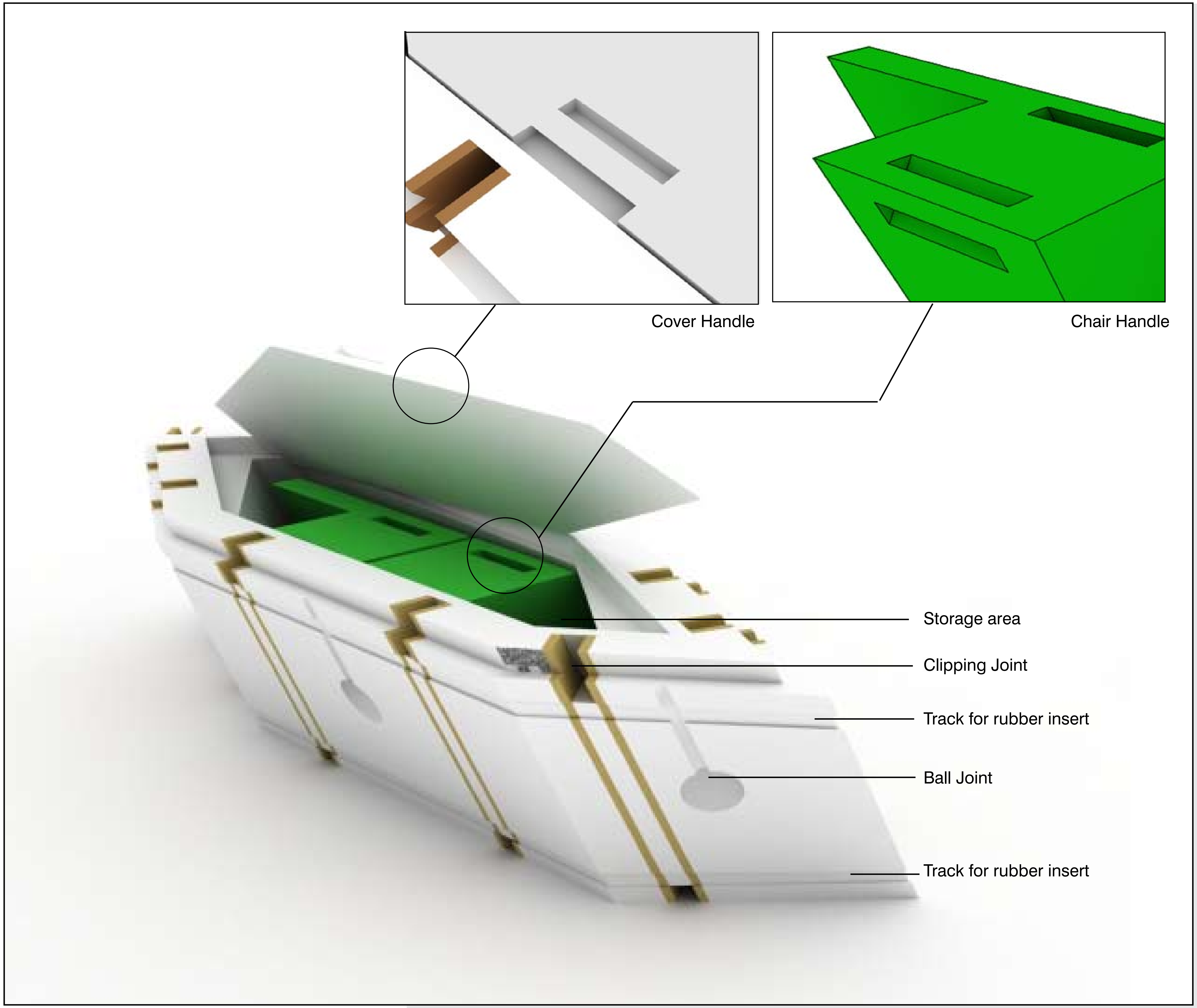


Figure 1-13. This render shows the final 3D modelled milling file for fabrication.

1.12. Component 6 - Furniture
Every small detail of the furniture is designed to integrate within the EPS, such as the handle for the chair and cover, therefore reduce the time for further manufacturing process. Moreover, the final component consists of the track for rubber insulation to prevent water leadage, the detail of the connection (the hole for the ball joint and wooden plate), the depression for the furnitures, the cover for the depression.

1. Bodycheck 06

Interaction Design

Interior Panels and Cable track covers

Urvi Sheth 1531174

1.13. Material options for the Panels

There are four options worked out in order to support different ambience. This could be more and the fixing detail of all these panels remain same so that they can be changed OR updated.

1.3.a. Paper pulp based computing:
The proposal is made to make the panels extremely light in weight. This is done by making these panels by one self as per the desire. Cables, micro chips, LED lights, etc can be used as inclusions while making the “Paper Panel” from the pulp. On one hand it a fixed arrangement because of the inclusions. On the other hand it is flexible as one can make it the way he/she wants and does not depend on any manufacturing or Company specifications.

1.3.b. Fabric woven with conducting threads:
This is a revolution in Fashion industry. Conductive threads are made with high safety that they could be used to wear. These are also used to make clothes for children.
Inspired from fashion, the such fabric could be used for creating ambience. One can again stitch micro chips, LED lights, arduino, etc.
Again these panels are light in weight and easy to fix. Fixing is as simple as using Velcro or press buttons same as used for garments.

1.3.c. Plexiglas with dot technology (binary system):
Plexiglas panels with do technology is a sandwich panel with a layer of dots in the center and a LED light strip on one side of the panel. The calculation of the density of dots for particular graphic is based on the binary system.
The is also possibility to use the foil over these panels to make it work for projection and touch sensitive.
This option is finally not possible for the project as it has to deal with the double curved surfaces. Cost of making double curved Plexiglas panel is too high. Again it is a fixed system.

1.3.d. E-paper and digital panels:
E-paper or e-ink display is a display technology designed to mimic the appearance of ordinary ink on paper . This is projected for the future.

ADAPTIVE SYSTEM WITH CHANGING SKIN

1. Bodycheck 06

Interaction Design

Interior Panels and Cable track covers

Urvi Sheth 1531174

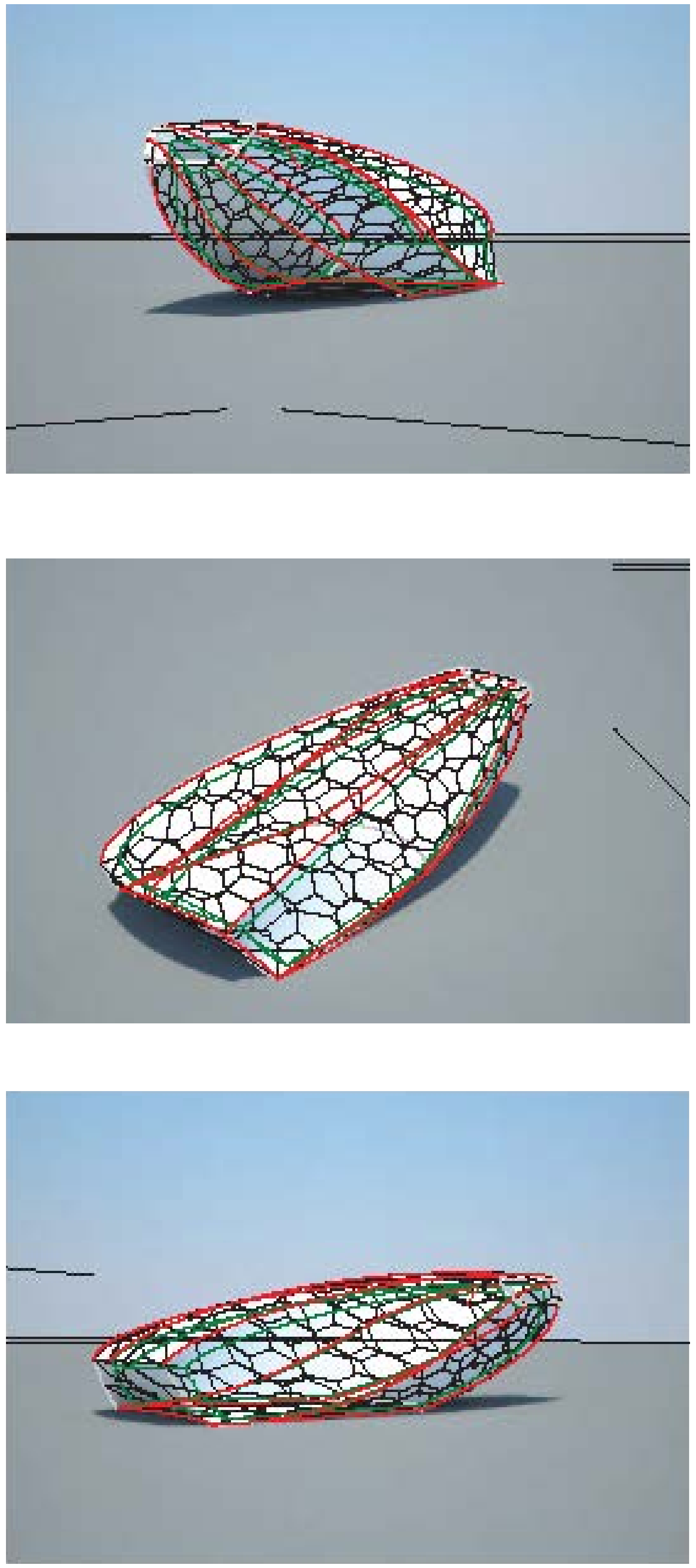


Figure 1-15. Diagram shows perforation for interactivity on exterior surface for the inputs to place camera/sensors/etc.

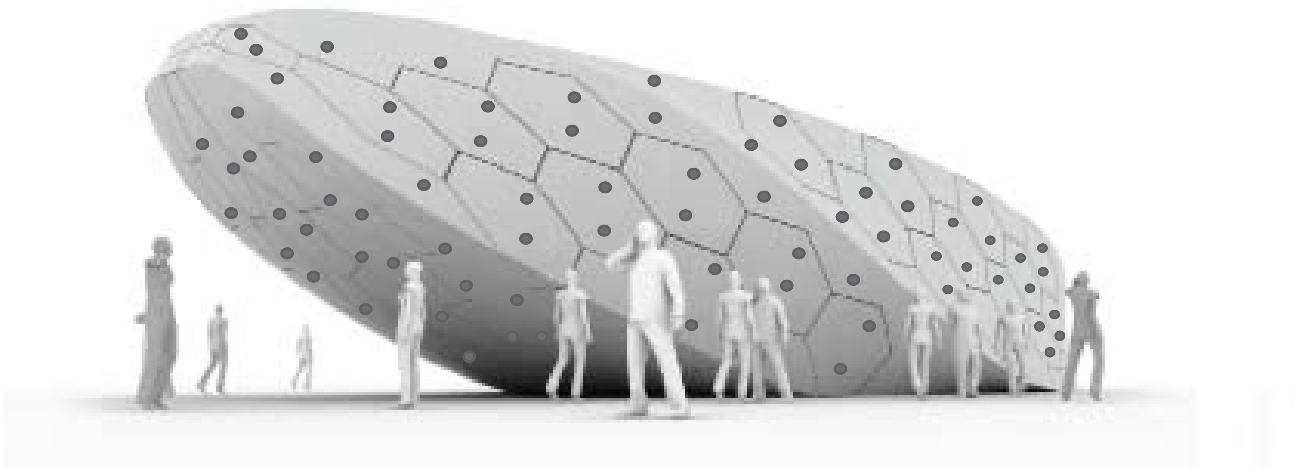


Figure 1-16. Diagram shows perforation for interactivity on exterior surface for the output to place DOTZ which create the pixels as graphis and information.

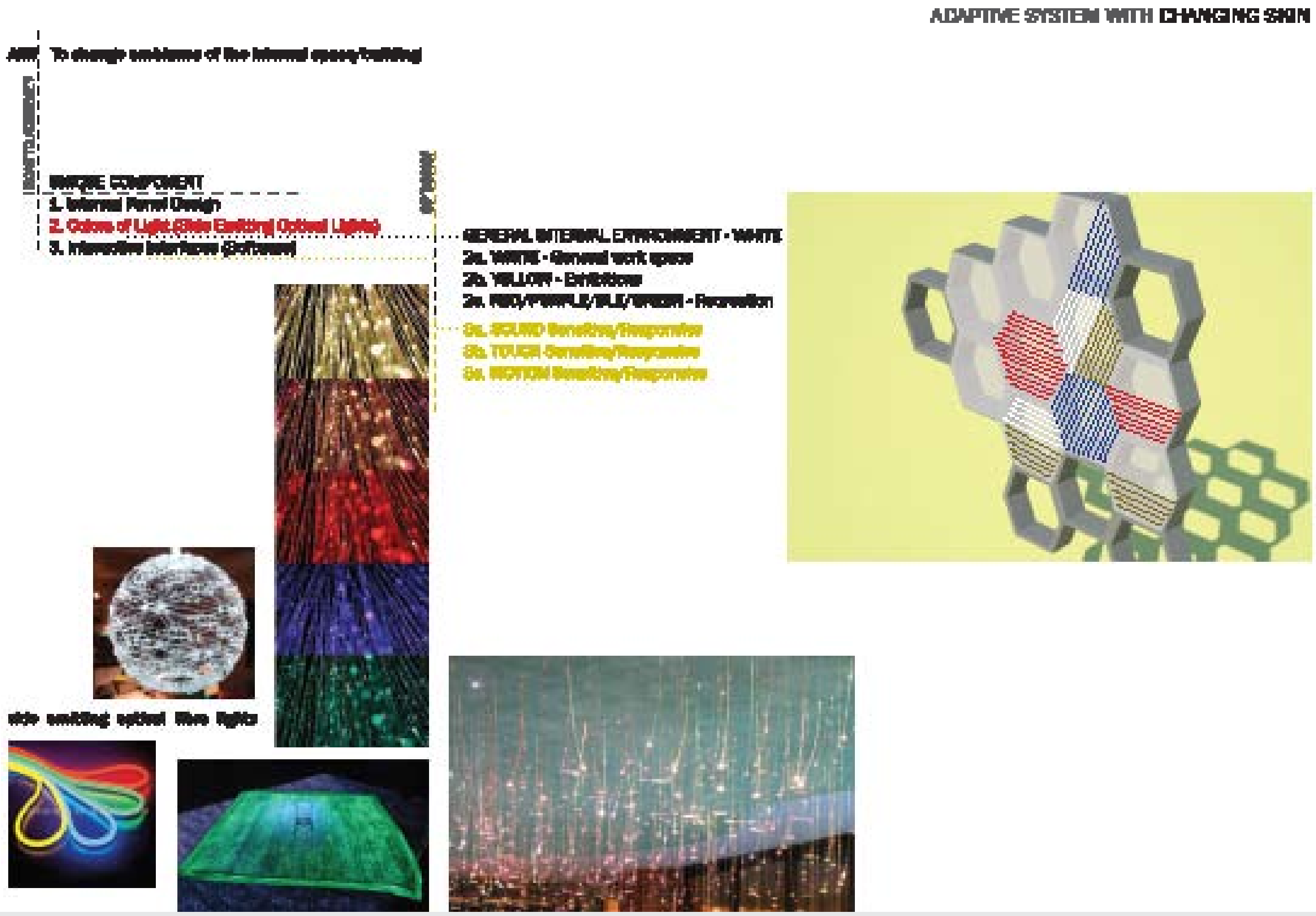


Figure 1-14. Proposal to show the effect of colors and light for the interior as well as exterior surfaces

1.14. Material options for the Panels

There are four options worked out in order to support different ambience. This could be more and the fixing detail of all these panels remain same so that they can be changed OR updated.

1.3.a. Paper pulp based computing:
The proposal is made to make the panels extremely light in weight. This is done by making these panels by one self as per the desire. Cables, micro chips, LED lights, etc can be used as inclusions while making the "Paper Panel" from the pulp. On one hand it a fixed arrangement because of the inclusions. On the other hand it is flexible as one can make it the way he/she wants and does not depend on any manufacturing or Company specifications.

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This is a revolution in Fashion industry. Conductive threads are made with high safety that they could be used to wear. These are also used to make clothes for children.
Inspired from fashion, the such fabric could be used for creating ambience. One can again stitch micro chips, LED lights, arduino, etc.
Again these panels are light in weight and easy to fix. Fixing is as simple as using Velcro or press buttons same as used for garments.

1.3.c. Plexiglas with dot technology (binary system):
Plexiglas panels with do technology is a sandwich panel with a layer of dots in the center and a LED light strip on one side of the panel. The calculation of the density of dots for particular graphic is based on the binary system.
The is also possibility to use the foil over these panels to make it work for projection and touch sensitive.
This option is finally not possible for the project as it has to deal with the double curved surfaces. Cost of making double curved Plexiglas panel is too high. Again it is a fixed system.

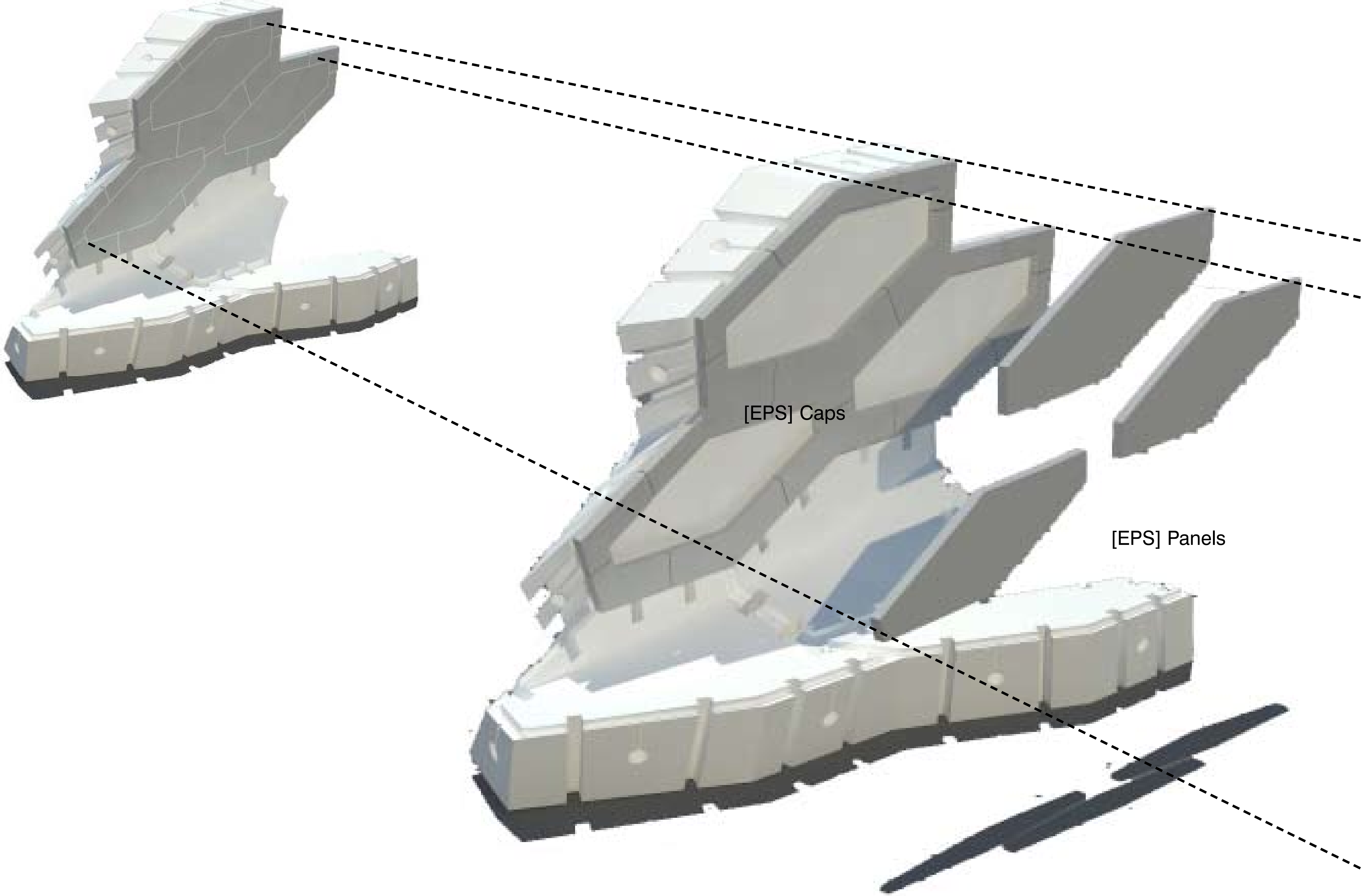
1.3.d. E-paper and digital panels:
E-paper or e-ink display is a display technology designed to mimic the appearance of ordinary ink on paper . This is projected for the future.

1. Bodycheck 06

Interaction Design

Interior Panels and Cable track covers

Urvi Sheth 1531174



1.15. File to factory component

At the end of the project, we have selected component number 3 and Panels for interiors as well as cable track covers to fabricate as a prototype. The furniture design was one of the component to be included to the prototype. The entire component will bemade out of EPS material and fabricate in Havadi using 5 axis milling machine. The connection between each component is joint together using clip both outside and inside of the structure. Theexplode view on the right shows 3 panels and cable cps betwween them to be milled as idividual pieces. They are in turn connected to respective component using Velcro (high quality).

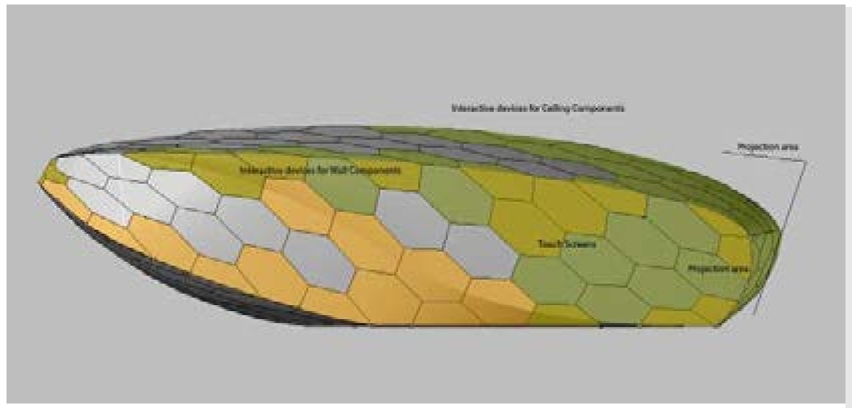
Figure 1-17. Prototype detail for Panels for the interior and covers for cable tracks

1. Bodycheck 06

Interaction Design

Interior Panels and Cable track covers

Urvi Sheth 1531174



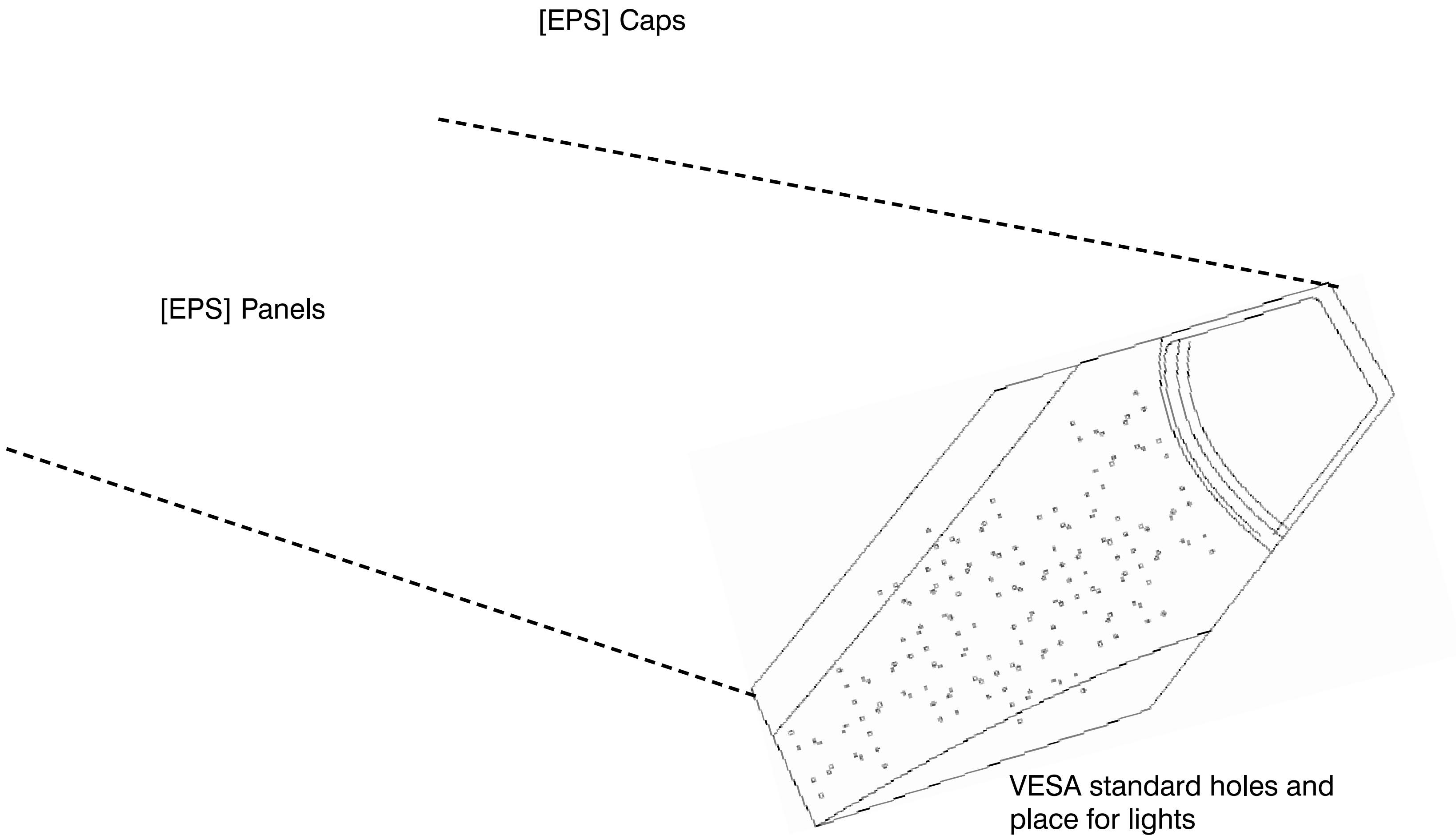


Figure 1-18. Prototype detail for Panels for the interior and covers for cable tracks

1.16. File to factory component

At the end of the project, we have selected component number 3 and Panels for interiors as well as cable track covers to fabricate as a prototype. The furniture design was one of the component to be included to the prototype. The entire component will bemade out of EPS material and fabricate in Havadi using 5 axis milling machine. The connection between each component is joint together using clip both outside and inside of the structure. Theexplode view on the right shows 3 panels and cable cps betwween them to be milled as idividual pieces. They are in turn connected to respective component using Velcro (high quality).

1. Bodycheck 06

Interaction Design

Devices

Vissarion Naoum 1535196

Figure 1-19. The final screen as device has been choosen.

LCD WALL MOUNT

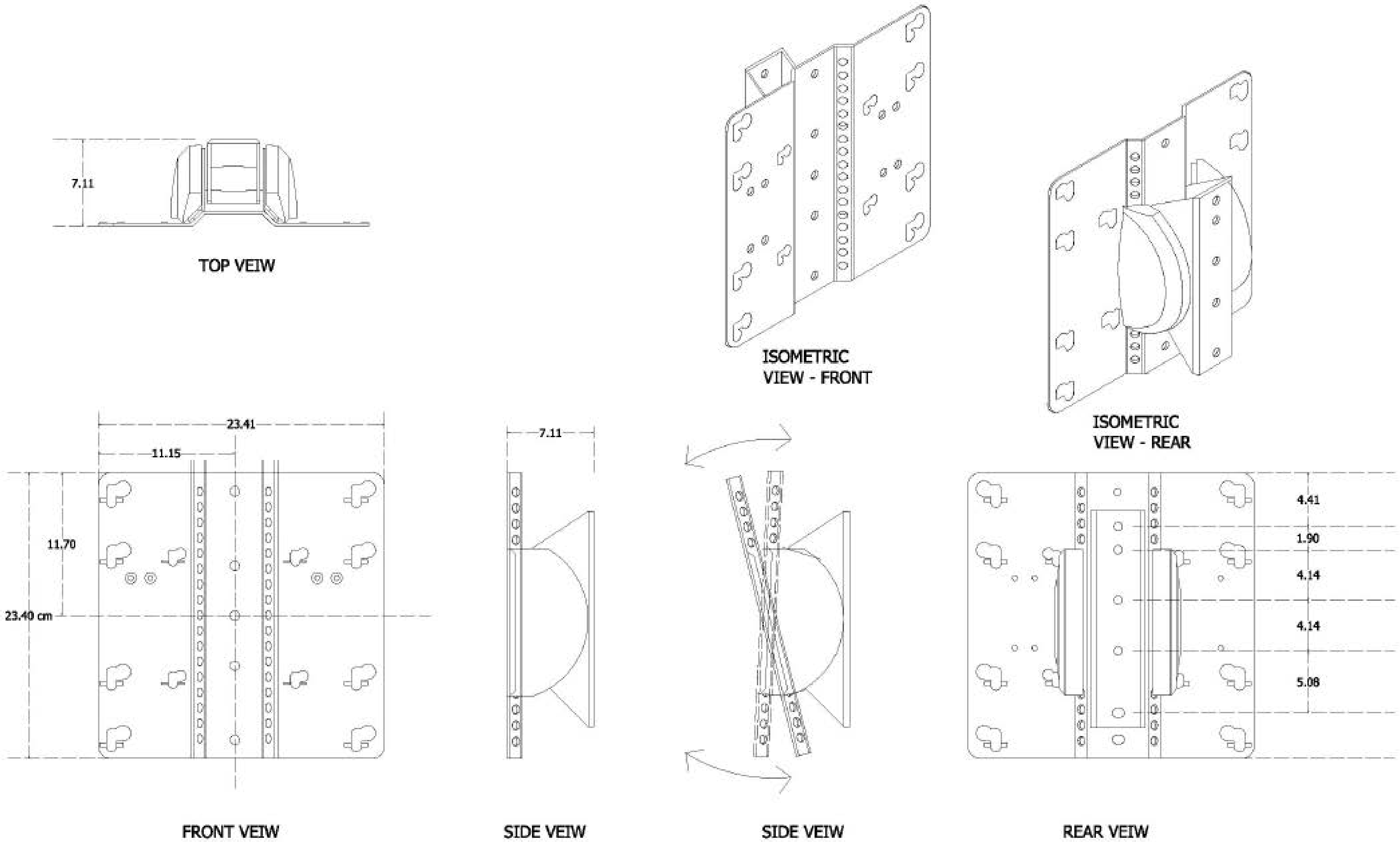


Figure 1-20. The final choisce as mount. Here we can see the details of the Screen Mount - from Vantage Point

1. Bodycheck 06

Interaction Design

Devices

Vissarion Naoum 1535196

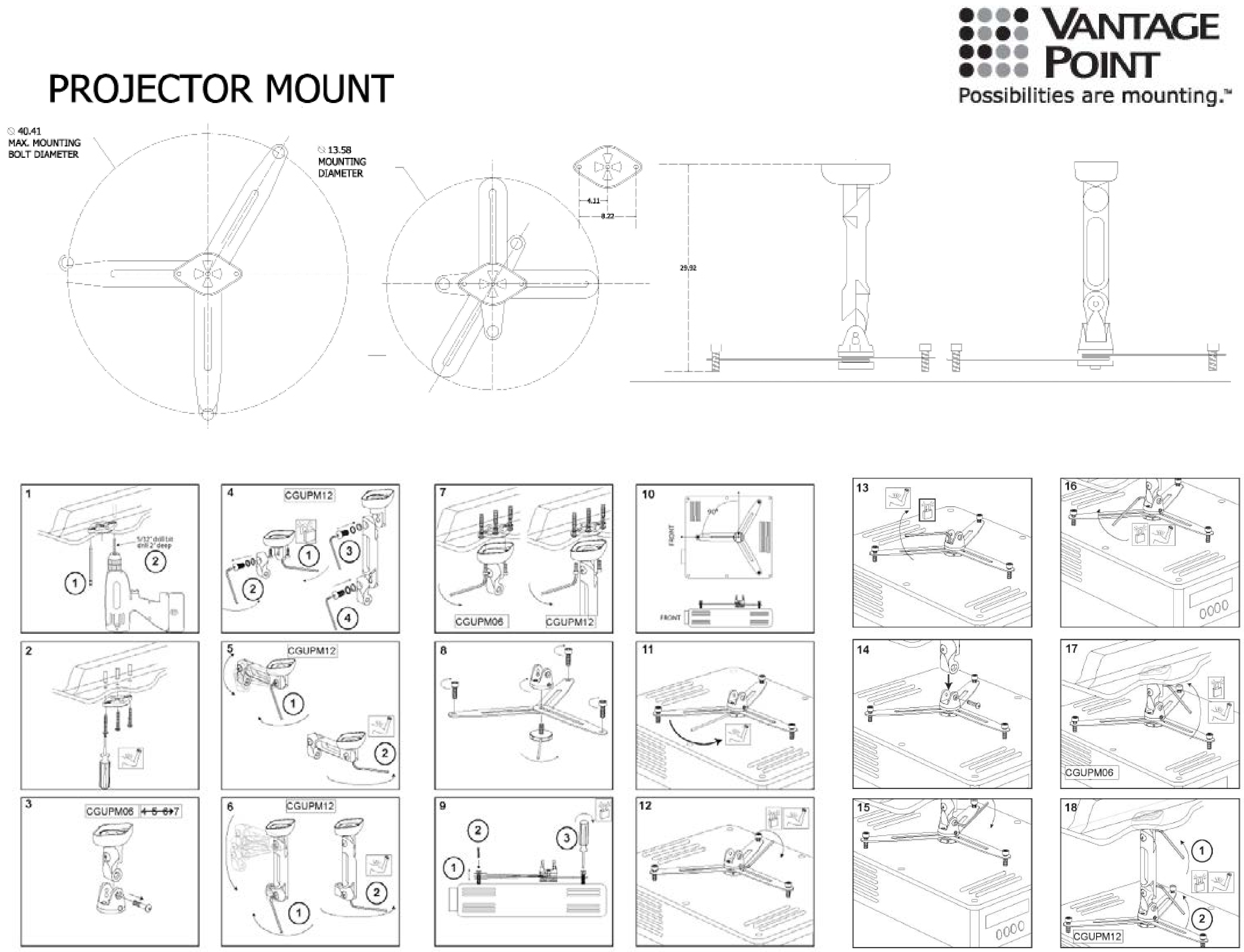


Figure 1-21. The final choice as mount. Here we can see the details of the Projector Mount - from Vantage Point

1. Bodycheck 06

Interaction Design

Devices

Urvi Sheth 1531174

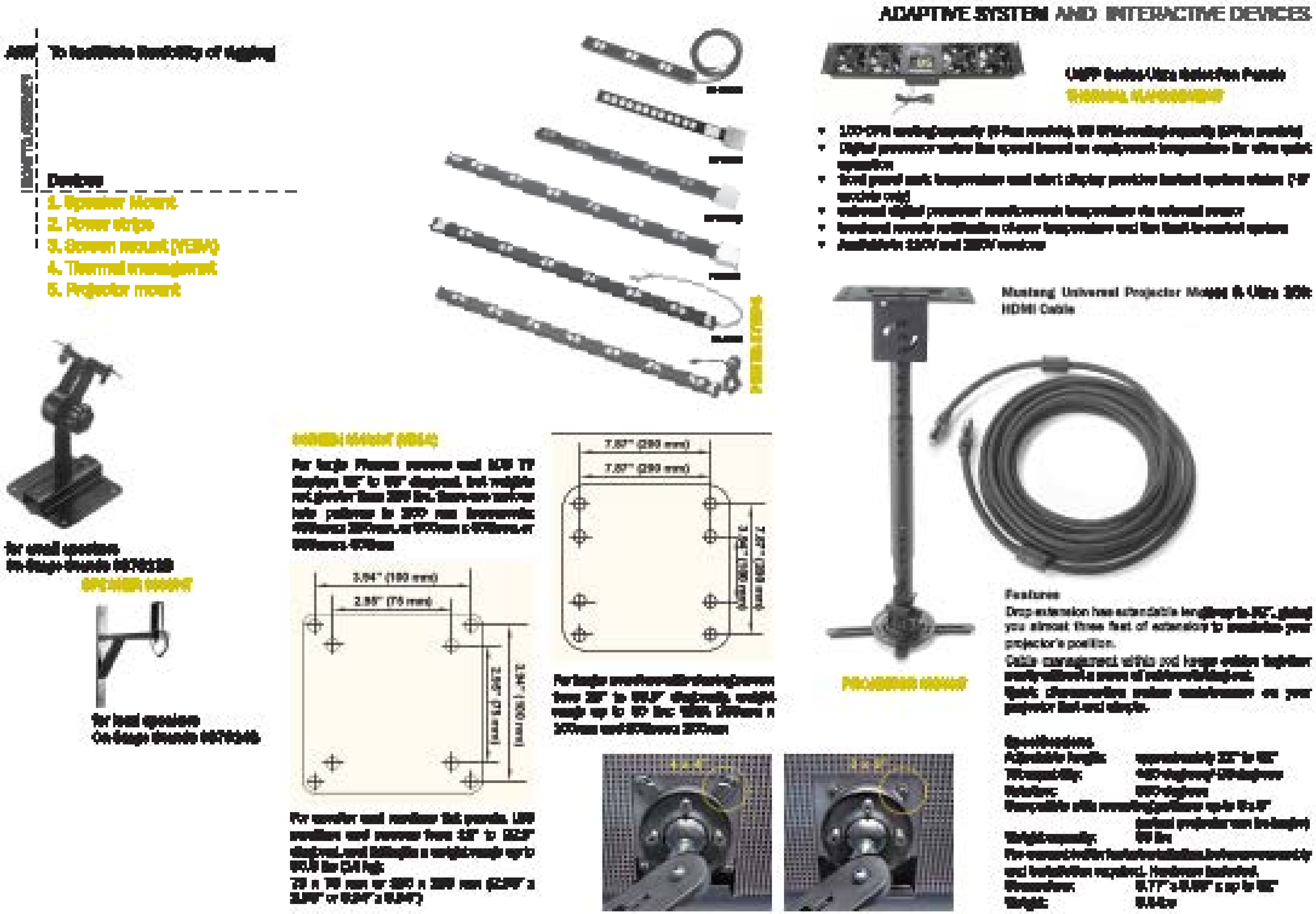


Figure 1-22. The diagram gives and idea of different interactive devices needed for the building

1. Bodycheck 6
MEP
Heating System

Marco Cimenti
1376853

1.1. About electrical under-floor heating system.
The electrical heating system is the final proposal we have to warm-up the pavilion. Water-based systems are somehow hard to fit together with component logic we have in the design. Many problems (water-leakage first) can rise with a system that is supposed to be assembled and disassembled. Moreover, a water-based system is winning in terms of performances when we design a building that has to stand for long time and which has to be used daily. Instead, our case is quite opposed; we were aiming a heating system able to warm-up fast the inner environment, which was not supposed to work every day of the winter at a high level. These considerations have brought us to look at electrical underfloor heating systems. These are winning for their good ratio of produced watts per square meters, thus they do not require a big surface in the pavilion (just around 10 mq). Usually they can be found with heating power between 150 W/mq to 210 W/mq in the form of mats or wires. The installation of this mats / wires is quite easy and they can be applied onto different component and make them like independent heat cells within the component. We established contacts with different companies, first of all we got connection with warmup.com, asking them if it was possible to integrate the heating mats into a thick layer of epoxy with fiber glass as well; their replay was negative, they have already reported in their experience problems with cracking of resins such us epoxy due to fast change of temperature. For this reason we started to research about synthetic materials able to resist high temperature differences and we ended by contacting Bolidt.com a Dutch chemical company, with an enormous experience for continuous flooring materials. With them we had a personal talk and they partially met our requests. They have products that can be integrated with heating systems, and which can resist strong temperature differences; however they asked to have a sample of the material that we are going to use to lay on the heating system, in order to make trials and to get results on the compatibility between their material and our material (eps or polyurea). Bolidt also provided a contact of a Dutch manufacturer of electrical underfloor heating systems (Jowitherm.nl), on which Bolidt usually relay on for their works.

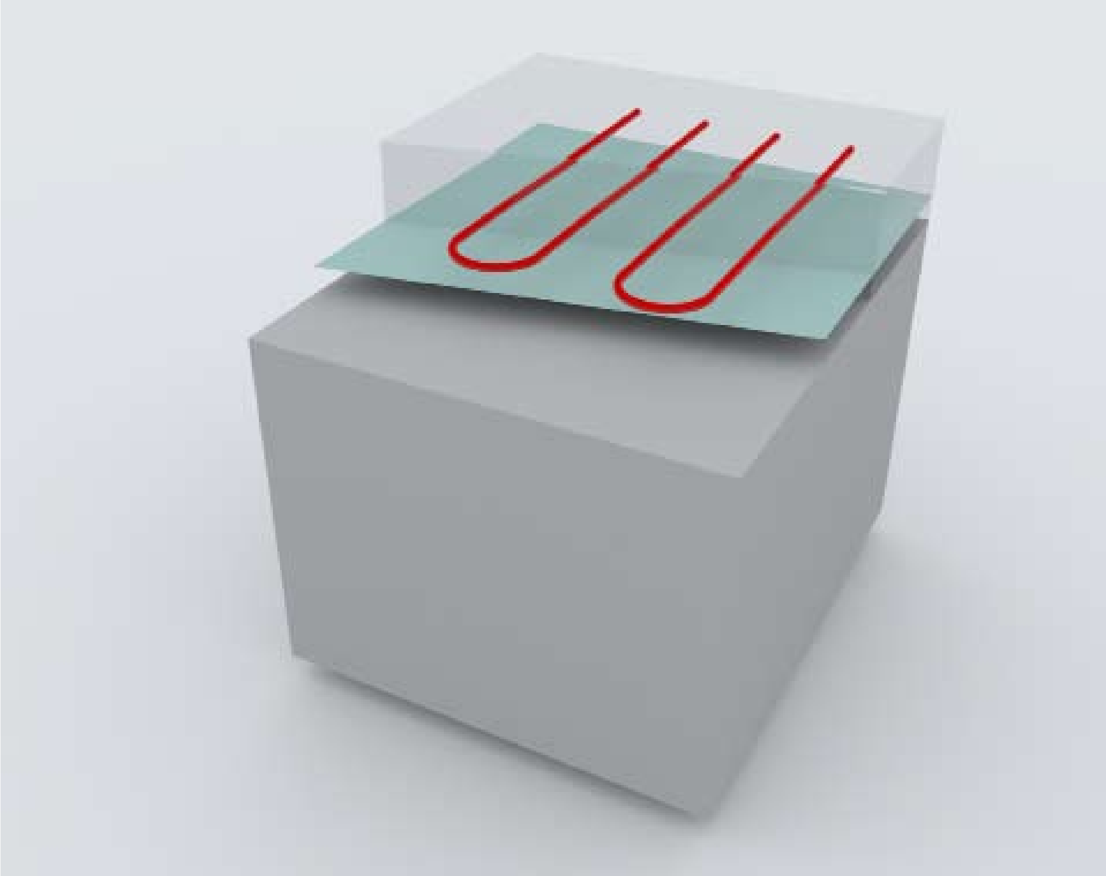


Figure 1-4. Render of the heating system embedded into a thick stratus of epoxy resin, under the electrical cables there is the fiber glass fabric. All this placed on the EPS.

Figure 1-3. Sample of under floor heating system provided by Bolidt.

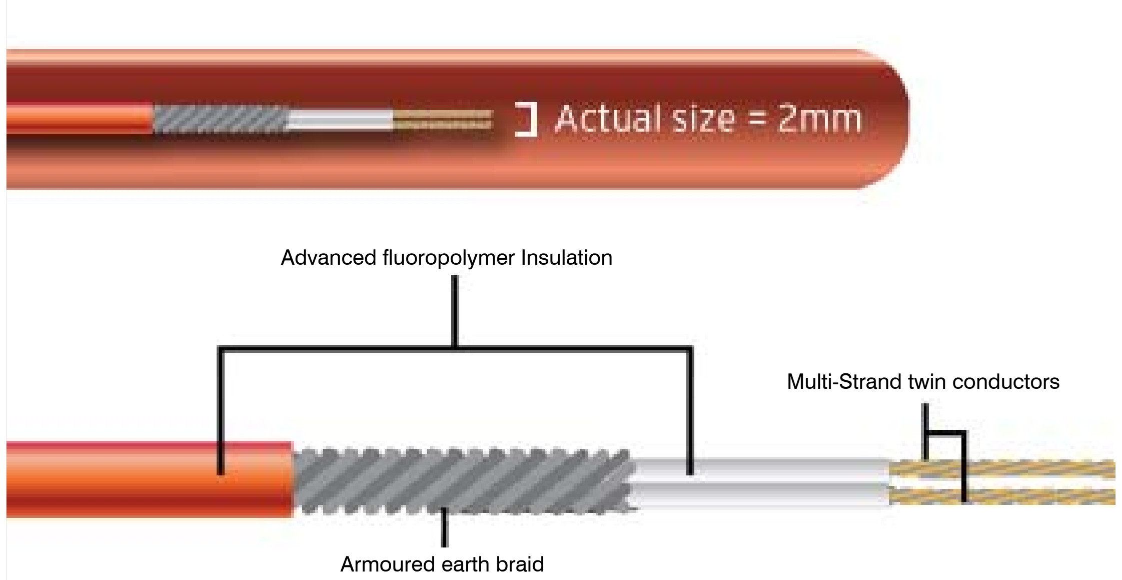


Figure 1-2. Heating cable.

Figure 1-1. Different kind of products: wires, mats and carbon fiber mats.

Bodycheck 6
MEP
Rhinoceros limits.

Marco Cimenti, Erwin van Osch, Harikrishnan Sasidharan
1376853, 1257757, 1541994

1.1 During the design process we have explored the possibilities of Rhino as modeling software. We pushed to the boundaries this software and we have tested its limits. Rhinoceros is of course one of the easiest to use 3D modeler software, but at the same time it is complete and does have a good upgradeability with plug-ins and the scripting. However, it has demonstrated the high level of approximation it owns; this is a limit for all the users that need high levels of precisions within their 3D models.
Commands such us ‘patch’ are heavily approximating to the curves from which the patch has been generated. This happens especially when using double curved curves and it means that the generate surface won’t respect the curves from which has been generated. This is a fundamental problem, which creates many difficulties when the edges of the ‘patch-surface’ have to be joined with other surfaces’ edges. We have struggled to re-model the surfaces in order to diminish the approximation and to be able to join the surfaces. A lost of time in the work process is always bringing bad consequences, thus by using Rhino, every user have to be really careful when modeling. We often do not care too much and we do not zoom in enough to check if there are small gaps in the structure we are modeling. By checking often the model and increasing a bit in time the modeling phase, some bad surprises can be avoided at the end of the work, when the user has to send the file to milling or 3D printing processes.
Some other commands are often imprecise and we refer to ‘trim’ and ‘split’. When trimming different 3d objects, instead of having two edges from the two solids, it is often possible to obtain more small edges from the trimming of the solids. Even if these small edges are not visible at a first sight, by zooming carefully you will probably be able to see them. These small edges are a huge problems when you will have to join for example three different surfaces and two (or one) of these surfaces won’t be composed by the small left edge. In this case, the geometry won’t close and join properly and a small gap will persist.
The suggestion for the future is to use more precise software, which are already embedding the main features for the parametric design and in which there is not much approximation, but more absolute values.

Figure 1-8. Openedges, even if generated from the same curves a gap has been formed.

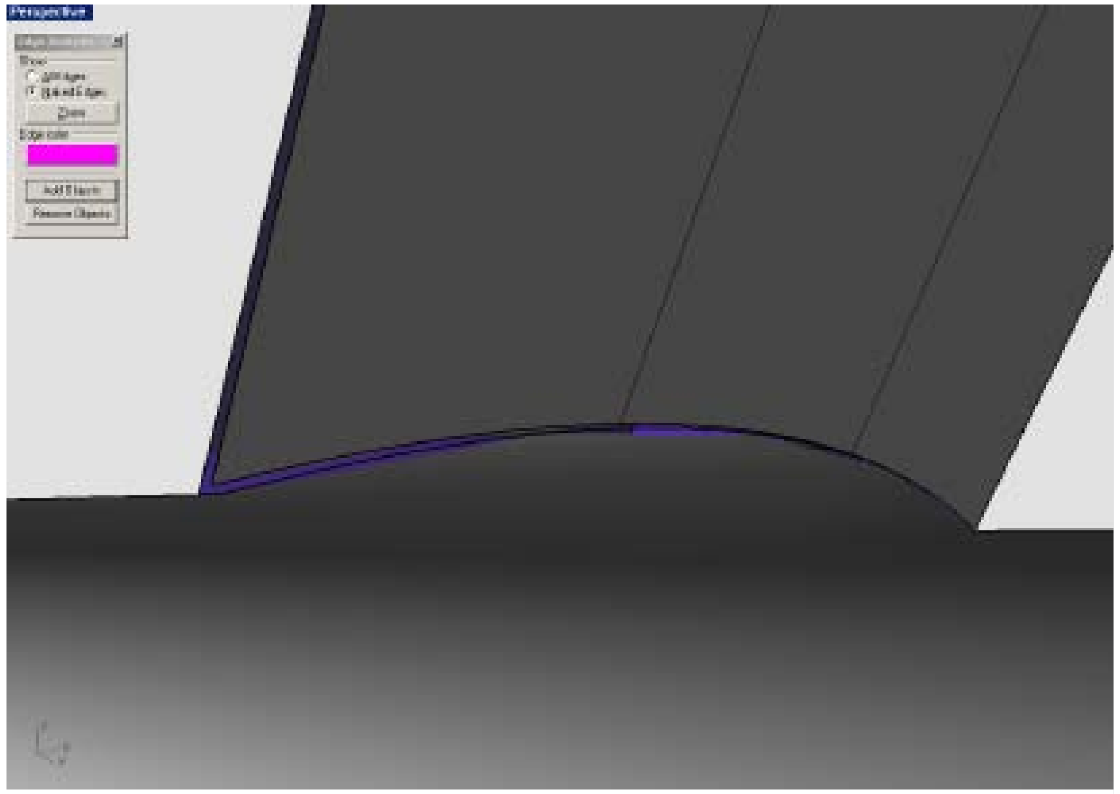


Figure 1-7. In this figure you can see the difference between the three surfaces, this is happend because when one of the surfaces has been created, a small edge was not selected. The edge is quite small, so it is not visible when operating without zooming carefully.

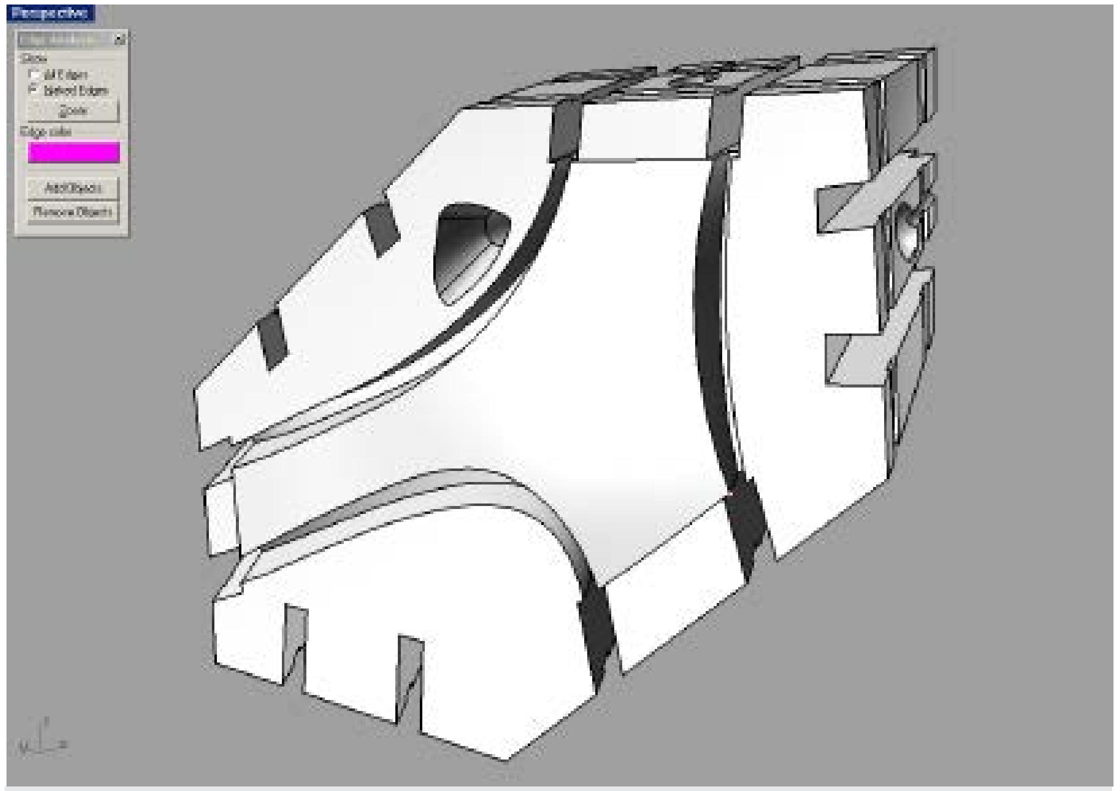


Figure 1-6. Component number 3, after re-modelling many times all the surfaces, a small gap (naked point) is still present.

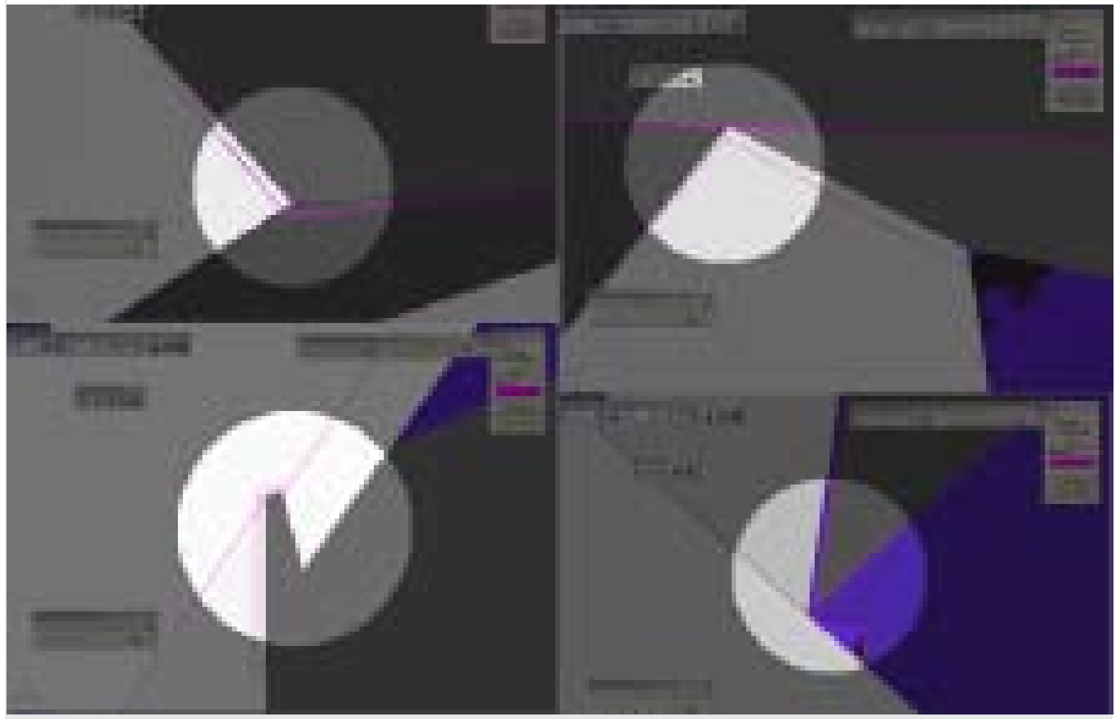


Figure 1-5. Some other Rhinoceros mistakes of approximation.

Bodycheck 6
MEP
Positioning

Marco Cimenti, Erwin van Osch, Harikrishnan Sasidharan
1376853, 1257757, 1541994

From the beginning we planned to do natural ventilation through the entire building, requiring openings and the front bottom (to let air in) and at the back (to let the air out). Due to the heating up the air will rise and flow out of the building, sucking in new, clean air. The components on the backside will also contain windows. This way there is no interference with the interaction setup but still natural daylight entry. Because structure requires a lot of closed components we are unable to house enough heat exchangers. combining them (more in one component) can be an option as long as the fans are more than 500mm apart (to prevent short circuit-ing of air).

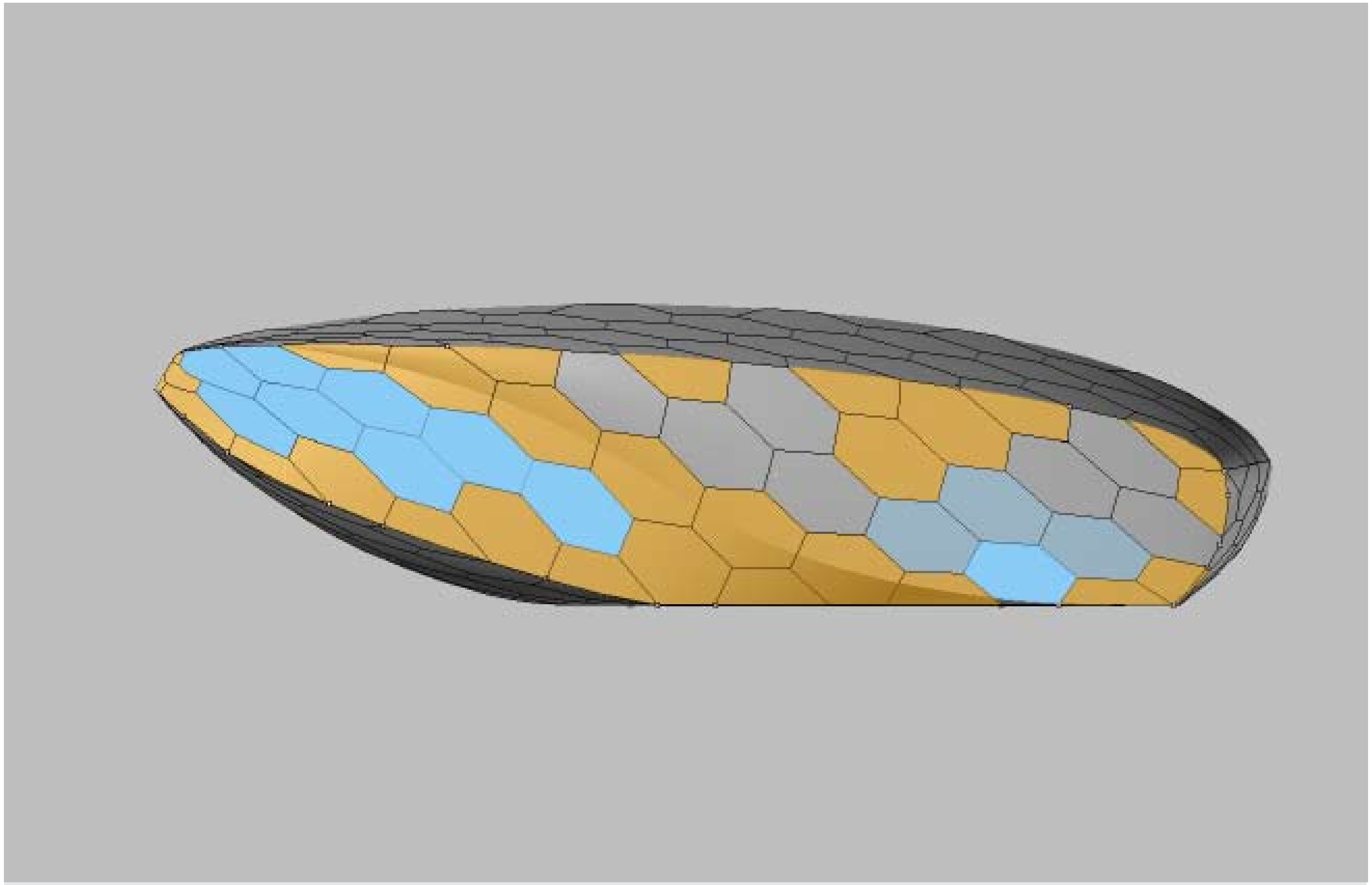


Figure 1-1. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Bodycheck 6
MEP
Parametric Excel

Marco Cimenti, Erwin van Osch, Harikrishnan Sasidharan
1376853, 1257757, 1541994

Because the variables of all our calculations where constantly changing we made the hole model parametric. Now if the floor area changes we don't have to do all the calculations again.
The model takes into account thermal transmission, ventilation, heat production and occupation. It will return the amount of devices needed, heat loads and time of the year it exceeds the maximum temperature. These values we got from weather data from the last 50 years. This gives us a clear sight of how much time of the year it gets to hot in the building.

We used various formulas:
- we calculated the heatloss through the skin
  overall_surface / heat_transmission
- we calculated the heatloss through the windows
  overall_surface / heat_transmission
- total heatloss
  skin_heatloss + window_heatloss
- ventilation required
  amount_people * 36
- ventilation per hour
  req_ventilation / overall_volume
- heatloss through ventilation
  req_ventilation x air_weight x Cp_air / 3,6
- amount of heatexchanger
  req_ventilation / avg_fiwihex
- people production
  amount_people * 126
- the air temperature over the last 50 years for every day

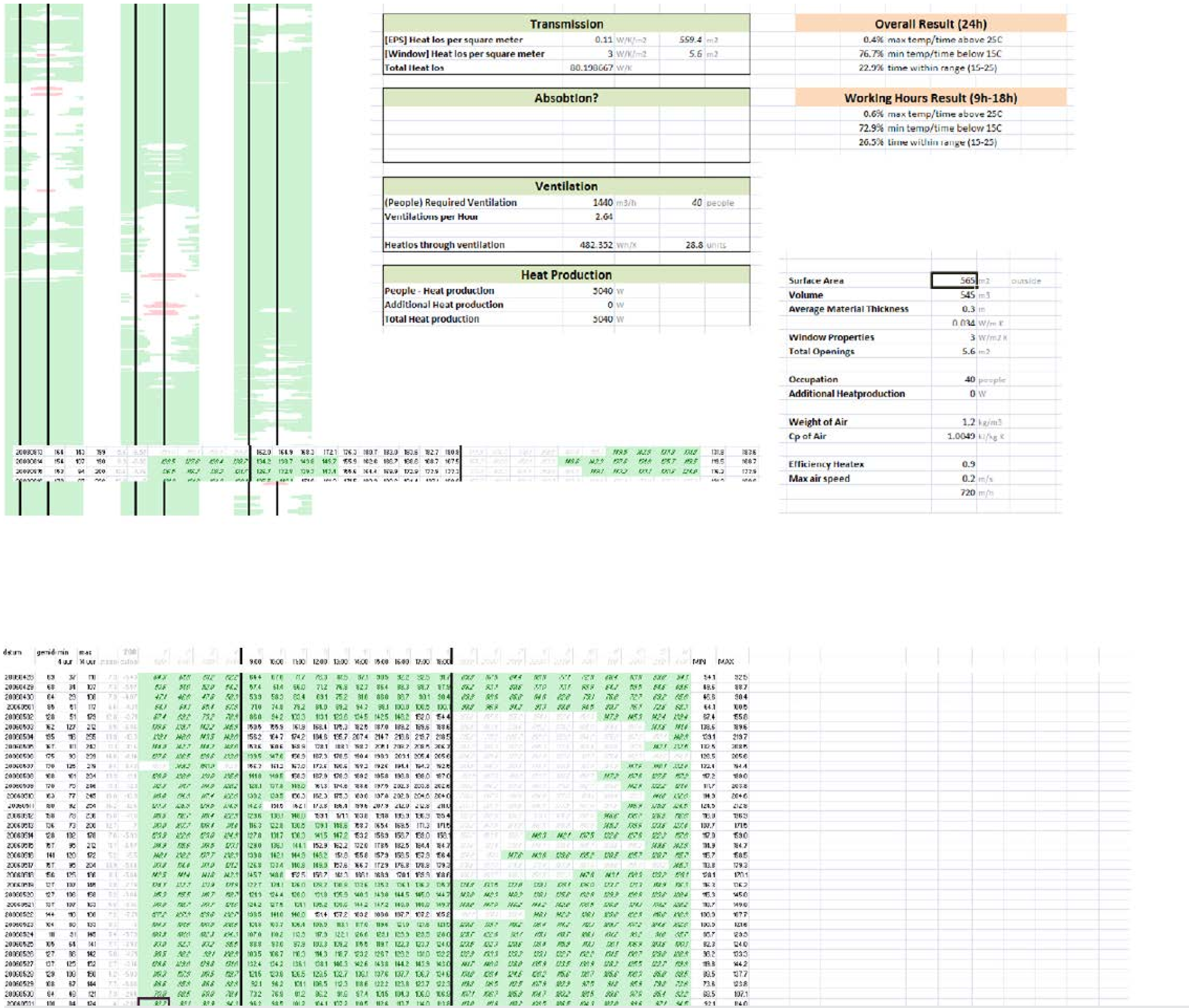


Figure 1-9. screenshots from the parametric model

1. Acoustics.

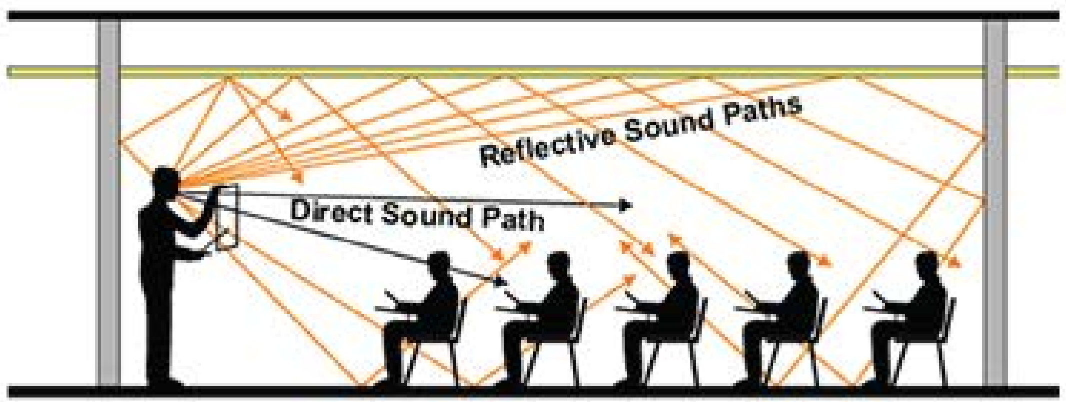
Marco Cimenti, Erwin van Osch, Harikrishnan Sasidharan
1376853, 1257757, 1541994

Acoustics plays an important part in maintaining the quality of a spatial volume.

REVERBERATION

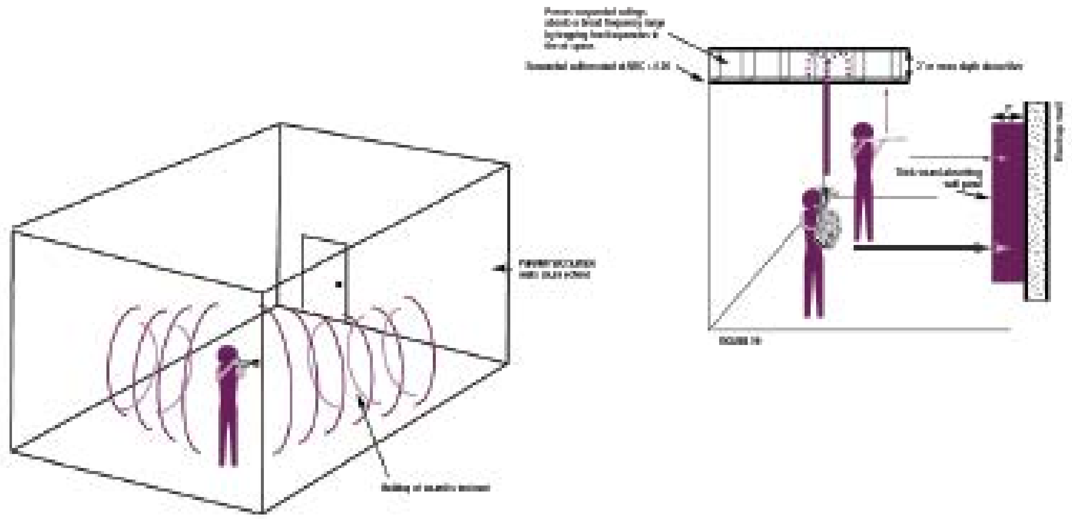
The time it takes for reflected sound to die down by 60 decibels from the cessation of the original sound signal (measured in seconds).

- Reflected sound tends to "build up" to a level louder than direct sound. Reflected sounds **MASK** direct sound.
- Late arriving reflections tend to **SMEAR** the direct sound signal.



http://www.acousticalsurfaces.com/acoustic_IOI/101_6.htm

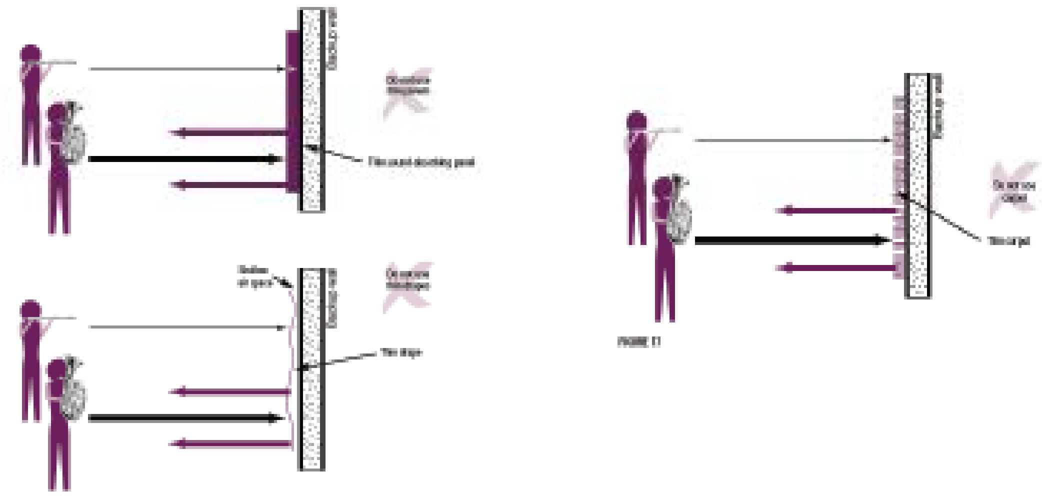
http://www.wengercorp.com/images/lit/lit/Acoustic%20Problems-Solutions.pdf



ACOUSTIC PROBLEMS

Acoustic shadows, regions in which some frequency regions of sound are attenuated, can be caused by diffraction effects as the sound wave passes around large pillars and corners or underneath a low balcony.

External noise can be a serious problem for halls in urban areas or near airports or highways. One technique often used for avoiding external noise is to construct the auditorium as a smaller room within a larger room



1.2. Acoustics

The quality of a space is heavily dependent on the behaviour of sound. The reverberation time should be in the acceptable limits of 25 and 33. The materials as well as the geometry of the pavillion plays a great role in the sound quality.

Another important point is the low frequency sound waves. For a light wight construction it is very difficult to cut out low frequency vibrations.

Although we would like to influence the shape by our (fresh) knowledge of accoustics we only knew the basic rules and could advice what not to do, but not what was the most optimal shape. Since this would require way more complex equations and we where adviced not to go to deep into this, since it very complex.

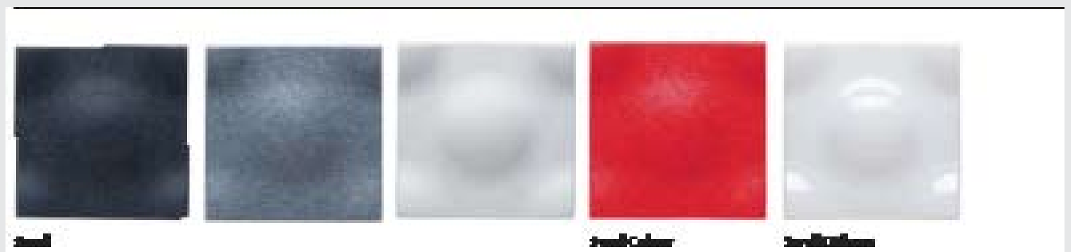


Figure 1-10 Graphs showing acoustic parameters for the pavillion design. nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

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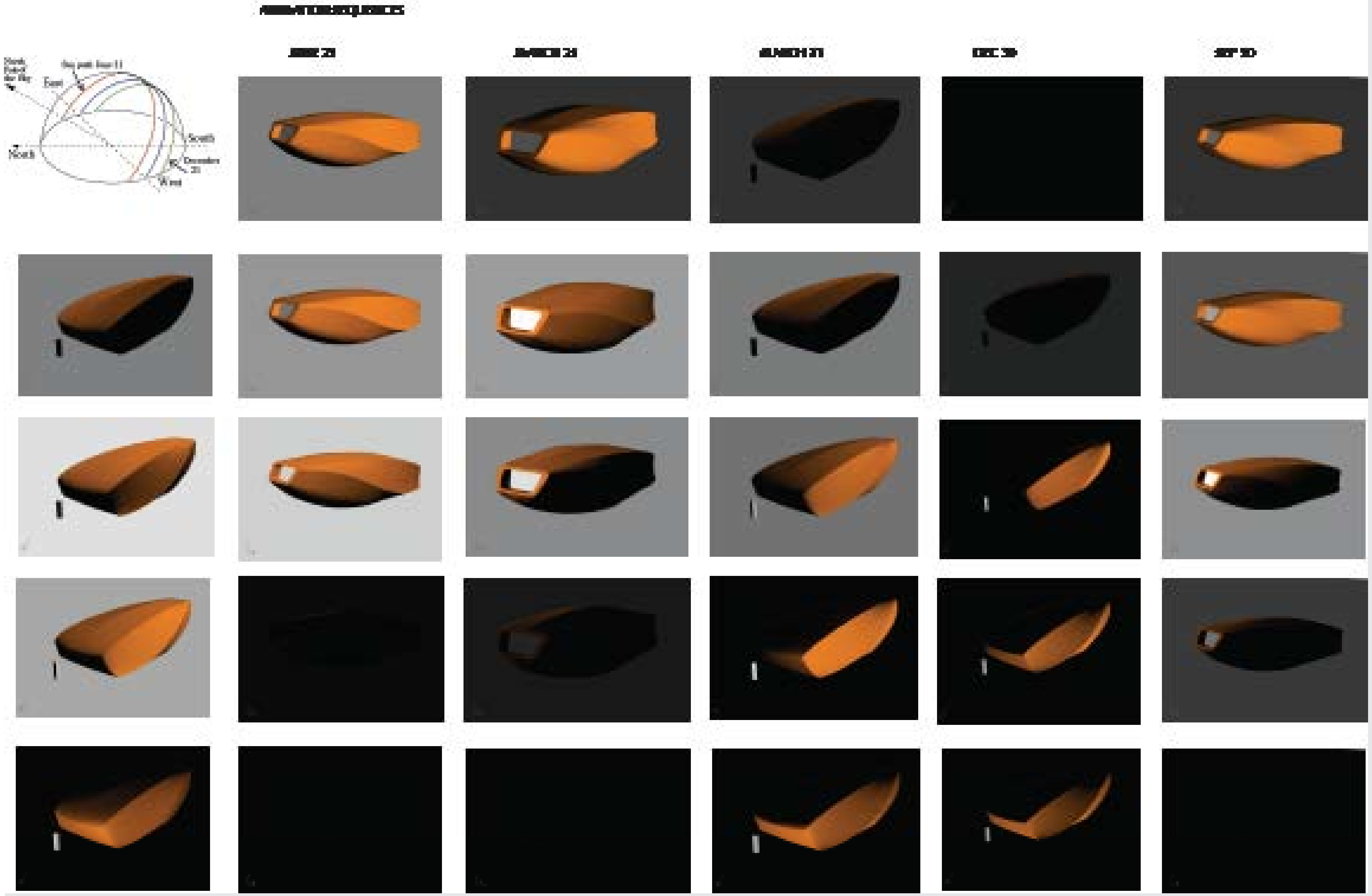
1376853, 1257757, 1541994



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1.3. Solar Analysis

The analysis of the sun is very important to the creation a performative space. It also placement of openings and the location of ventillation and heat exchanger components.

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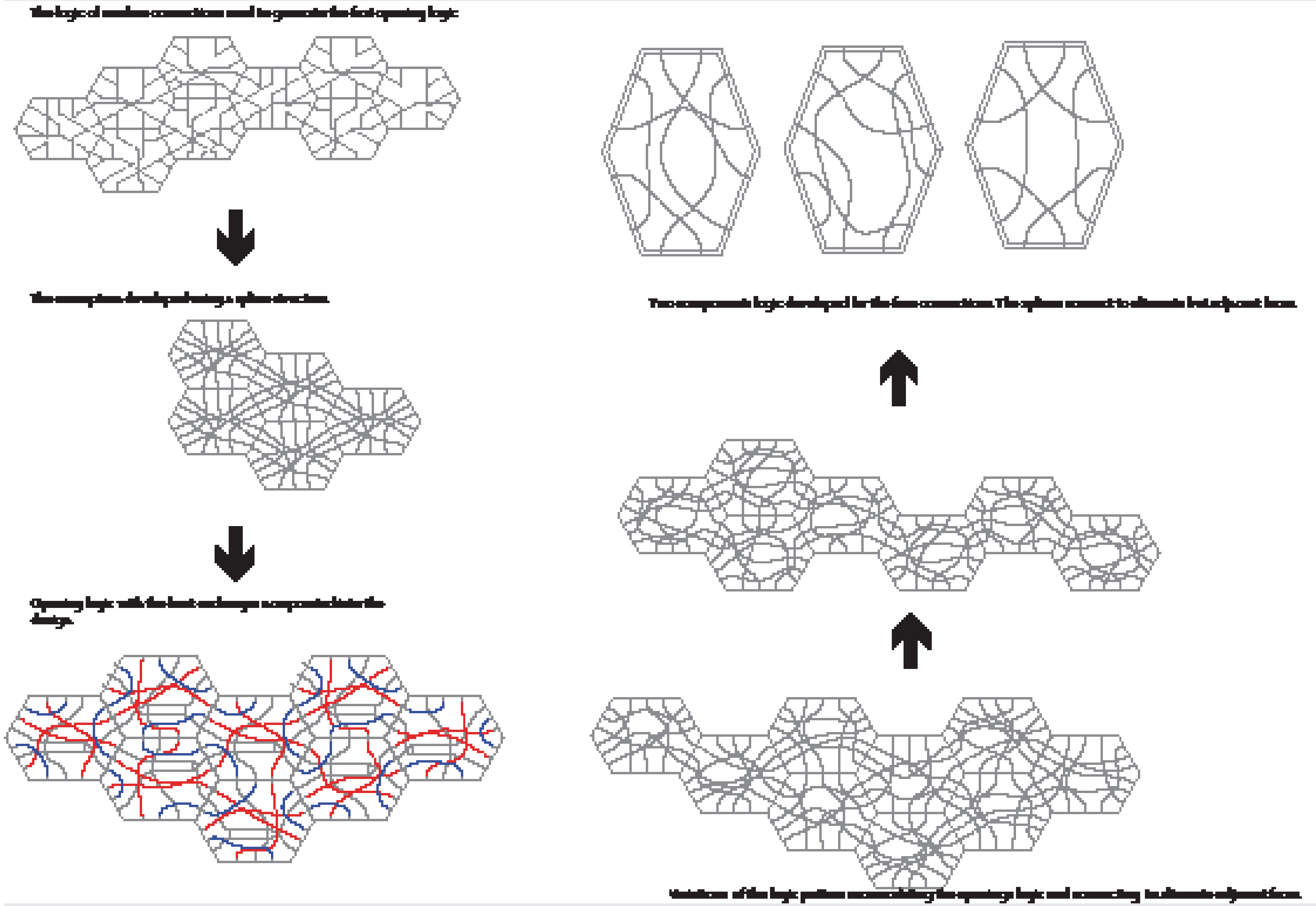
1.4. Openings Logic.
The various logics of incorporating the components to ac-



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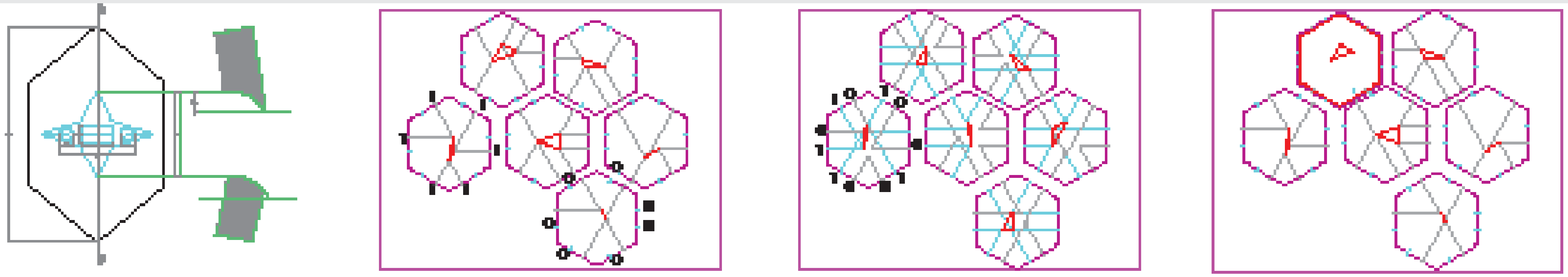
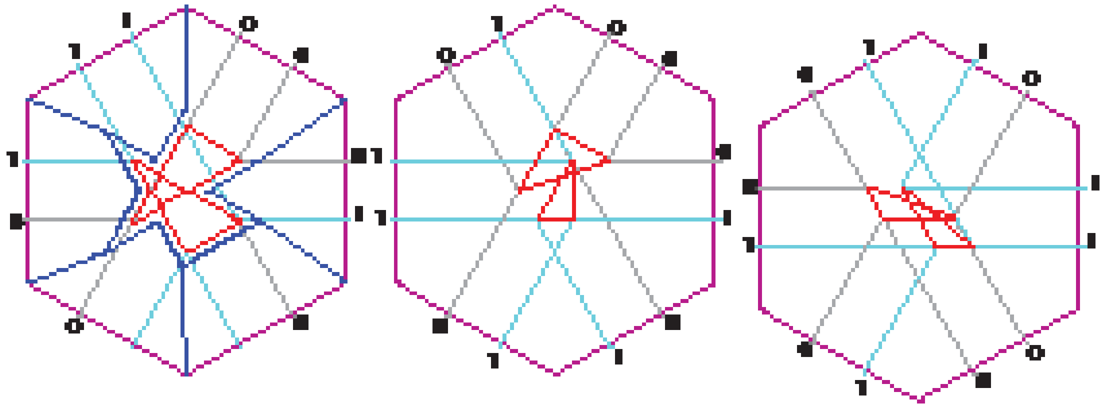
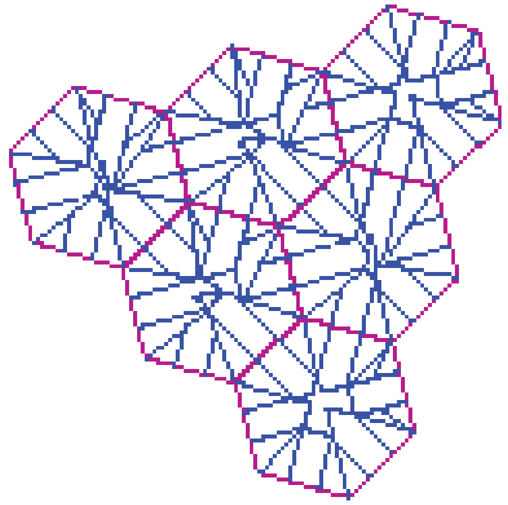
comodate the functional aspects into the tesselation was explored. It involved the use idea of connecting the structural claps along the face in a logical manner.

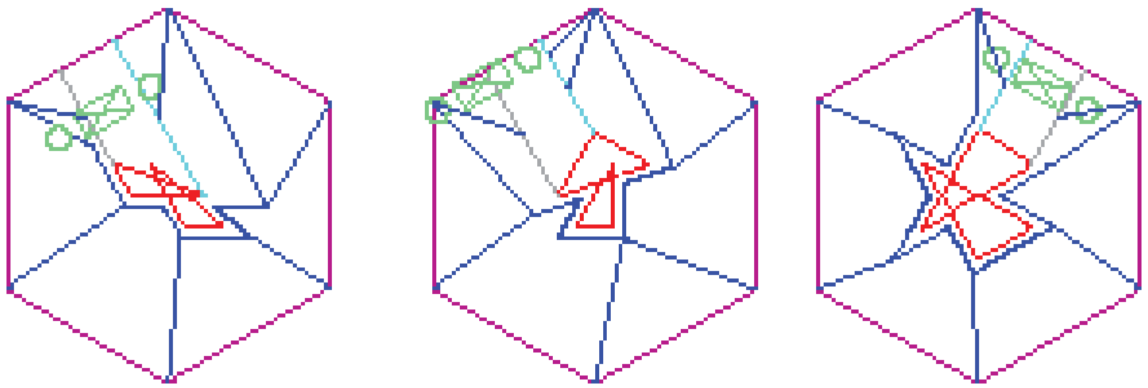




The Number Sequence

1	1	1	0	1	1
0	1	0	1	1	0
0	0	1	0	0	1
1	1	0	1	1	0
1	0	1	0	1	1
0	0	0	1	0	0
1	1	1	0	1	0
1	0	0	0	0	0
0	1	0	1	0	1
0	0	1	0	1	1
1	0	1	0	0	0
0	1	0	1	1	1





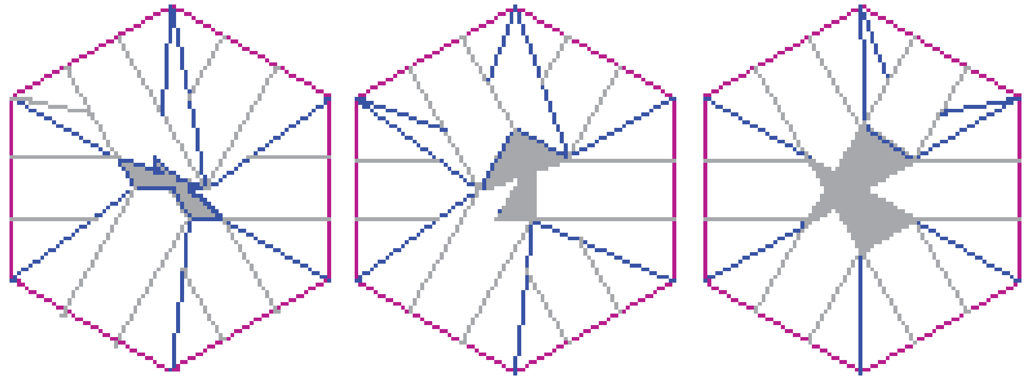


Figure 1-23 The renders showing the evolution of the logic development using digital numbers ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.5. Dual Connections.

The design involves a digital logic of development where random digital nos are assigned to the face connections and allowed to form random spatial configurations capable of accomodating variations.

Bodycheck 6
MEP
Heat Exchanger.

Marco Cimenti, Erwin van Osch, Harikrishnan Sasidharan
1376853, 1257757, 1541994

1.6. The Heat Exchanger.

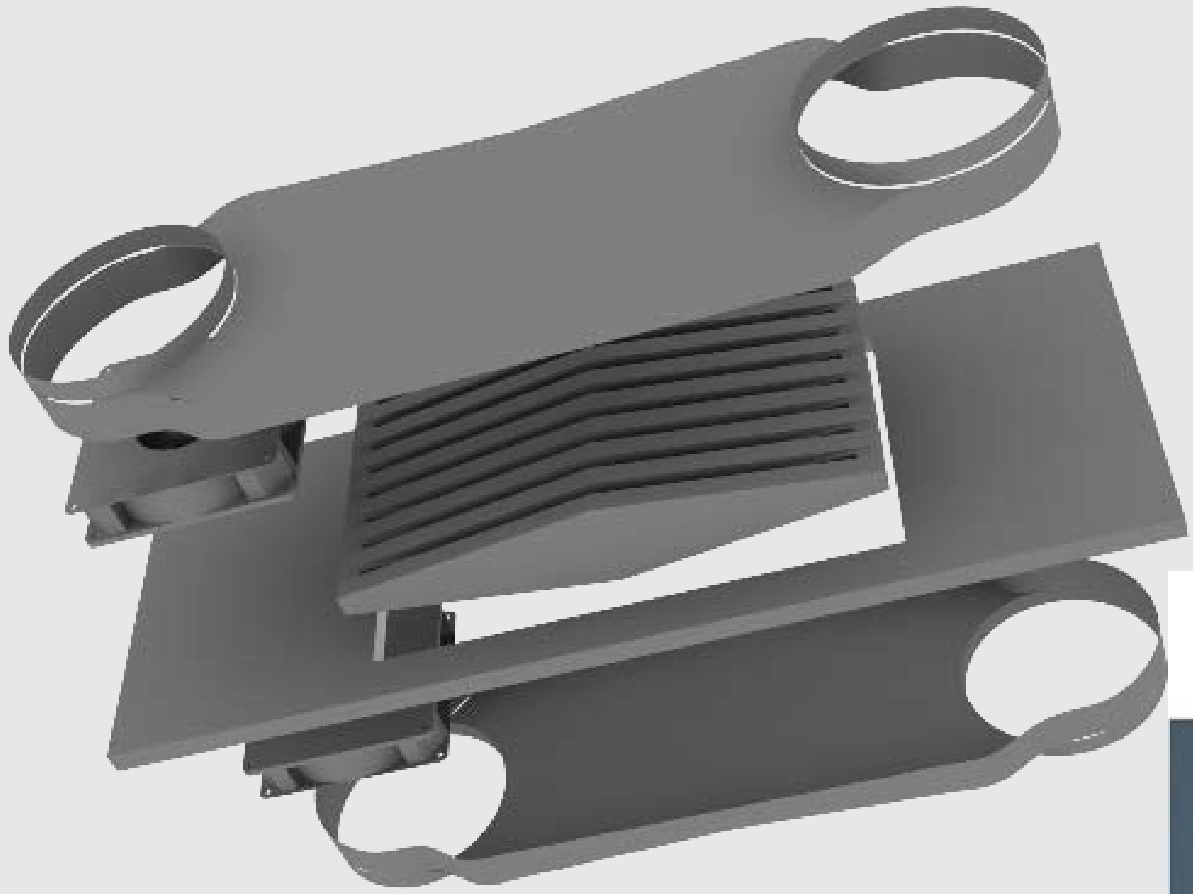
The heat exchanger is a compact assembly with two radial exhaust fans which pushes the criss crossing streams of air.

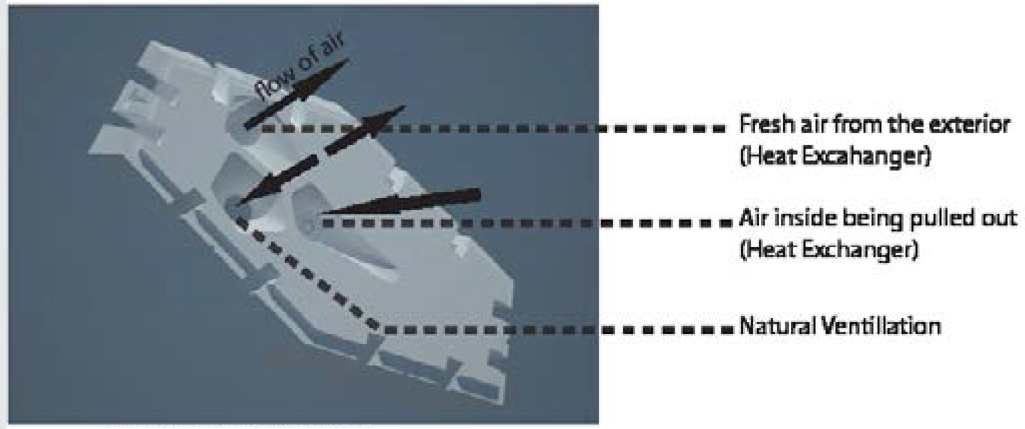
The small picture on the right shows the direction of the airflow within the component.

For the heat excahnger it is important to keep the ventilation channels at least 500mm appart, to prevent short circuiting of air. In that case there is more power required to move the same amount of air.

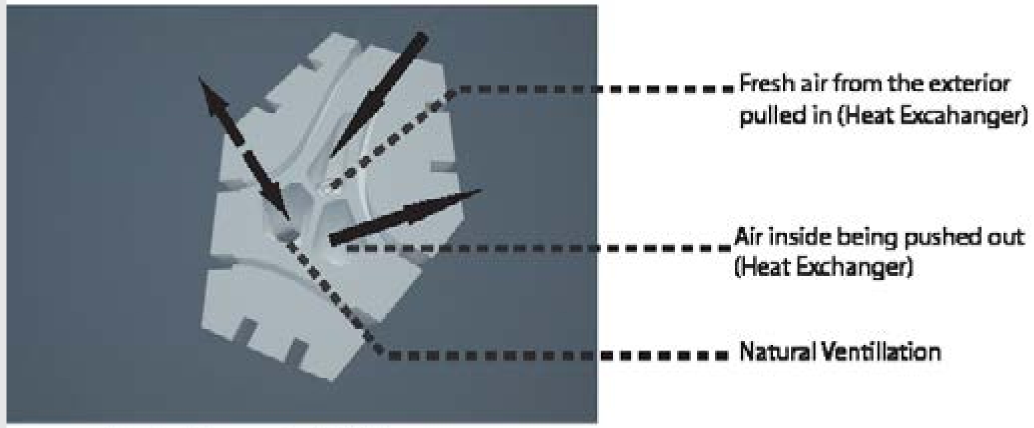
These channels are fixed within a fixing board (preferably wood since it also insulates). Within the board the fiwihex is fixed to seperate the airflows. Two radial fans make sure air is sucked in and blown out. These fans create less turbulance (which is good) than normal axial fans.

Since all these parts require maintainance it is important that the complete box can be removed easily, to clean the heat exchanger or fix new fans.





Interior Perspective(MEP)
Component No 2



Exterior Perspective(MEP)
Component No 2

Figure 1-14. exploded view of the heat exchanger and fans.

Components for milling
The final componnets for MEP made for milling

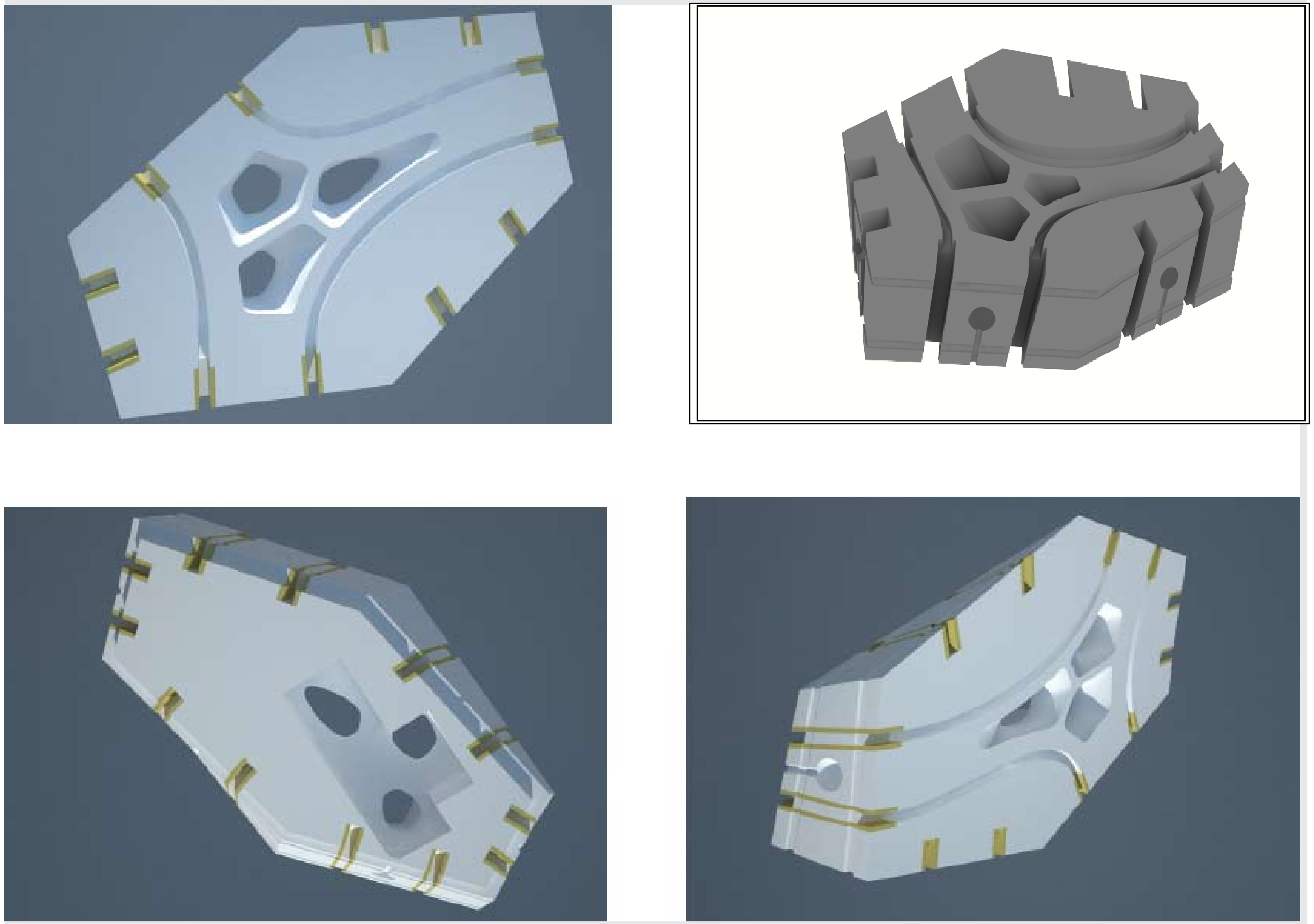


Figure 1-15. Rendered views of the MEP component 2 and component 1for miling.

1.7. Electrical Ducting

The ducting layout is integrated into the component logic. It runs along the edges of the hexagon. The cable tray has a cross section of 70 X 70 mm.

Red and blue represent different types of cables, data and power. Since this ducting solution doesn't solve the interference issue between audio and power cables the cables need to be run smart along the surface.

We desided to do this after a long discussion, the interference can be solved by routing the cables in a different way or routing them to possible ducts on the surface, or even over the components.

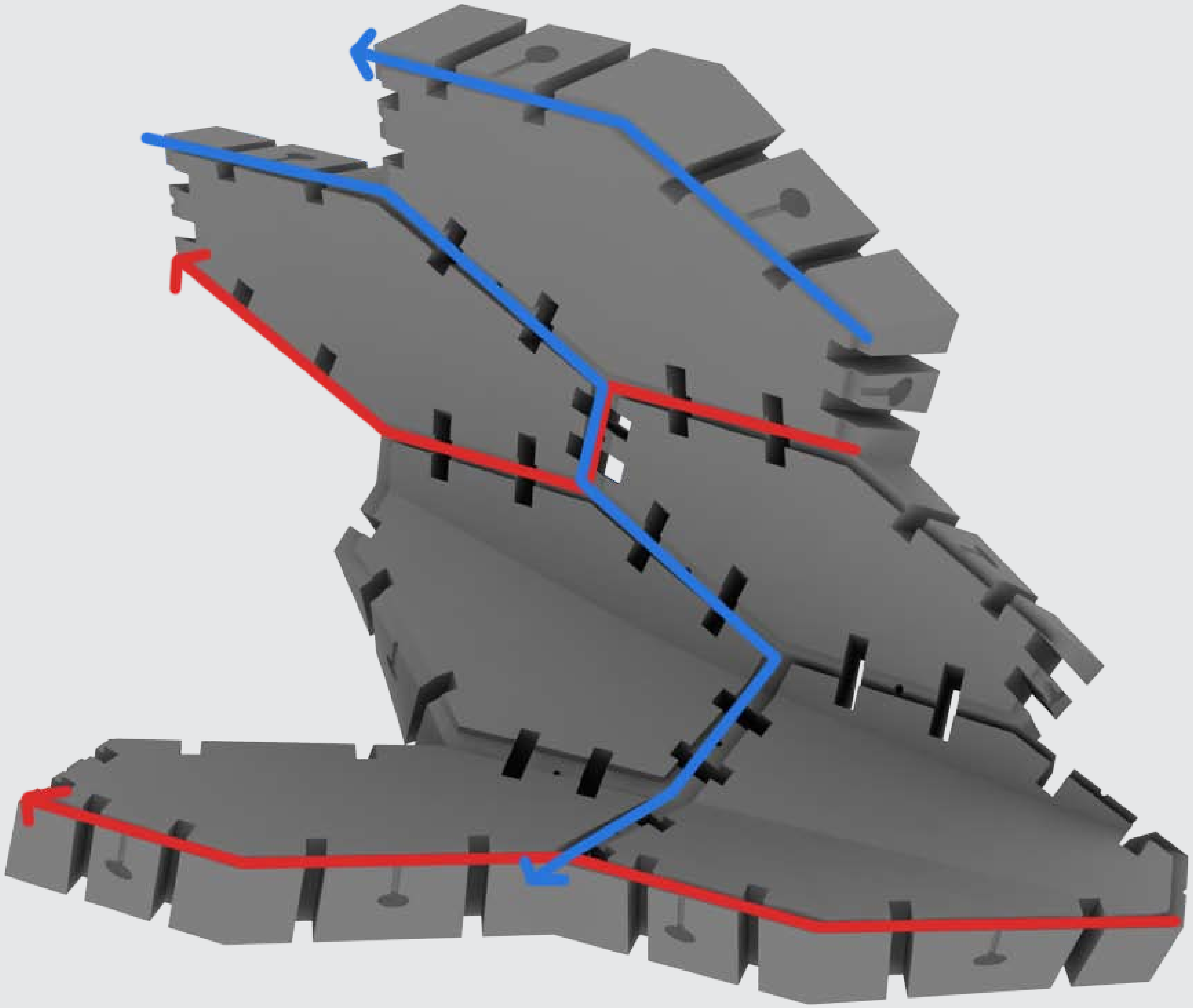


Figure 1-16. Cable solution

1. Bodycheck 3 Styling Group Form Finding Process

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

1.1. Constraints
Modelling of the colaborative phase was constrained by earlier received model of the outer ‘cage’, which was describing the main character of the space and some basic dimensions.

1.2. Process of the modelling
On the diagram on the right hand side you can easily notice how the form was changing during the studio development. Generally it went through six main steps:

1. study of the given cage for further development; analyzing specific powerline, basic dimensions and character of the overall space.

2. creating first dynamic powerlines, whcih made some smooth transitions of the surface

3. reducing the size of the cantiliver in front of the form, and integrating the ‘nose’ with the rest of the ‘body’

4. rounding the nose, by making from it a part of the side walls, treating the whole form as one body without unique elements

5. coming back to the idea of the opening in place of the ‘nose’; big window at the end of the directional form could provide daylight in the sitting area and make the overall project more characteristic

6. finally rounding the nose, but making it in the same time a bit smaller; rounding the back of the shape

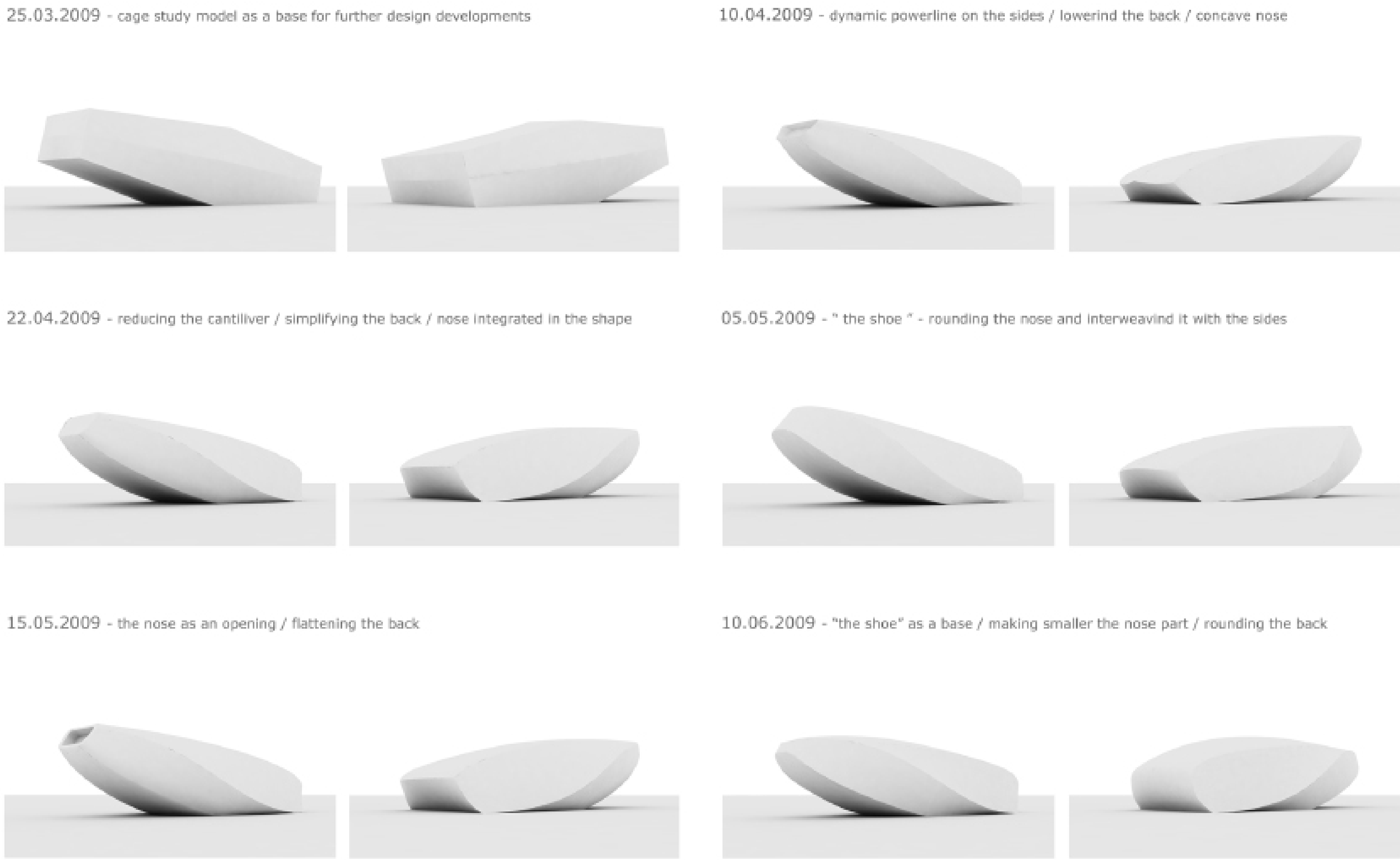


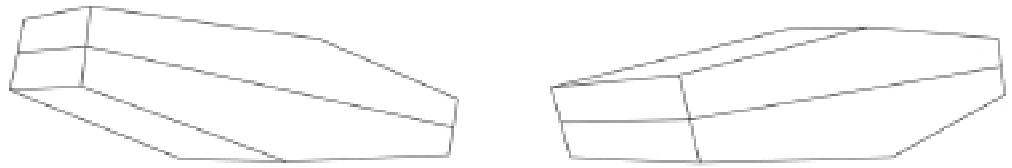
Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-1. This diagram illustrates the process of modelling the Protospace 3.0 final form. Starting at the early begining from the simple cage till last iteration of the form

1. Bodycheck 3 Styling Group Form Finding Process

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

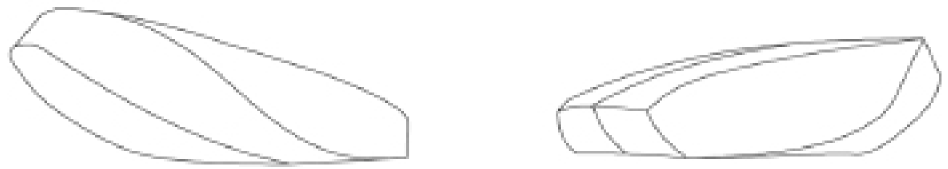
25.03.2009 - cage study model as a base for further design developments



10.04.2009 - dynamic powerline on the sides / lowerind the back / concave nose

22.04.2009 - reducing the cantiliver / simplifying the back / nose integrated in the shape

05.05.2009 - " the shoe " - rounding the nose and interweavind it with the sides



15.05.2009 - the nose as an opening / flattening the back

10.06.2009 - "the shoe" as a base / making smaller the nose part / rounding the back

Figure 1-2. The same process as on the diagram before but just showing everything by main powerlines which were adapting the overall form

Figure 1-1. This render shows the ... minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.3. Shaping the form by playing with the powerlines

As Kas Oosterhuis says:

“The building body is like a shaped container, a flexible box that is shaped by a set of curvilinear powerlines. The powerlines describe the path of development of the body, the folding lines in the surface of the volume, and/or the trajectories of the users navigating through the building body.”

Thus our process of modelling the shape was the process of creating specific relations between all the powerlines. Each one of them was responsible for concrete function of the interior space:

1. powerlines on the roof and bottom
- making the ‘V’ shape of the surfaces, which is much better structuraly

2. Powerlines in the moddle of the walls
- emphasizing the division of the interior space into two different area: zone of podium, zone of main arena

3. Powerlines on the back of the form
-regarding the size of the projection area

1. Bodycheck 3 Styling Group Modelling the Inner Surface

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

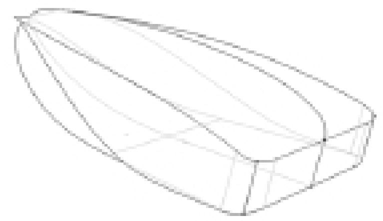
1.4. Main factors for modelling the inner surface
Modelling of the inner surface was an example of the complex process of exchanging all the possible information between all of the groups of specialists.
Main factors shaping the inner surface were:

1. Styling factors
The inner surface was supposed to follow the main geometry of the outer one, keeping similar relation between all the powerlines.

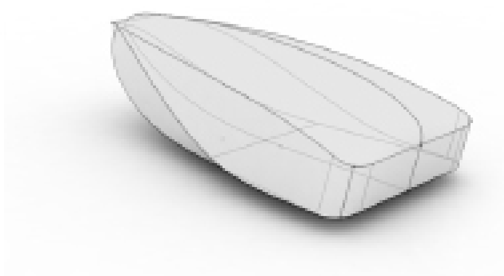
2. Structural input
Structural group gave as crucial inputs about the thicknesses in all the specific places. Thickness of the wall varies from 30 centimeters till almost 1,5 meter, what made the modelling process much more complex

3. Interactive group input
Interactivity group was giving us two different input for modelling the inner surface:
-areas of the two main functional zones
-specific modelling of the back wall of the inner surface, which would be supposed the projection area

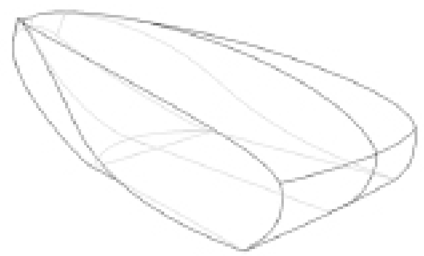
01. powerlines of the inner surface



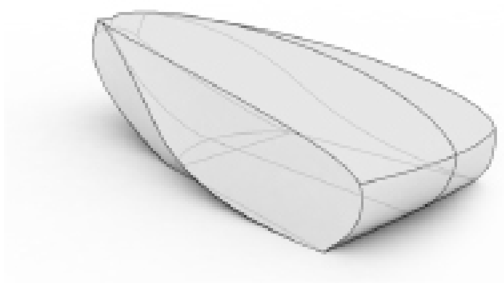
02. shape of the inner surface



03. powerlines of the outer surface



04. shape of the inner surface



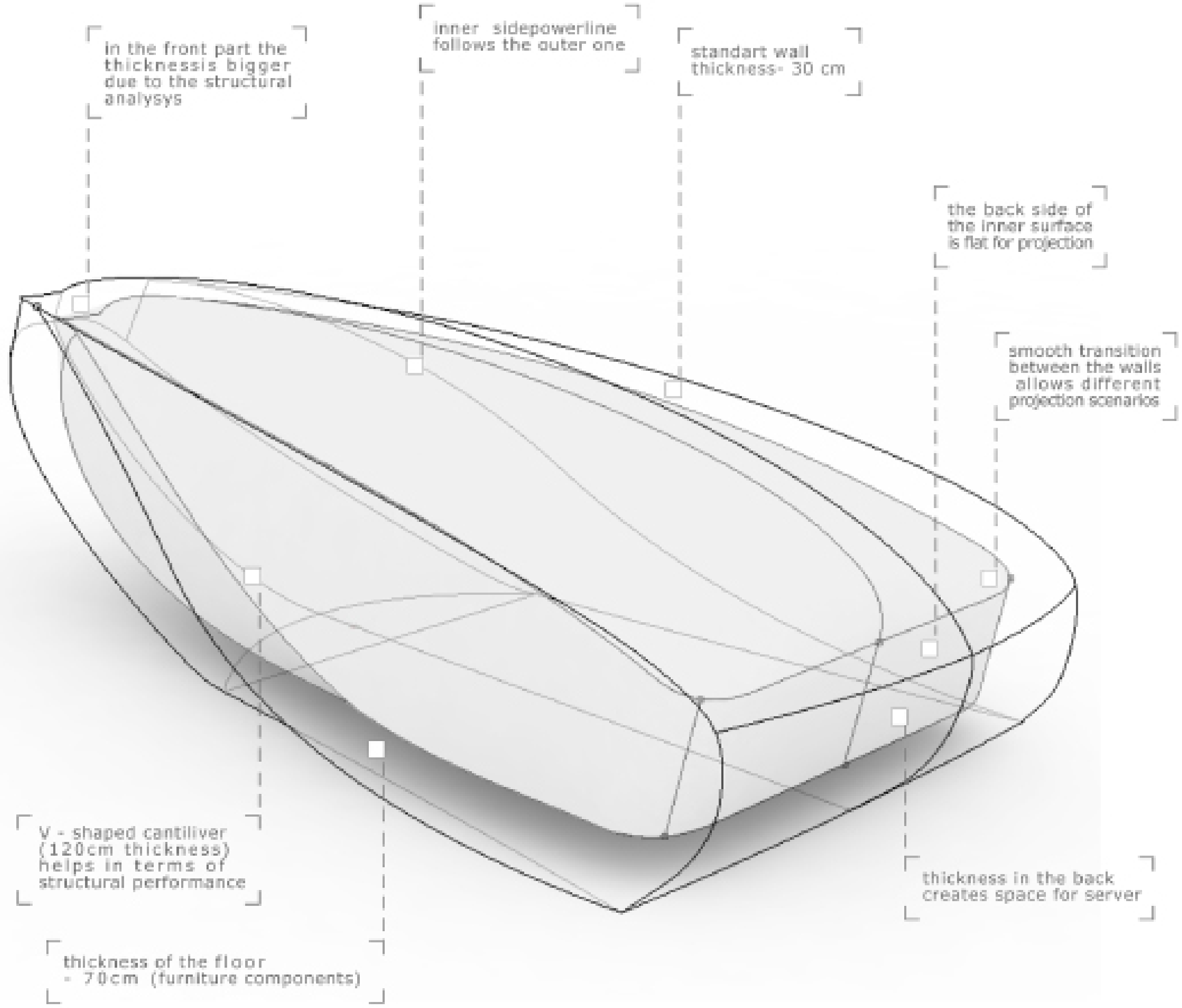


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Figure 1-3. Shaping the inner surface (interior) of the pavilion by taking into consideration different inputs from all the groups of specialists

1. Bodycheck 3 Styling Group Process of Modelling the Form

Agata Kyia - 1530275
Roxana Palfi - 1535269

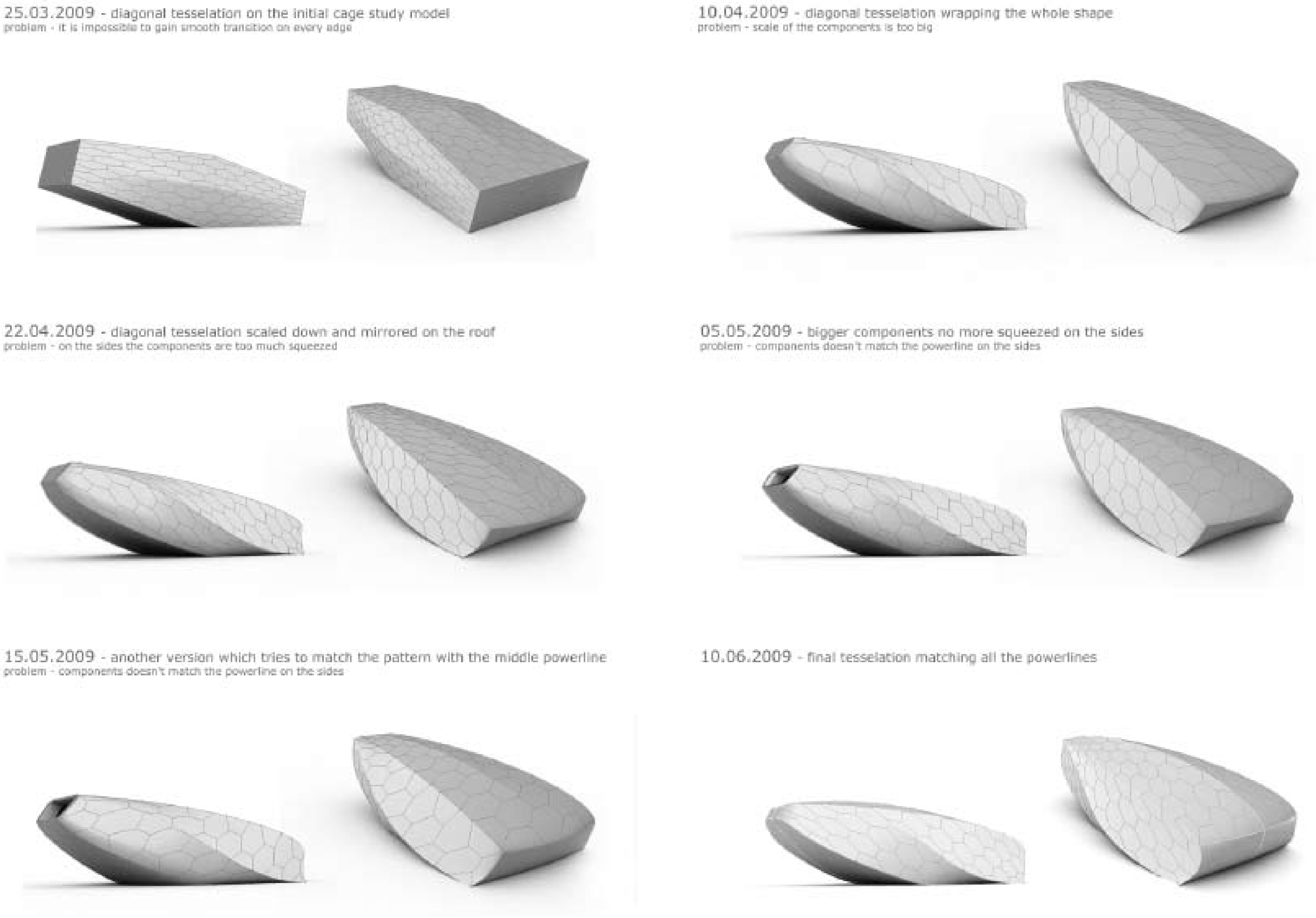

Figure 1-4. This diagram shows the way of developing tesselation systems. Starting from 1-parallel one, going through different dynamic versions and finished with the final method

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1.5. Modelling the tesselation

The first important decision which was taken in the Studio was to take a hexagonal grid as way of subdividing the whole bulding body into components.
Then the process of developing the tesselation method went through many different step:

1. diagonal tesselation on the initial cage study model / problem wrapping by it closed three dimensional model

2. first version of the new subdividing method - too big blocks for assembling process

3. scaled down tesselation / problem of fitting tesselation with all the powerlines

4. final tesselation, whcih fits with all the powerlines and produce block which veries between 1 meter till 3 meters

1. Bodycheck 3 Styling Group Dialog Between the Outer and Inner Tesselation

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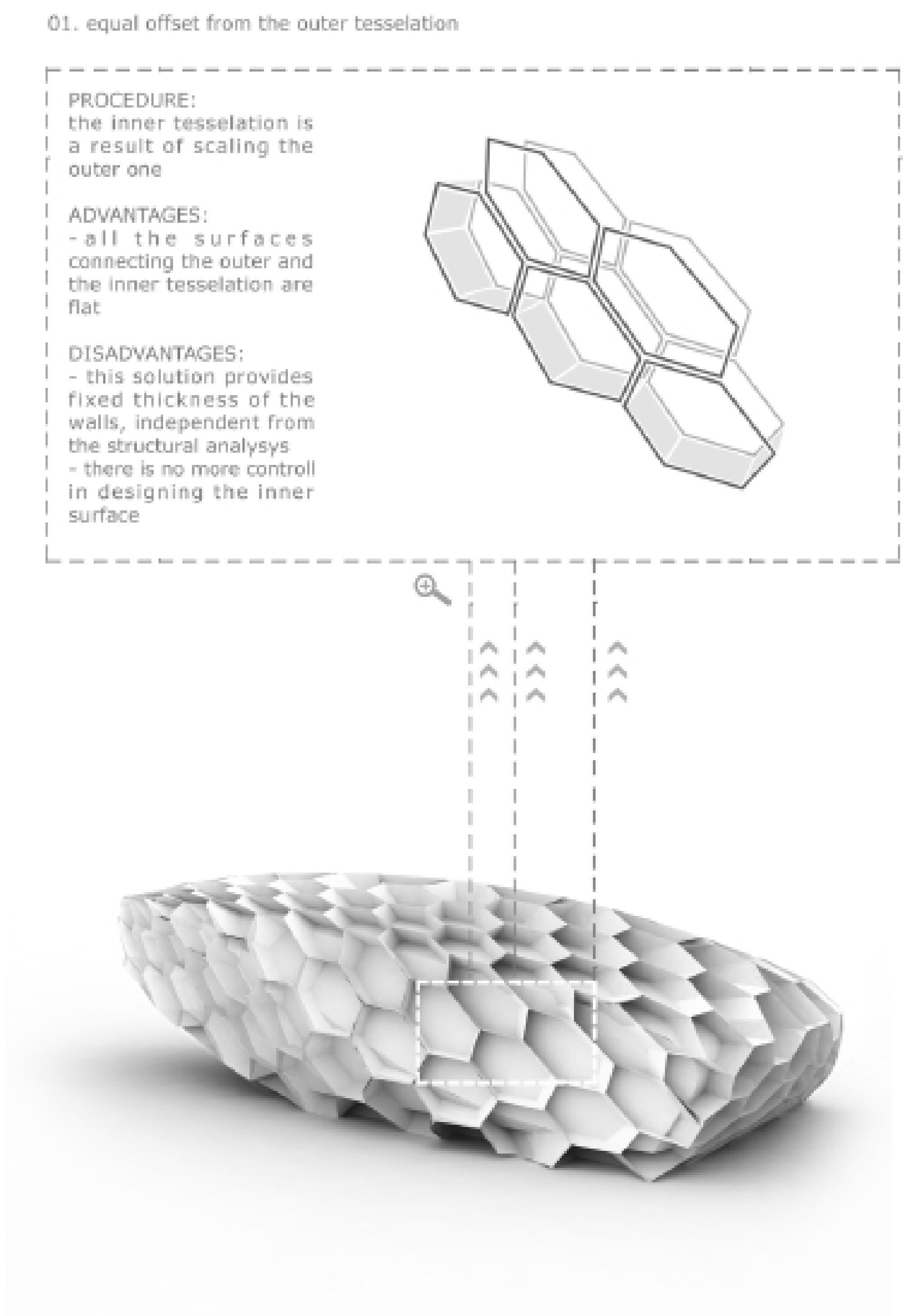
Roxana Palfi - 1535269

1.6. First trials of inner tesselation method
To achieve proper tesselation of the inner surface we were trying many different methods.
Here the important factor was the assembling method chosen by the manufacturing group. It effects the relation between outer and inner one, for instance by demanding that all the common edges of components shouldn't be twisted (this idea was later skipped as not the best one in case of structural forces).+
The first two methods of relating the inner tesselation to the outer one were:

-scaling down the outer tesselation (equel offset from the outer tesselation)

-connecting outer tesselation to one point and then finding intersection of these lines with the inner surface



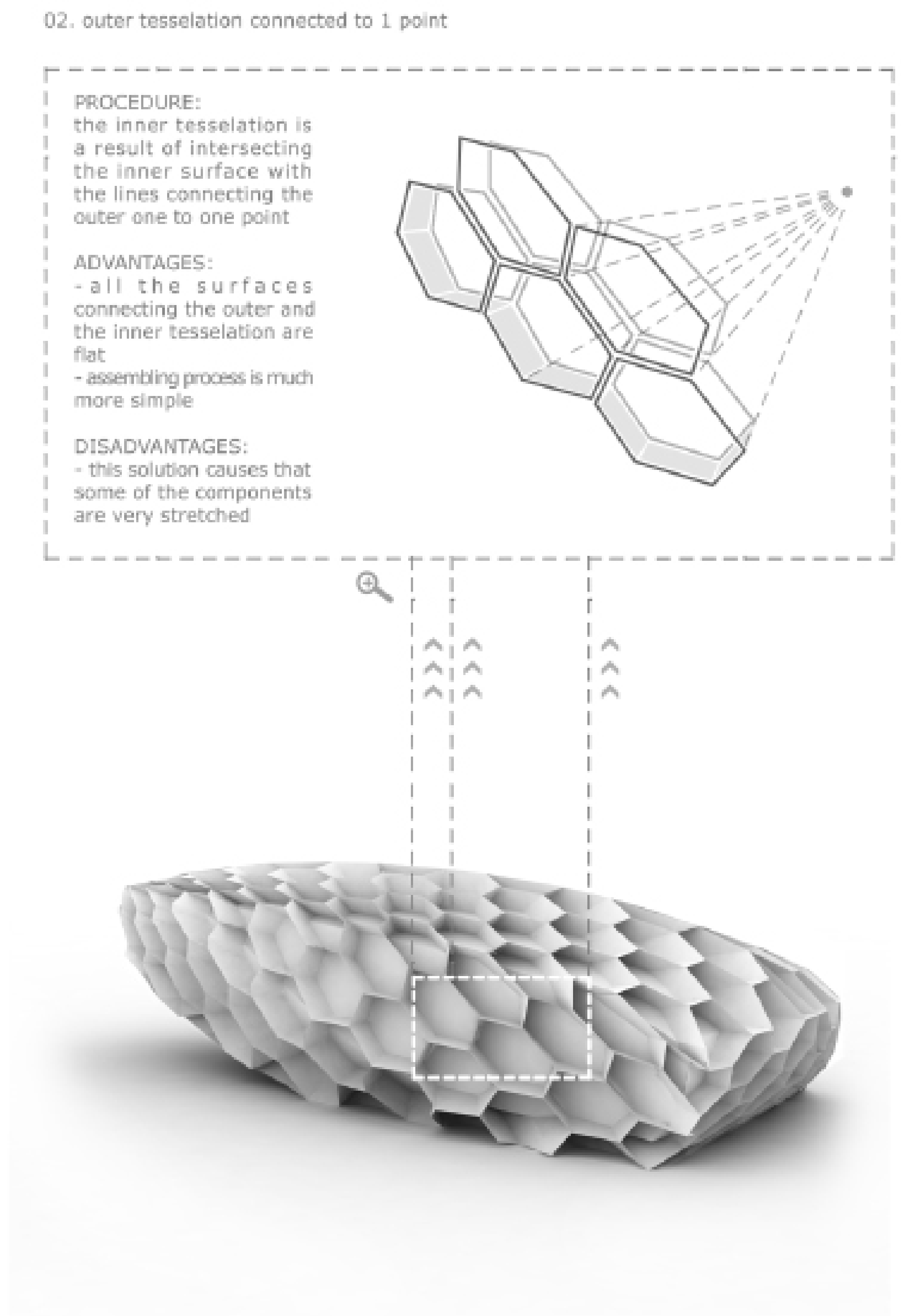


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Figure 1-3. First two methods of modelling the tesselation for inner surface: equel offset of the outer tesselation and connecting the outer tesselation to one point and looking for the intersection with the inner surface

1. Bodycheck 3 Styling Group Dialog Between the Outer and Inner Tesselation

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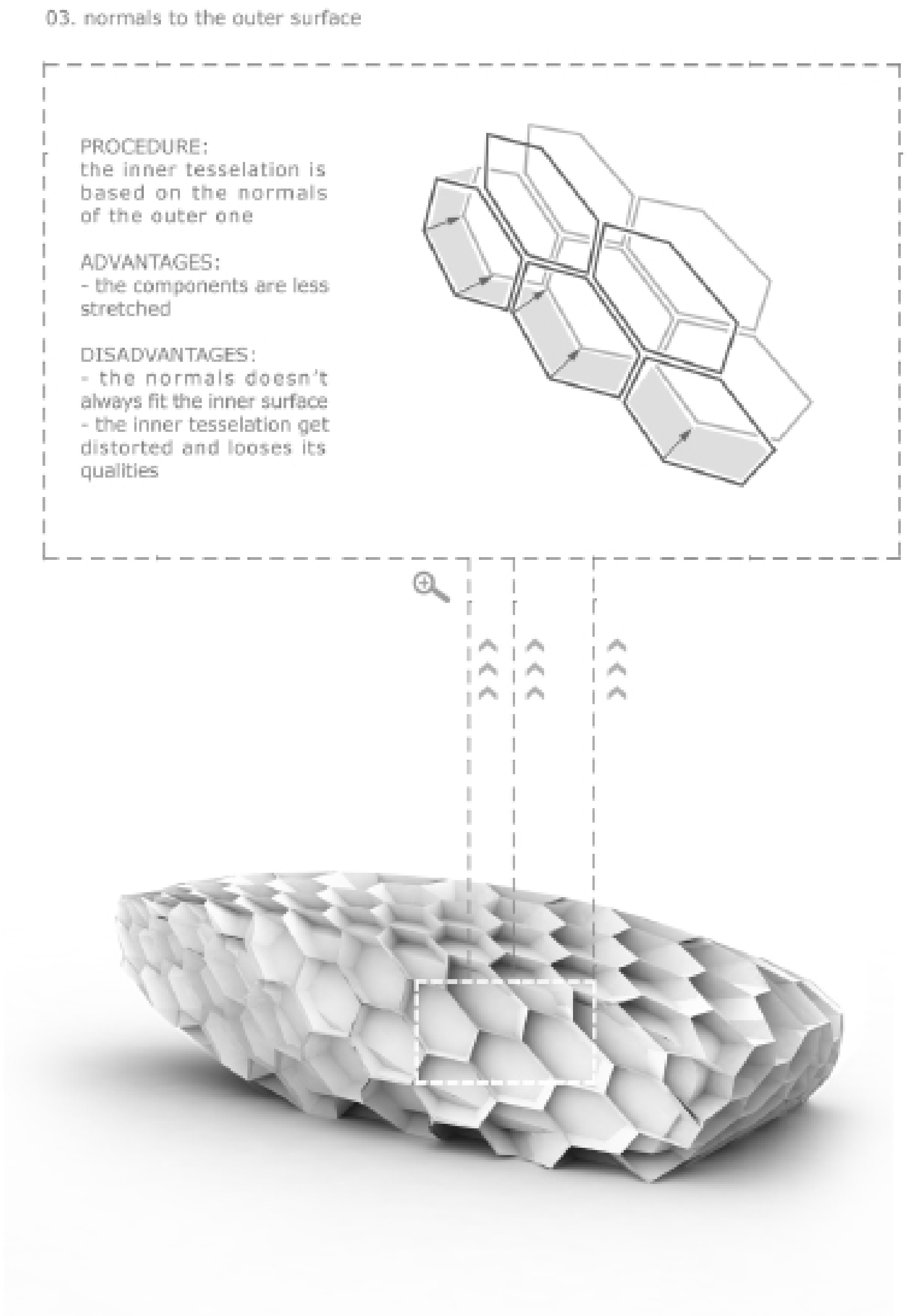
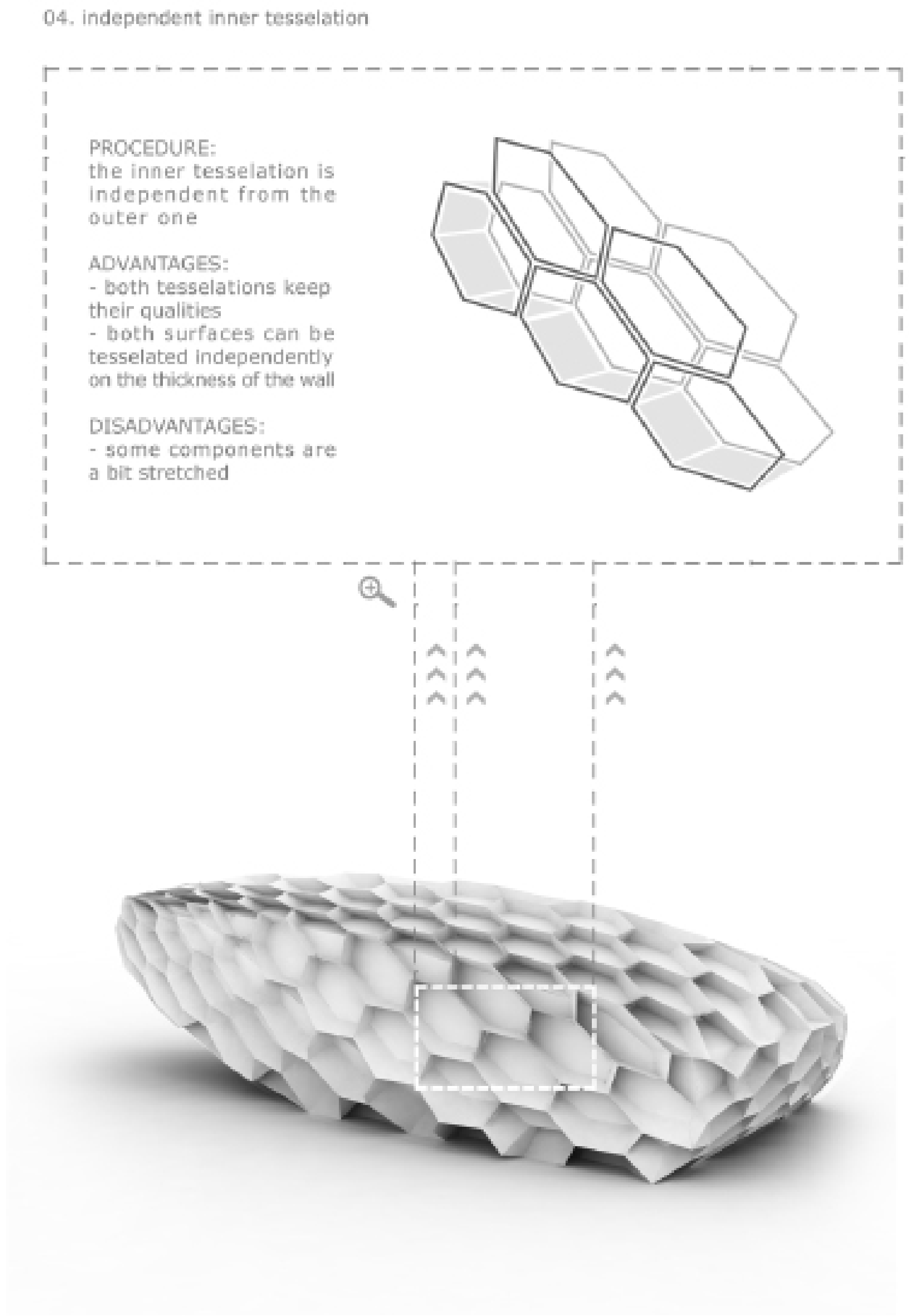




1.7. Second trials of inner tesselation method

Other method of doing the inner subdivion were not focused on achiveving components edges as planar surfaces but just finding the way to propotionally tesselate inner surface without big distortions in a probleatic places of huge wall thickness.

Alternative one was to follow the normals to the main surface in vertices of outer subdivision.

However for final one was chosen a method were inner tes-selation was done sort of separately from the inner one, and later on tthe process of joining both of them happened. It gives the most convincing result without strong distortions, and at the same time it allowed manufacturing group to de-velop specific assembling method just for this solution.

Figure 1-6. Two other methods of tesselating inner surface: by normals to the outer tesselation and just by doing sort of independent inner tessela-tion and then joining it with outer one

Figure 1-1. This model shows ... veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

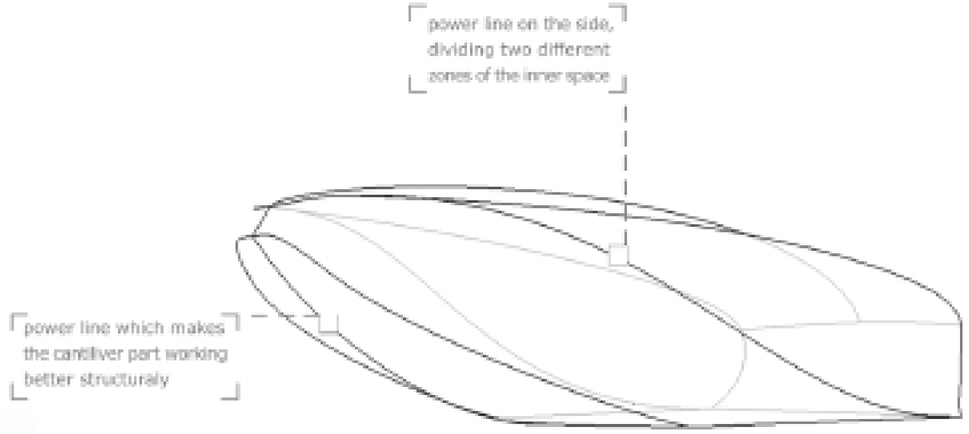
1. Bodycheck 3
Styling Group
Final Shape - Surfaces and Powerlines

Krzysztof Gornicki - 1530259

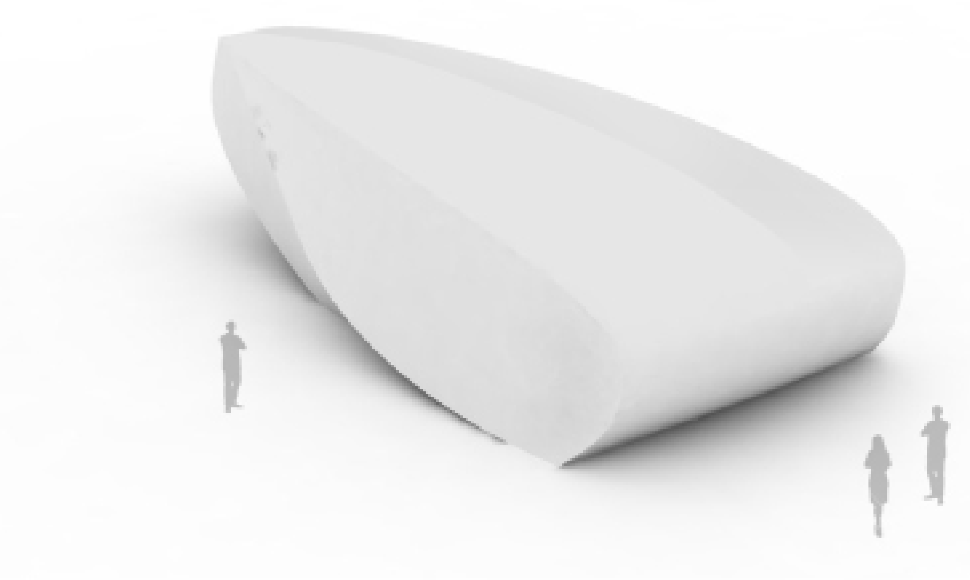
1.8. Building Body
Following the main ONL mission statement::
First of all each building is regarded and developed as a building body. A building body is a consistent organism where most constituing elements are specifically developed for that body. The modern building body is no longer based on repetition but on an complex interaction between unique components.
That was our main principle during modelling the final shape. Achiving the form which a closed ‘Building Body’ with possiblity to be regularilly tesselated with set of hexagonal components.

01. final form of the project - human perspective

02. powerlines shaping the final form - human perspective



03. final form of the project - upper view



04. powerlines shaping the final form - upper view

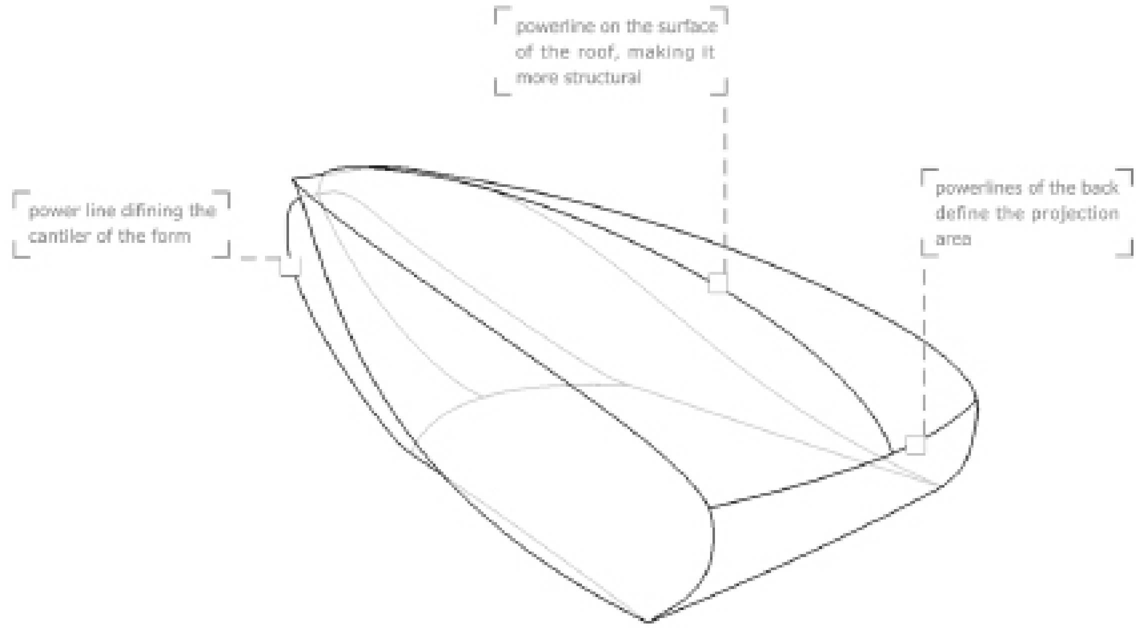


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Figure 1-7. The most important and characteristic elements of the final version of the shape

1. Bodycheck 3 Styling Group Final Tesselation Method - Outer and Inner One

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Roxana Palfi - 1535269

1.9. Final tesselation
However at the beginning the task to subdivide unique and non-standard form with regular hexagonal grid seemed to be almost impossible, after some trials we managed to achieve satisfying version, which consitsts just three exceptions of the pentagons on three different corners.
Inner tesselation followed the same idea as the outer one, and then the edges of the components are the result of jining both surfaces together.

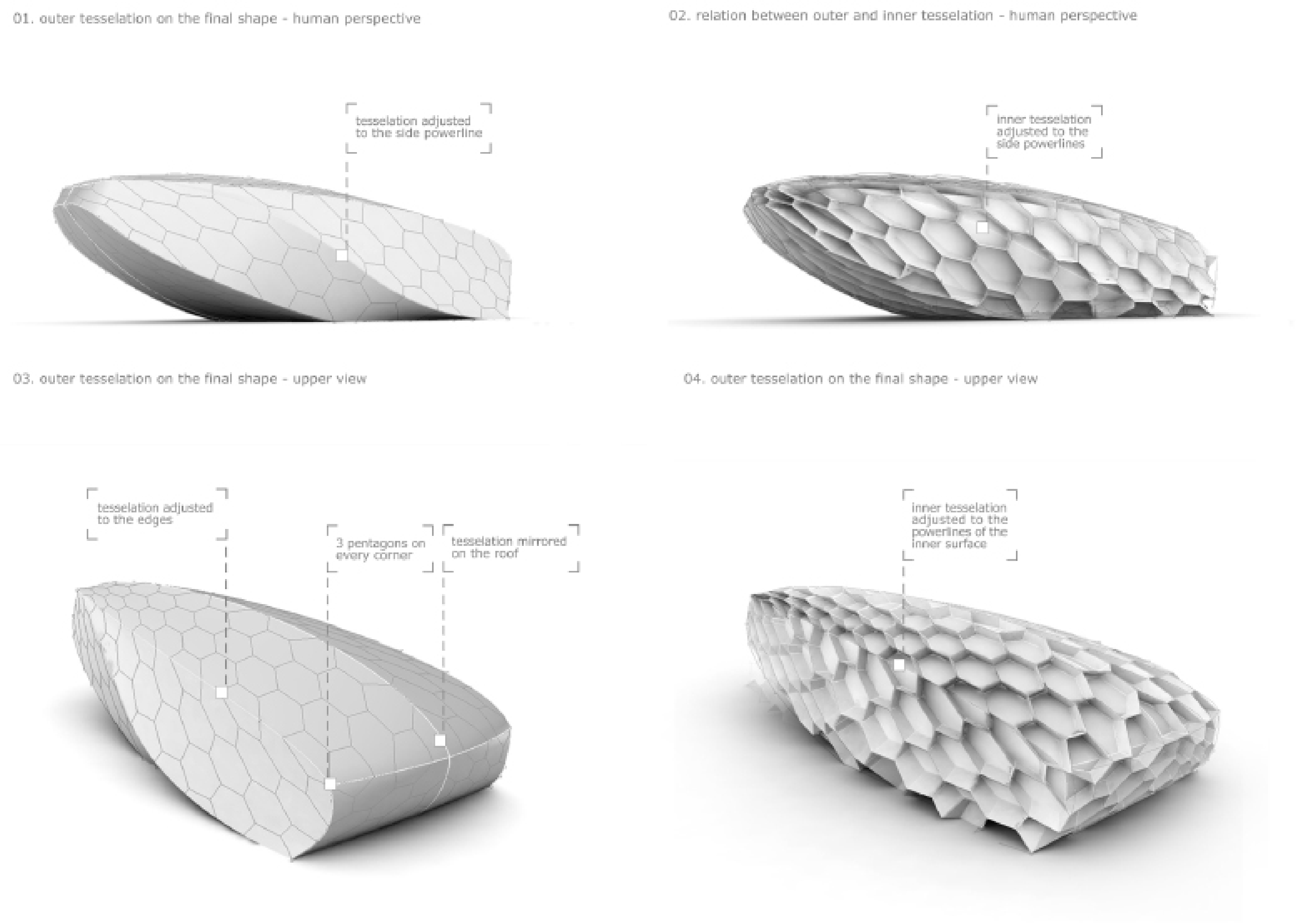

Figure 1-8. The most characteristic and important elements for the final version of the outer and inner tesselations

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1. Bodycheck 3
Styling Group
The Overall Process of Modelling Shape and Tesselation (Inputs - Outputs)

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Agata Kycia - 1530275
Roxana Palfi - 1535269
JinJie Yan- 1530607

1.10. Overall process of modelling
The overall process of modelling final form and both tessealtion was a complex way of exchanging the most important data between all the groups. Styling group as that one which was responsible for shaping the building body were collecting all the inputs from different groups of specialists and then trying to find the optimal solution in case of three dimensional model.

'In the swarm there is a constant flux of data' K. Oosterhuis

And so process of designing is going to be a constant process of exchanging information between many different professions. Increasingly graphics, composers, planners, publishers broadcasters or visual artists are building very strong positions in every architectural office, in some of them are already on the same status as architects (for example ONL – I. Lenard – artist, K. Oosterhuis – architect).

'Members in a swarm are always calculating' K. Oosterhuis

Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-3 Diagram illustrating the whole process of form finding. Different inputs from all the groups of specialists effected the form in every single aspect.

1. Bodycheck 3 Styling Group Numbering Components / All Specific Data

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

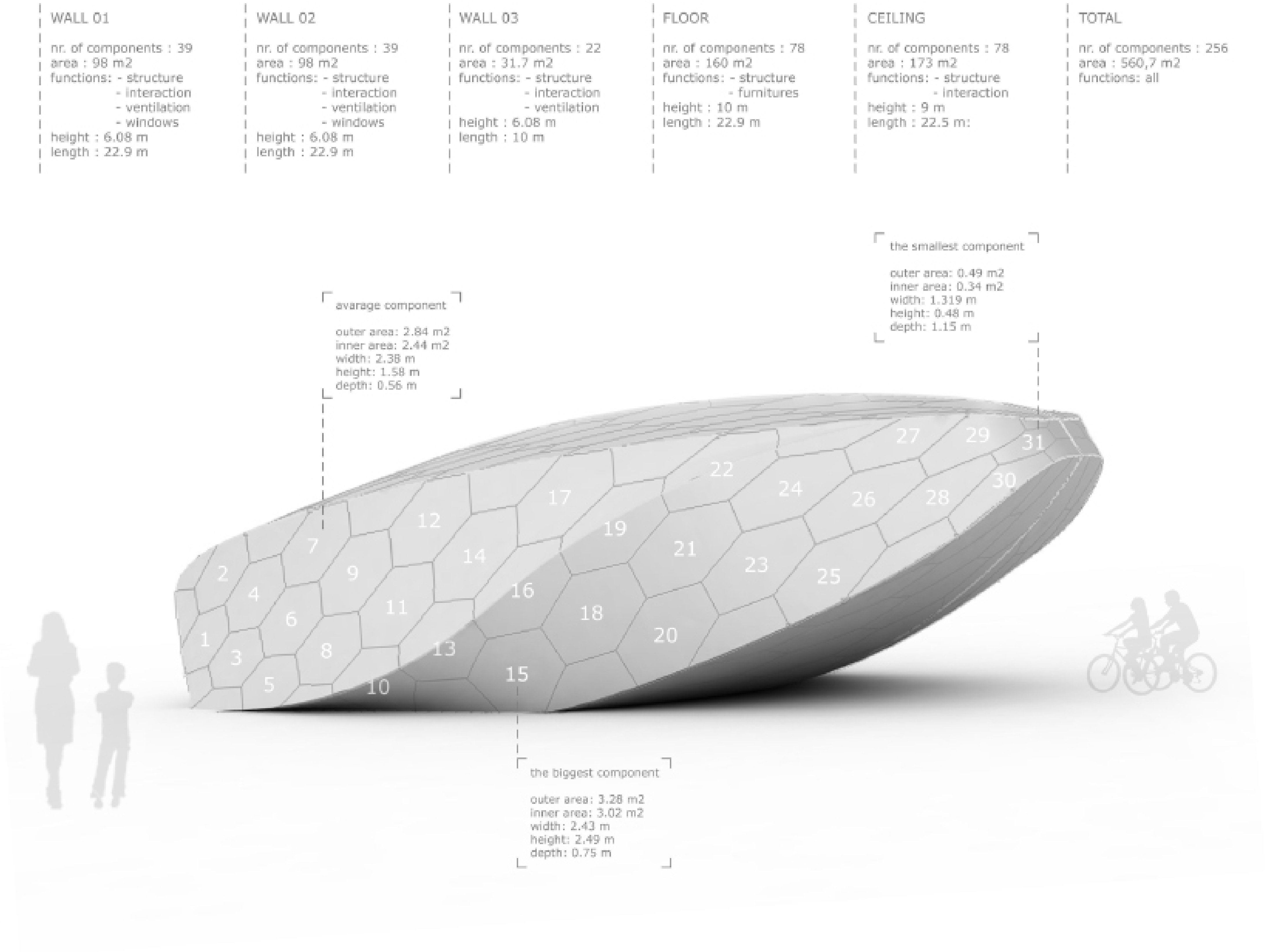

Figure 1-10. Numbering all the components with individual code. Presenting all the data about building elements.

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1.11. Numbering components

When the final shape and outer and inner tesseation were done, the next step of developing the overall process was to give to each one of component the unique number code. Based on it that was possible to go further with functions distribution and preparing files for final fabrication of the full scale prototype.

1. Bodycheck 3 Styling Group Distrubution of Different Functions Throughout the Components

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1.12. Swarm of bodies
Again we were following ideas of the Studio professor Kas Oosterhuis, who says:
“Each Body Plan evolves through a process called specification.
Certain parts of the Building Body specialize to be the structure, other parts specialise to be the skin, again others the internal empty spaces, other the arteries / MEP installation. There is a specific instruction in the evolution of the genes for the body plan for each of those functions. At the same time all points / cells of the system keep communicating as members in a swarm.
They become members of a specialized sub-swarm.

Thus our purpose was to create such a swarm type idea in the proposed design solution. Each one of unique-numbered component is dedicated to the specific function:

1. Structural block

2. MEP - heating/ventilation

3. MEP - providing daylight

4. Interactive - embadded interactive devices

5. Interactive - with cavity for furniture

In this way all the data about the building were coded in one excel file, which further was used as a base for generative procedure in Rhino application.

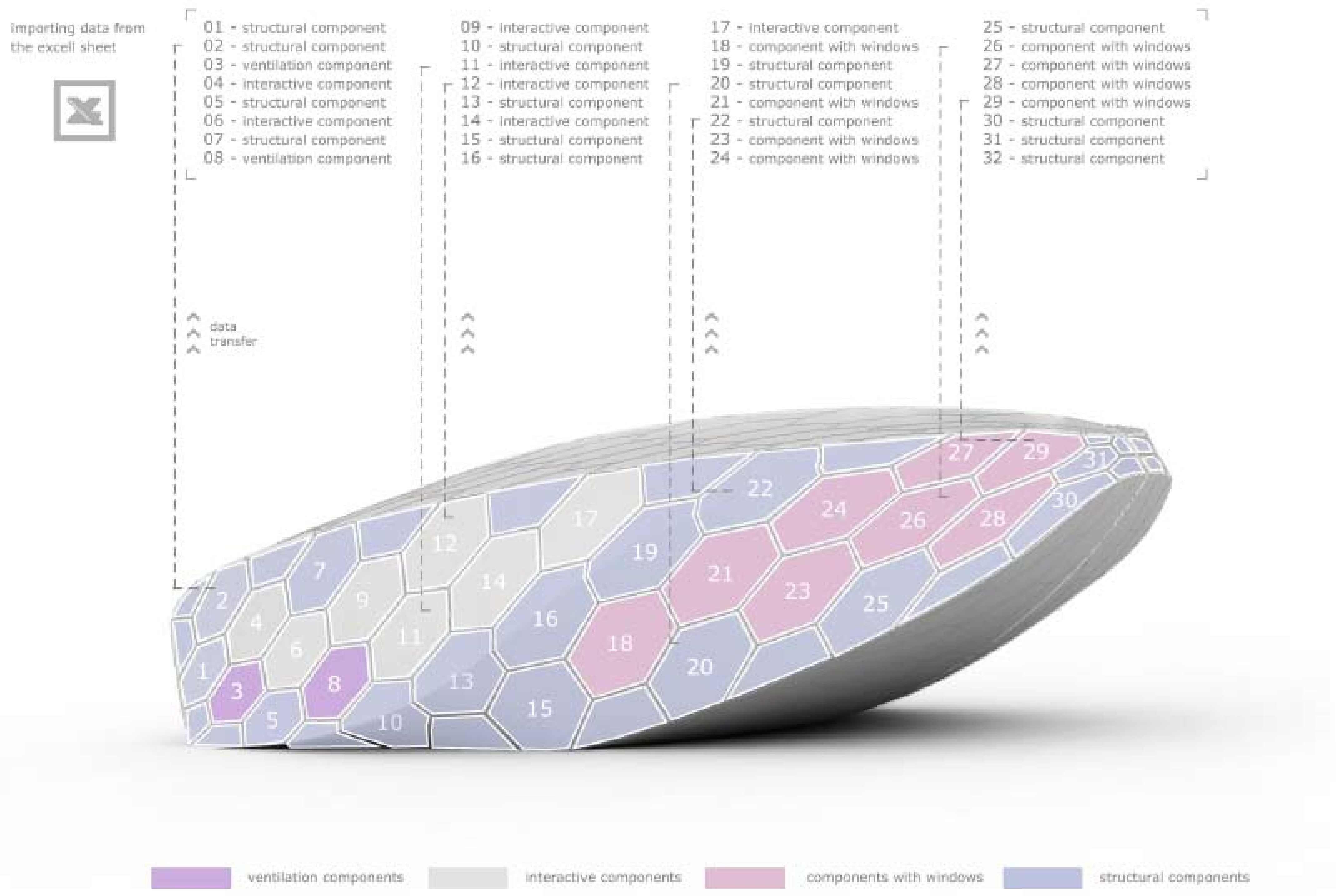

Figure 1.1. Distribution of functions throughout the components, each group of specialists were choosing the components for their specific purposes.

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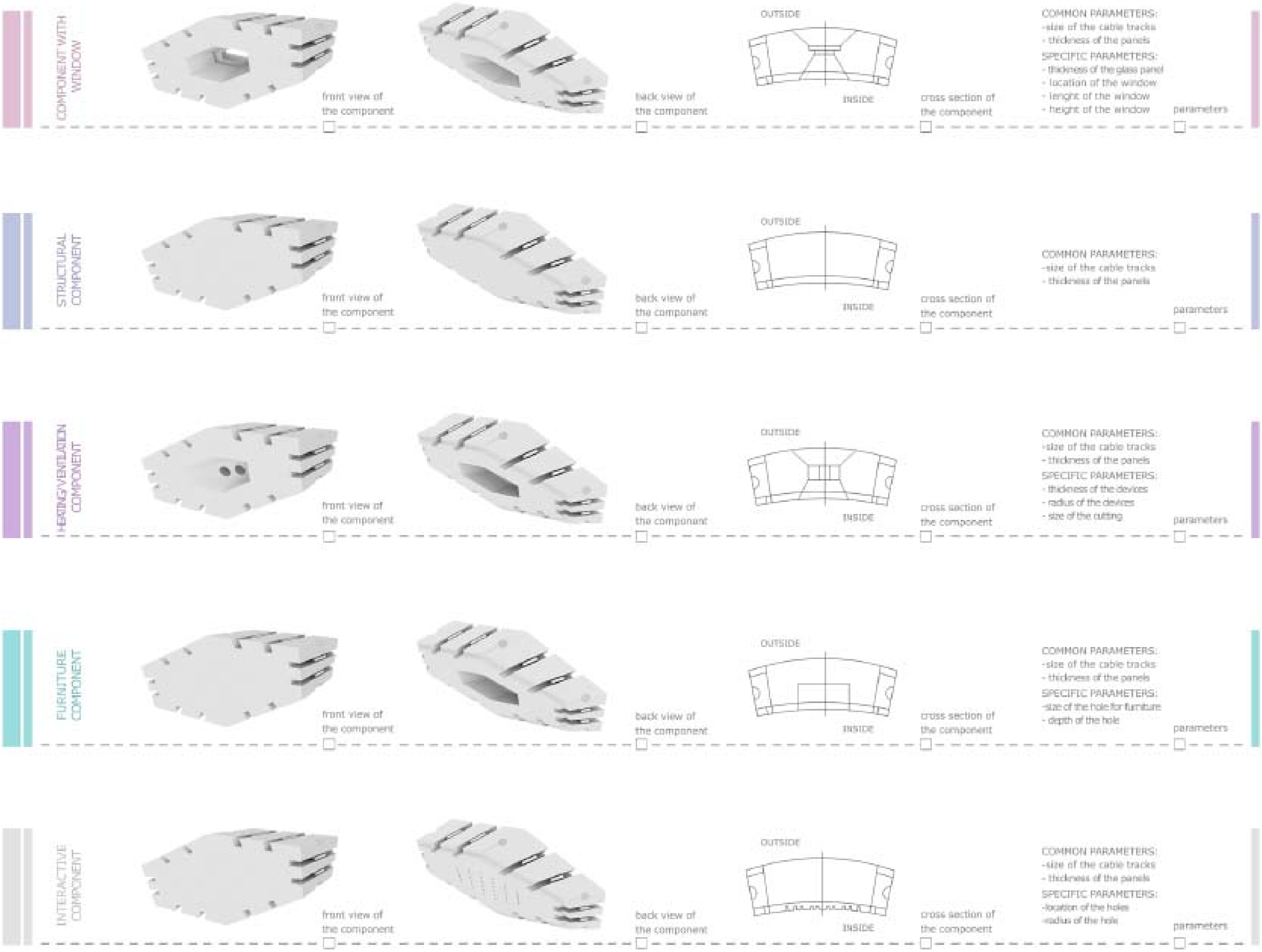

1. Bodycheck 3 Styling Group Catalog of Five Main Component Functions - Specific Forms and Parameters

Krzysztof Gornicki - 1530259

1.13. Shaping the form by playing with the powerlines

As Kas Oosterhuis says during the introduction lecture of our studio class:

“Develop each specialized swarm of nodes of the structure or the internal / external skin, either enveloping spaces or enclosing gas / water / electricity /air flow, according to a parametric detail.
Make all details one big family, where all family members share the same detail in principle, but with local and temporal different values.
They share the same formula, but with from point to point changing values for the parameters. Aim at limiting the number of different parametric details, try to integrate as many details into one complex systemic Parametric Detail.

One building, one detail.

Figure 1-12. Eacg function has a specific variation of the form of parametric component, driven by concrete set of parameters

Figure 1-11. This picture shows the architect Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. Bodycheck 3 Styling Group Geometry Description of Random Component

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1.14. Logic of the geometry

Written in Rhino application generative procedure works in specific order, executing concrete step:

1. INPUTS
Generative procudure requires some inputs of specific geometric description:
-strusrface (type: surface)
-strsurface02 (type: surface)
-arrcurves (type: closed curves on the strsurface)
-arrcurves02 (type: closed curves on the strsurface02)

2. PARAMETERS
The generative procedure is based on set of parameters, which allow to control he most important data about the form. In this case you can always adjust: size of the cavity for cables, clips dimensions, radius of the cavity for the nitrogen ball, and some parameters controlling specific functions.

3. BASIC ELEMENTS
Based on the inputs script generates some basic geometrical desciption of the component, by creating arraysof vertices (arrP, arPo2), two surfaces cut from main surface (piece, piece02) and loft between selected curves (loft).

4. FUNCTIONS
Running script executes for each group of input and basic geometry speceific functions, responsible for creaing some repetitve elements. And so there are functions generating cavities for the nitrogen balls, cuttings for connectors, cavity for cables, and some general geometrically helpful functions

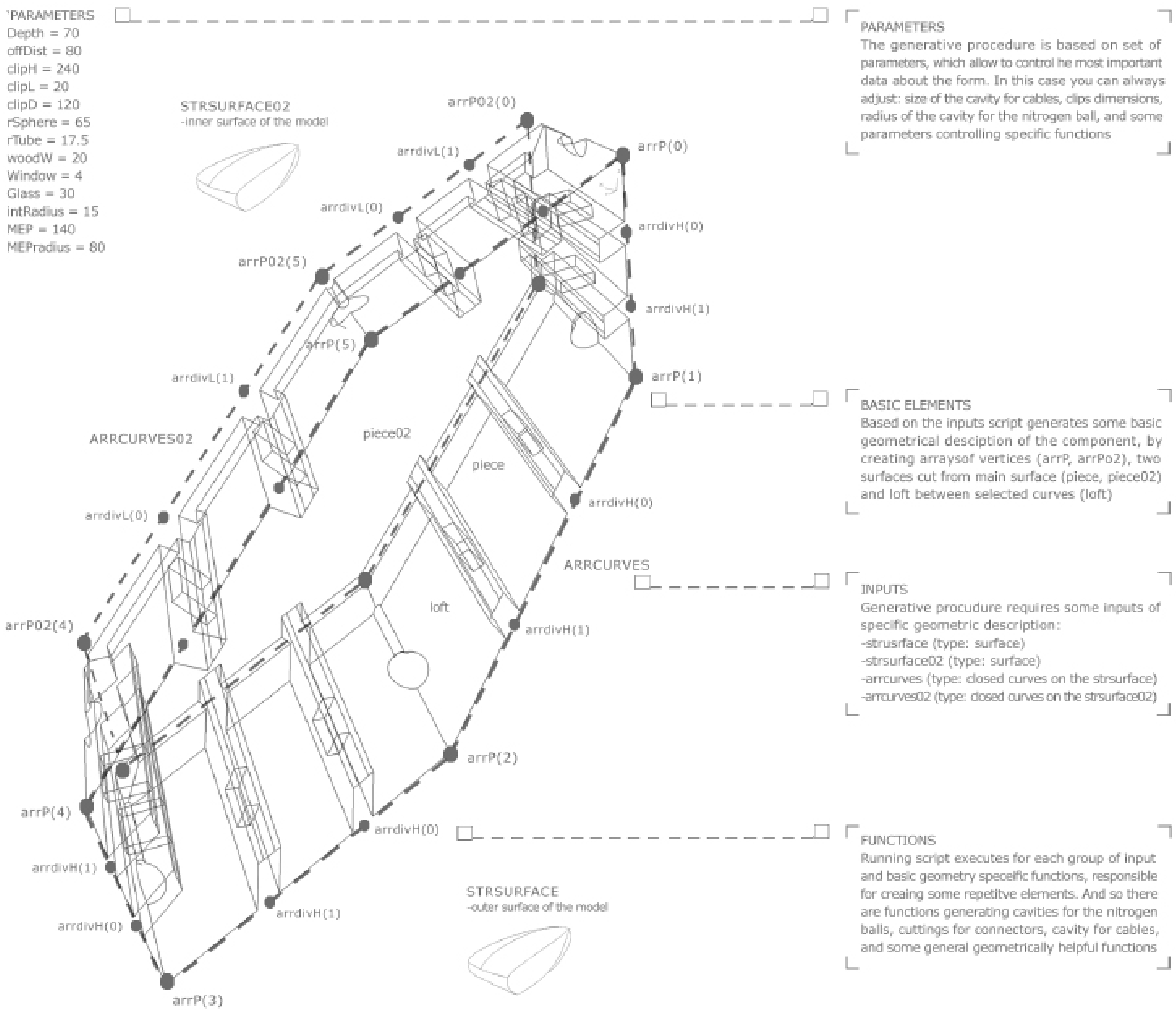

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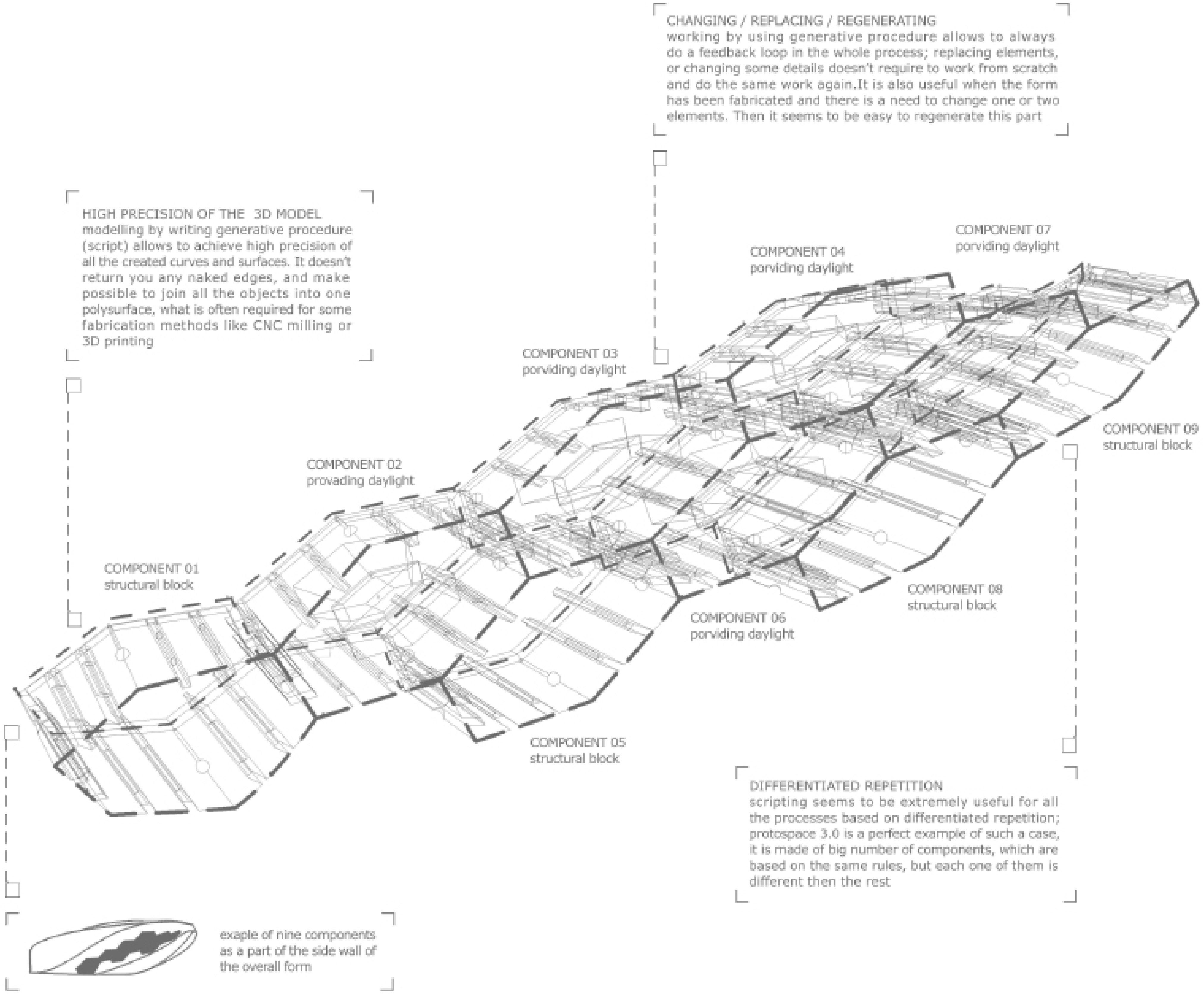
Figure 1-18. This diagram presents the way of describing geometry of each component by writing a generative proceudre.

1. Bodycheck 3 Styling Group Advantages of Working with Generative Procedures

Krzysztof Gornicki - 1530259



1.15. Generative Procedure

Working by using generative procedure gives many advantages comparing to 'manual' three dimensional modelling.

1. DIFFERENTIATED REPETITION
Scripting seems to be extremely useful for all the processes based on differentiated repetition; protospace 3.0 is a perfect example of such a case, it is made of big number of components, which are based on the same rules, but each one of them is different then the rest.

2. CHANGING / REPLACING / REGENERATING
Working by using generative procedure allows to always do a feedback loop in the whole process; replacing elements, or changing some details doesn't require to work from scratch and do the same work again.
It is also useful when the form has been fabricated and there is a need to change one or two elements. Then it seems to be easy to regenerate this part.

3. HIGH PRECISION OF THE 3D MODEL
Modelling by writing generative procedure (script) allows to achieve high precision of all the created curves and surfaces. It doesn't return you any naked edges, and make possible to join all the objects into one polysurface, what is often required for some fabrication methods like CNC milling or 3D printing

Figure 1-14. Part of the side wall with 9 generated components. Advantages of working with non-standard geometry by writing script.

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1. Bodycheck 3 Styling Group Generative Procu-dure As Way of Cre-ating the Final Mod-el

Krzysztof Gornicki - 1530259

1.16. Generative procedure / **Rhinoscripting**
Main steps of the generative procedure:

1. START OF THE PROCESS
Collecting all the necessary inputs:
-excel file describing specific functions
 for specific components
-3D model of the final form (including
 outer and inner surfaces
-hexagonal tesselation for inner and
 outer surface

2. RUNNING THE SCRIPT
Running the script requires selecting all the inputs in a proper order. First of all outer and inner surfaces, later outer and inner tesselation of the components you would like to generate. At the end you have to choose the excel file for necessary data.

3. GENERATIVE PROCEDURE
Generative procedure creates in Rhino application forms of designed components. It includes all the details and varies the functions of the specific components based on excel sheet.

4. FINAL RESULT
Final result of the whole process is divided into to different parts. The first one consits all the components placed in a specific place on the 3D dimensional model, the second one collects all the components separeted on the 2D grid and ready for fabrication

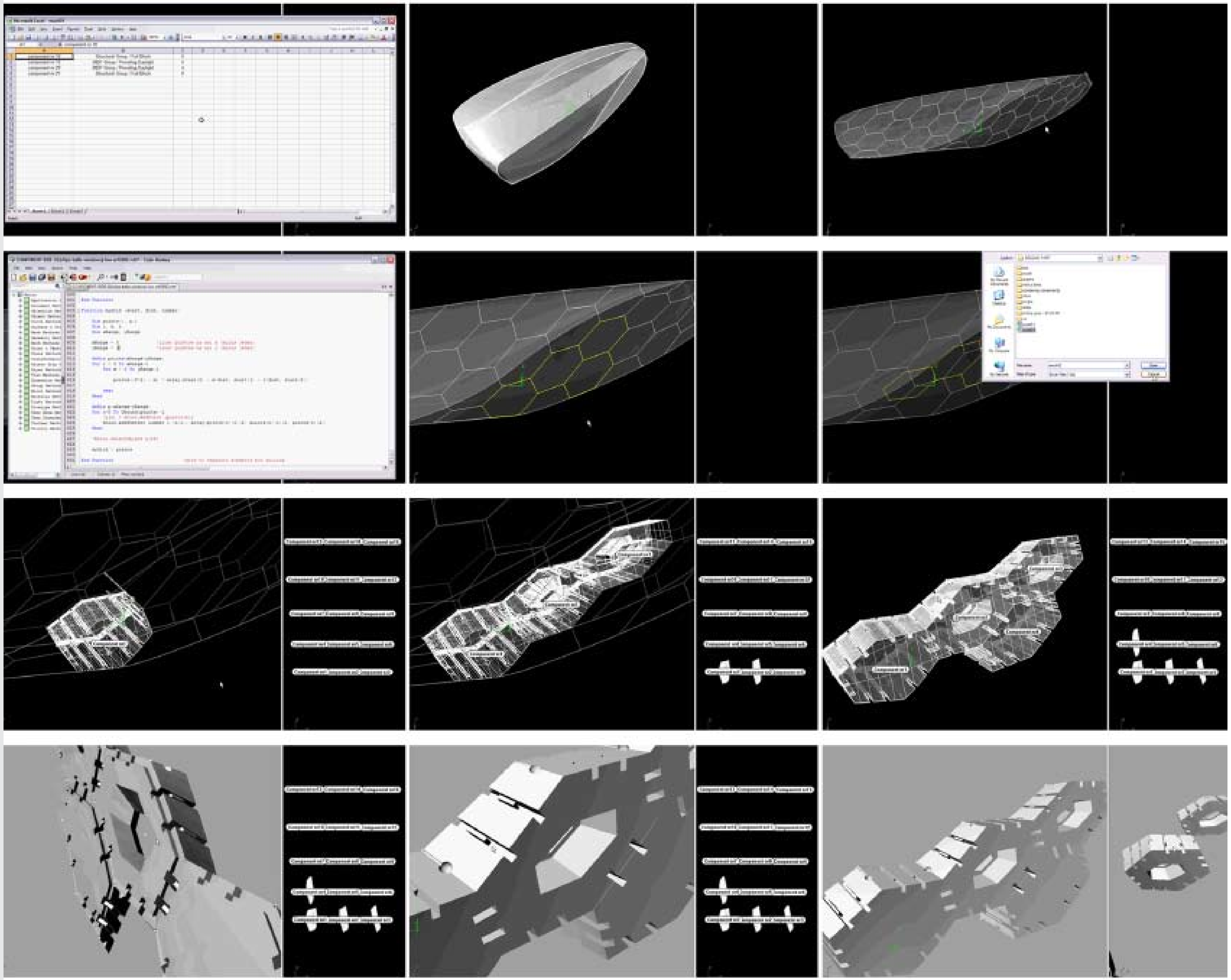

Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostr
Figure 1-16. Screenshots from the process of generating four chosen components with specific functions.
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1. Bodycheck 3 Styling Group Six Components Chosen for the Final Fabrication of the Prototype

Krzysztof Gornicki - 1530259

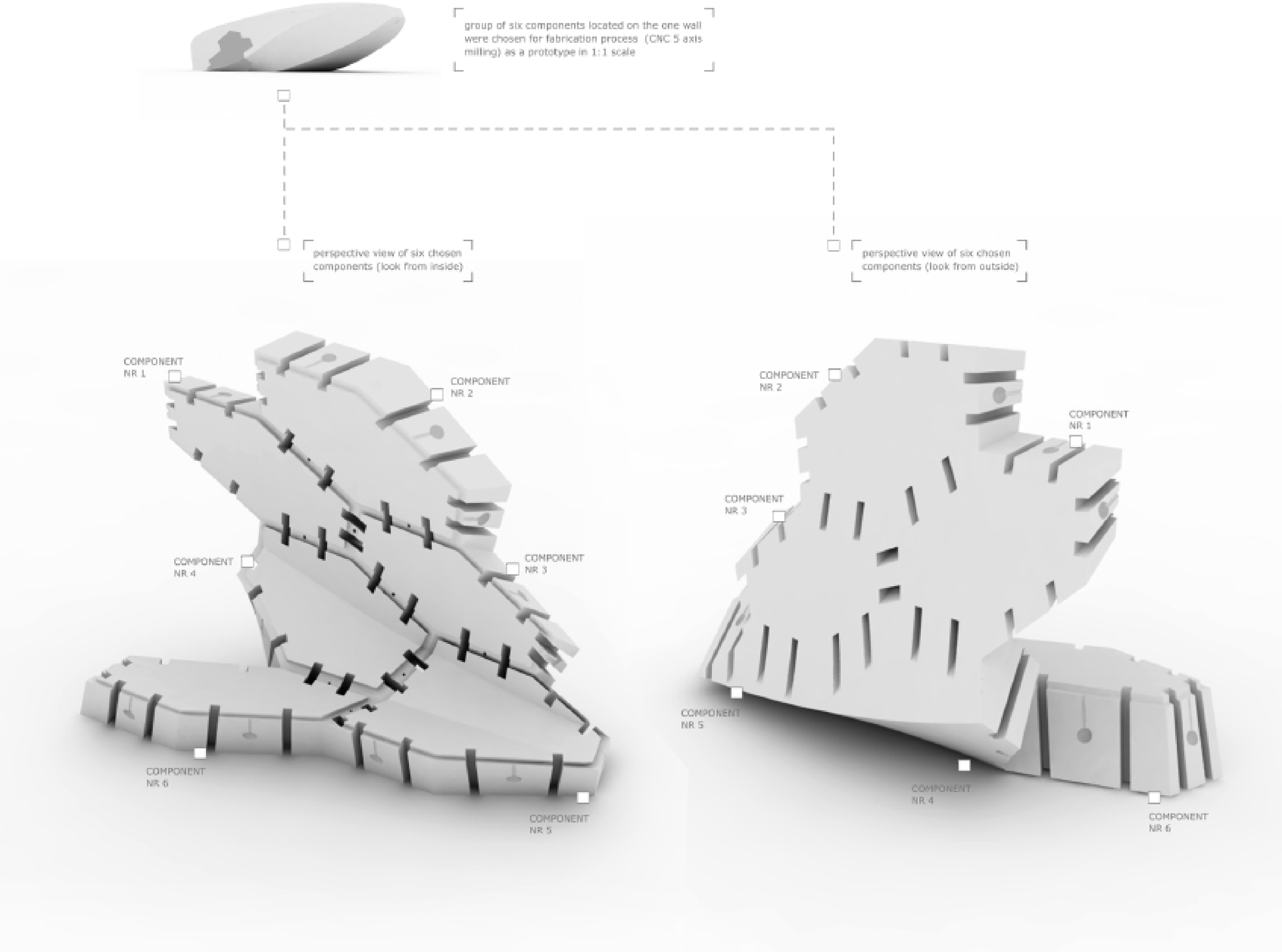

Figure 1-16. Six components chosen to be full scale prototype of the Protospace 3.0 project. Basic model generated by Styling Group without decision on functons

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1.17. Generative six components for fabrication

There were chosen six components for fabrication of the prototype in full scale. The whole process of generating them were based on one of Kas Oosterhuis tips he gave us during an introduction lecture:

To be sure of a direct relation between your BIM and the actual fabrication, you must write your own scripts to link your machine to their machine, this is called machine to machine [M2M] communication and File to Factory [F2F] fabrication. Design such as to fabricate only by CNC [Computer Numerical Control] machines. Avoid bypasses, but make sure the manufacturer imports your data directly, without rebuilding 3d models and rewriting scripts. Talk with the manufacturers and prepare your data in such a way that they can be used unconditionally.

1. Bodycheck 3 Styling Group Six Components for Fabrication - Separeted Models for Process of CNC Milling

Krzysztof Gornicki - 1530259

1.18. File-to-Factory
Six chosen components ready for fabrication process. Each one of them as a closed surface model without ‘naked edges’, whcih is crucial for letting CNC milling machine fabricate it.
However after generating these files Studio decision was to add some more ornament on each one of them - just to test different possiblities of milling process. And so there were another iteration of modelling components.
Each one of components went to specific person, who was responsible for creating some patterns on its surface.

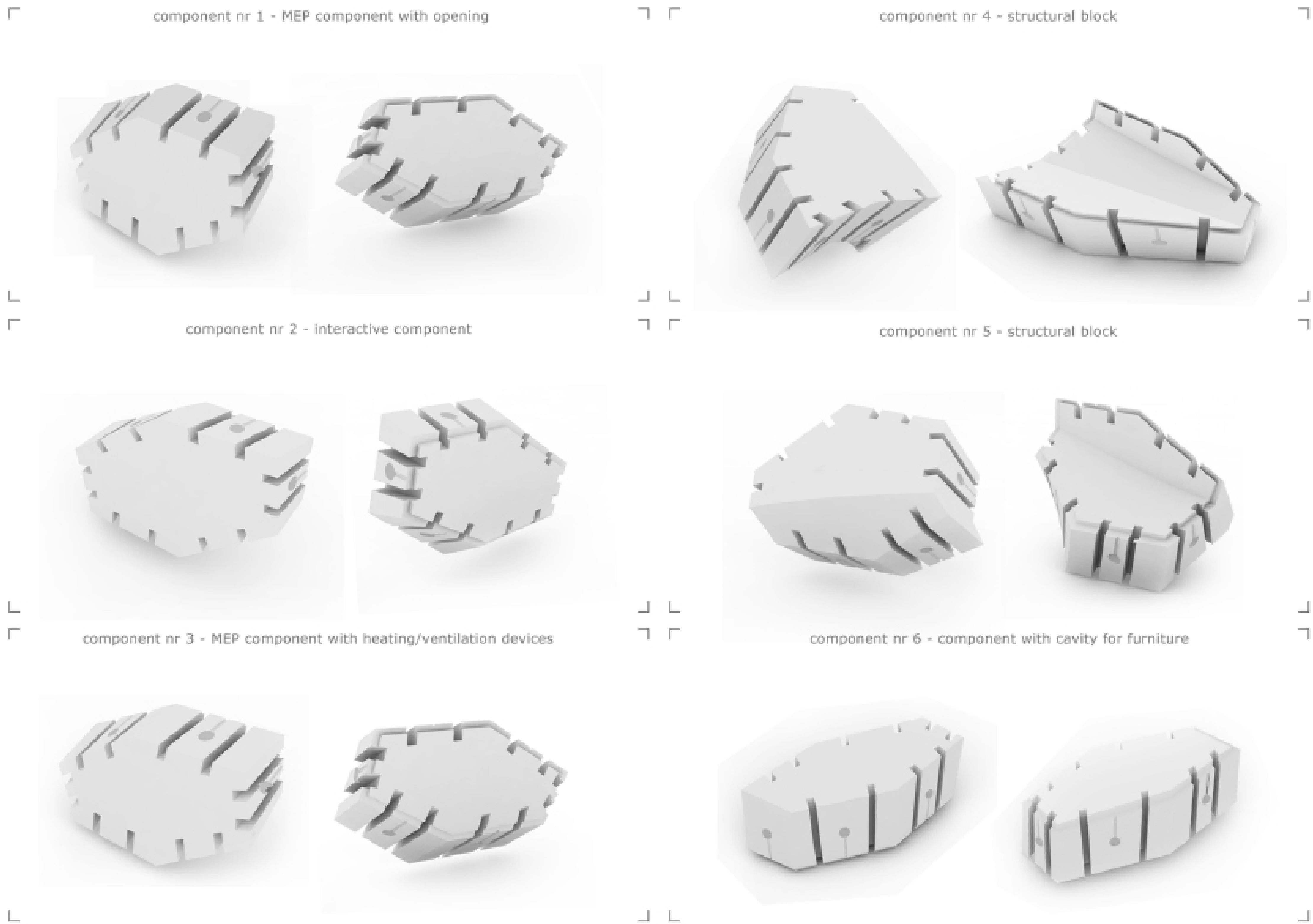

Figure 1-17. Six files ready for further fabrication process.

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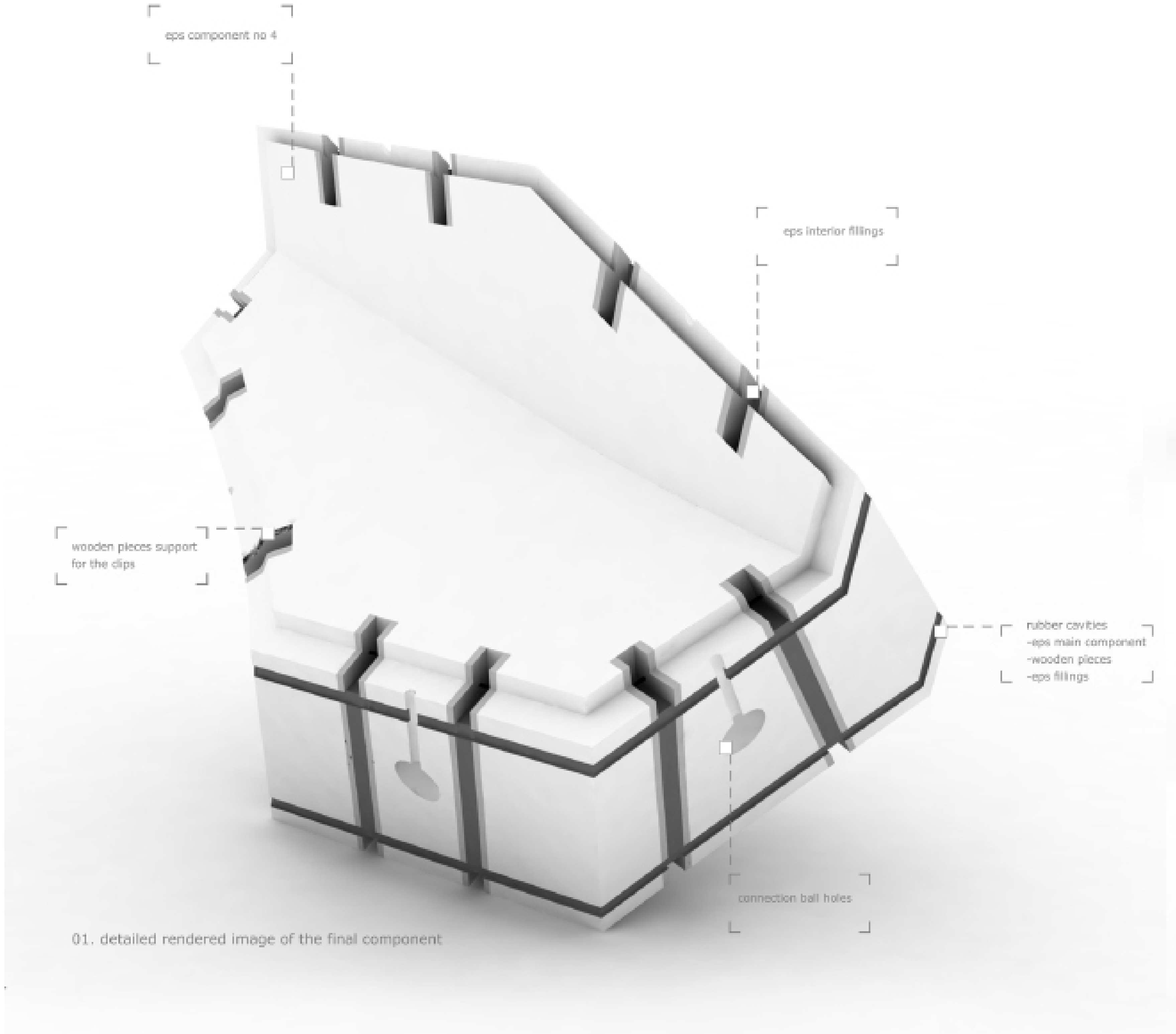
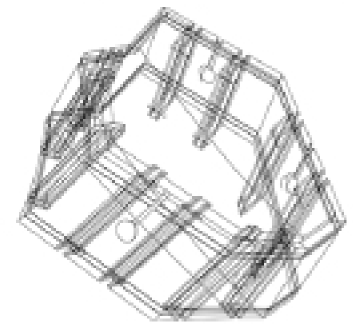
1. Bodycheck 3 Styling Group Detailing Component Number 4

Roxana Palfi - 1535269



01. detailed rendered image of the final component

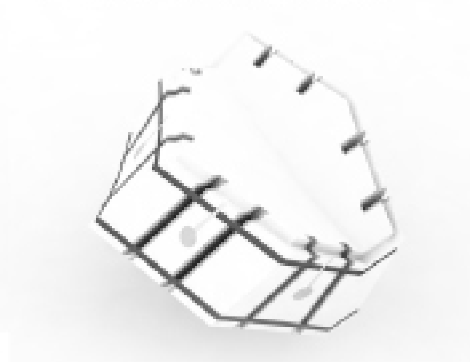
02. component - wireframe image



03. component - rendered image

04. component - rendered image

05. component - rendered image



1.19. New details

One of the components for econd iteration of modelling were modelled by styling group as well.
However component nr4 was decided not to have any specific ornaments or textures. The only thing which had to be changed were places for clips and adding cavity for rubber.

Figure 1-18. Detailing one of the fabrication components, adding some new construction details.

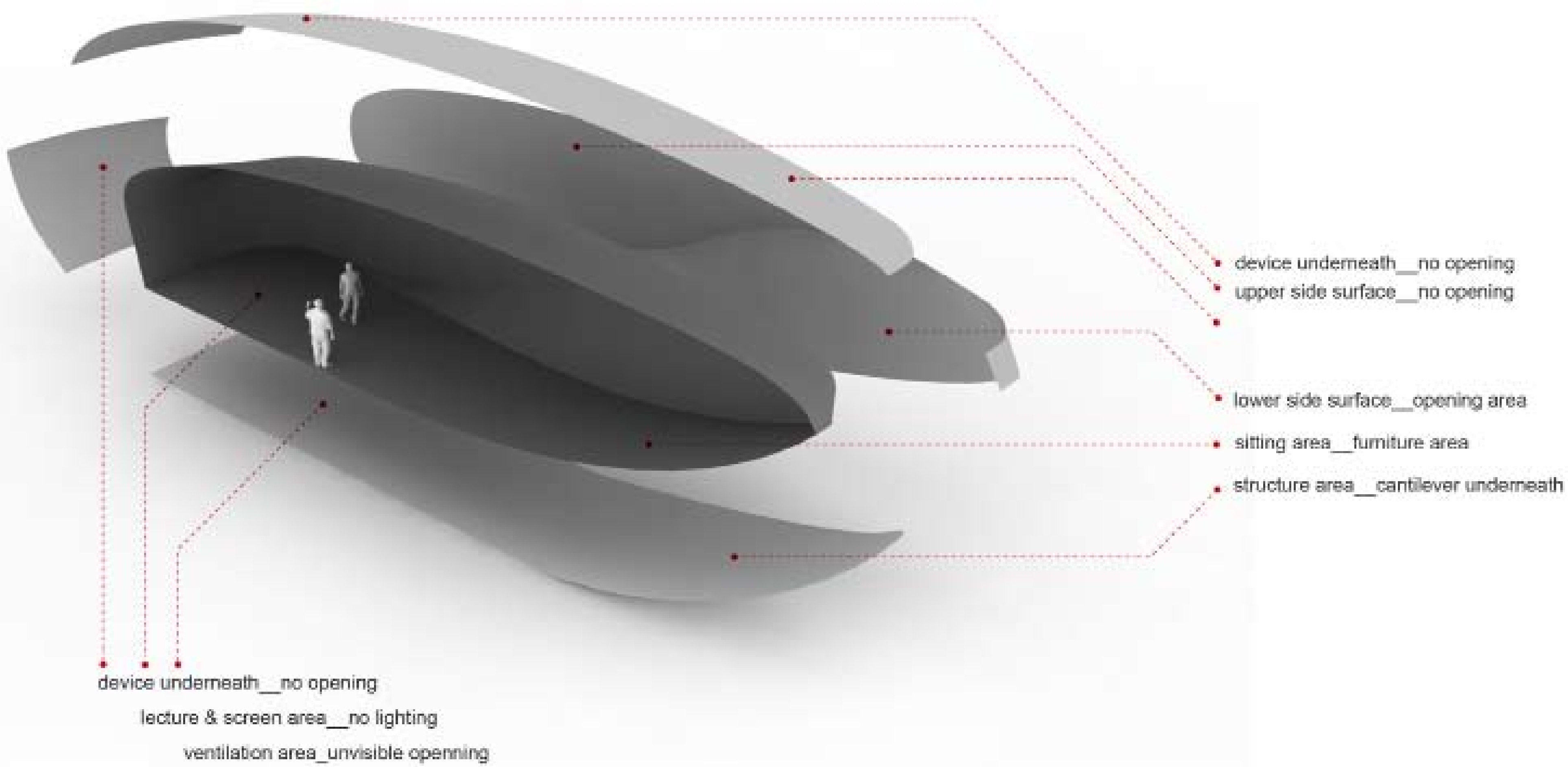
Figure 1-4. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. Bodycheck 3
Styling Group
Location of the Openings

JinJie Yan- 1530607

1.20. Different zones of the space - location of the windows

The space of the project is divided into different functional zones and the location of the openings follows this logic. Thus there is no single opening in the zone of the ‘arena’, which is space for projections and lectures.
The openings appear in the part of ‘podium’, giving chance to users to look outside the building body, and at the same provide a bit of sunlight.



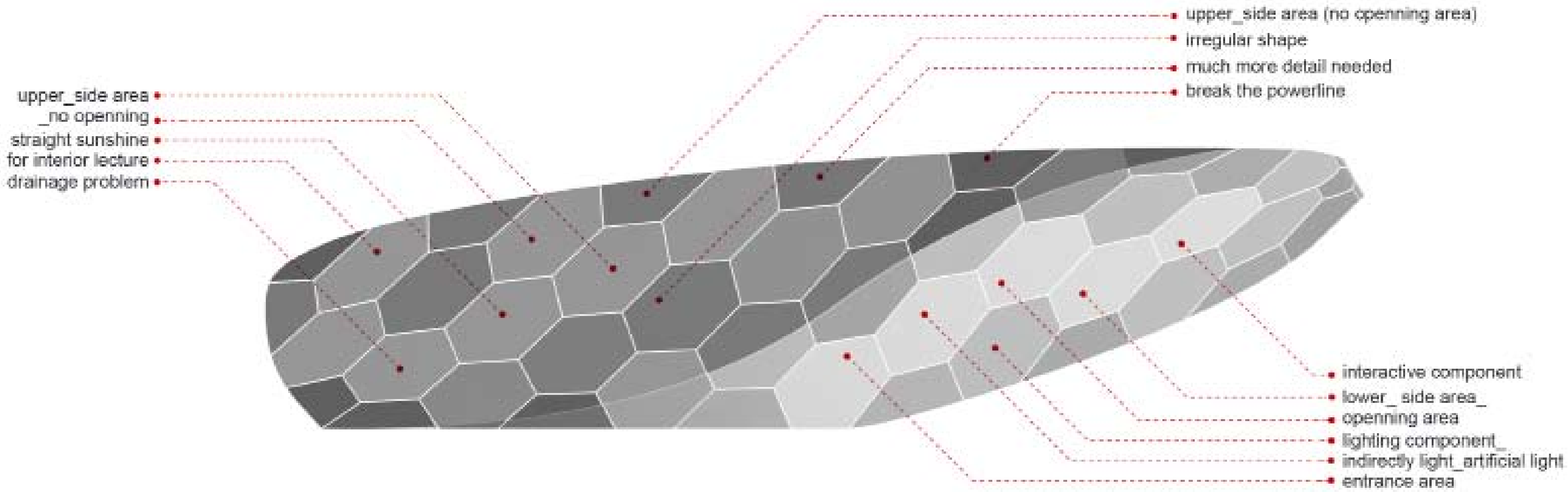


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Figure 1.19. Diagrams showing the possible location of the windows. DIfferent functional zones driving the specific positions.

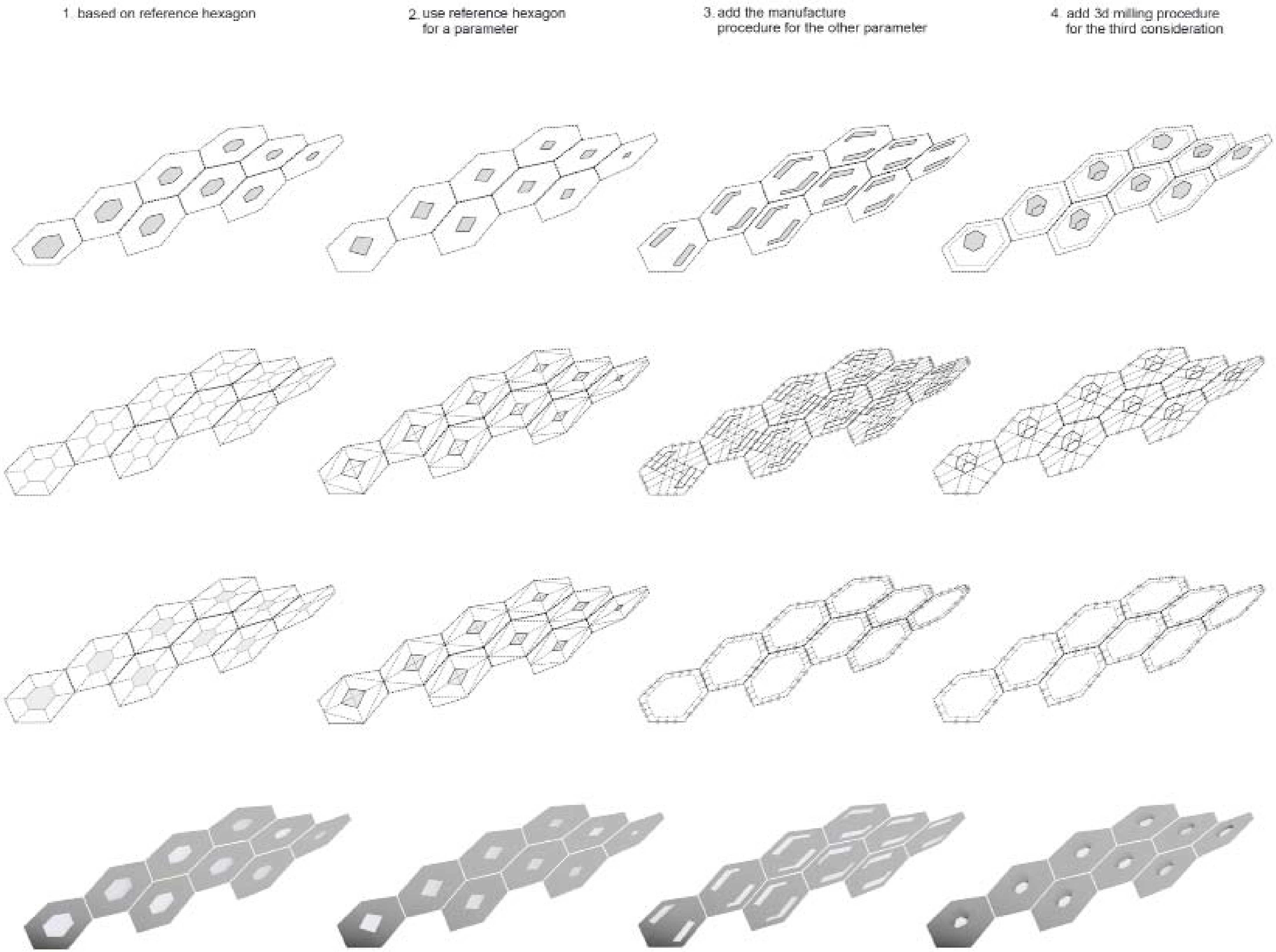

Figure 1-20. Different development of the windows shape. Looking for the proper geometrical logic as a starting point.

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1. Bodycheck 3 Styling Group Different Kinds of Openings for Chosen Group of Components

JinJie Yan- 1530607

1.21. Patterns for the openings

The next step of designing the pavilion was the decision about the pattern of the openings.

The first trial was based on the exact shape of the component, so the openngs got the hexagonal shape as well.

Later we were trying to develop a pattern based on the geometrical logic of the component and its cuttings for the connectors.

Except for these trials there is an additional layer of developing the window shape, related to the third dimension of it. Thickness of the component and five axis milling procedure allows to make a window changing the shape (different one on the outer surface and inner).

1. Bodycheck 3 Styling Group Different Variations of the Openings on Three Dimensional Form

JinJie Yan- 1530607

1.22. Different variations
Trying different variations on the three dimensional model and comparing all of them together. Four specfic design propositions:

1. Big hexagonal openings
Radius of each hexagon is based on the referenced hexagon.

2. Square shape
Width and length based on propotion of the referenced hexagon.

3. Following the geometry logic
Trying to develop a logic based on the geometry of the component and its cuttings.

4. Small components
Refering to the sizes of the component

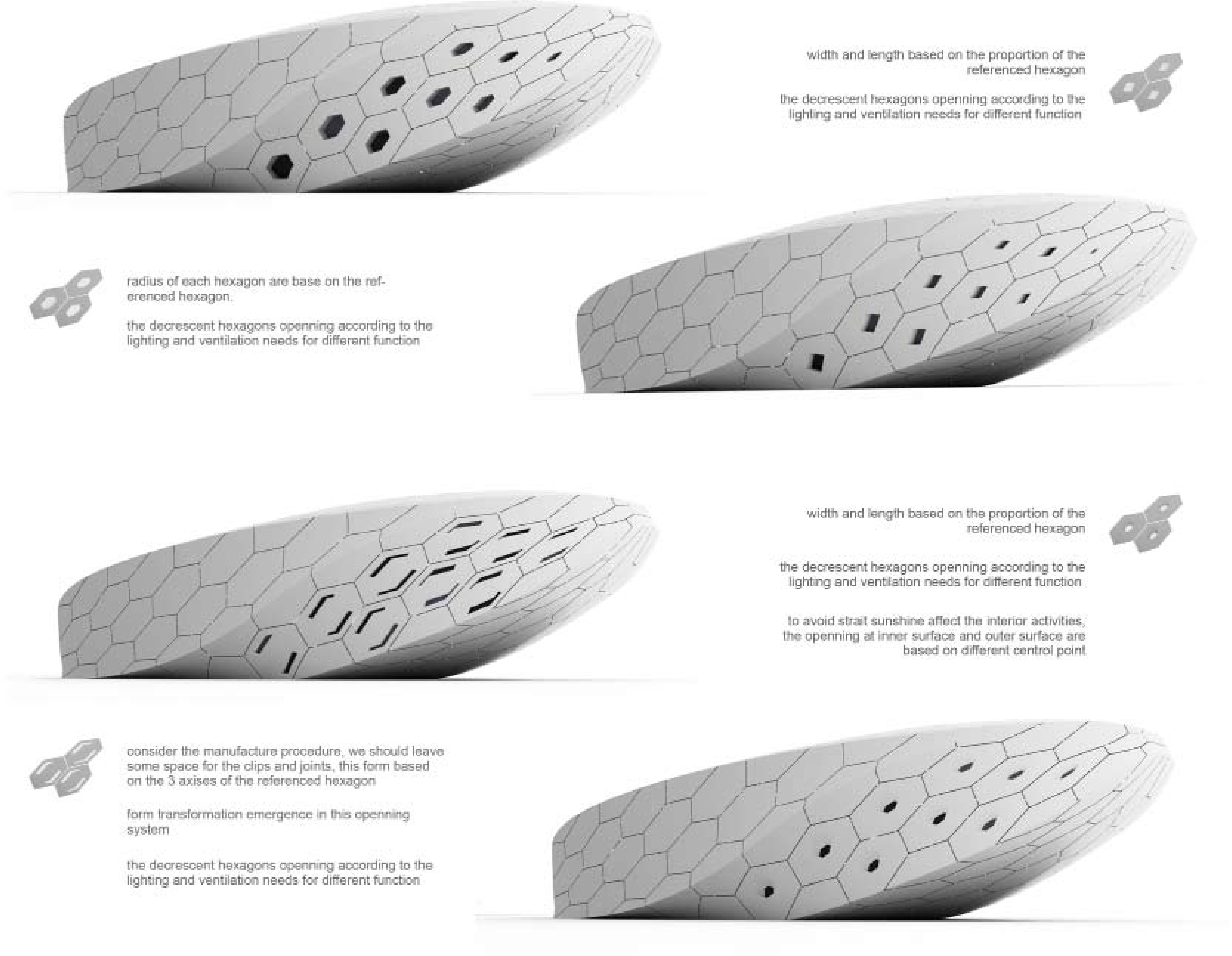

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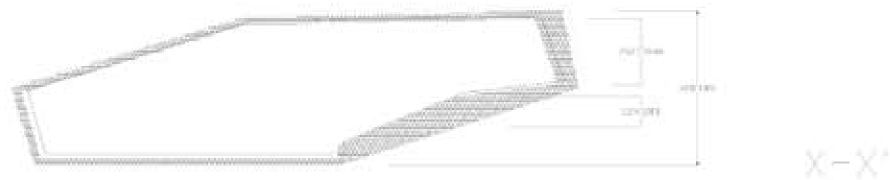
Figure 1-21. Final rendering of the project proposal of the Protospace 3.0 (vizualization done by Jackie Yan)

Figure 1-1. This text shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Drawing of Components' Thickness

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Calculation of components' thickness



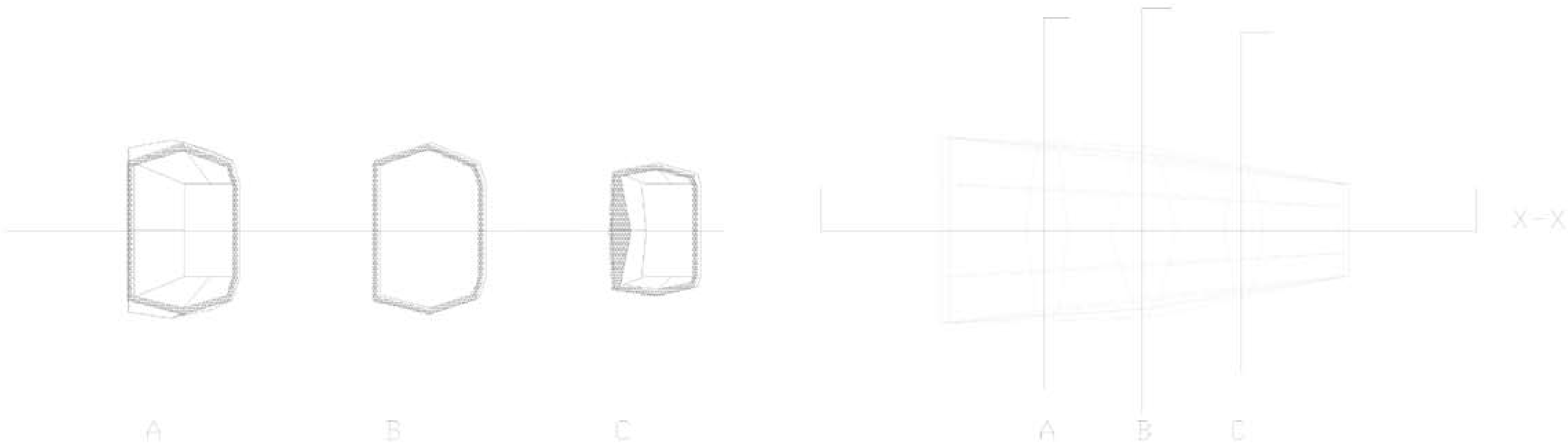


Figure 1-1. Section of model

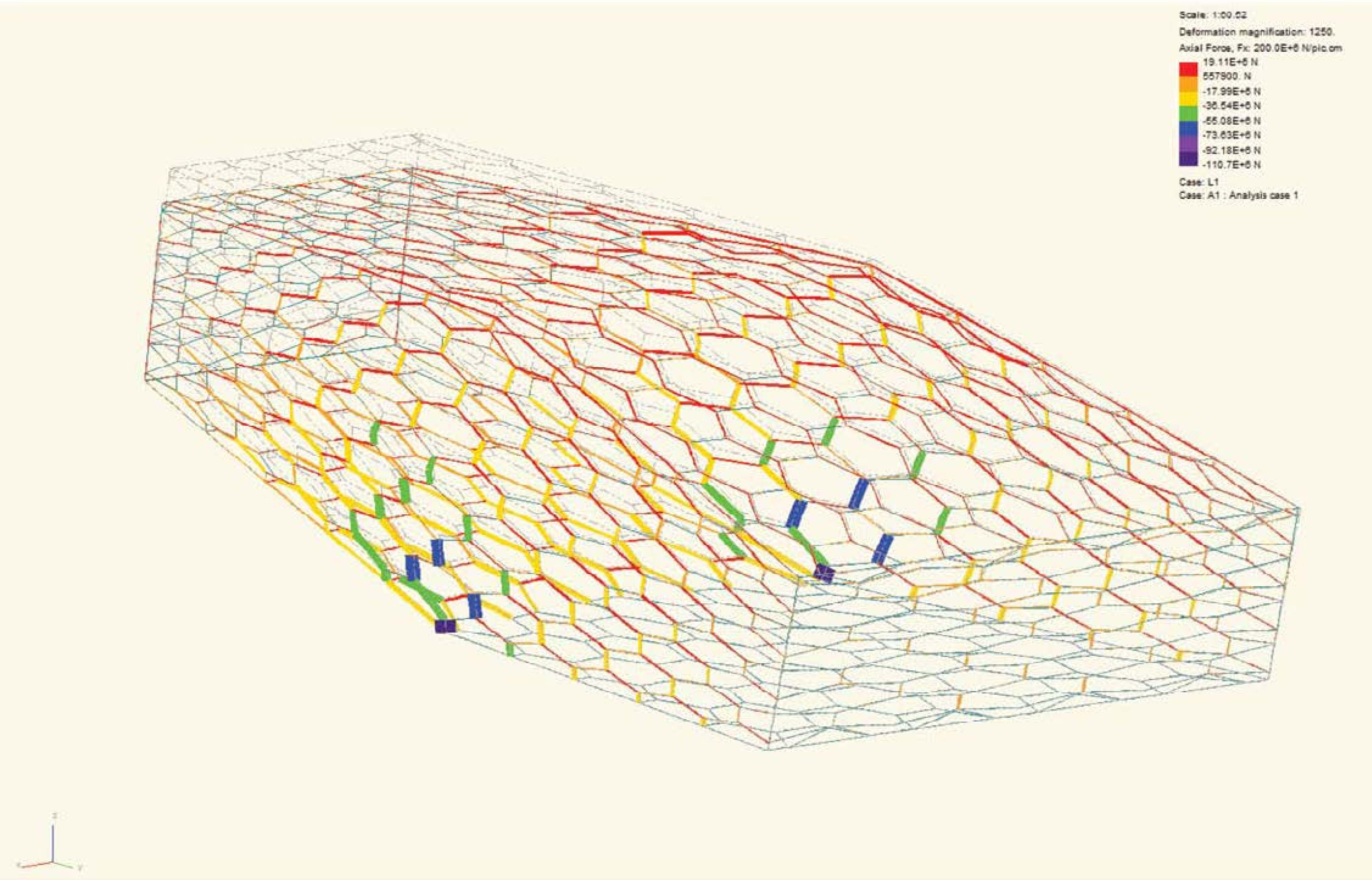


Figure 1-2. Analysis of wireframe

Bodycheck 4
Structure

Analysis of Wire-frame

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Calculation of components' thickness

Bodycheck 4
Structure

Study of Loding Cases

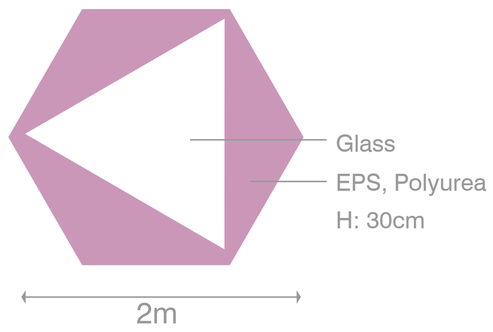
Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Study of loading cases

SELF WEIGHT

G=19kg/m^2 * 9.81= 0.19 KN/m^2

Rough size
of a component



Closing part
EPS: 14kg
Polyurea: 12kg
Total: 26kg 9.88/m^2

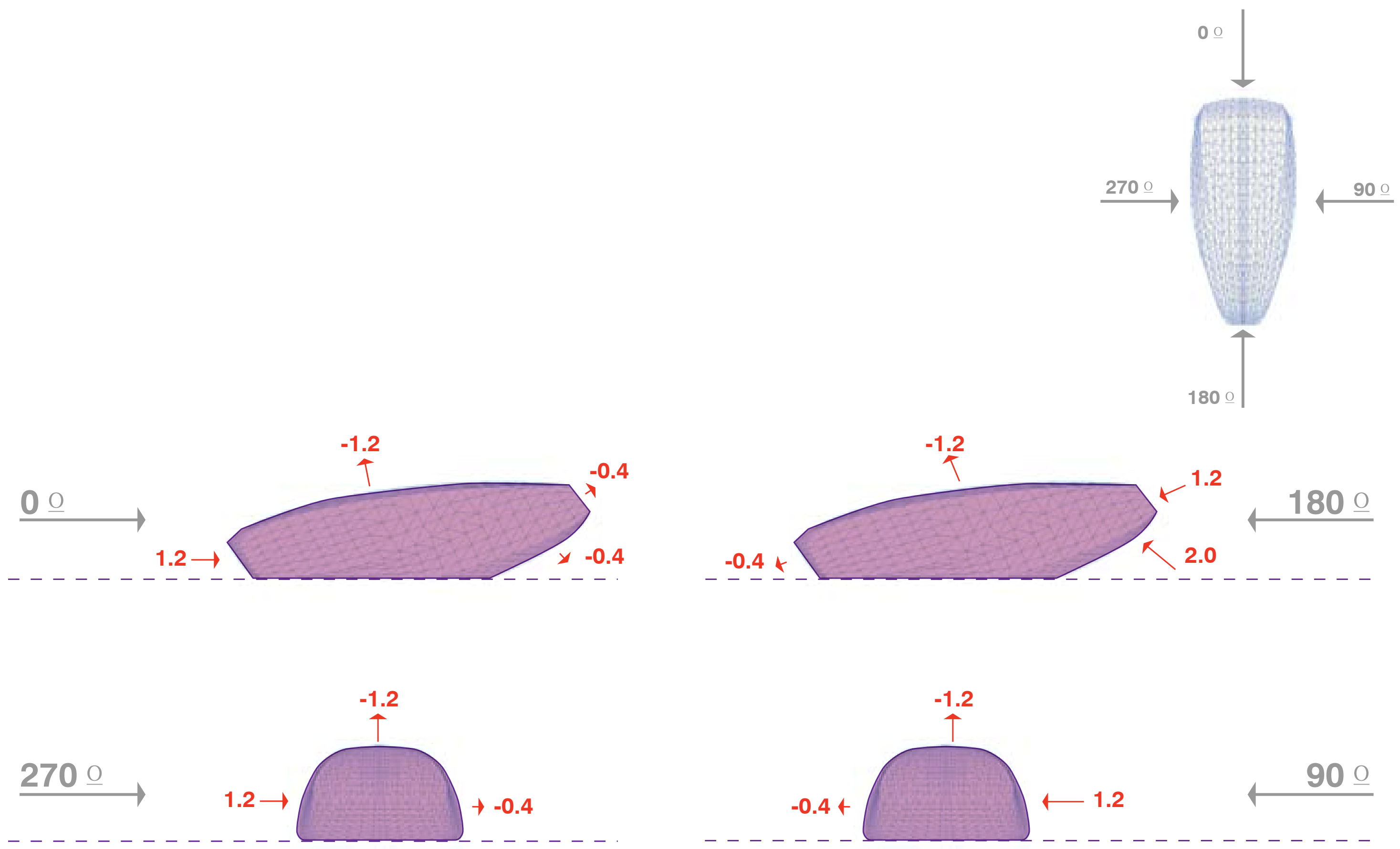
Open part
Glass: 24kg
Total: 24kg 9.12kg/m^2

19kg / m^2

EPS: 28kg/m^3
Polyurea: 1-1.1kg/l
Glass: 30kg/m^3

VARIABLE ACTIONS

Q(snow)= 0.7 KN/m^2
Q(imposed load)= 5KN/m^2
Q(wind load)
= different values in 4 directions



Analysis of Surface

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Calculation of components' thickness

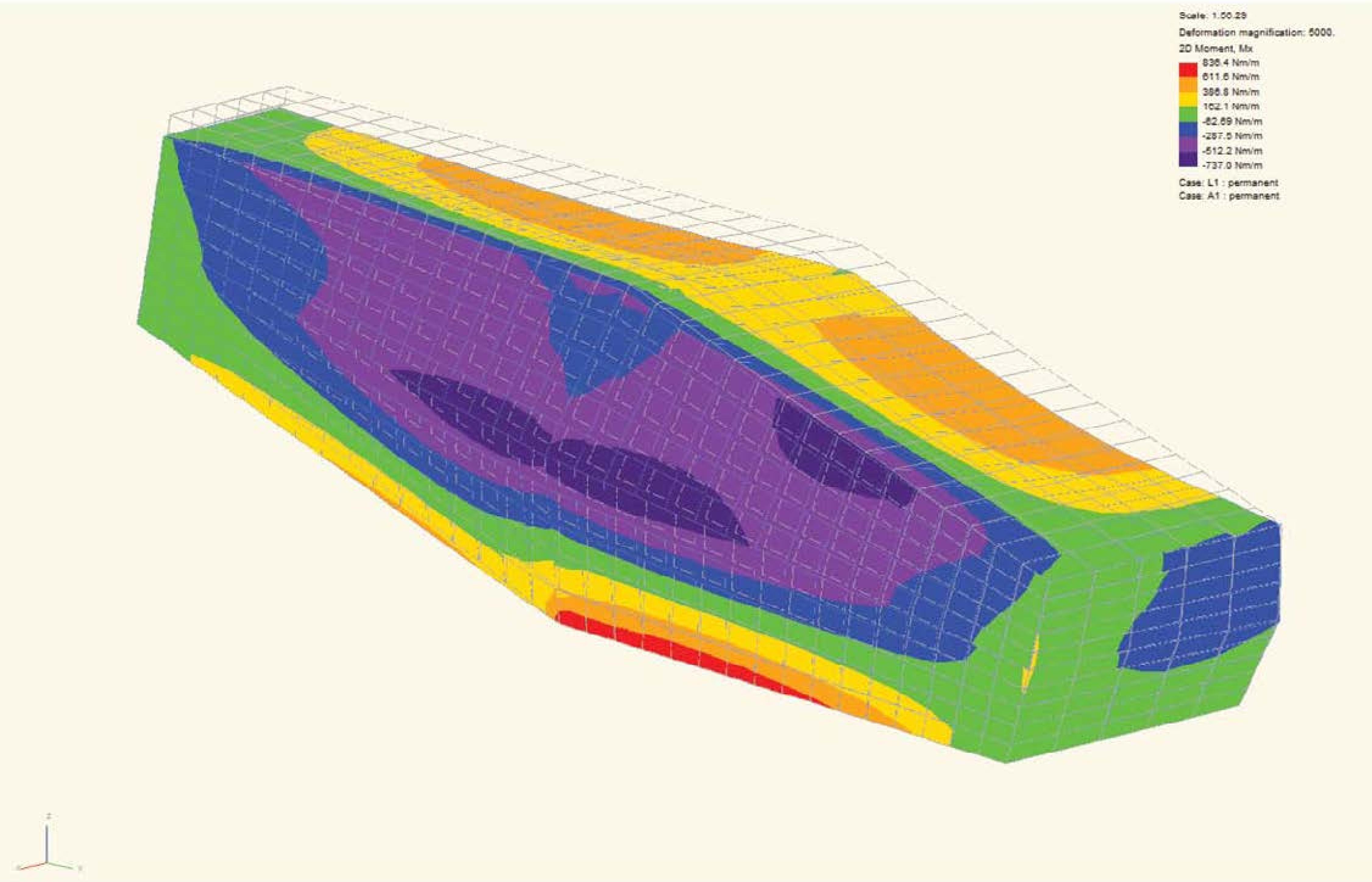


Figure 1-3. Analysis of model

Adjustment of Componens' Thickness

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Calculation of components' thickness

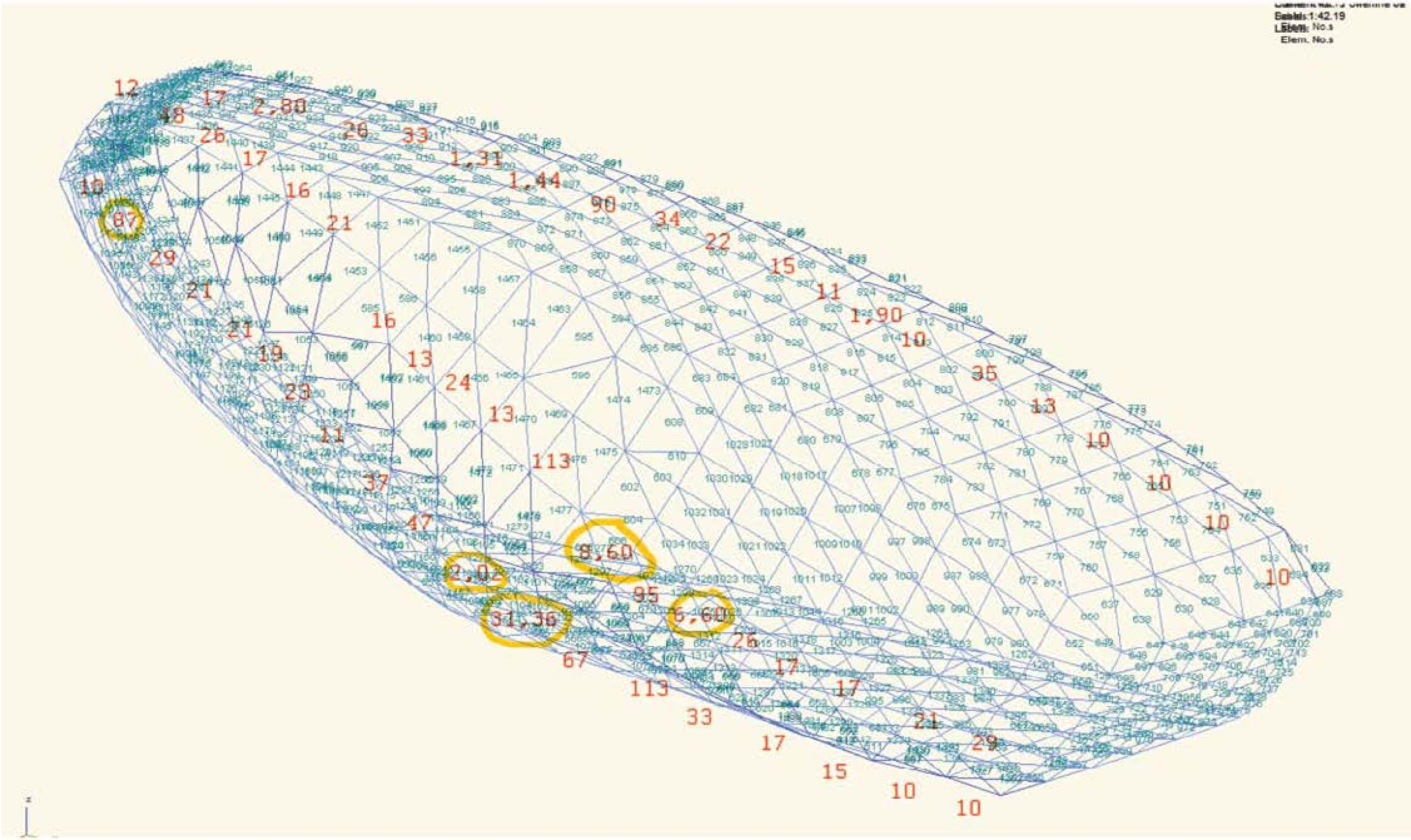


Figure 1-4. adjustment of components' thiickness

Modify components' connections

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

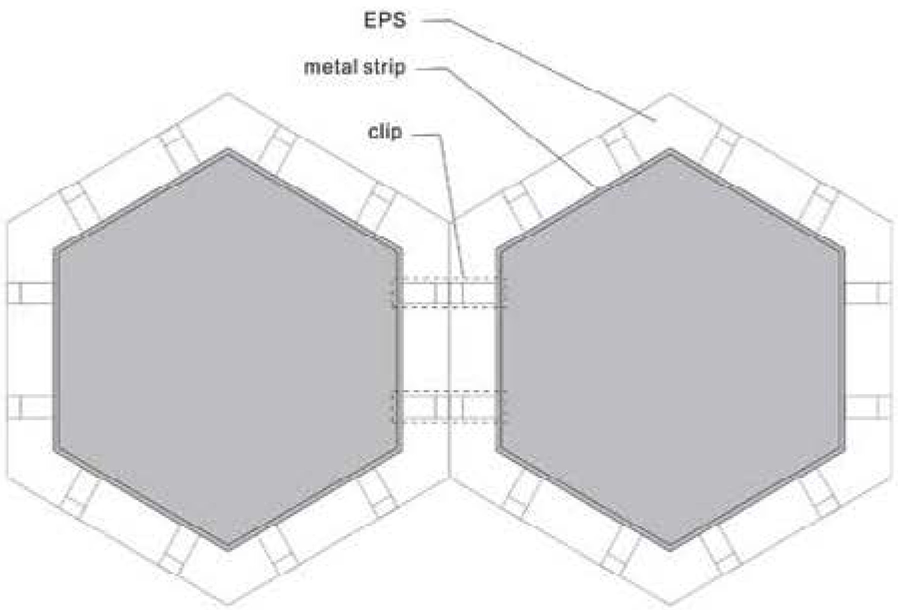
Calculation of components' thickness

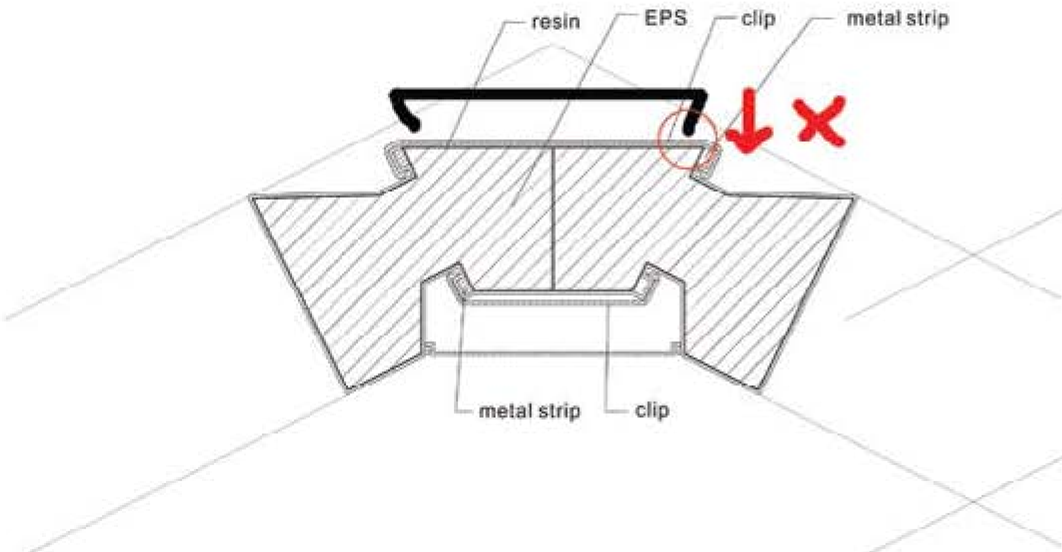
We really like all of your proposes. However, we decided this clip methord is the most effircint methord for construction.

We are wondering if you want to use this joint, you cannot install clip from top to down. Because we should use very strong clip materials which is not elastic thing.

Therefore, we suggest clamp which can adjust length of distance between components and it will be easy to construct.

Can you evalute this joint is good or not?





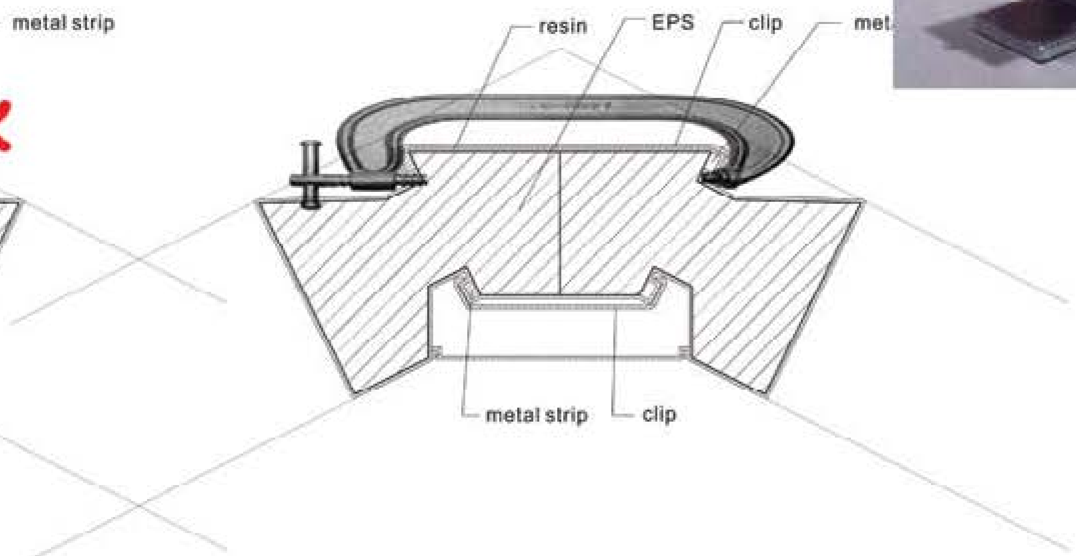


Figure 1-5. Advice of connection detail

Bodycheck 5
Structure

Load cases

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Load application

We applied 6 load cases and 12 load combinations on surface in total.

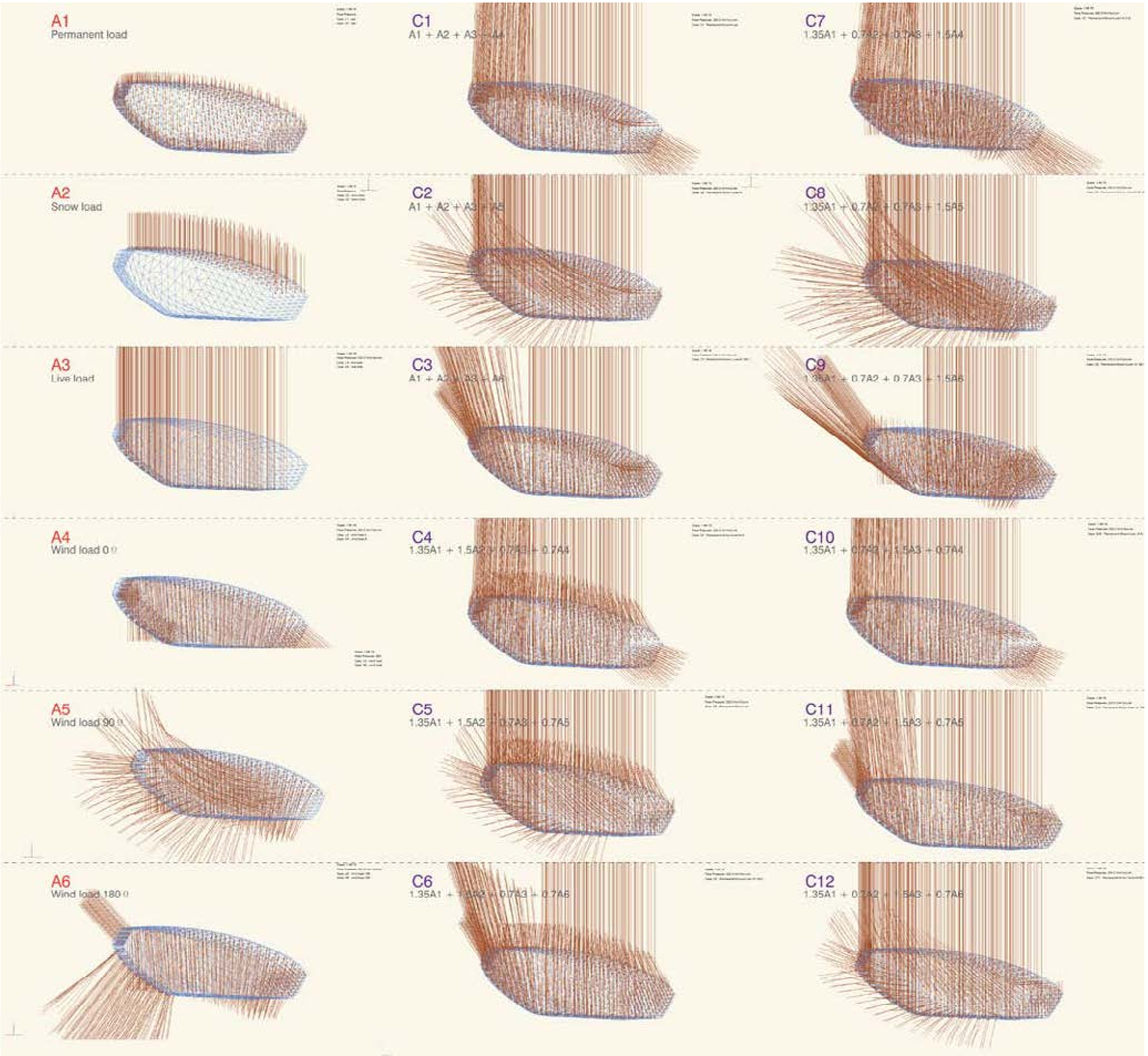


Figure 1-1. Load cases and their combinations.

Bodycheck 5
Structure

Component thickness

Soran Park 1530801
Mingyu Seol 1535234
Stella PC Lam 1535129

Results from GSA analysis gave data on bending moments and axial froces acting inside each element all over the building skin. Data were then transferred to excel for component thickness calculation. A long list of thickness in all the 12 load combinations was created and only the largest value of each element among the 12 cases were chosen. They were then grouped into similar ranges to give a uniform and smooth inner surface to the building. The diagrams show the thickness of components in different parts of building at this stage.

For more details and updated thicknesses, please refer to Bodycheck - 6 - Component thickness.

Inner surface

Maximum thickness: 1.2m (Not allowed to have window, storage etc.)
Minimum thickness: 0.7m (Storage net height 0.6m + minimum structural height 0.1m)

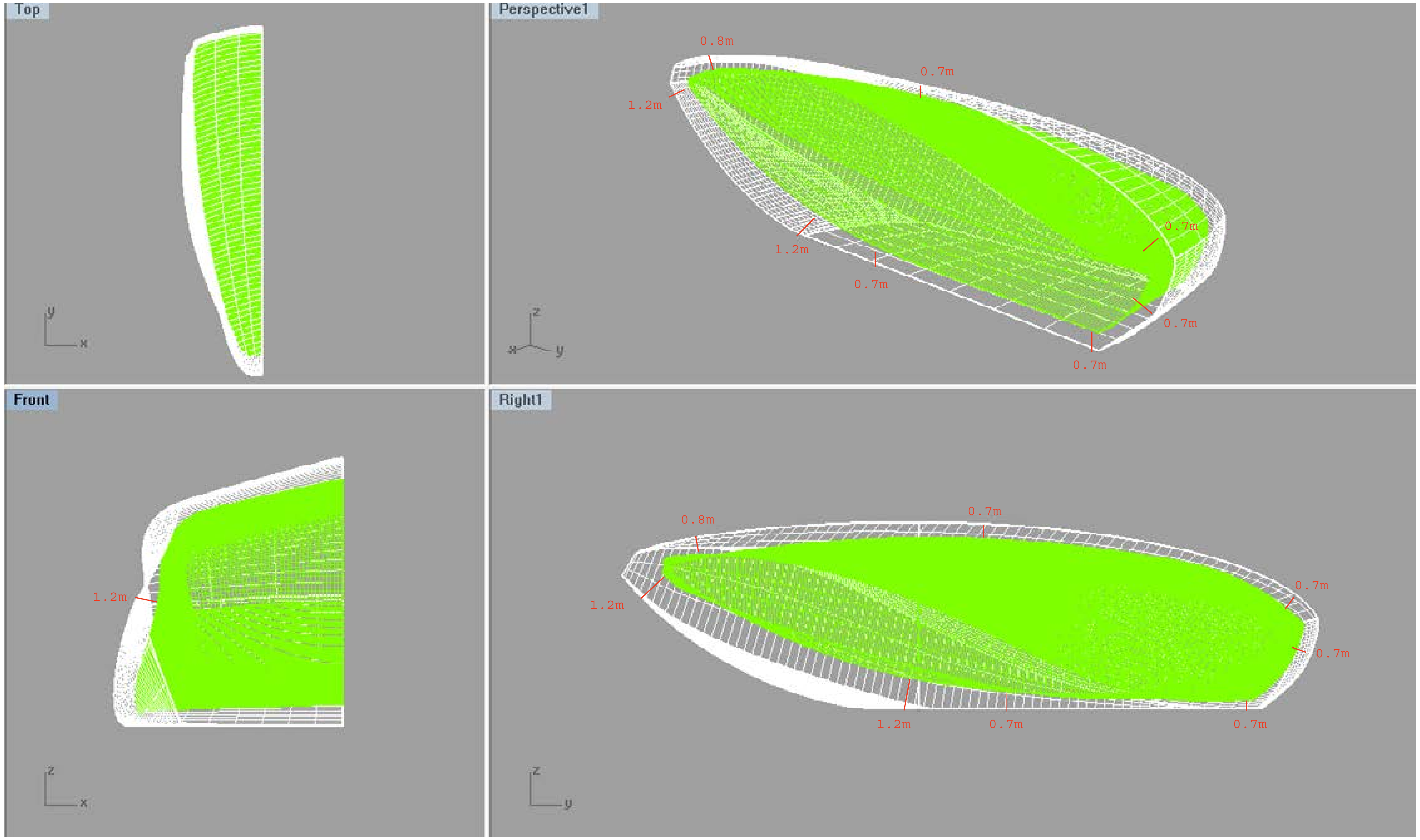


Figure 1-2. Thicknesses of components.

Bodycheck 5
Structure

Openings on components

Soran Park 1530801
Mingyu Seol 1535234

The possibility of Opening size
In terms of calculation, some of the components are strong enough to stand structure. Therefore, we can provide opening space at the wall through using overplus structure.

The generation opening space in parametric way
We provided the maximum size of opening which can be generate from center point of hexagonal components. Therefore, stylist group can generate opening tessellation easily without a lack of flexbilities.

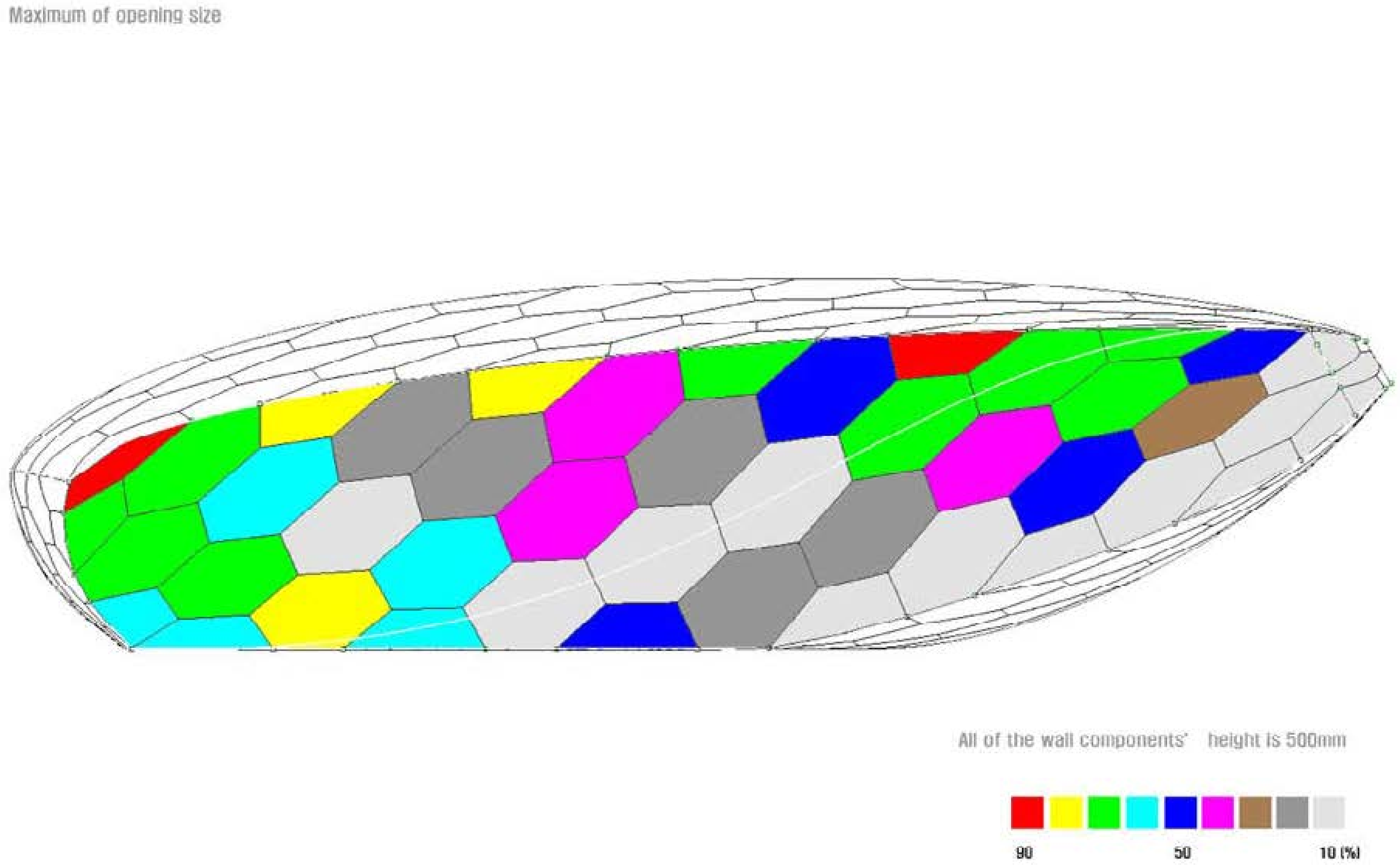


Figure 1-3. Maximum sizes of openings and cavities, shown in percentage in relation to surface area to that of the component

Bodycheck 5
Structure

Door options

Stella PC Lam 1535129

Five options of door opening positions were analysed. They were subjected to moments, forces and deformation analysis in 12 different load cases.

In comparison of the options in each case, the best options are chosen according to the selection criteria. (For selection criteria, please refer to Bodycheck 6- structure - Door options.) The options being most frenquently selected in each analysis (eg.max. 2D moments, max. 2D forces, deformation) are collected, then among these options, the most frequent selected options are then chosen again as the optimum door options. (For more details, please refer to Bodycheck 6- structure - Door options.)

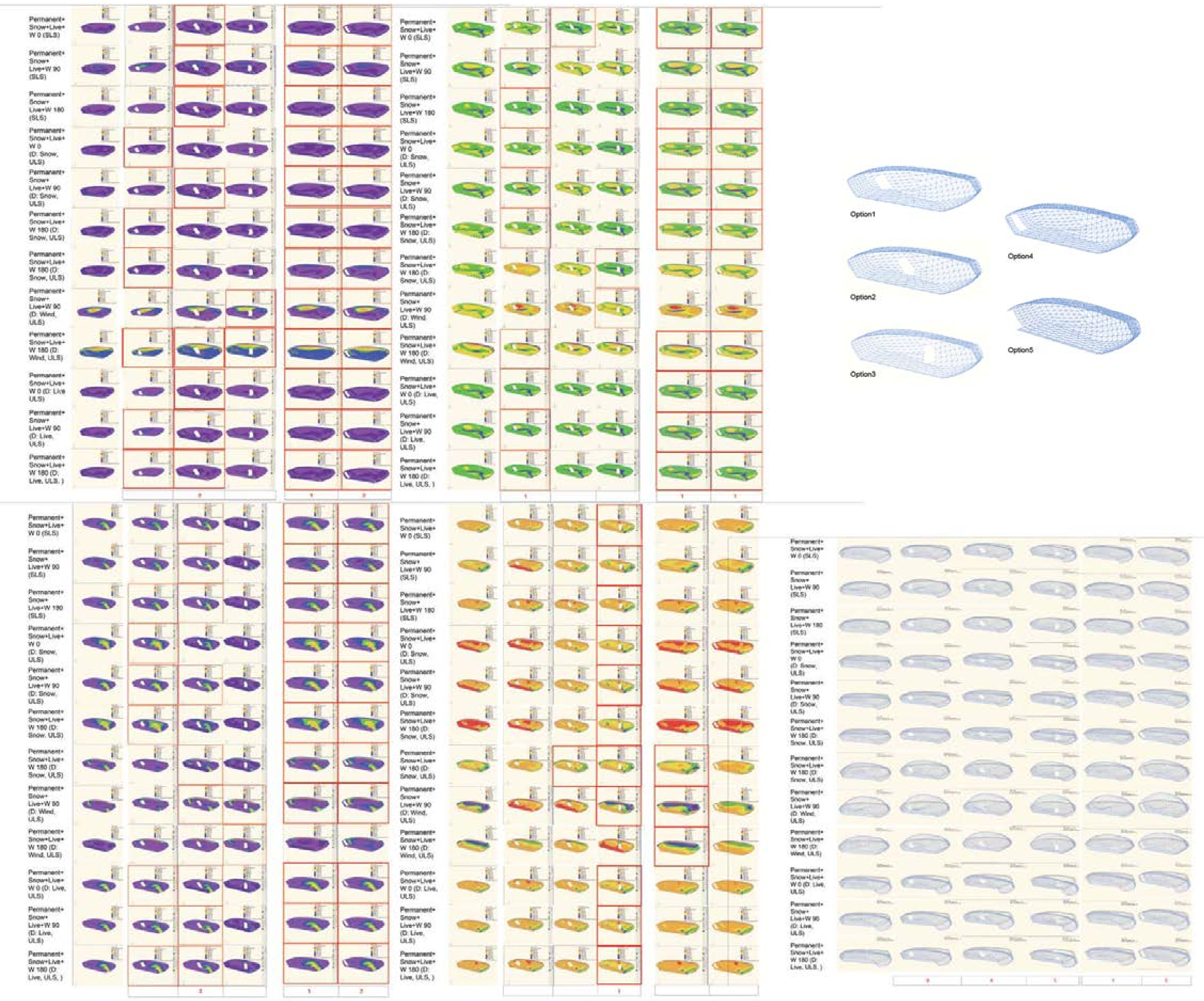


Figure 1-4. Door options under different load cases in moments, forces and deformation analysis

Bodycheck 5
Structure

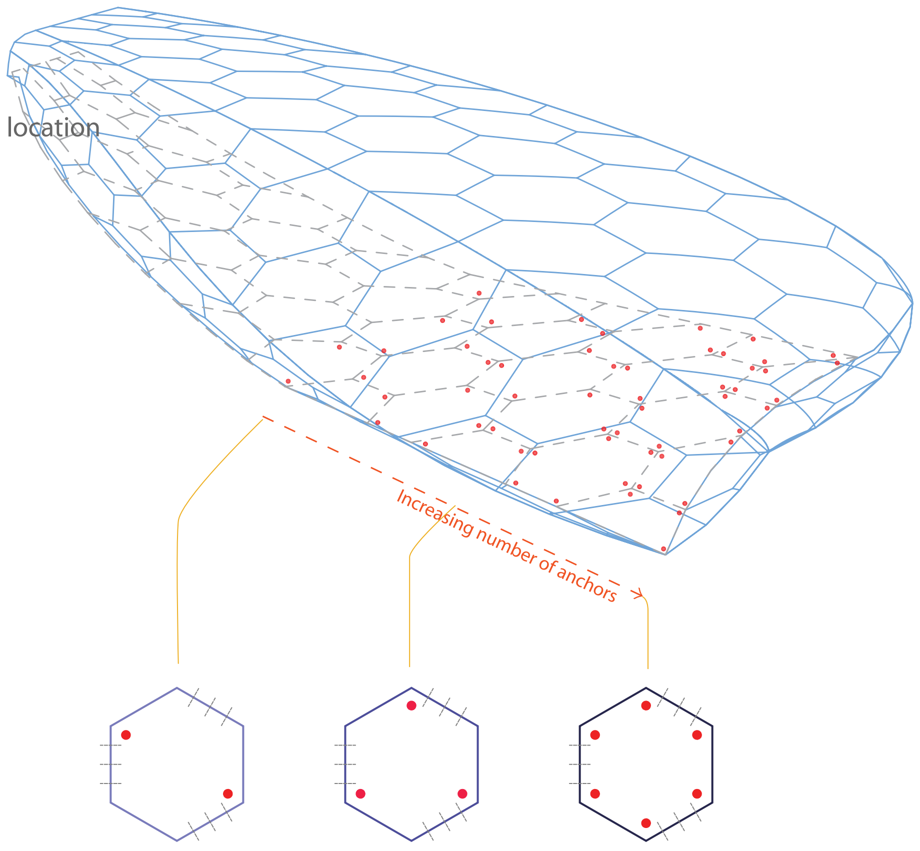
Anchor and founda-tion

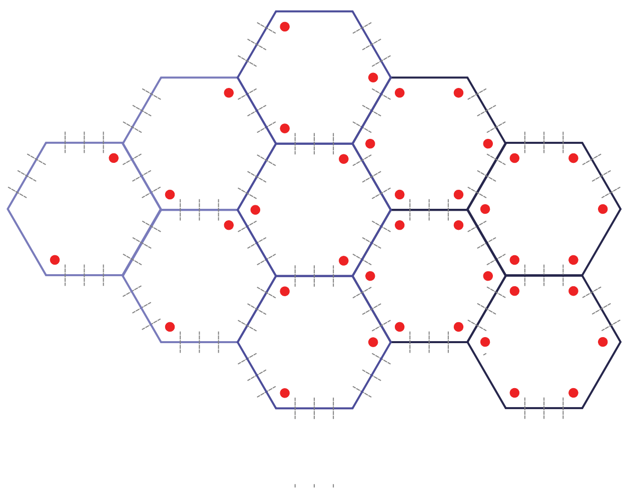
Soran Park 1530801
Mingyu Seol 1535234

The number of anchors
Because of huge cantilever part of building, the momentum increases when it comes from the middle part of structure to the end part. According to the amount of strength we can change the number of anchors as well. There are three kinds of component having different number of anchors.

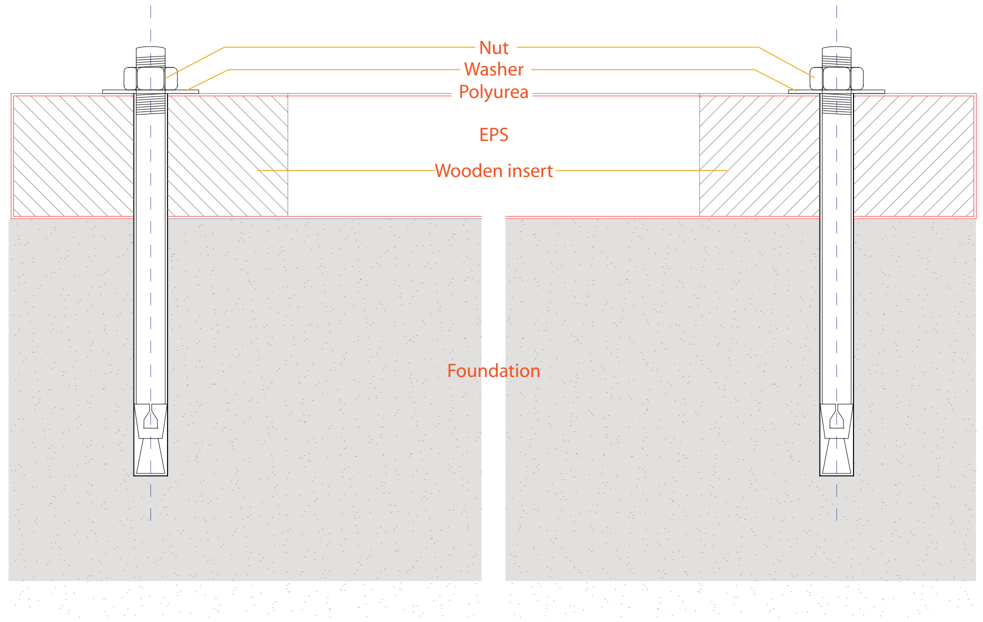
Anchor detail
EPS and Polyurea might be too soft to resist with steel anchor we suggested to have wooden inserts.

Anchor location





Anchor detail

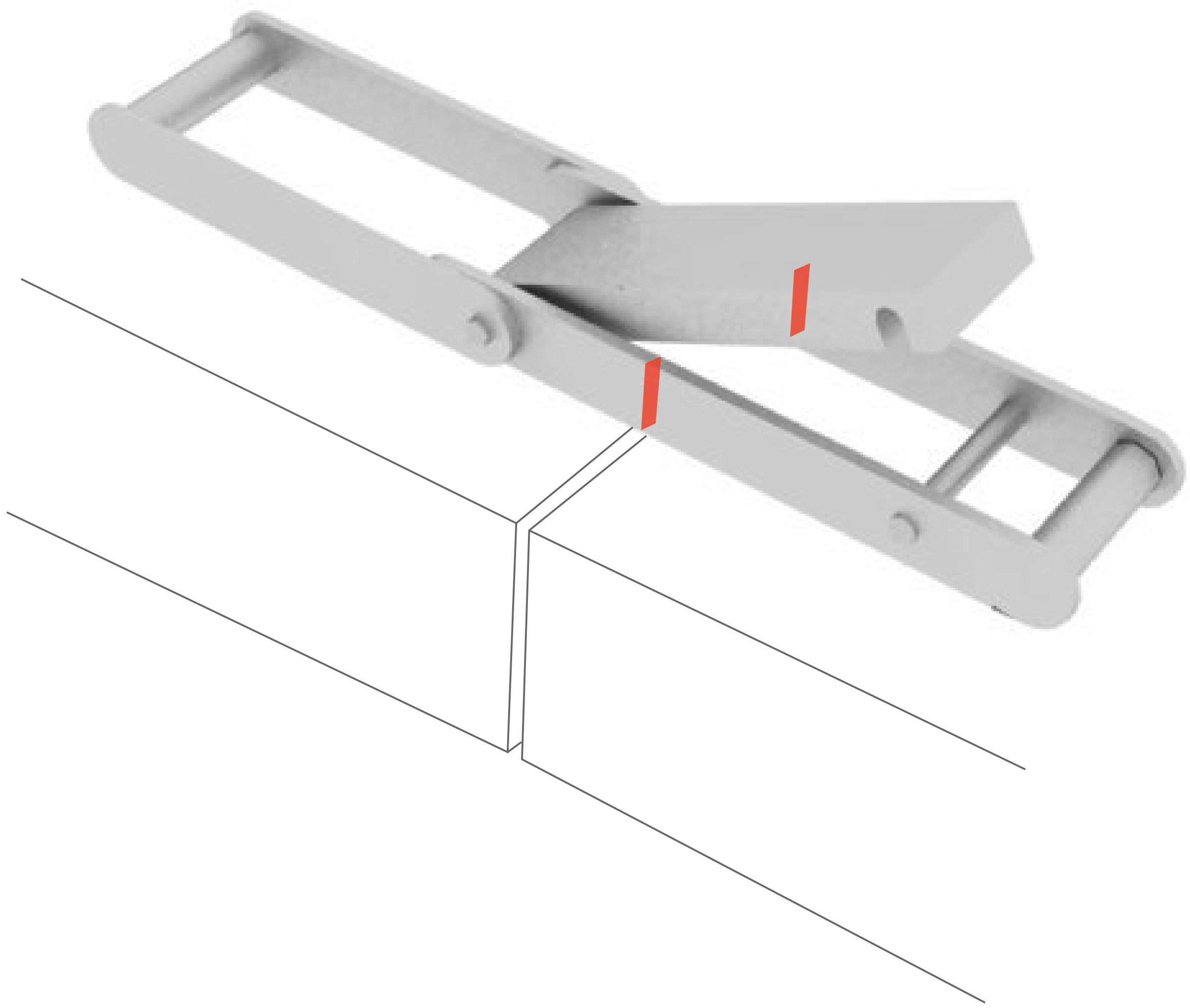


Products

Figure 1-5. Foundation and anchors- positions, detail and samples.

Clip & Ball Joint

Soran Park 1530801



Clip (Stress)

One clip
Section area: 15 x 3 x 2 = 90 mm^2
90 mm^2 x 324N/mm^2= 29160N = 29KN

PolyUrea
2mm x 1000mm x 10KN/mm^2= 20KN

Ball (Shear force)

Maximum Shear load
39880N/m (from GSA caculation)

Laminate ball strength
2,500 psi = 17,236,893 N/m^2

Figure 1-6. Clip and ball joint and its feasibility.

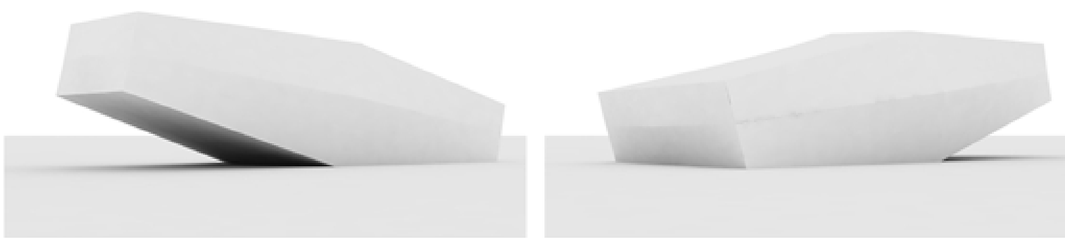
Structural feedback on clip proposal
Fabrication group suggested clip connection. In the first proposal the weakest part (hinge) of clip was placed on the most crucial part as a structure, so we proposed to replace clip. In addition, to resist momentum effectively, we optimized the clip location by keeping the maximum distance between two clips.

Connection strength and number of connections
Clip does not need to be stronger than overall structure, so we compared steel strength of section of clip with polyurea coating strength. According to the calculation, one set of clip is enough for two-meter edge. However, since it is not good to concentrate on one point, we suggested having three sets of clip per meter.
To give input about the number of balls to fabrication group, we compared between ball strength and maximum shear load from GSA calculation. As a result, we found one ball is covering one- meter edge.

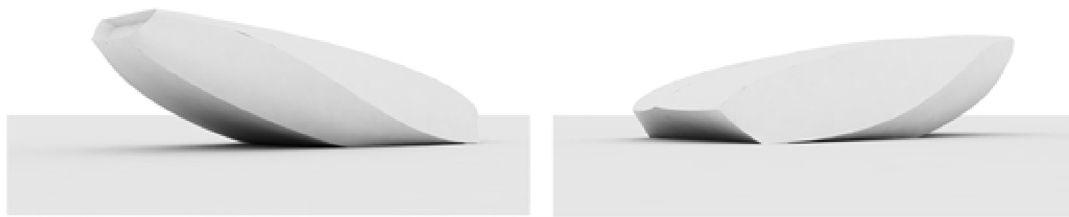
1. Bodycheck 3 Styling Group Form Finding Process

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

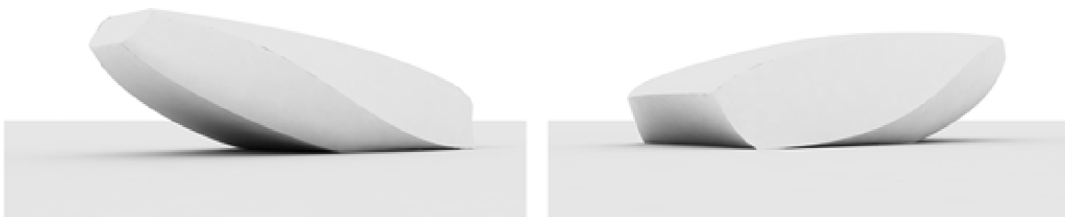
25.03.2009 - cage study model as a base for further design developments



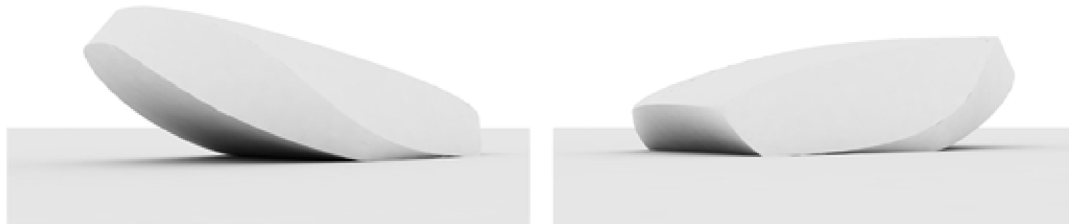
10.04.2009 - dynamic powerline on the sides / lowerind the back / concave nose



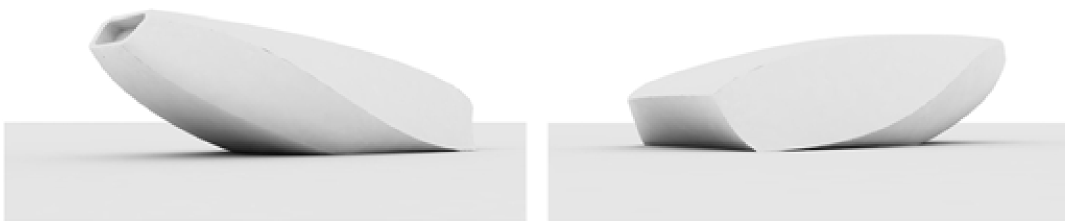
22.04.2009 - reducing the cantiliver / simplifying the back / nose integrated in the shape



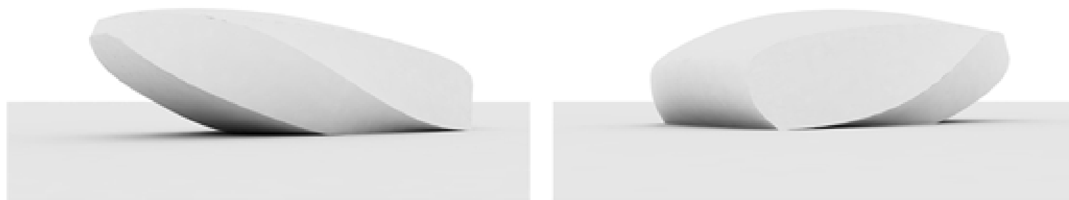
05.05.2009 - " the shoe " - rounding the nose and interweavind it with the sides



15.05.2009 - the nose as an opening / flattening the back



10.06.2009 - "the shoe" as a base / making smaller the nose part / rounding the back



1.1. Constraints
Modelling of the colaborative phase was constrained by earlier received model of the outer ‘cage’, which was describing the main character of the space and some basic dimensions.

1.2. Process of the modelling
On the diagram on the right hand side you can easily notice how the form was changing during the studio development. Generally it went through six main steps:

1. study of the given cage for further development; analyzing specific powerline, basic dimensions and character of the overall space.

2. creating first dynamic powerlines, whcih made some smooth transitions of the surface

3. reducing the size of the cantiliver in front of the form, and integrating the ‘nose’ with the rest of the ‘body’

4. rounding the nose, by making from it a part of the side walls, treating the whole form as one body without unique elements

5. coming back to the idea of the opening in place of the ‘nose’; big window at the end of the directional form could provide daylight in the sitting area and make the overall project more characteristic

6. finally rounding the nose, but making it in the same time a bit smaller; rounding the back of the shape

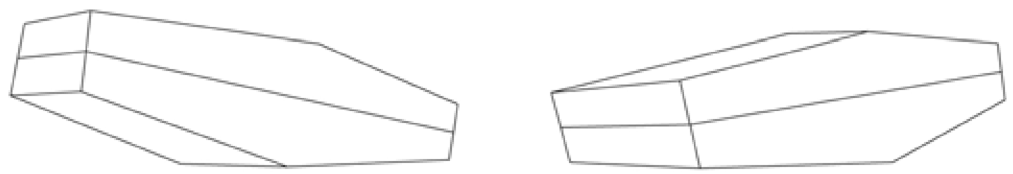
Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-1. This diagram illustrates the process of modelling the Protospace 3.0 final form. Starting at the early begining from the simple cage till last creation of the form.

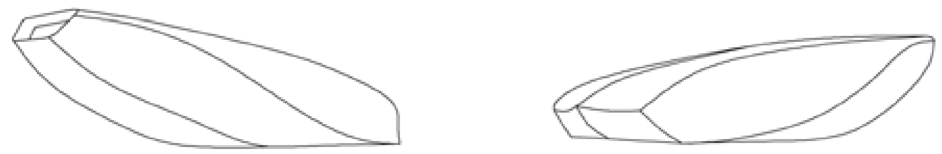
1. Bodycheck 3 Styling Group Form Finding Process

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

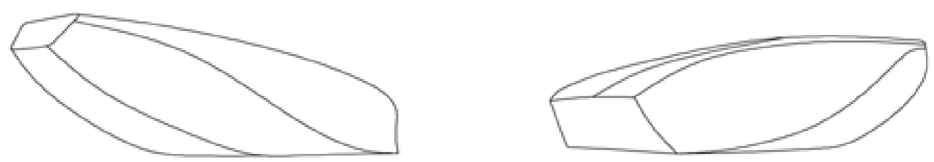
25.03.2009 - cage study model as a base for further design developments



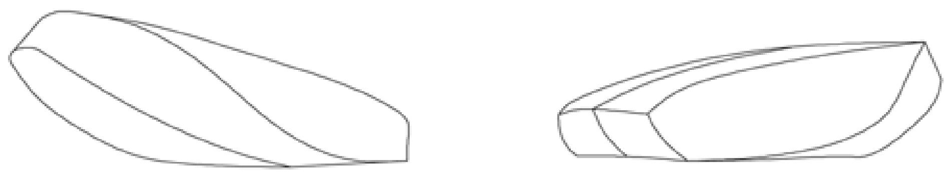
10.04.2009 - dynamic powerline on the sides / lowerind the back / concave nose



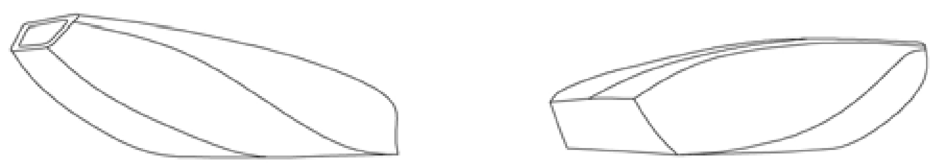
22.04.2009 - reducing the cantiliver / simplifying the back / nose integrated in the shape



05.05.2009 - " the shoe " - rounding the nose and interweavind it with the sides



15.05.2009 - the nose as an opening / flattening the back



10.06.2009 - "the shoe" as a base / making smaller the nose part / rounding the back

Figure 1-2. The same process as on the diagram before but just showing everything by main powerlines which were shaping the overall form

Figure 1-1. This render shows [illegible] minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.3. Shaping the form by playing with the powerlines

As Kas Oosterhuis says:

"The building body is like a shaped container, a flexible box that is shaped by a set of curvilinear powerlines. The powerlines describe the path of development of the body, the folding lines in the surface of the volume, and/or the trajectories of the users navigating through the building body."

Thus our process of modelling the shape was the process of creating specific relations between all the powerlines. Each one of them was responsible for concrete function of the interior space:

1. powerlines on the roof and bottom
- making the 'V' shape of the surfaces, which is much better structuraly

2. Powerlines in the moddle of the walls
- emphasizing the division of the interior space into two different area: zone of podium, zone of main arena

3. Powerlines on the back of the form
-regarding the size of the projection area

1. Bodycheck 3
Styling Group
Modelling the Inner Surface

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

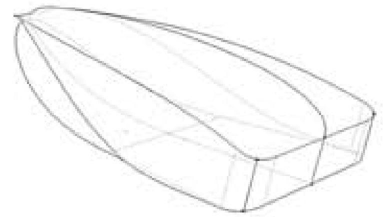
1.4. Main factors for modelling the inner surface
Modelling of the inner surface was an example of the complex process of exchanging all the possible information between all of the groups of specialists.
Main factors shaping the inner surface were:

1. Styling factors
The inner surface was supposed to follow the main geometry of the outer one, keeping similar relation between all the powerlines.

2. Structural input
Structural group gave as crucial inputs about the thicknesses in all the specific places. Thickness of the wall varies from 30 centimeters till almost 1,5 meter, what made the modelling process much more complex

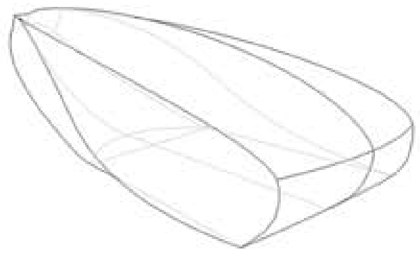
3. Interactive group input
Interactivity group was giving us two different input for modelling the inner surface:
-areas of the two main functional zones
-specific modelling of the back wall of the inner surface, which would be supposed the projection area

01. powerlines of the inner surface

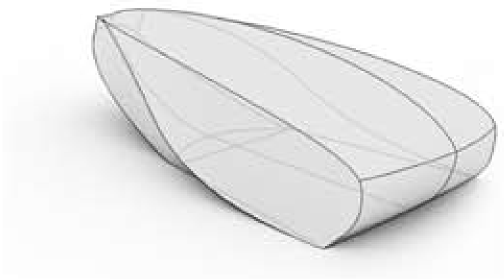


02. shape of the inner surface

03. powerlines of the outer surface



04. shape of the inner surface



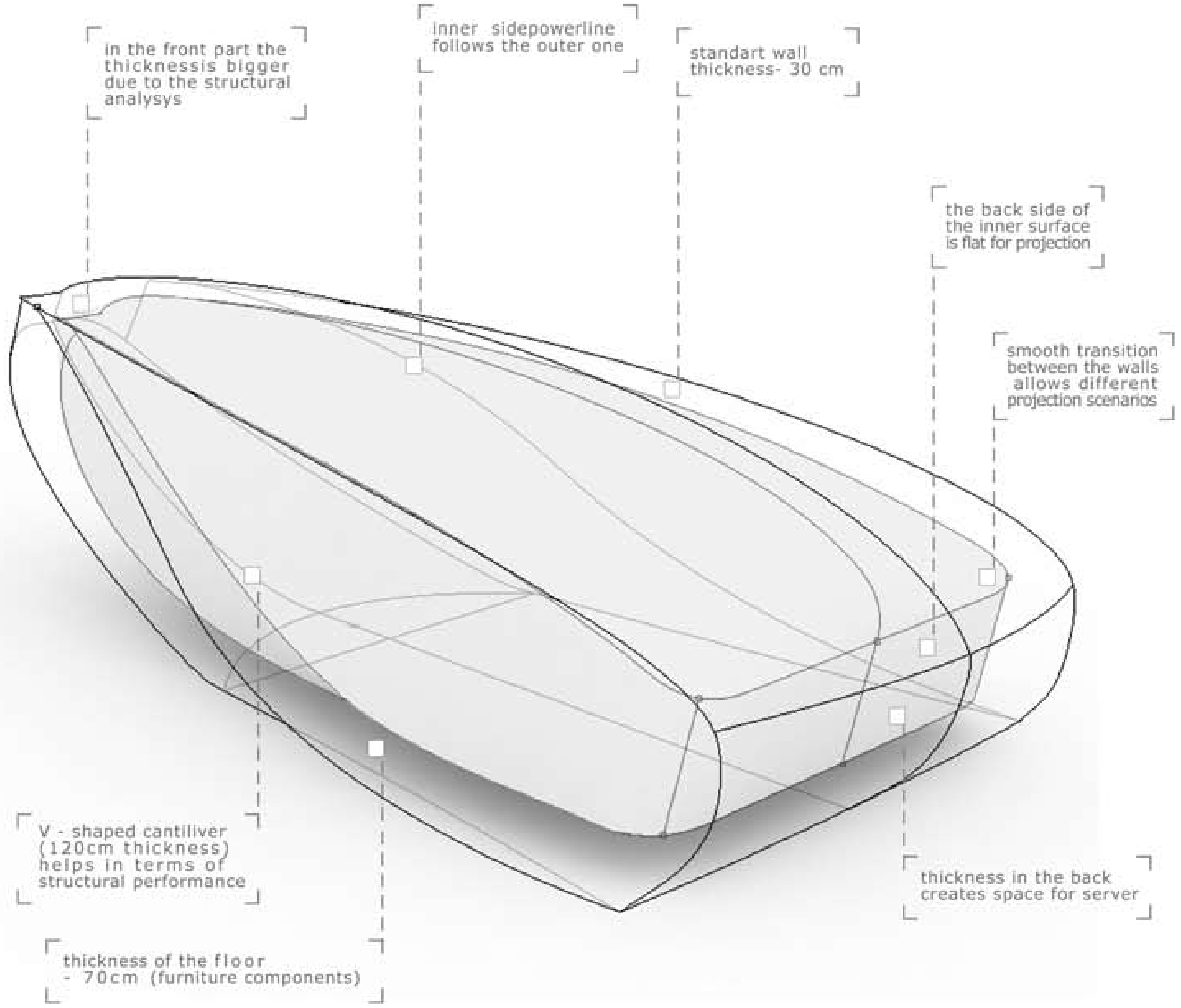


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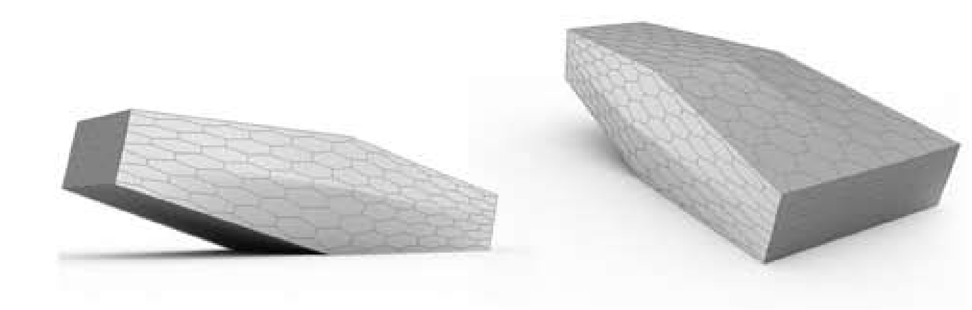
Figure 1-3. Shaping the inner surface (interior) of the pavilion by taking into consideration different inputs from all the groups of specialists

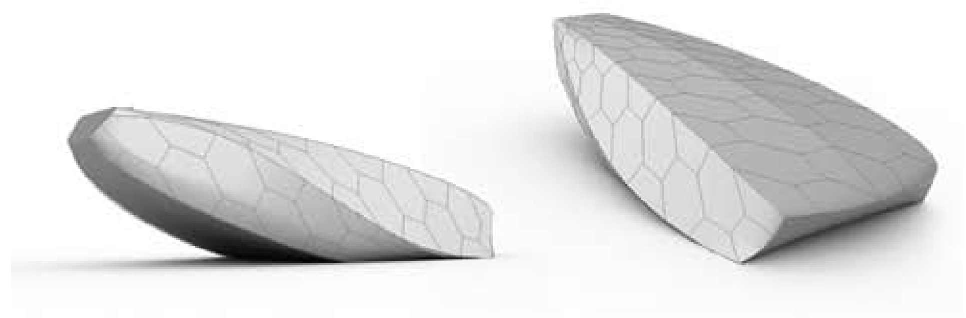
1. Bodycheck 3
Styling Group
Process of Modelling the Form

Agata Kyia - 1530275
Roxana Palfi - 1535269

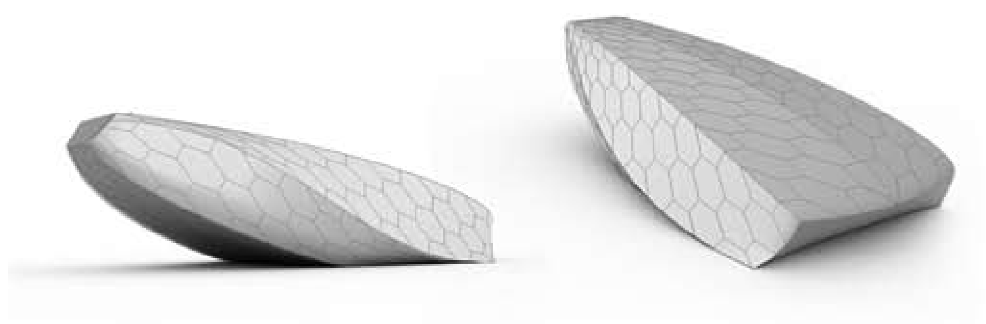
25.03.2009 - diagonal tesselation on the initial cage study model
problem - it is impossible to gain smooth transition on every edge



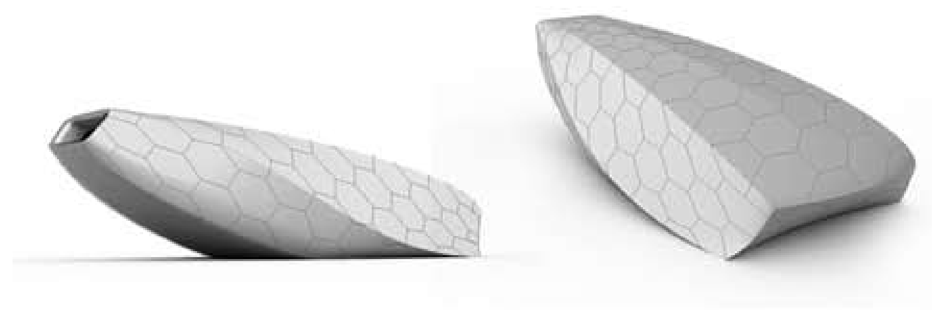
10.04.2009 - diagonal tesselation wrapping the whole shape
problem - scale of the components is too big



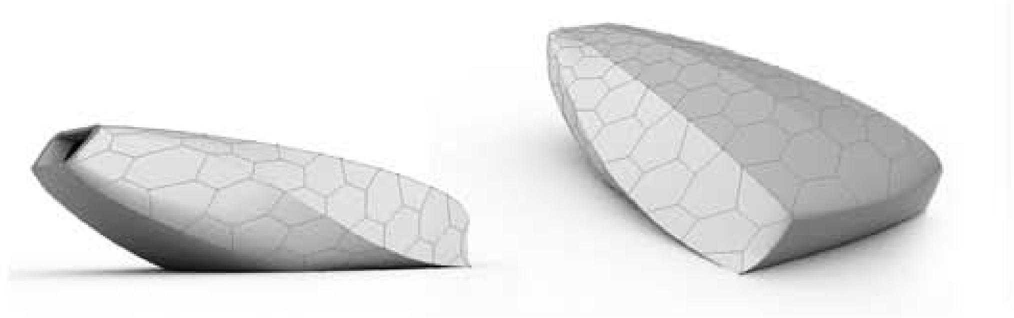
22.04.2009 - diagonal tesselation scaled down and mirrored on the roof
problem - on the sides the components are too much squeezed



05.05.2009 - bigger components no more squeezed on the sides
problem - components doesn't match the powerline on the sides



15.05.2009 - another version which tries to match the pattern with the middle powerline
problem - components doesn't match the powerline on the sides



10.06.2009 - final tesselation matching all the powerlines

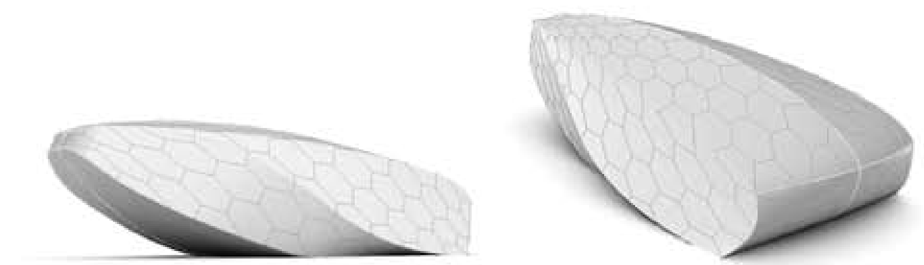


Figure 1-4. This diagram shows the way of developing tesselation systems. Starting from 1 parallel one, going through different dynamic versions and finished with the final method

Figure 1-1. This render shows the ... Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.5. Modelling the tesselation

The first important decision which was taken in the Studio was to take a hexagonal grid as way of subdividing the whole bulding body into components.
Then the process of developing the tesselation method went through many different step:

1. diagonal tesselation on the initial cage study model / problem wrapping by it closed three dimensional model

2. first version of the new subdividing method - too big blocks for assembling process

3. scaled down tesselation / problem of fitting tesselation with all the powerlines

4. final tesselation, whcih fits with all the powerlines and produce block which veries between 1 meter till 3 meters

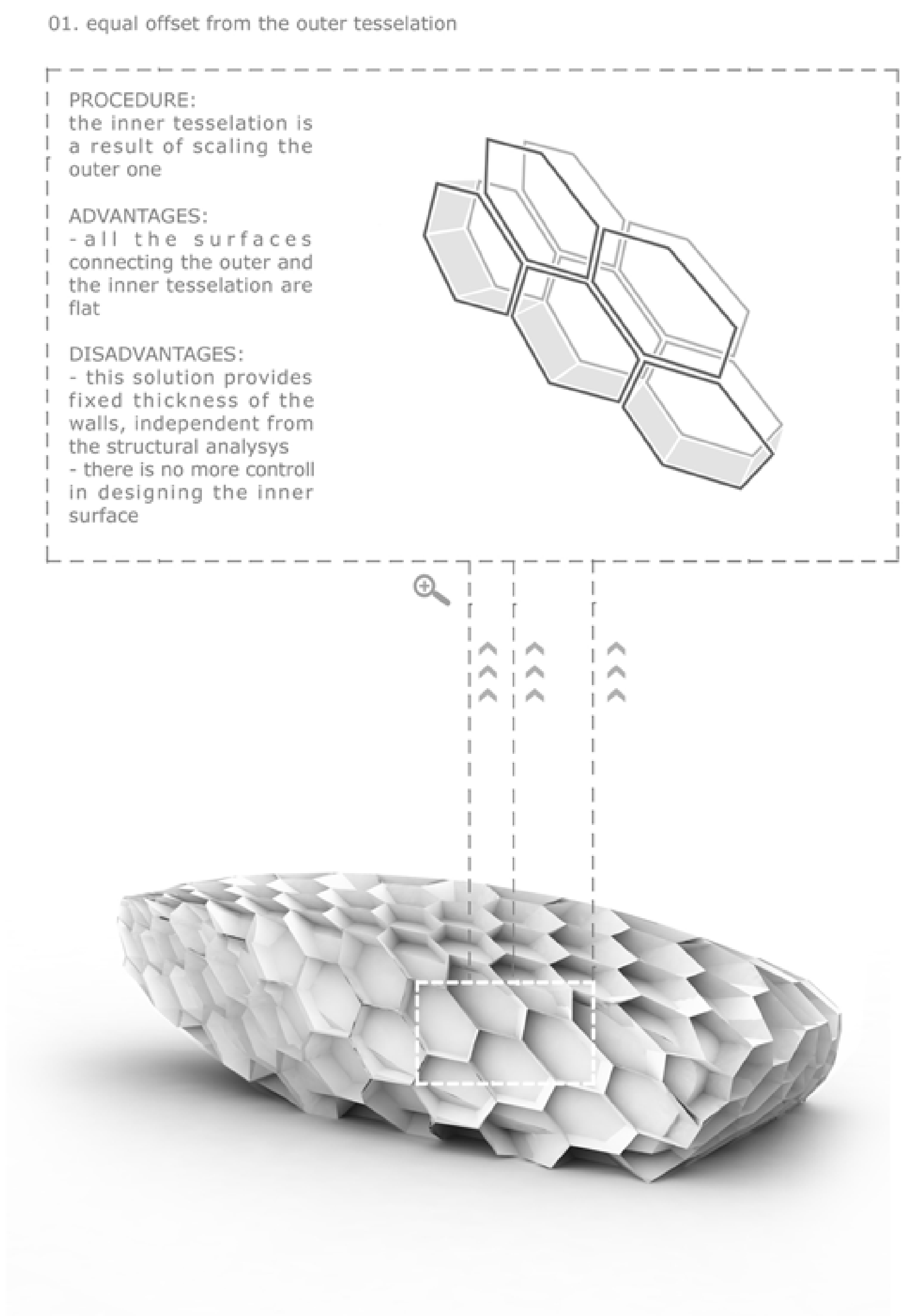
1. Bodycheck 3
Styling Group
Dialog Between the Outer and Inner Tesselation

Agata Kycia - 1530275
Roxana Palfi - 1535269

1.6. First trials of inner tesselation method
To achieve proper tesselation of the inner surface we were trying many different methods.
Here the important factor was the assembling method chosen by the manufacturing group. It effects the relation between outer and inner one, for instance by demanding that all the common edges of components shouldn't be twisted (this idea was later skipped as not the best one in case of structural forces).+
The first two methods of relating the inner tesselation to the outer one were:

-scaling down the outer tesselation (equel offset from the outer tesselation)

-connecting outer tesselation to one point and then finding intersection of these lines with the inner surface



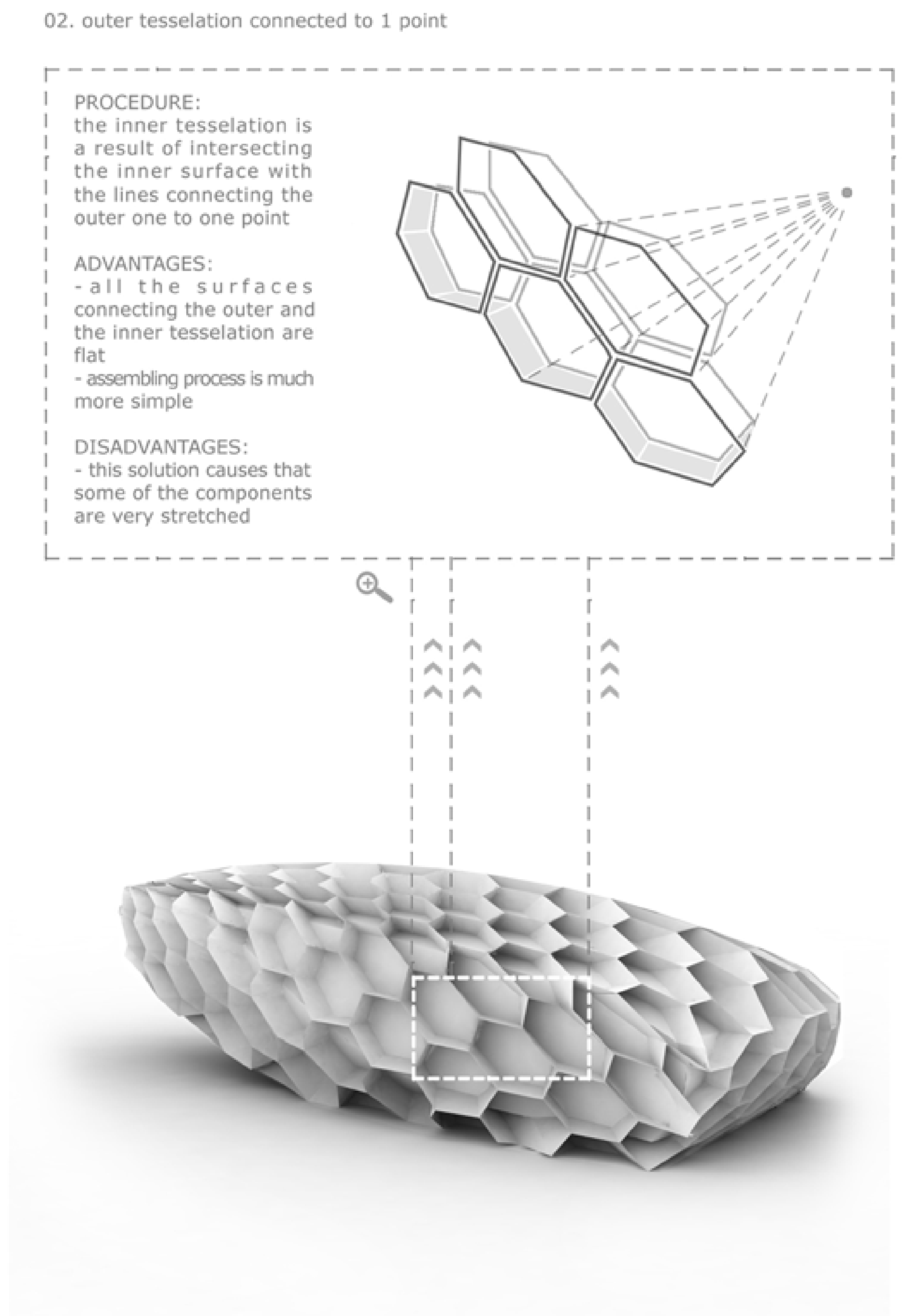


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Figure 1-3. First two methods of modelling the tesselation for inner surface: equel offset of the outer tesselation and connecting the outer tesselation to one point and looking for the intersection with the inner surface

1. Bodycheck 3 Styling Group Dialog Between the Outer and Inner Tesselation

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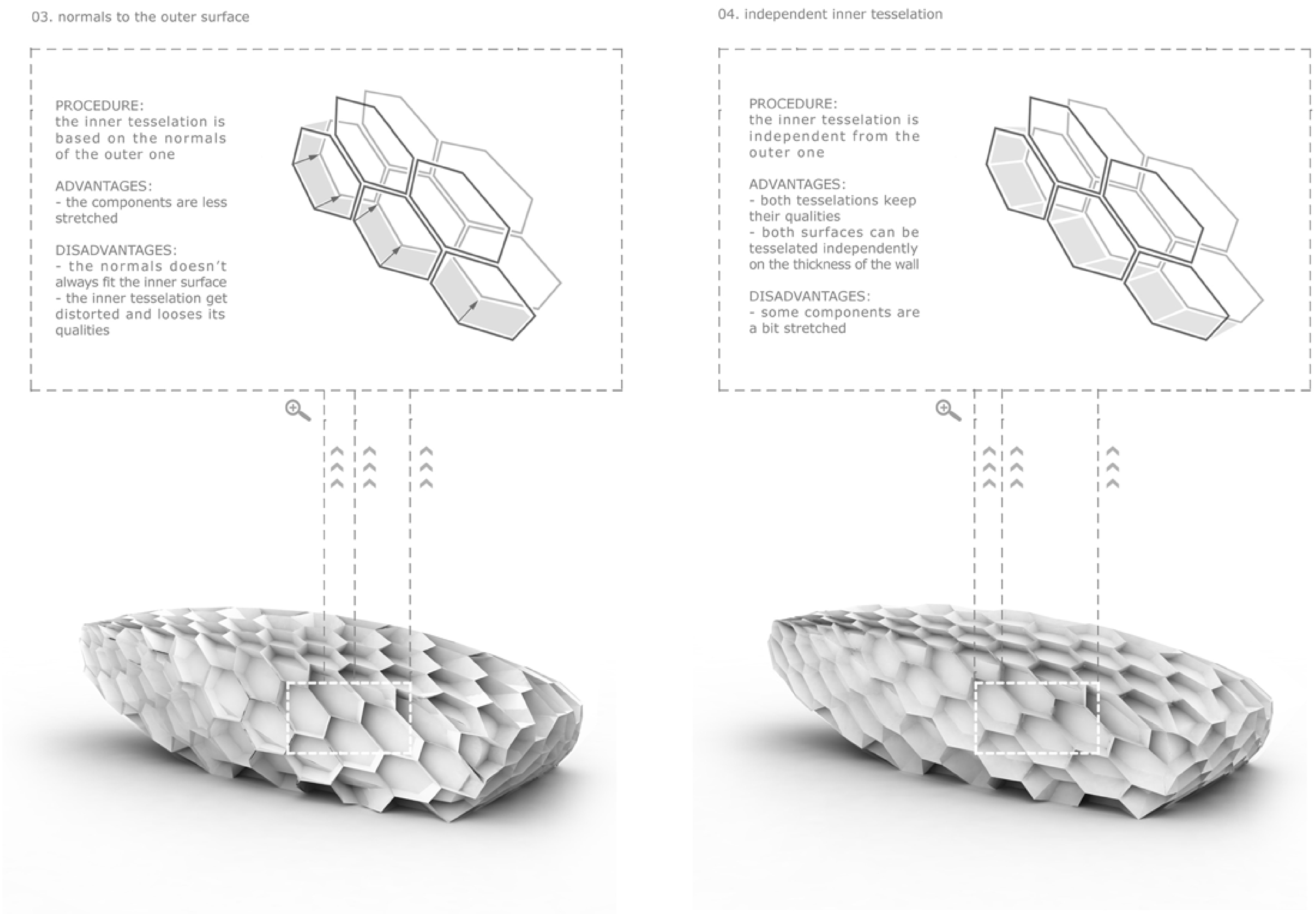


1.7. Second trials of inner tesselation method
Other method of doing the inner subdivion were not focused on achiveving components edges as planar surfaces but just finding the way to propotionally tesselate inner surface without big distortions in a probleatic places of huge wall thickness.
Alternative one was to follow the normals to the main surface in vertices of outer subdivision.
However for final one was chosen a method were inner tesselation was done sort of separately from the inner one, and later on tthe process of joining both of them happened. It gives the most convincing result without strong distortions, and at the same time it allowed manufacturing group to develop specific assembling method just for this solution.

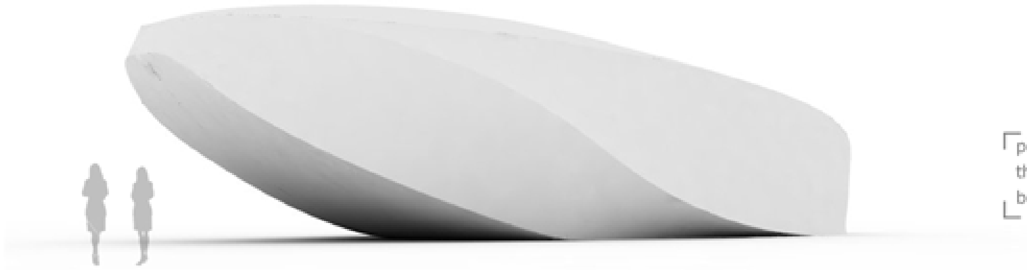
Figure 1-6. Two other methods of tesselating inner surface: by normals to the out[illegible] tion and then joining it with outer one

[illegible] iam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

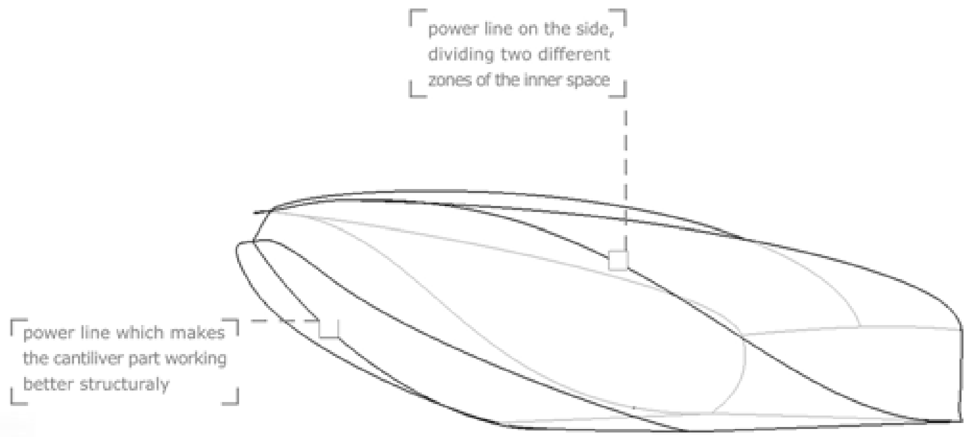
1. Bodycheck 3 Styling Group Final Shape - Surfaces and Powerlines

Krzysztof Gornicki - 1530259

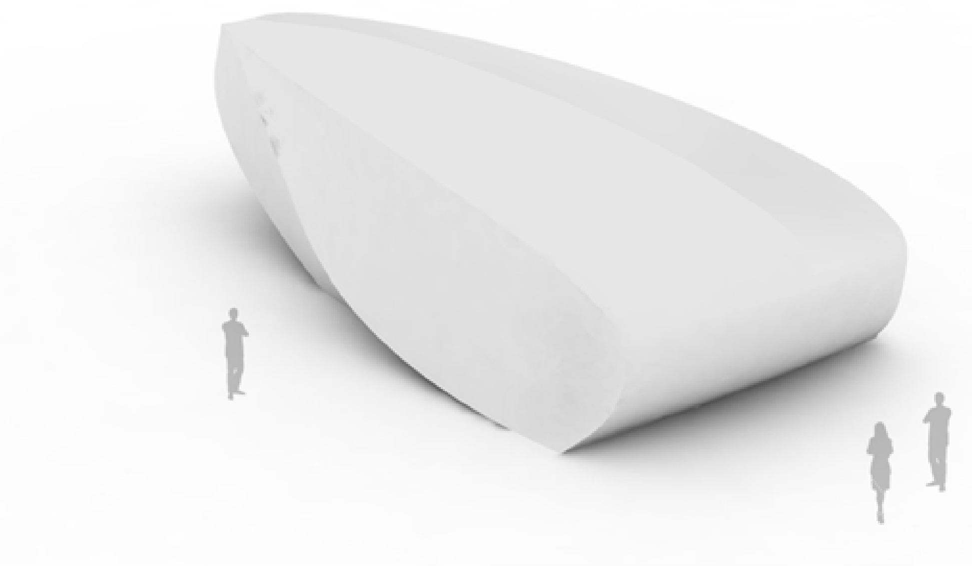
01. final form of the project - human perspective



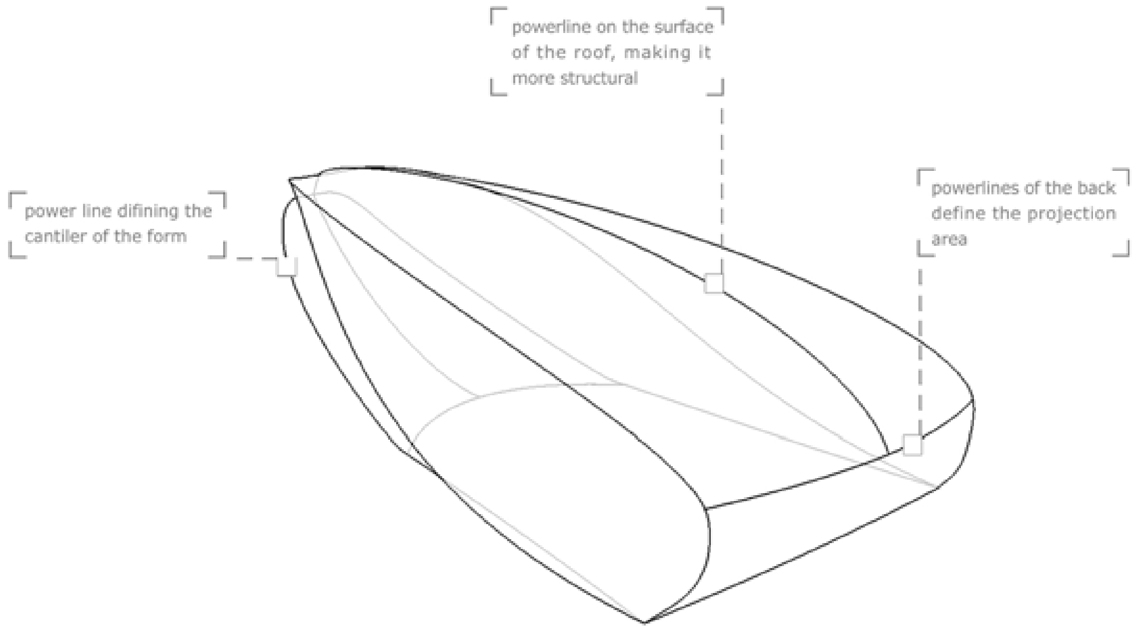
02. powerlines shaping the final form - human perspective



03. final form of the project - upper view



04. powerlines shaping the final form - upper view



1.8. Building Body

Following the main ONL mission statement::
First of all each building is regarded and developed as a building body. A building body is a consistent organism where most constituing elements are specifically developed for that body. The modern building body is no longer based on repetition but on an complex interaction between unique components.
That was our main principle during modelling the final shape. Achiving the form which a closed 'Building Body' with possiblity to be regularilly tesselated with set of hexagonal components.

Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-2. The most important and characteristic elements of the final version of the shape

1. Bodycheck 3 Styling Group Final Tesselation Method - Outer and Inner One

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Roxana Palfi - 1535269

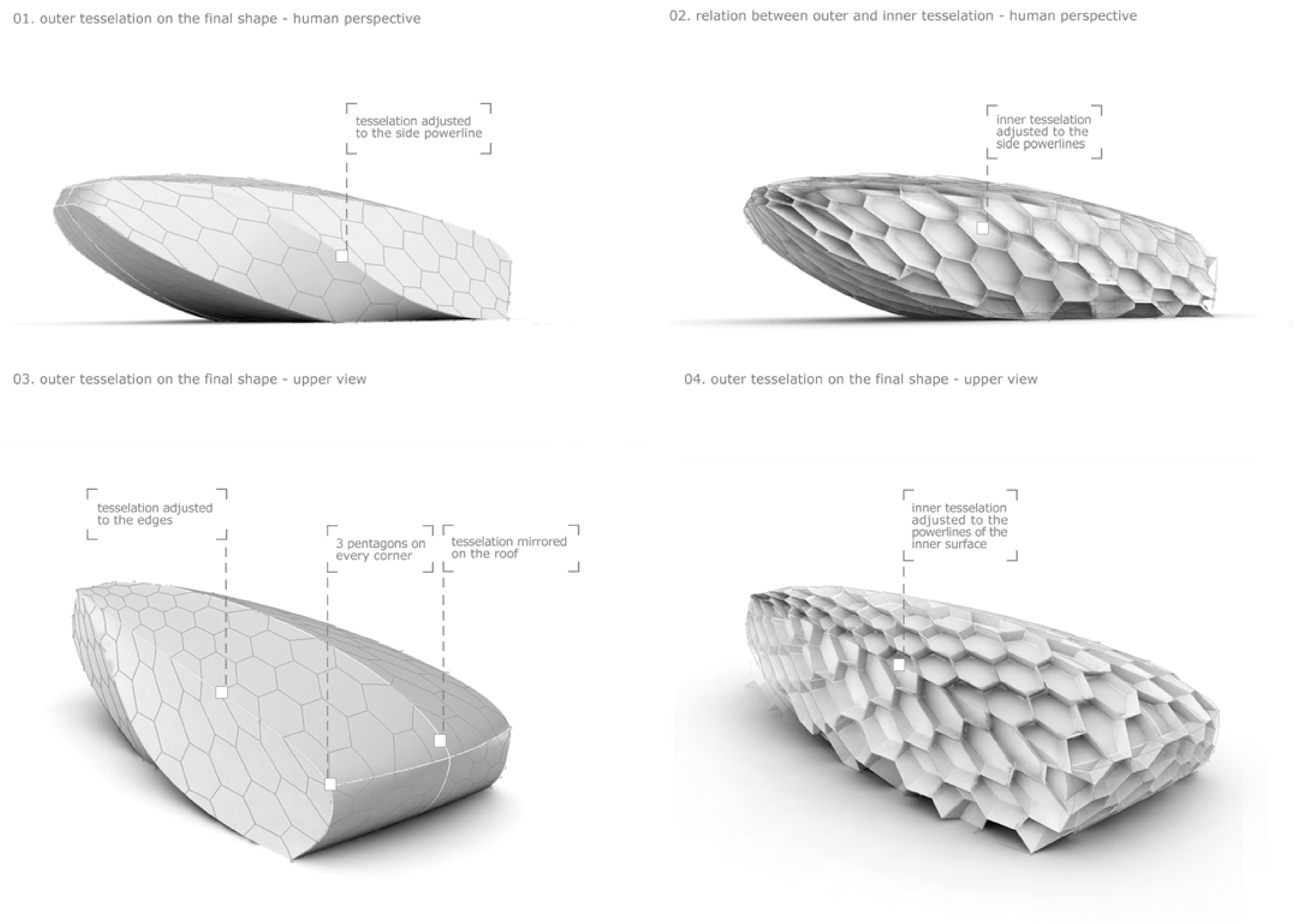

Figure 1-8. The most characteristic and important elements for the final version of the outer and inner tesselations

Figure 1-1. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.9. Final tesselation

However at the beginning the task to subdivide unique and non-standard form with regular hexagonal grid seemed to be almost impossible, after some trials we managed to achieve satisfying version, which consitsts just three exceptions of the pentagons on three different corners.
Inner tesselation followed the same idea as the outer one, and then the edges of the components are the result of jining both surfaces together.

1. Bodycheck 3 Styling Group The Overall Process of Modelling Shape and Tesselation (Inputs - Outputs)

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Agata Kycia - 1530275
Roxana Palfi - 1535269
JinJie Yan- 1530607

1.10. Overall process of modelling

The overall process of modelling final form and both tesseal-tion was a complex way of exchanging the most important data between all the groups. Styling group as that one which was responsible for shaping the building body were collecting all the inputs from different groups of specialists and then trying to find the optimal solution in case of three dimensional model.

'In the swarm there is a constant flux of data' K. Oosterhuis

And so process of designing is going to be a constant process of exchanging information between many different professions. Increasingly graphics, composers, planners, publishers broadcasters or visual artists are building very strong positions in every architectural office, in some of them are already on the same status as architects (for example ONL – I. Lenard – artist, K. Oosterhuis – architect).

'Members in a swarm are always calculating' K. Oosterhuis

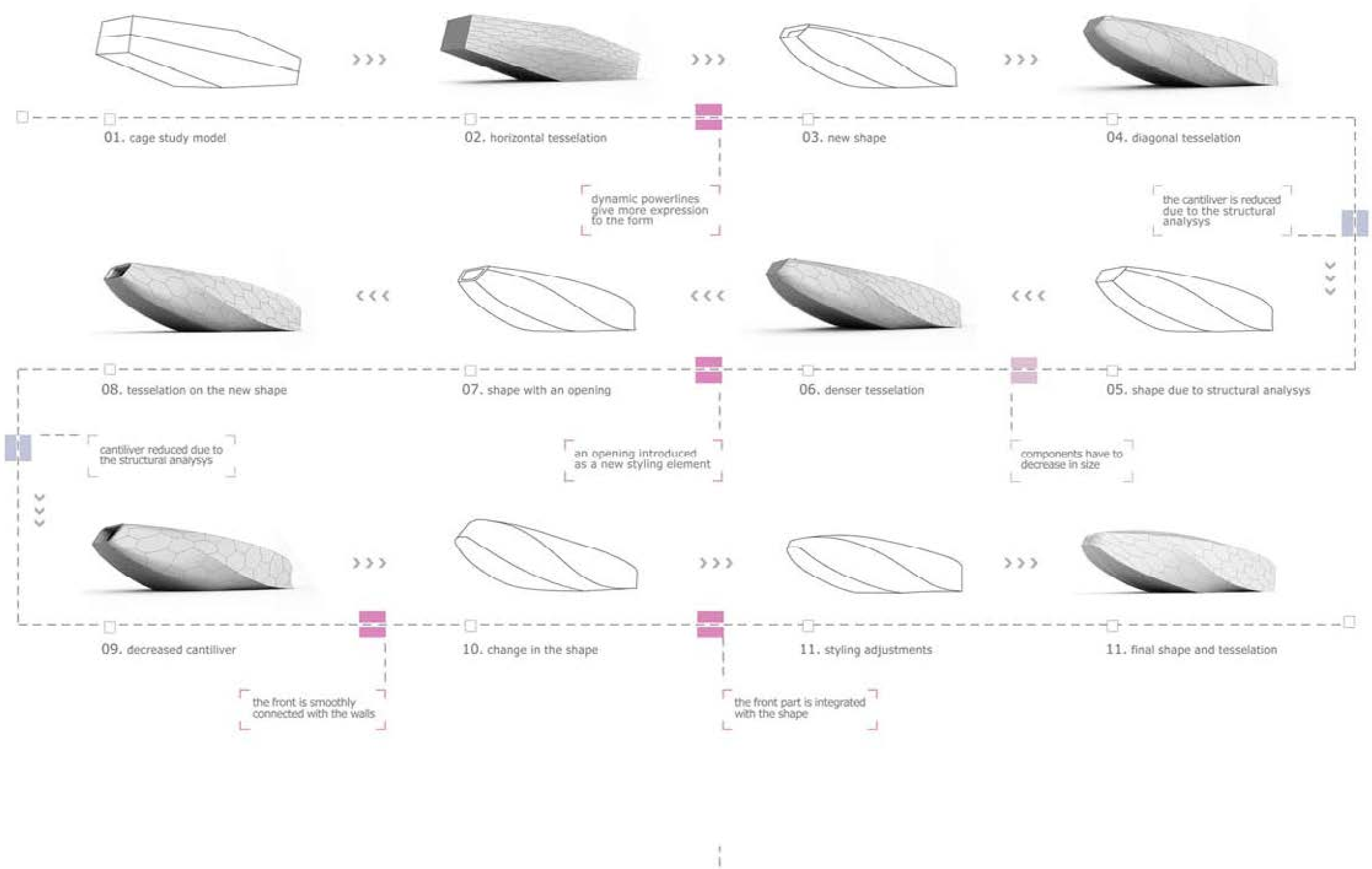


Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1-3. Diagram illustrating the whole process of form finding. Different inputs from all the groups of specialists effected the form in every single aspect.

1. Bodycheck 3 Styling Group Numbering Components / All Specific Data

Krzysztof Gornicki - 1530259
Agata Kycia - 1530275

WALL 01
nr. of components : 39
area : 98 m2
functions: - structure
- interaction
- ventilation
- windows
height : 6.08 m
length : 22.9 m

WALL 02
nr. of components : 39
area : 98 m2
functions: - structure
- interaction
- ventilation
- windows
height : 6.08 m
length : 22.9 m

WALL 03
nr. of components : 22
area : 31.7 m2
functions: - structure
- interaction
- ventilation
height : 6.08 m
length : 10 m

FLOOR
nr. of components : 78
area : 160 m2
functions: - structure
- furnitures
height : 10 m
length : 22.9 m

CEILING
nr. of components : 78
area : 173 m2
functions: - structure
- interaction
height : 9 m
length : 22.5 m:

TOTAL
nr. of components : 256
area : 560,7 m2
functions: all

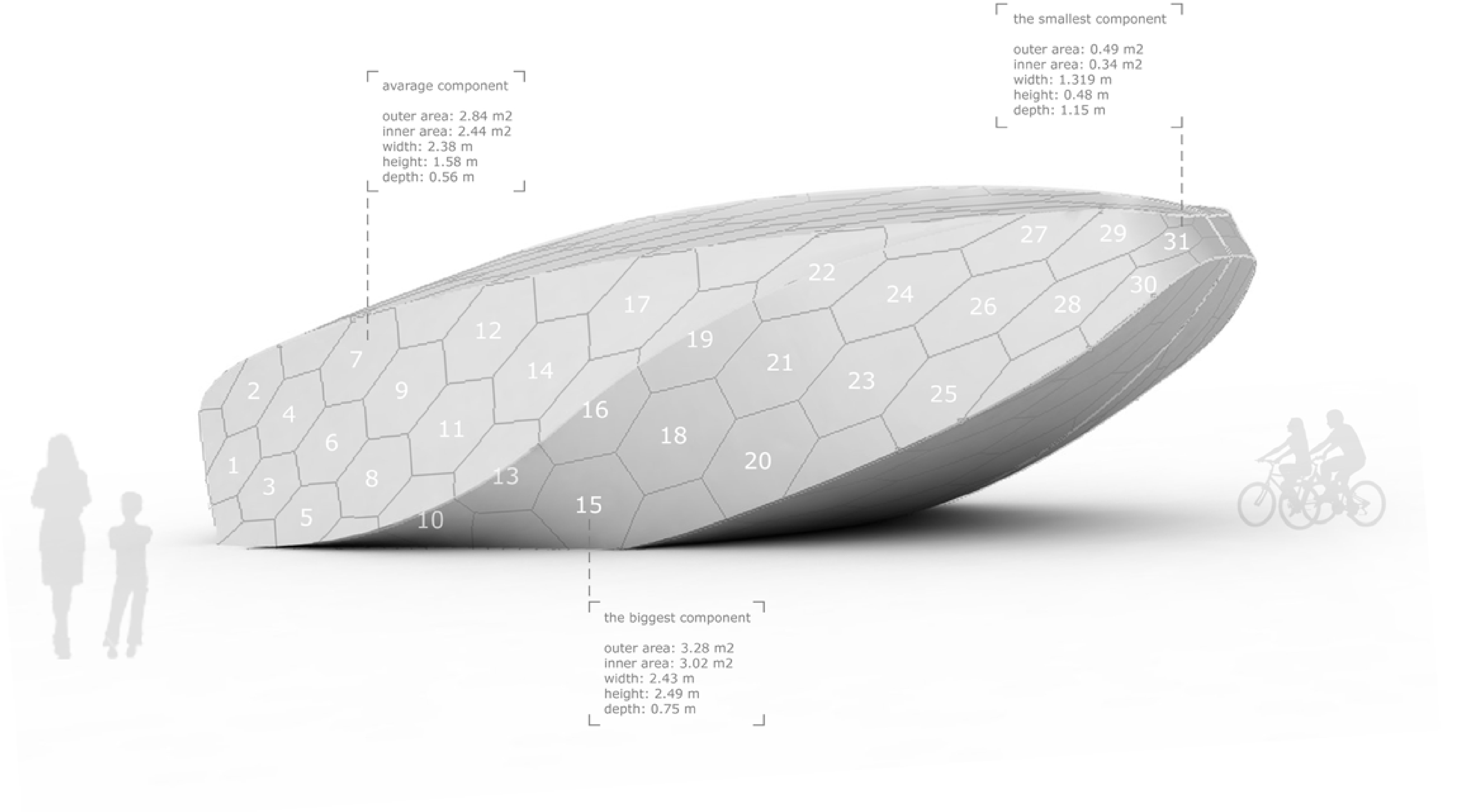


Figure 1-10. Numbering all the components with individual code. Presenting all the data about building elements

Figure 1.1. This image shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.11. Numbering components

When the final shape and outer and inner tesseation were done, the next step of developing the overall process was to give to each one of component the unique number code. Based on it that was possible to go further with functions distribution and preparing files for final fabrication of the full scale prototype.

1. Bodycheck 3 Styling Group Distrubution of Different Functions Throughout the Components

Krzysztof Gornicki - 1530259

1.12. Swarm of bodies
Again we were following ideas of the Studio professor Kas Oosterhuis, who says:
"Each Body Plan evolves through a process called specification.
Certain parts of the Building Body specialize to be the structure, other parts specialise to be the skin, again others the internal empty spaces, other the arteries / MEP installation. There is a specific instruction in the evolution of the genes for the body plan for each of those functions. At the same time all points / cells of the system keep communicating as members in a swarm.
They become members of a specialized sub-swarm.

Thus our purpose was to create such a swarm type idea in the proposed design solution. Each one of unique-numbered component is dedicated to the specific function:

1. Structural block

2. MEP - heating/ventilation

3. MEP - providing daylight

4. Interactive - embadded interactive devices

5. Interactive - with cavity for furniture

In this way all the data about the building were coded in one excell file, which further was used as a base for generative procedure in Rhino application.

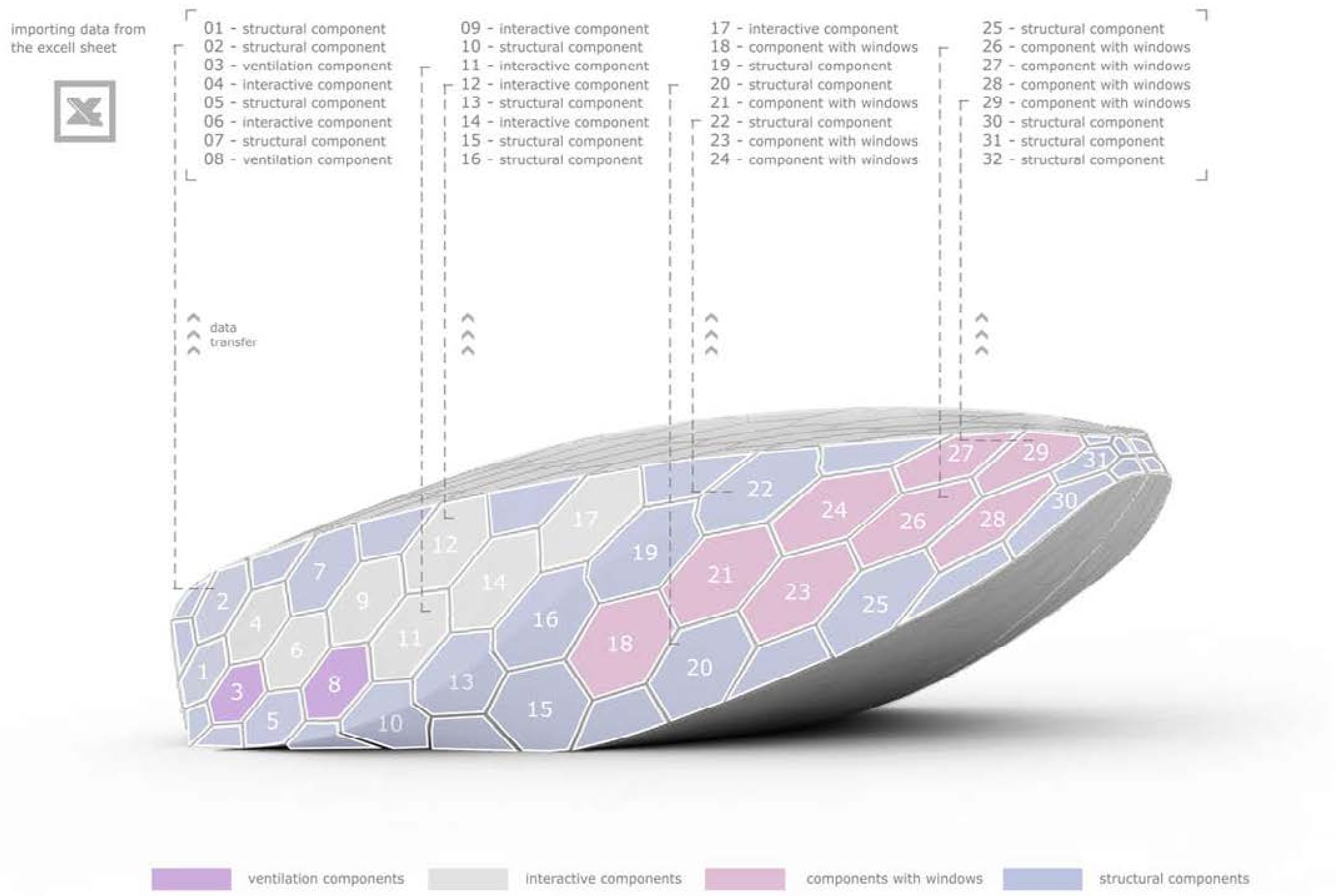


Figure 1.2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Figure 1.11. Distribution of functions throughout the components, each group of specialists were choosing the components for their specific purposes.

1. Bodycheck 3 Styling Group Catalog of Five Main Component Functions - Specific Forms and Parameters

Krzysztof Gornicki - 1530259

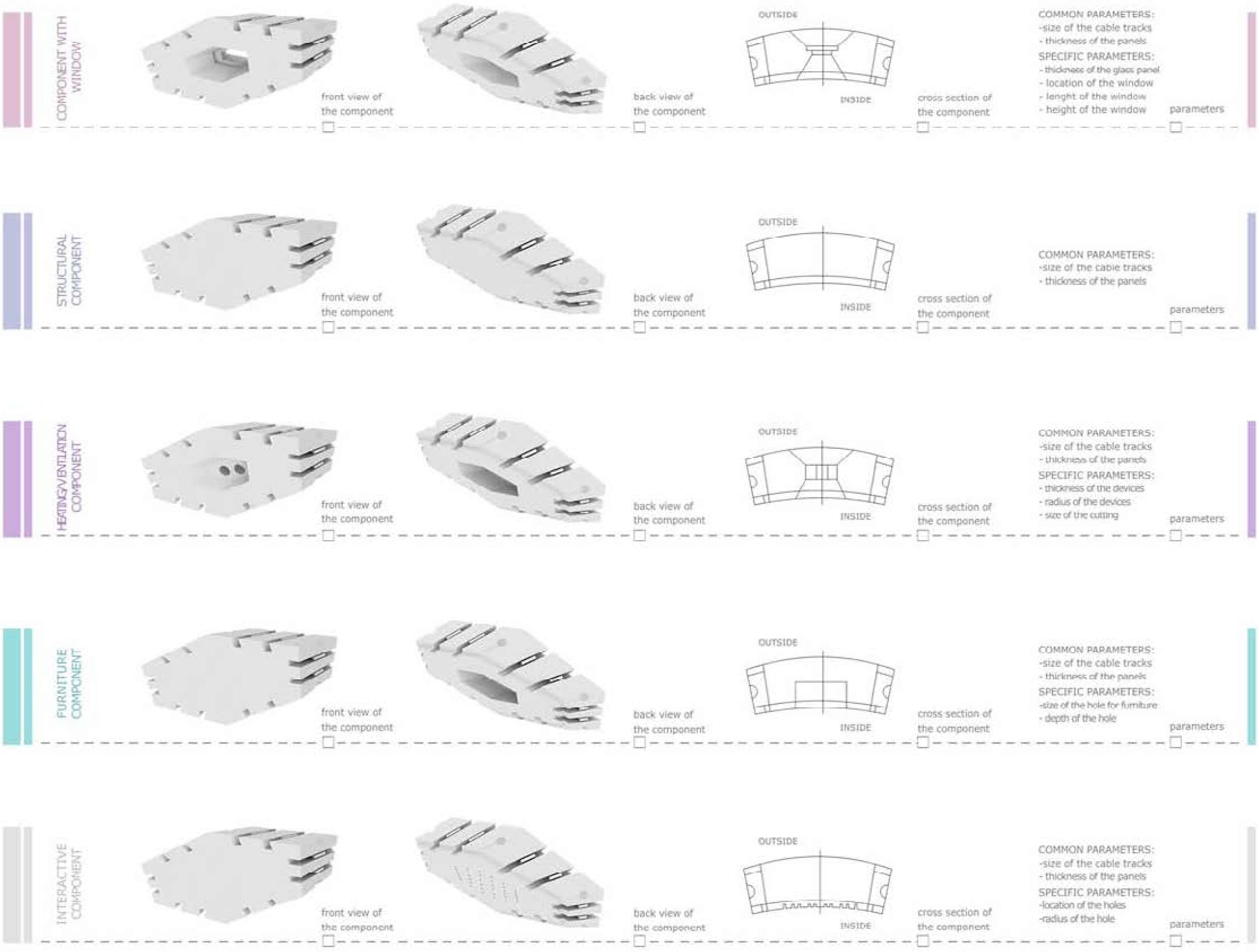


Figure 1-12. Eacg function has a specific variation of the form of parametric component, driven by concrete set of parameters.

Figure 1-11. This render shows the set of parameters. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.13. Shaping the form by playing with the powerlines

As Kas Oosterhuis says during the introduction lecture of our studio class:

"Develop each specialized swarm of nodes of the structure or the internal / external skin, either enveloping spaces or enclosing gas / water / electricity /air flow, according to a parametric detail.
Make all details one big family, where all family members share the same detail in principle, but with local and temporal different values.
They share the same formula, but with from point to point changing values for the parameters. Aim at limiting the number of different parametric details, try to integrate as many details into one complex systemic Parametric Detail.

One building, one detail.

1. Bodycheck 3 Styling Group Geometry Description of Random Component

Krzysztof Gornicki - 1530259

1.14. Logic of the geometry

Written in Rhino application generative procedure works in specific order, executing concrete step:

1. INPUTS
Generative procudure requires some inputs of specific geometric description:
-strusrface (type: surface)
-strsurface02 (type: surface)
-arrcurves (type: closed curves on the strsurface)
-arrcurves02 (type: closed curves on the strsurface02)

2. PARAMETERS
The generative procedure is based on set of parameters, which allow to control he most important data about the form. In this case you can always adjust: size of the cavity for cables, clips dimensions, radius of the cavity for the nitrogen ball, and some parameters controlling specific functions.

3. BASIC ELEMENTS
Based on the inputs script generates some basic geometrical desciption of the component, by creating arraysof vertices (arrP, arrPo2), two surfaces cut from main surface (piece, piece02) and loft between selected curves (loft).

4. FUNCTIONS
Running script executes for each group of input and basic geometry speceific functions, responsible for creaing some repetitve elements. And so there are functions generating cavities for the nitrogen balls, cuttings for connectors, cavity for cables, and some general geometrically helpful functions

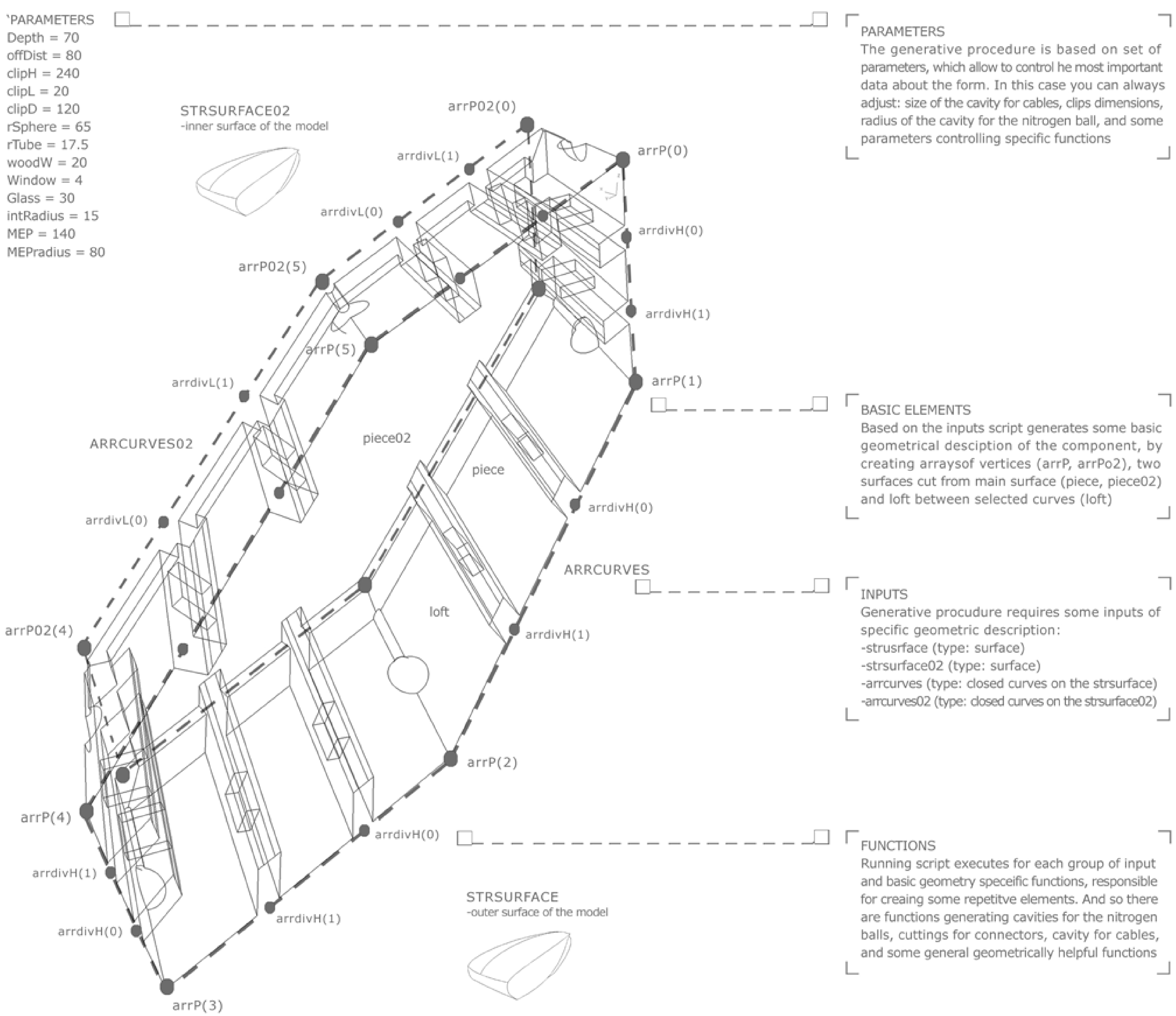


Figure 1-18. This diagram presents the way of describing geometry of each component by writing a generative proceudre.

Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. Bodycheck 3 Styling Group Advantages of Working with Generative Procedures

Krzysztof Gornicki - 1530259

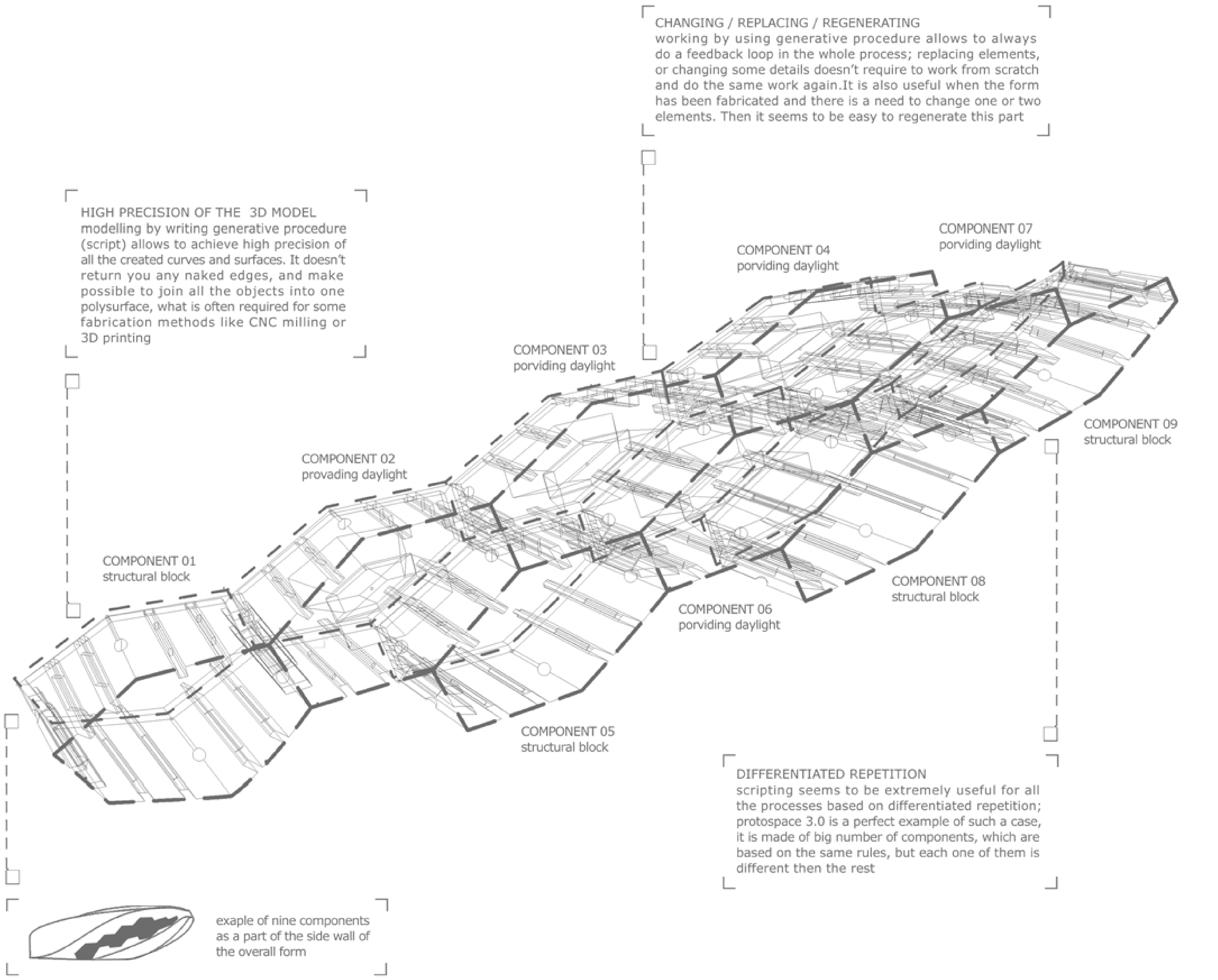


Figure 1-14. Part of the side wall with 9 generated components. Advantages of working with non-standard geometry by writing script.

Figure 1-1. This render shows the ... Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.15. Generative Procedure

Working by using generative procedure gives many advantages comparing to 'manual' three dimensional modelling.

1. DIFFERENTIATED REPETITION

Scripting seems to be extremely useful for all the processes based on differentiated repetition; protospace 3.0 is a perfect example of such a case, it is made of big number of components, which are based on the same rules, but each one of them is different then the rest.

2. CHANGING / REPLACING / REGENERATING

Working by using generative procedure allows to always do a feedback loop in the whole process; replacing elements, or changing some details doesn't require to work from scratch and do the same work again.

It is also useful when the form has been fabricated and there is a need to change one or two elements. Then it seems to be easy to regenerate this part.

3. HIGH PRECISION OF THE 3D MODEL

Modelling by writing generative procedure (script) allows to achieve high precision of all the created curves and surfaces. It doesn't return you any naked edges, and make possible to join all the objects into one polysurface, what is often required for some fabrication methods like CNC milling or 3D printing

1. Bodycheck 3 Styling Group Generative Procucure As Way of Creating the Final Model

Krzysztof Gornicki - 1530259

1.16. Generative procedure / Rhinoscripting
Main steps of the generative procedure:

1. START OF THE PROCESS
Collecting all the necessary inputs:
-excel file describing specific functions
 for specific components
-3D model of the final form (including
 outer and inner surfaces
-hexagonal tesselation for inner and
 outer surface

2. RUNNING THE SCRIPT
Running the script requires selecting all the inputs in a proper order. First of all outer and inner surfaces, later outer and inner tesselation of the components you would like to generate. At the end you have to choose the excel file for necessary data.

3. GENERATIVE PROCEDURE
Generative procedure creates in Rhino application forms of designed components. It includes all the details and varies the functions of the specific components based on excel sheet.

4. FINAL RESULT
Final result of the whole process is divided into to different parts. The first one consits all the components placed in a specific place on the 3D dimensional model, the second one collects all the components separeted on the 2D grid and ready for fabrication

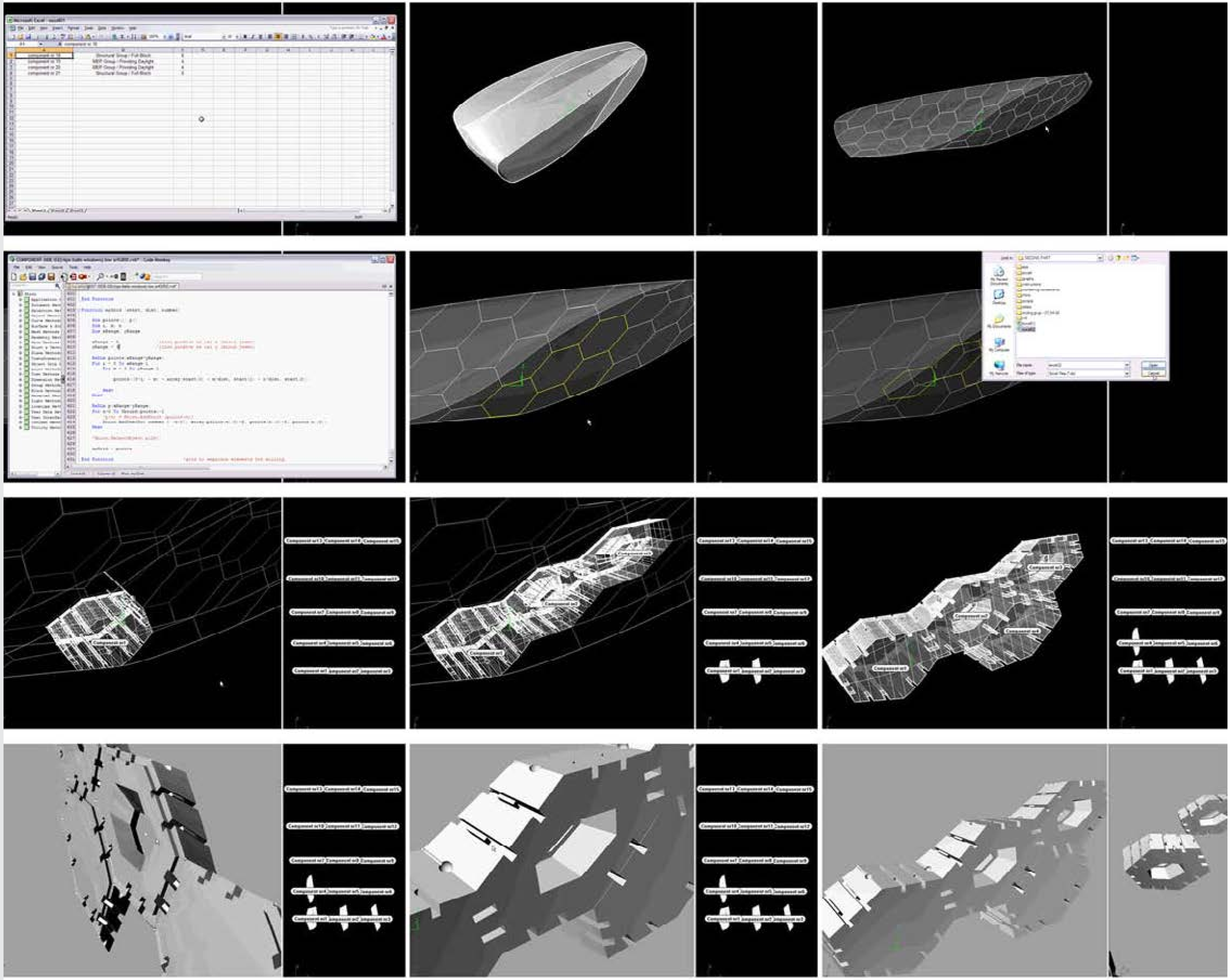


Figure 1.16. Screenshots from this process of generating four chosen components with specific functions.

Figure 1-2. This render shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1. Bodycheck 3 Styling Group Six Components Chosen for the Final Fabrication of the Prototype

Krzysztof Gornicki - 1530259

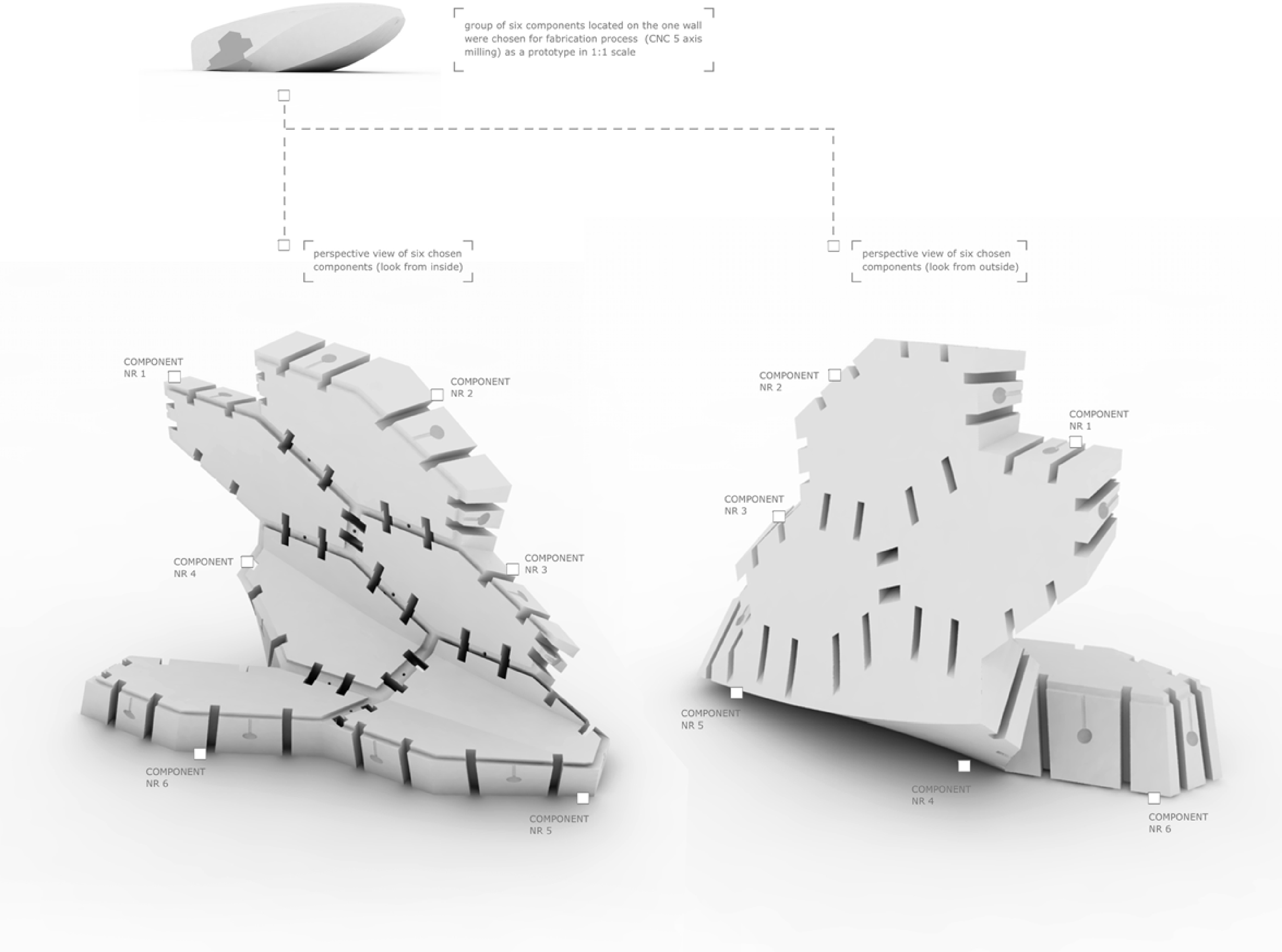


Figure 1-16. Six components chosen to be full scale prototype of the Protospace 3.0 project. This render shows that by Stylist Group without deci-sion on functons

Figure 1-1. Basic model generated by Stylist Group ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

1.17. Generative six components for fabrication

There were chosen six components for fabrication of the prototype in full scale. The whole process of generating them were based on one of Kas Oosterhuis tips he gave us during an introduction lecture:

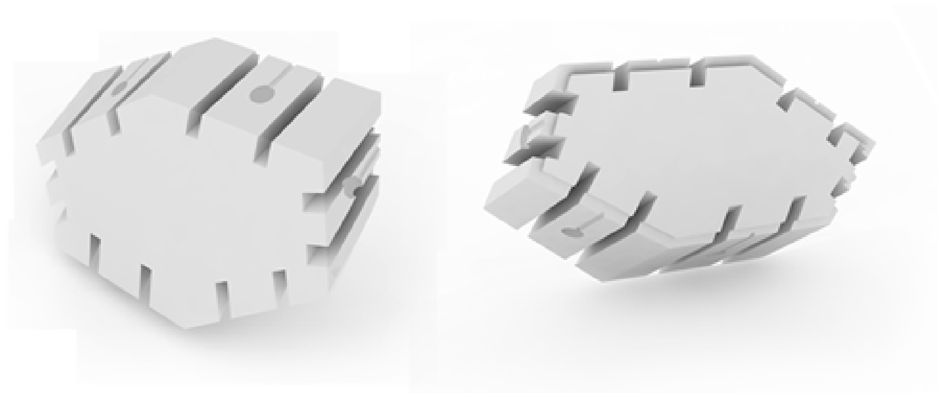
To be sure of a direct relation between your BIM and the actual fabrication, you must write your own scripts to link your machine to their machine, this is called machine to machine [M2M] communication and File to Factory [F2F] fabrication. Design such as to fabricate only by CNC [Computer Numerical Control] machines. Avoid bypasses, but make sure the manufacturer imports your data directly, without rebuilding 3d models and rewriting scripts. Talk with the manufacturers and prepare your data in such a way that they can be used unconditionally.

1. Bodycheck 3 Styling Group Six Components for Fabrication - Separeted Models for Process of CNC Milling

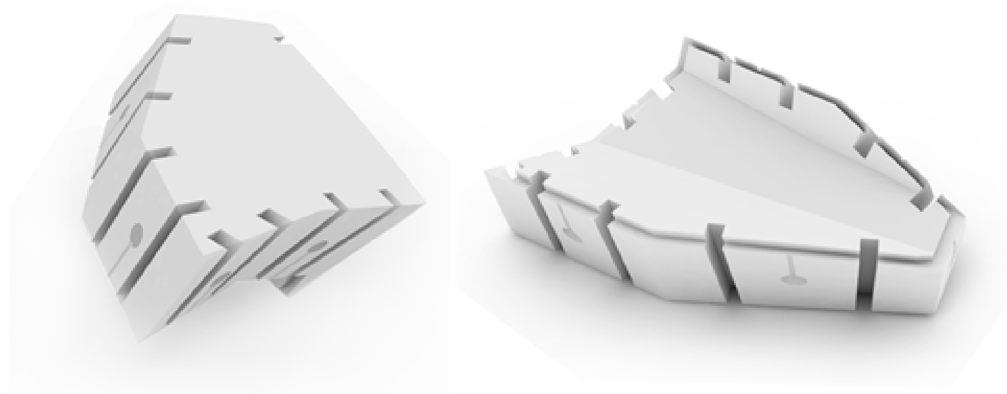
Krzysztof Gornicki - 1530259

1.18. File-to-Factory
Six chosen components ready for fabrication process. Each one of them as a closed surface model without ‘naked edges’, whcih is crucial for letting CNC milling machine fabricate it.
However after generating these files Studio decision was to add some more ornament on each one of them - just to test different possiblities of milling process. And so there were another iteration of modelling components.
Each one of components went to specific person, who was responsible for creating some patterns on its surface.

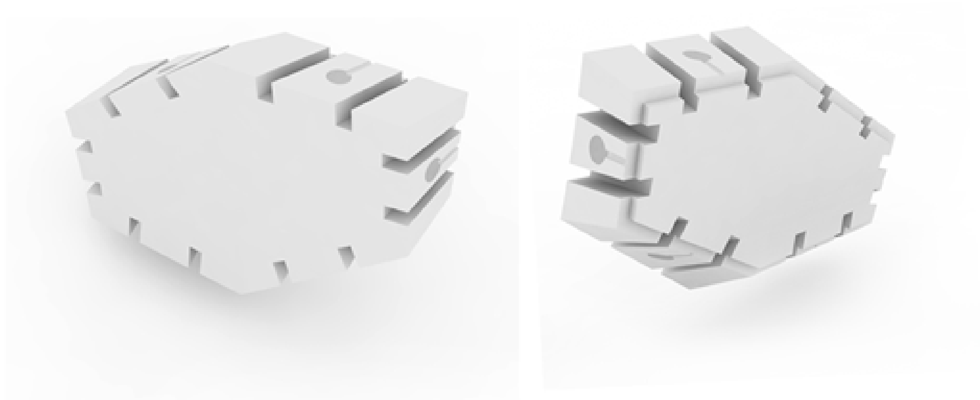
component nr 1 - MEP component with opening



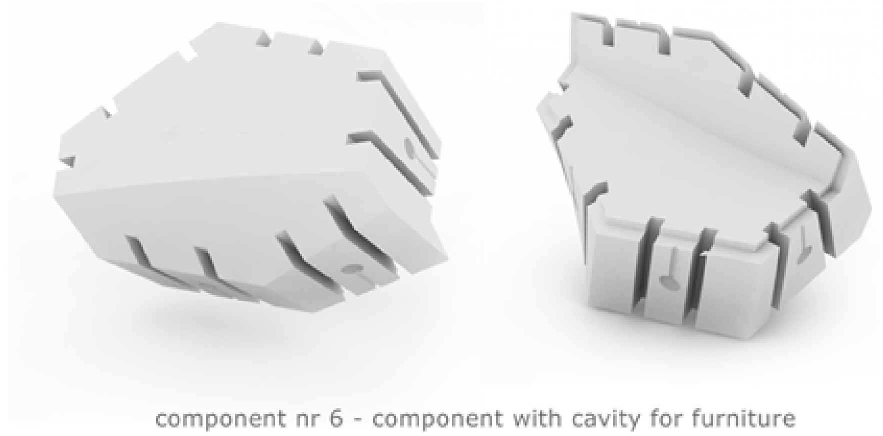
component nr 4 - structural block



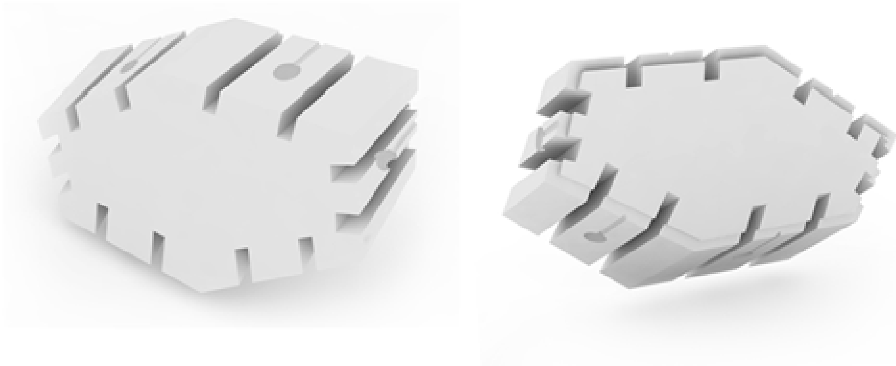
component nr 2 - interactive component



component nr 5 - structural block



component nr 3 - MEP component with heating/ventilation devices



component nr 6 - component with cavity for furniture

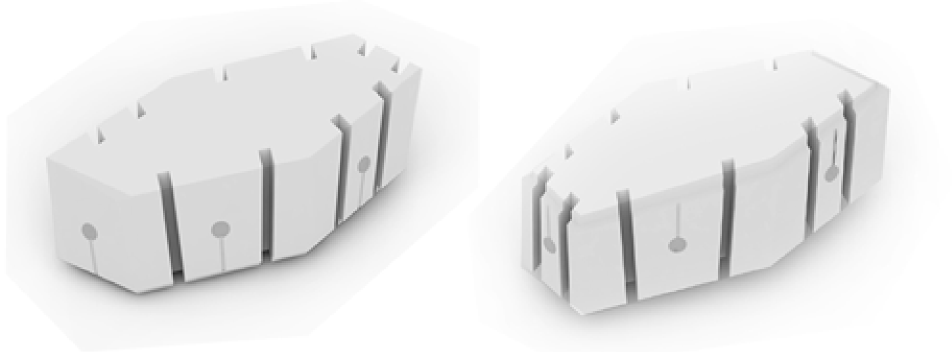


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Figure 1.17. Six files ready for further fabrication process.

1. Bodycheck 3 Styling Group Detailing Component Number 4

Roxana Palfi - 1535269

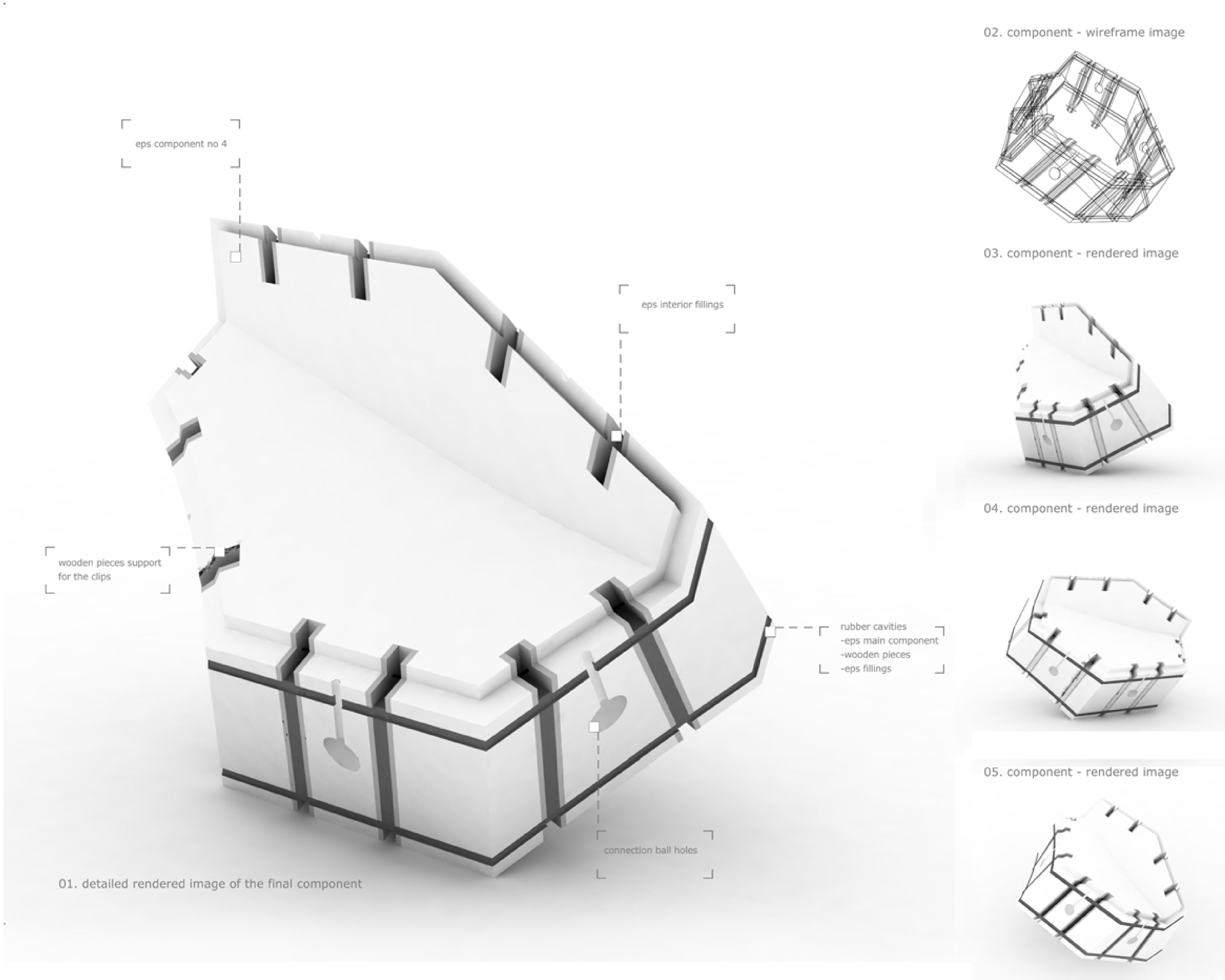

Figure 1-18. Detailing one of the fabrication components, adding some new construction details.

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1.19. New details

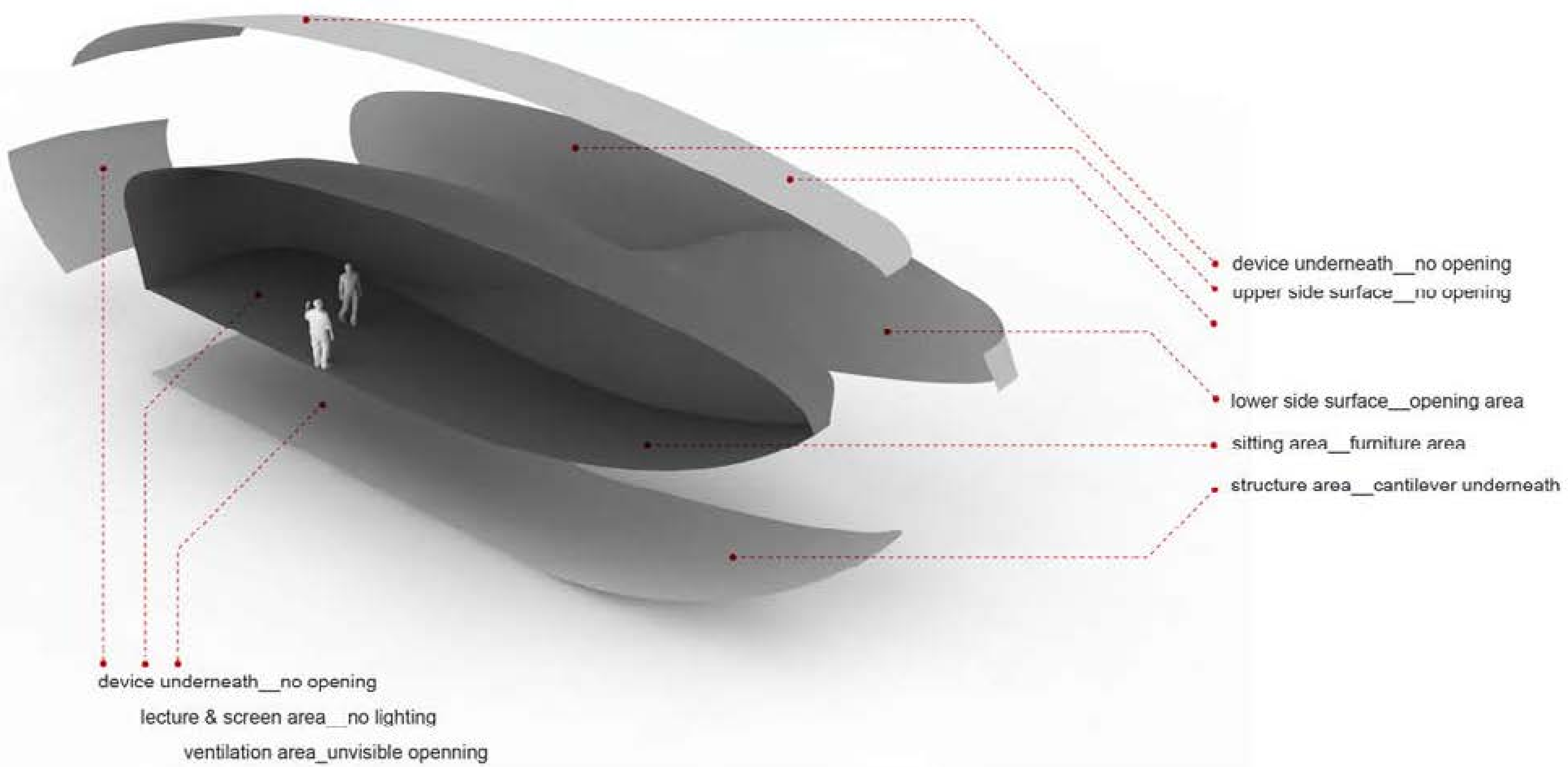
One of the components for econd iteration of modelling were modelled by styling group as well.
However component nr4 was decided not to have any specific ornaments or textures. The only thing which had to be changed were places for clips and adding cavity for rubber.

1. Bodycheck 3 Styling Group Location of the Openings

JinJie Yan- 1530607

1.20. Different zones of the space - location of the windows

The space of the project is divided into different functional zones and the location of the openings follows this logic. Thus there is no single opening in the zone of the 'arena', which is space for projections and lectures.
The openings appear in the part of 'podium', giving chance to users to look outside the building body, and at the same provide a bit of sunlight.



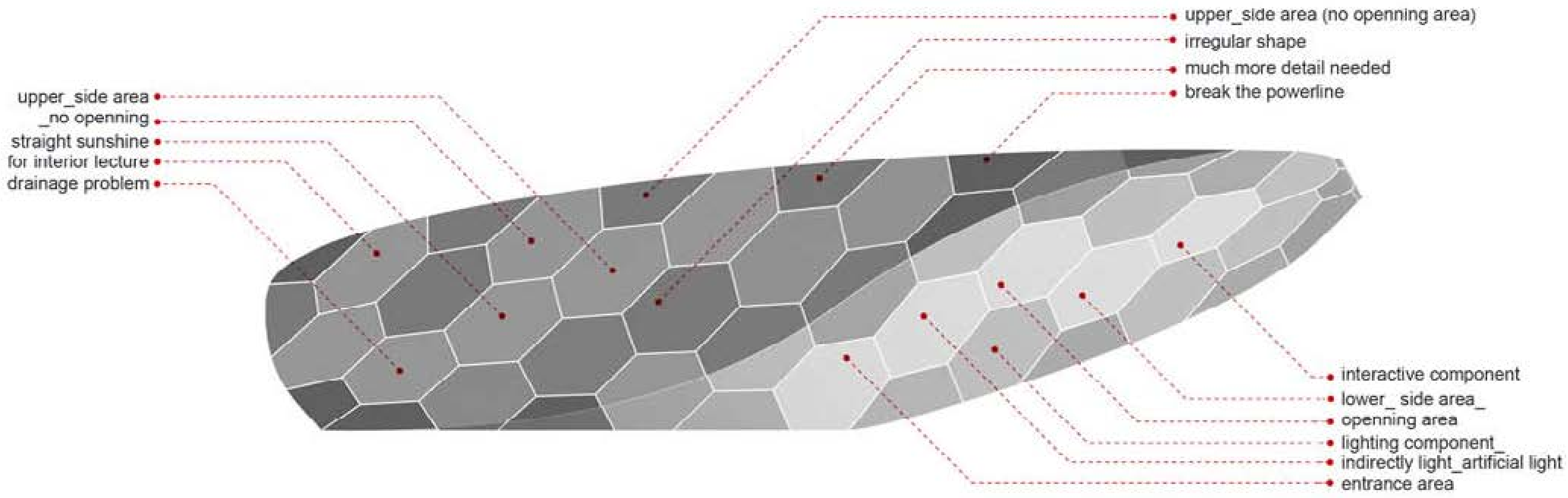


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Figure 1-19. Diagrams showing the possible location of the windows. DIfferent functional zones driving the specific positions.

1. Bodycheck 3 Styling Group Different Kinds of Openings for Chosen Group of Components

JinJie Yan- 1530607

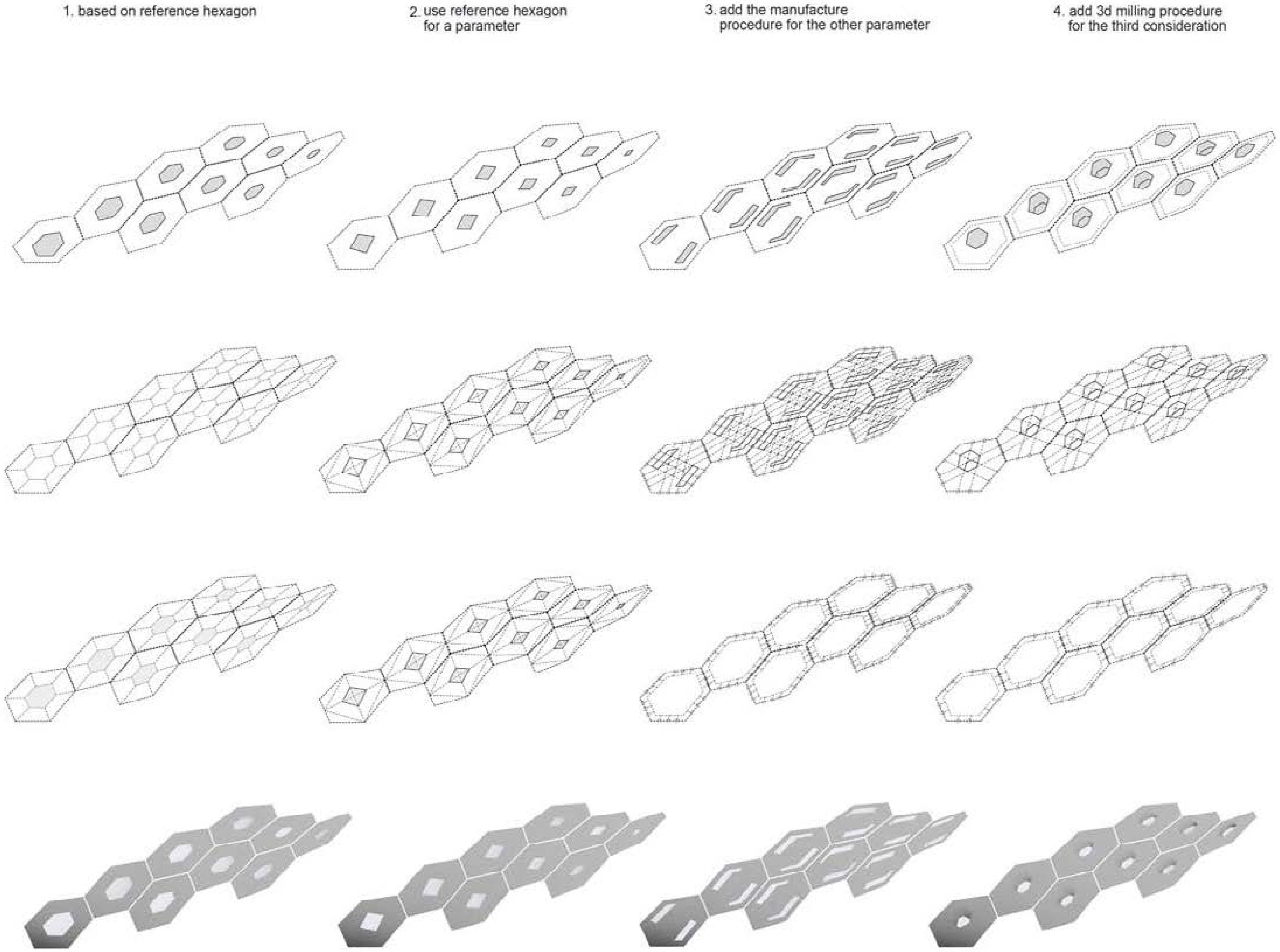

Figure 1-20. Different development of the windows shape. Looking for the proper geometrical logic as a starting point.

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1.21. Patterns for the openings

The next step of designing the pavilion was the decision about the pattern of the openings.
The first trial was based on the exact shape of the component, so the openngs got the hexagonal shape as well.
Later we were trying to develop a pattern based on the geometrical logic of the component and its cuttings for the connectors.
Except for these trials there is an additional layer of developing the window shape, related to the third dimension of it. Thickness of the component and five axis milling procedure allows to make a window changing the shape (different one on the outer surface and inner).

1. Bodycheck 3 Styling Group Different Variations of the Openings on Three Dimensional Form

JinJie Yan- 1530607

1.22. Different variations
Trying different variations on the three dimensional model and comparing all of them together. Four specfic design propositions:

1. Big hexagonal openings
Radius of each hexagon is based on the referenced hexagon.

2. Square shape
Width and length based on propotion of the referenced hexagon.

3. Following the geometry logic
Trying to develop a logic based on the geometry of the component and its cuttings.

4. Small components
Refering to the sizes of the component

width and length based on the proportion of the referenced hexagon

the decrescent hexagons openning according to the lighting and ventilation needs for different function

radius of each hexagon are base on the referenced hexagon.

the decrescent hexagons openning according to the lighting and ventilation needs for different function

width and length based on the proportion of the referenced hexagon

the decrescent hexagons openning according to the lighting and ventilation needs for different function

to avoid strait sunshine affect the interior activities, the openning at inner surface and outer surface are based on different centrol point

consider the manufacture procedure, we should leave some space for the clips and joints, this form based on the 3 axises of the referenced hexagon

form transformation emergence in this openning system

the decrescent hexagons openning according to the lighting and ventilation needs for different function

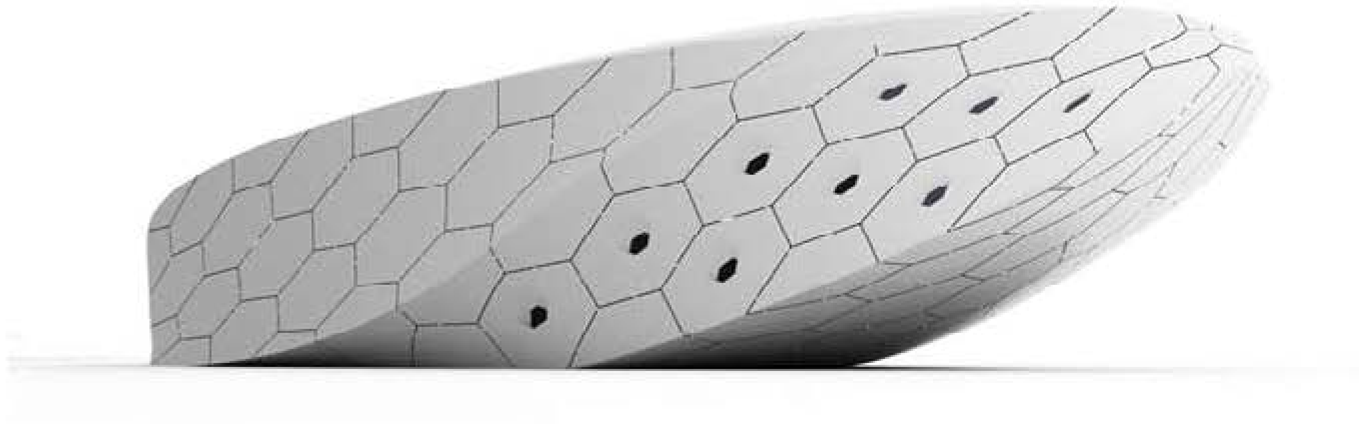

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Figure 1-21. Final rendering of the project proposal of the Protospace 3.0 (vizualization done by Jie Yan)

Figure 1-1. This image shows this and that. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.