Phase 3: The application of the canopy as part of a pavilion 7

Knowing through modeling

7.1 Textile canopy

7.1.1 Modelling techniques

The first step during the conceptual design phase was to apply folded textile pockets onto a canopy structure. As mentioned in section 4.4 a singular sheet of paper or textile can't easily be shaped into both pockets and openings, based on existing folding patterns. Discoveries based on hand-folding are very valuable to assess the spatial potential of each, however it is a time-consuming method if in-depth studies are required. This led to computer-aided modelling as a tool to assess the appearance of folded canopy elements when applied at different scales and in different conformations. The notion of computer modeling goes against the initial discussion regarding making by hand. Can it be used to supplement hand-making, and play a supporting role during the investigation process?

computer-aided modeling to supplement hand-making

The hand discovers what a material wants to be, and the computer repeats these possibilities.

Parametric design is a mathematically-driven technique where real-world parameters such as light and stress forces are entered into a digital script. The design outcome changes based on the parameters, and this is often used in architecture to design solar facades. Initially, this tool was used because of the need to model different versions of the canopy based on the qualities of space uncovered during the hand-folding process. However, it illustrated the value of technology when combined with hand-making methods.

Even though more time is spent developing the script than on folding paper, any variable that the user changes will be shown in the model without having to rewrite the entire definition. Thus many more iterations can be generated once the script is written. Inputs such as the number and size of folds, as well as the spatial conformation, allowed the generation of canopy designs and the visualisation of their characteristics along with

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their shading-and containment properties.

7.1.2 Design logic

Because this phase makes use of computer software to model design ideas, the resulting designs are not considered to be samples, as in phases 1 and 2. They are instead referred to as iterations (refer to figure 27).

Iteration 1 focused on a folding pattern without openings. Instead, the way in which plants could be viewed was based on its spatial conformation, changing as the user moves underneath the canopy. Despite its possibilities, openings in the pattern were desired, not only to experience the plant canopy, but also to create visually appealing shadow patterns. In this way the interest can be both on the overhead plane as well as on the ground plane.

Similarly to phase 2, no established folding pattern was used. Instead, an idealised version of the canopy was modelled, with an interplay between folded textile plant-containing pockets, and openings in the pattern in order to view and experience the plants. Iteration 2 combined folded textile pockets along with openings applied on a flat overhead plane. Further variations of this definition investigated curved planes, contorted in three dimensions, to reveal the plants from different angles. A more elegant geometry was required, and thus the curved surfaces needed to be simplified.

Due to the multiplicity of functions desired, the canopy should be separate from the pavilion structure and be able to be used in different scenarios. During phase 2 a hypar paper structure was folded (sample 4), but its potential as a plant-containing element was dismissed due to the nature of the folds. However, the logic of the structure itself showed potential: as a lightweight frame onto which irrigation pipes can be attached, which, in turn, act as a structure onto which the folded textile pockets can be suspended by their mountain folds. The canopy can act as a free-standing structure, as well as be suspended from a larger structural frame. This was the motive behind the form of the hypar, and when modelled digitally, it displayed an elegance in its aesthetic.

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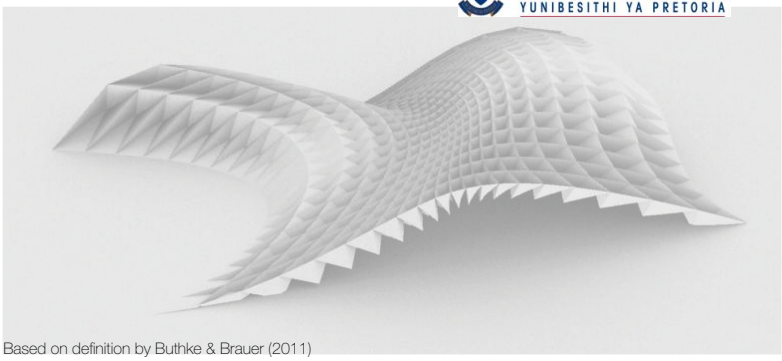
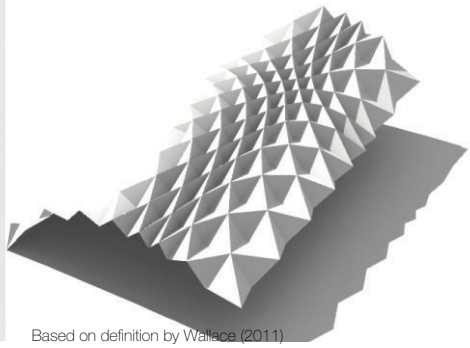
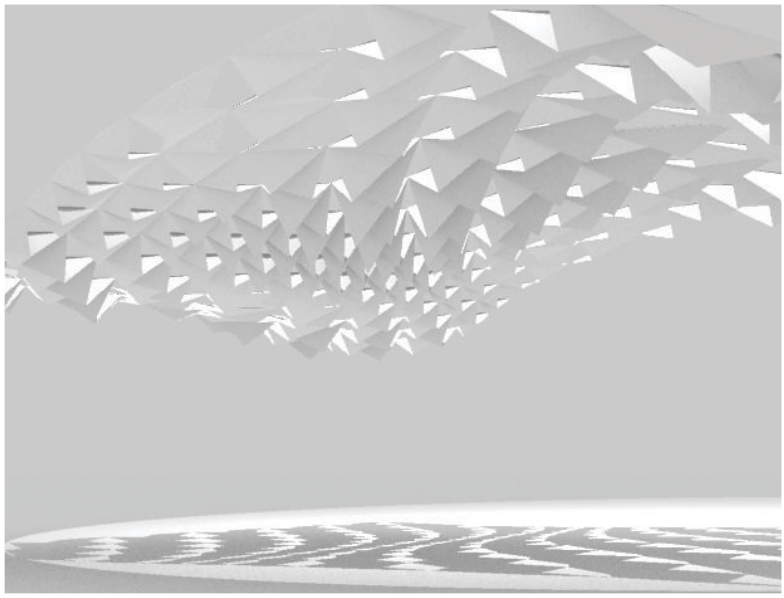


Based on definition by Buthke & Brauer (2011)

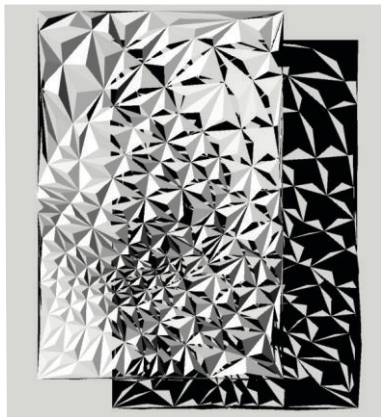


Based on definition by Wallace (2011)

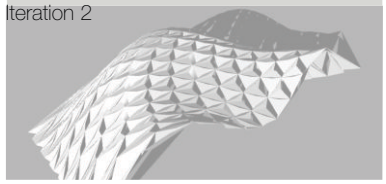
Iteration 1: folded pockets



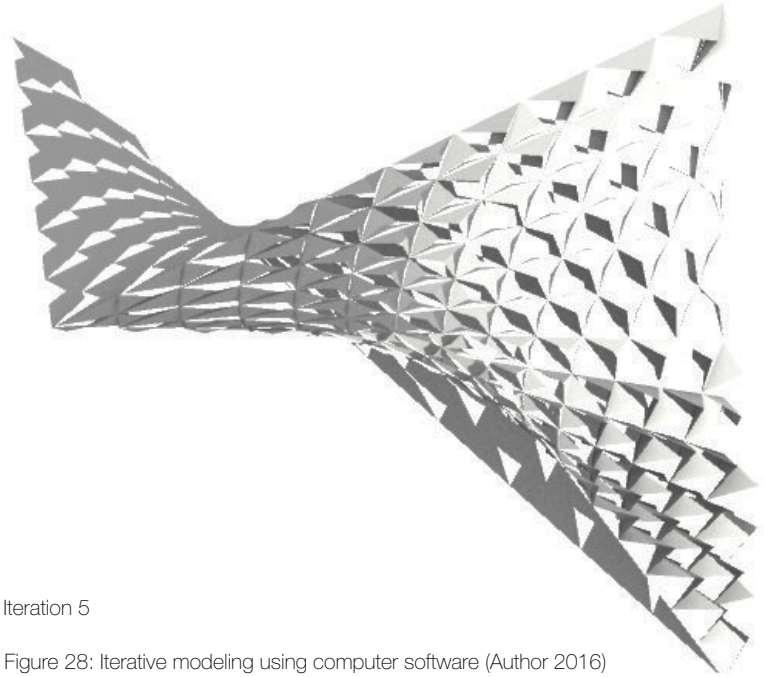
Iteration 3



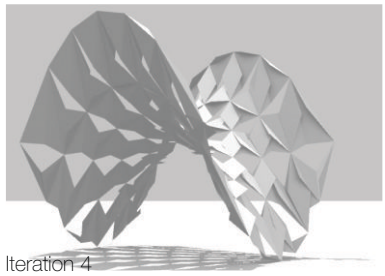
Iteration 2



Iteration 3



Iteration 5



Iteration 4

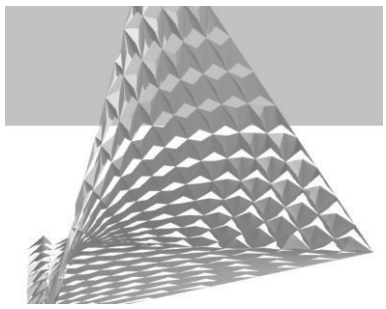


Figure 28: Iterative modeling using computer software (Author 2016)

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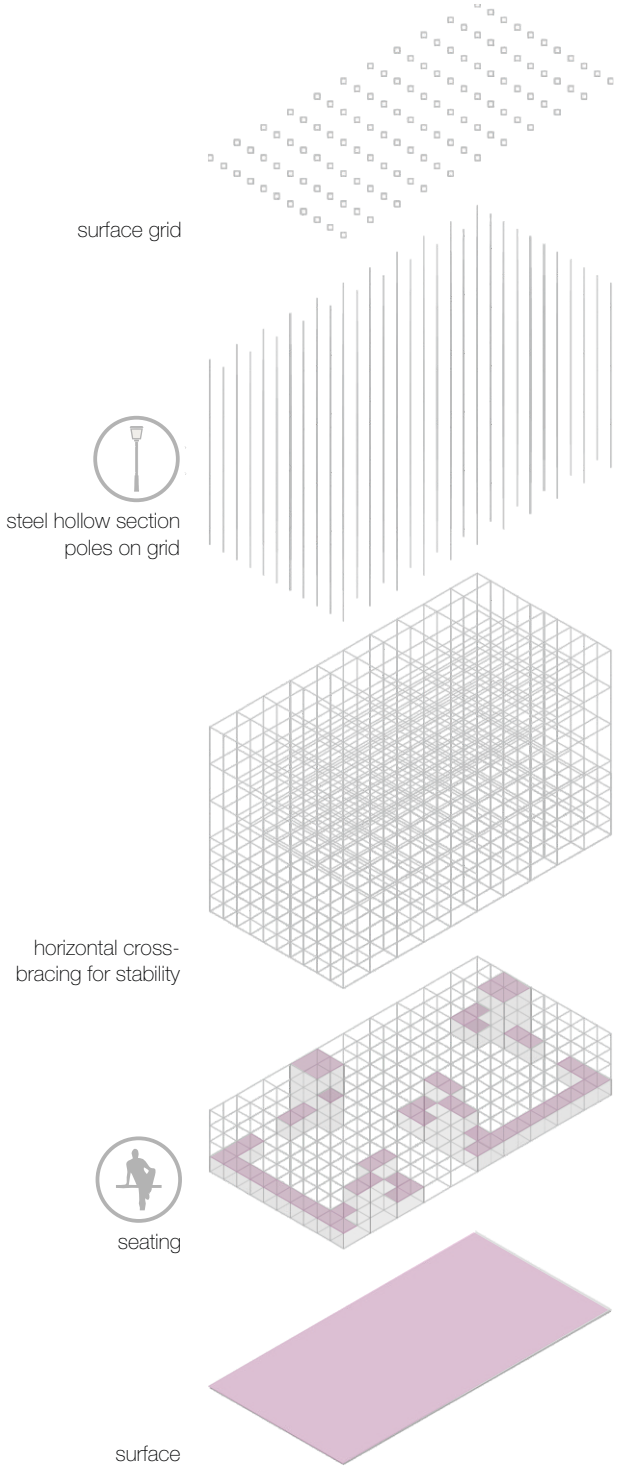

Figure 29: Pavilion composition (Author 2016) (continued on following page)

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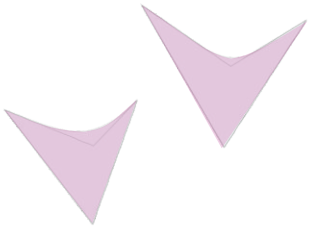
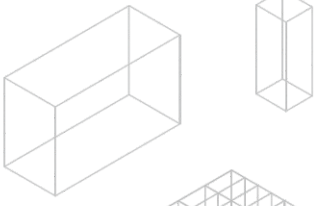
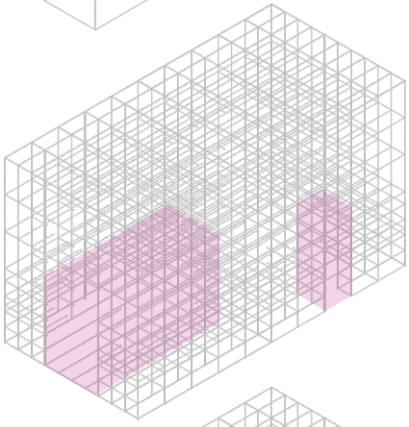
textile canopies



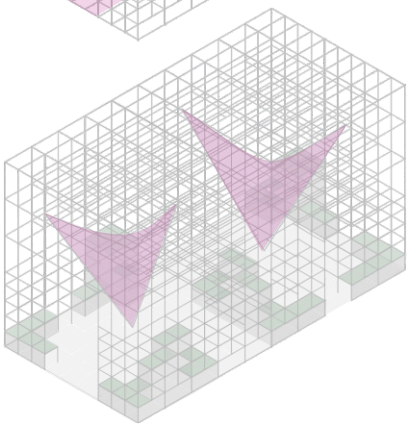
points of entry
cut out of structure



volume subtraction



resulting structure



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7.2 Structural grid

Conceptually, the structure was based on a grid, out of which programmatic spaces were subtracted (see figure 28). This was modelled parametrically, based on the dimensions required by seating and walking. The canopy was then suspended on the structure, further subtracting from the frame's conceptual grid. The value of modelling the structure in this way was in quickly generating a series of responses based on the parameter of dimensions, incorporating circulation as well as seating into the structure.

The opportunities of working with a structural grid also presented themselves in the form of lighting design. Vertical non-structural members can also act as luminaires, either between the canopy and the main structural frame, or as vertical members below the canopy structure. Figures 30-36 illustrate further explorations of the pavilion.

7.3 Reflection

During this phase of investigations, there was an interplay between digital modelling and physical model-building. A physical scale model was built based on the digital model in order to determine the essence of the design and acted like a *parti* drawing (figure 29). It helped to simplify the conceptual design, and to determine further spatial possibilities by acting as a tangible object that was responded to by critics, examiners and fellow students. Parametric design assisted in generating quick responses, and model-building was useful on a conceptual design level.

Figure 30: Conceptual model acting as a *parti* diagram (Author 2016)

New possibilities discovered during phase 3 include the value of parametric modelling, and the possibilities of the hypar as structural frame. The next phase in the design of the pavilion is the generation of different spatial possibilities of the pavilion in order to choose the most successful one that can be taken further on a technical level.

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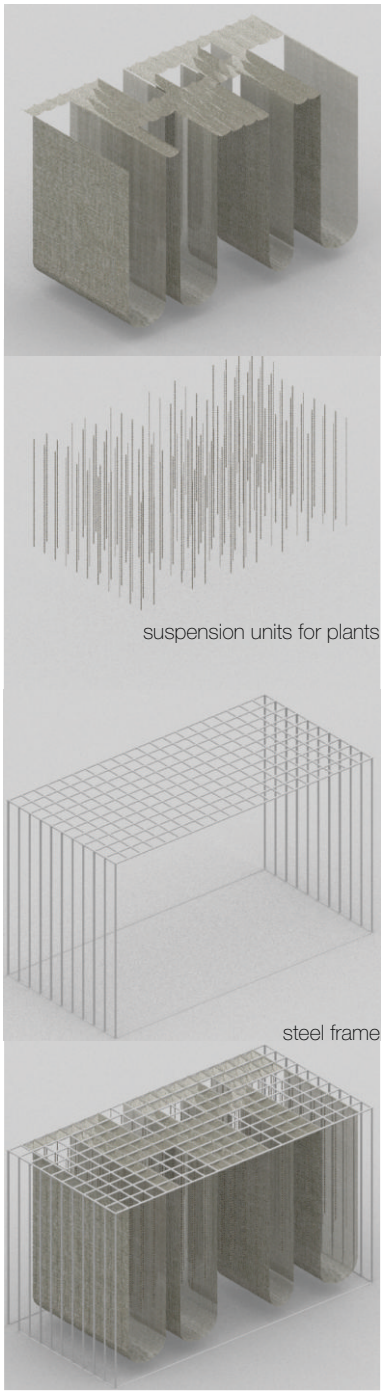

Figure 31: Textile pavilion as provider of immersive experience (Author 2016)

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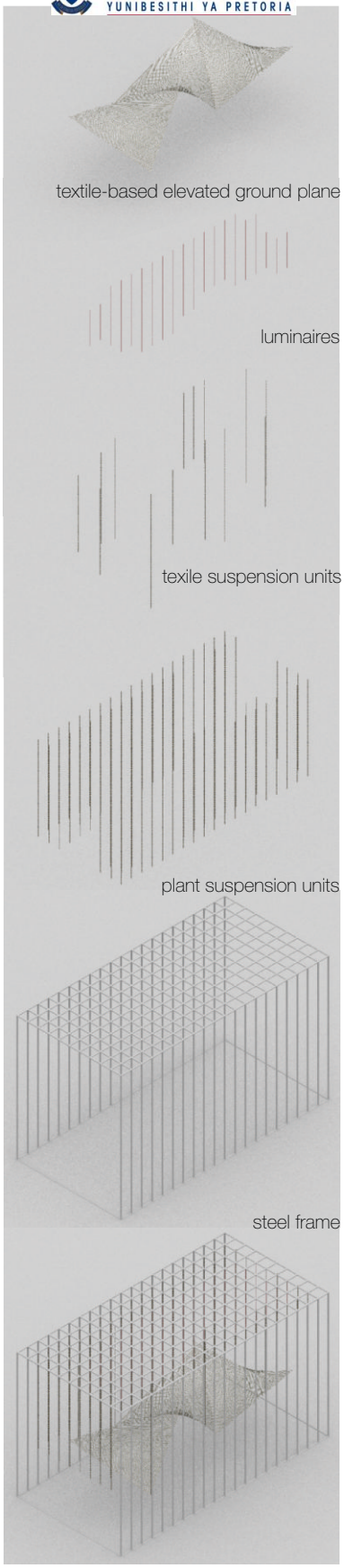

Figure 32: Pavilion as provider of immersive experience (Author 2016)

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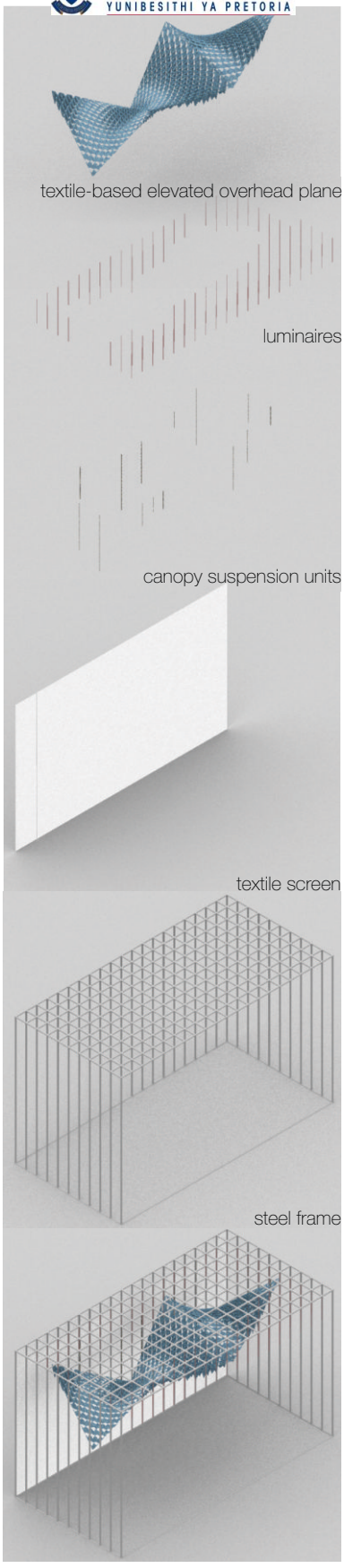

Figure 33: Pavilion as provider of services (Author 2016)

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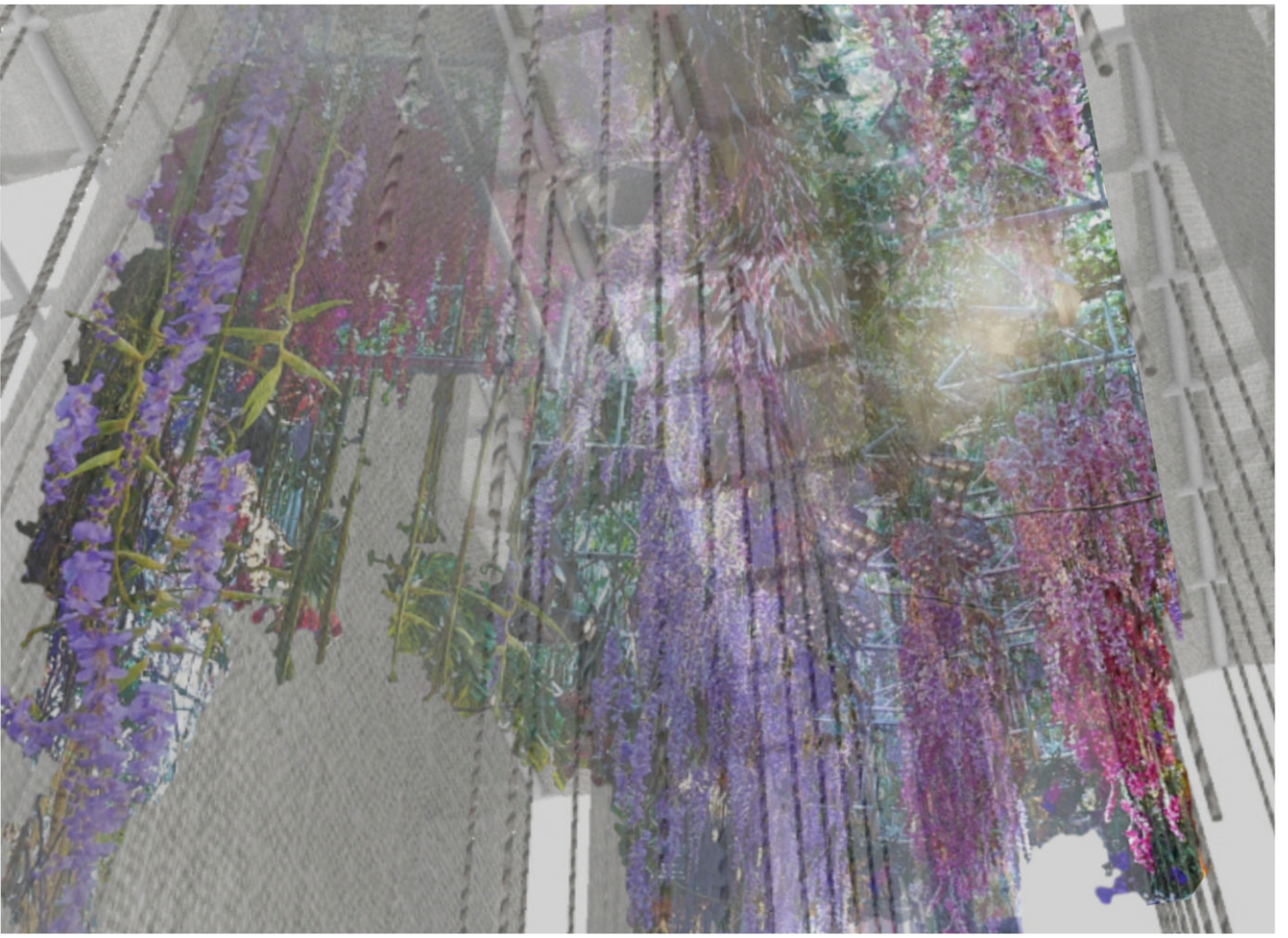

Figure 34: Immersive experience with plants and textiles (Author 2016)

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Figure 35: An elevated textile base plane adding to a unique user experience (Author 2016)

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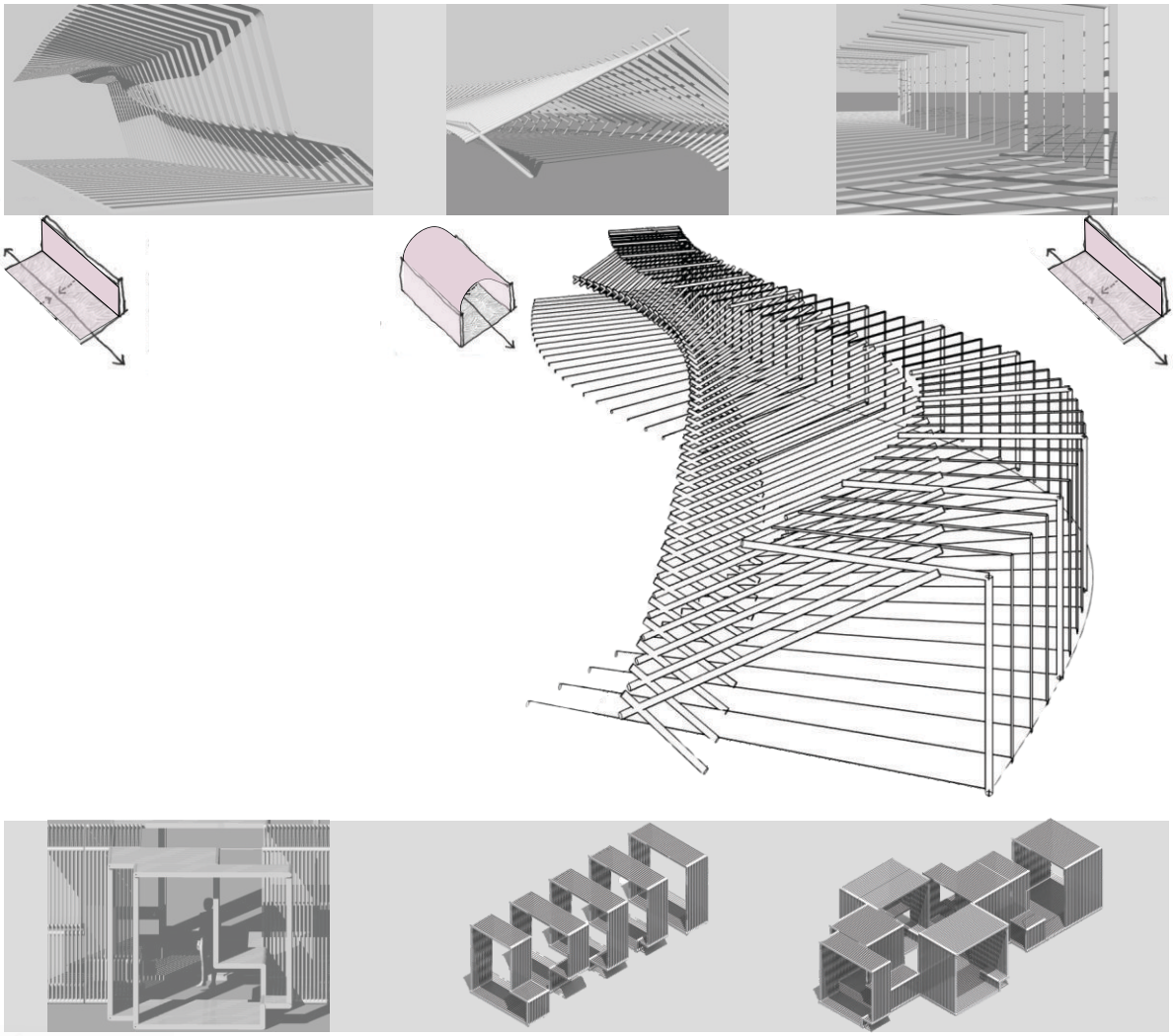

Figure 36: Selected iterations of the structural component of the pavilion (Author 2016)

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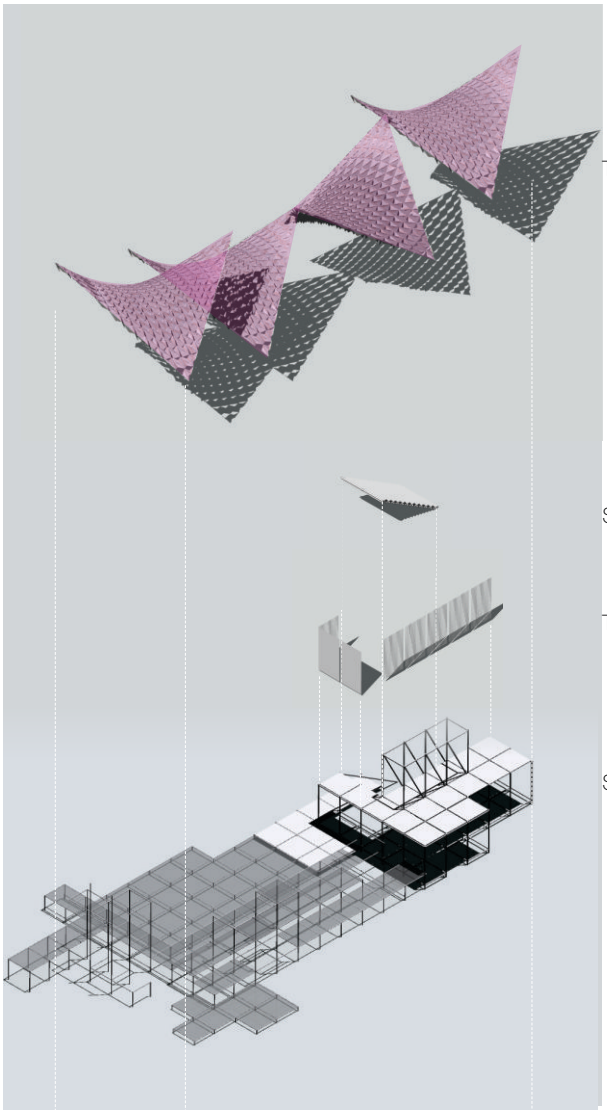

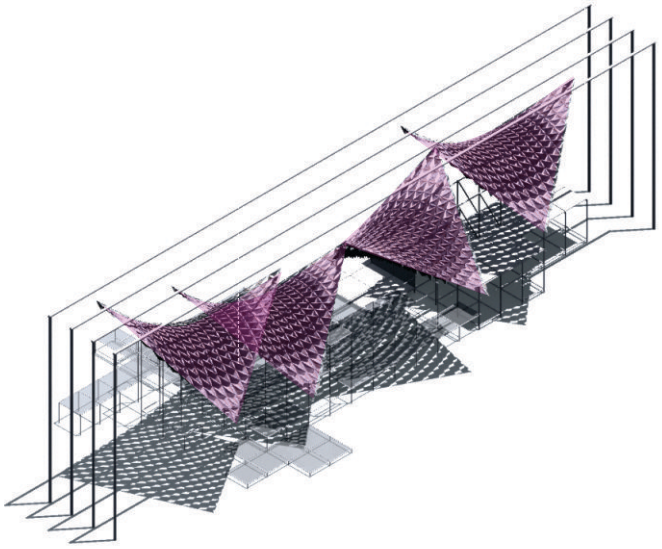

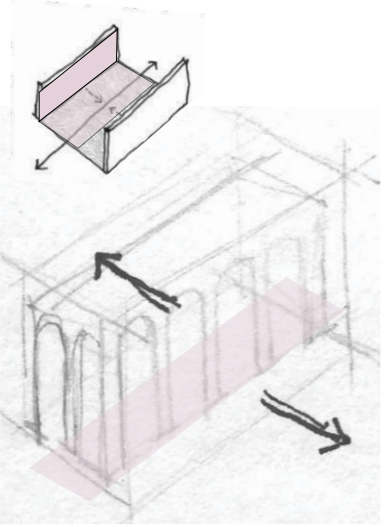

Figure 37: Linear pavilion acting as threshold and gathering space (Author 2016)

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