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The Paresite - The Environmental Summer Pavilion is a möbius shaped structure, built from torsed pine wood planks in triangular grid with thin pine wood triangular sheets that provide shadow and evaporate moisture in dry weather (Figure 1). A möbius concept is also considered for our final pavilion project. We could inspire from this project in terms of the structure and materials. In addition, in the Paresite project the sheets, cut in a tangential section, interact with humidity by warping themselves, allowing air circulation for the evaporation in arid conditions. The design was accomplished in Grasshopper for Rhino in combination with Rhino and afterwards digitally fabricated. The goal was to design and build a pavilion from a solid pine wood in order to analyse its material properties and reactions to the environment and to accommodate functions for a festival [4].

Figure 1: PareSITE (photo: Wágnerová, 2013)

The project was examined with the material performance of solid wood. Because of its ability to bend, it was agreed to use green wood for the structure. The concept of evaporating moisture and thus humidifying the air is called 'mashrabīyas'. The principle of wooden 'mashrabīyas' operates on hygroscopity of the material and its environmental conditions. At night, when the relative humidity is high, the wood absorbs moisture which is evaporated during the day (Figure 2) [4].

Figure 2: Mausoleum of Sultan Oljeitu, Sultaniyeh in Iran [1]

'Mashrabīyas are multi-functional elements that control light penetration, airflow, privacy and views, while operating on a synergetic relation between ornamental pattern and material distribution (Figure 3) [2]. The project used warping of wood in tangential section for supporting the circulation of humid air. This warping generates so called 'cup' across the fiber [3]. The boards are nailed towards the upper edge, just below the joint where they overlap. In dry weather, the lower board ends bend outwards, allowing dry air into construction. In wet weather the boards close again [6].

Figure 3: Torsed Structure with Responsive Skin (photo: Zapletal, 2013)

For the design process, several Grasshopper plug-ins implemented. LunchBox plug-in was used to design Environmental Summer Pavilion. The plug-in contained algorithmic geometry, panelling tools, structure and powerful utilities. It became the main tool to finish [4].

For the initial surface a möbius surface was used with its logic of closed and vertiginous continuity. Then, the final surface of two layers was developed. The first layer contained static structure presented by triangular tilling creating torsional hexagon loops over the surface. The second layer was again a triangular tilling that was cracking each triangle of the first layer of the initial surface (Figure 4) [5].

Figure 4: pareSITE (photo: Zapletal, 2013)

The initial surface was generated in Lung Box than edited in Rhino 5 afterwards offset in Grasshopper. The ends of the surfaces had to be connected in Rhino 5 manually and the structure was loft between those two offset surfaces, through the panelling tools from Lunch Box (Figure 5) [4].

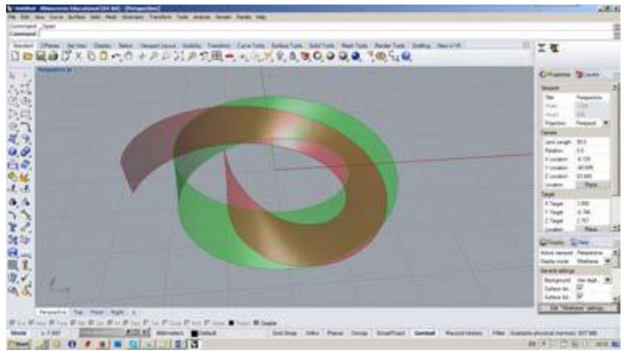

Figure 5: Offset of Möbius Stripe (photo: Davidová, 2014)

Structural Design of the Paresite Pavilion

Triangular grid was chosen for the construction of möbius shape because of its ability to mimic curvatures and stability features. Grid was offset inward thus defining shapes of planks which are generally perpendicular to the surface of möbius stripe. Hypothetically, to achieve planarity, all of the joints axes would have to intersect in one point. In case of möbius stripe, parts where joint axes would be parallel with the surface would occur, making planks parallel too, and therefore weakening rigidness of whole structure. Planks were cut and put together to form triangular particles. Each particle consisting of three twisted pine planks was connected by metal sheet overlay on whole length of connecting edge tightened by screws [4].

The form of pavilion does not allow subdivision into planar surfaces, but anisotropic properties of the material support torsion. The angles of cuts hold the boards' torsion together in the joint. There was a deal with twisted planks which introduced new set of forces into the structure. Due to rather unpredictable and complex nature of these forces, decision was made to encapsulate these into triangular particles, preventing unwanted accumulation and interactions [5].

System presented good manufacturing options as particles or differently sized clusters could be prefabricated indoors and easily assembled on site later. Bolt connections allowed for a later distribution of imprecision throughout surrounding structure, making it less disturbing. Each plank and joint (accept rim parts) was doubled, providing additional strength necessary for the use of green solid wood. Torque forces locked in triangles preloaded them and added rigidity, proving advantages of solid wood [4].

References

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