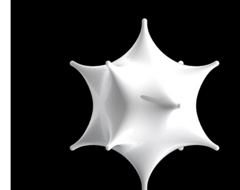
JAN DÜRRER I FA ČVUT V PRAZE I 2022/2023 I DOC. ING. ARCH. MILOŠ FLORIÁN, PH.D.; ING. ARCH. JAN PETRŠ, PH.D.



Bacilux Construktux

ASSIGNMENT

Adepts of architecture are invited to design different types of hall pavilions for the assembly of buildings on the robotic principle in the Dejvice campus of universities. Modularity, variability, rebuildability, interactivity and adaptability to the environment should become the hallmarks of the new typologies. To this end, students will investigate and develop alternative structural systems, materials, geometries and mechanisms that would be able to meet the autonomous functioning of indoor buildings, taking into account not only mobility but also economic, social, cultural and environmental issues.

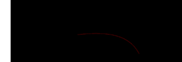
VISIONS

The design principle assumes a robotic assembly principle and is based on the use of autonomous robots to assemble and build the structure. These robots then become part of the construction themselves. The system is designed to be able to assemble a complex structure quickly and efficiently, with zero human intervention.

MISSION

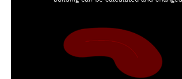
Robotic pavilions are able to react quickly and accurately to different parameters and conditions. Robots can be programmed to adapt to changing environments, allowing for variable structures and adaptive architecture. This is particularly useful for temporary structures such as pavilions at exhibitions, festivals or events.

PARAMETRIC APPROACH



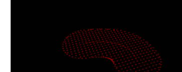
INTRO

The whole building is designed in a parametric way. This design is defined by a single control curve. The advantage of this solution lies in the highly variable possibilities. In the following steps you will be introduced to the process that takes place in the background. The shape of the building can be calculated and changed in real time.



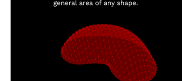
SEARCH FOR BOUNDARIES

This step deals mainly with defining the area. In the next step, the control curve is offset by a parametrically specified value. This creates a part of the pavilion area. The front and back of the object are formed by two semicircular shapes. This type of treatment is inspired by the apse.



DECONSTRUCTION OF THE AREA

This step of the algorithm deals with the preparation for the analysis of the ideal shape of the house. By deconstructing the surface into individual points and creating a mesh, it allows a detailed analysis and understanding of the resulting structure. This procedure can be applied to a general area of any shape.

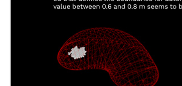


SHAPE DESIGN PROCEDURE

The Kangaroo2 plugin, which is an extension for the Rhino graphics software, was used for this step. This plugin provides tools for simulating and optimizing structures and designs. Its main focus is the analysis and manipulation of soft bodies such as diaphragms, cables, flexible objects, etc. The Kangaroo2 plugin uses the finite element method (FEM) to simulate and interact with these structures.

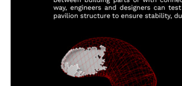
ENVELOPE

From the most optimal geometry, an envelope was created that defines the boundaries for automatic generation. A value between 0.6 and 0.8 m seems to be the optimal size.

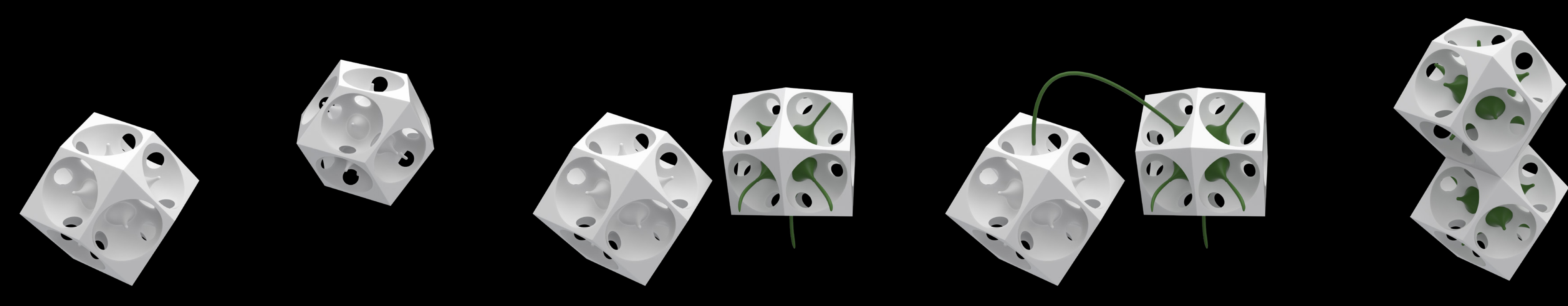


DISCRETE ELEMENT METHOD

The Discrete Element Method (DEM) is a numerical method used to simulate the behavior of an ensemble of discrete elements such as particles, granules, or solids. In the context of architecture and robotic pavilion, DEM can be used to model and analyze the interaction between different elements and components of a structure. In this case, DEM is used to simulate the behavior for the construction of the robotic pavilion. These are structures created by robots that build and assemble elements into complex geometric configurations. DEM enables the simulation of the interaction between elements of the pavilion, for example between building parts or with connected joints. In this way, engineers and designers can test and optimise the pavilion structure to ensure stability, durability and safety.

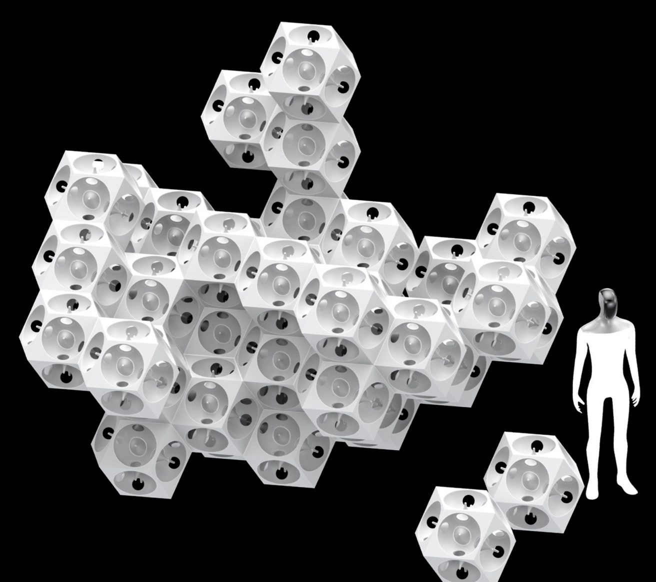


FOR MORE VISIT



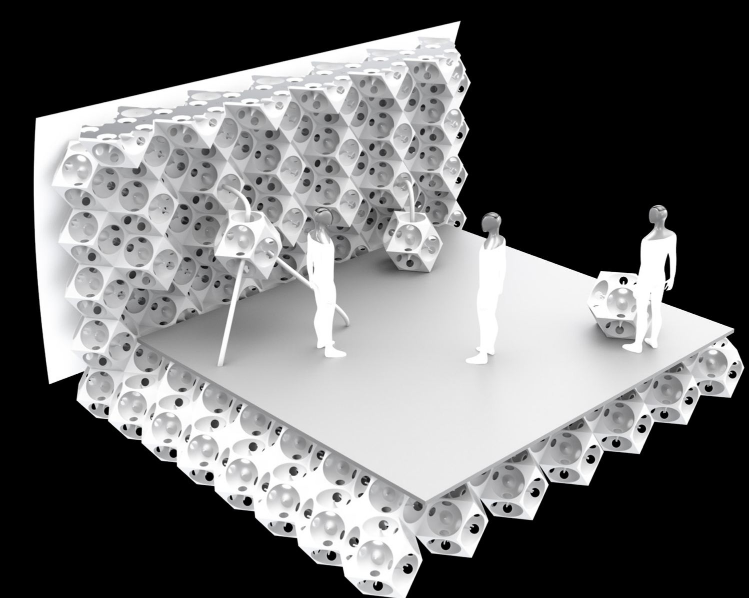
ROBOTIC MOVEMENT

Is provided by soft robotic parts. These components originate from the centre of the module and allow smooth horizontal and vertical movement of the module on other modules and surfaces. The sequence above shows the horizontal and vertical movement of the module.



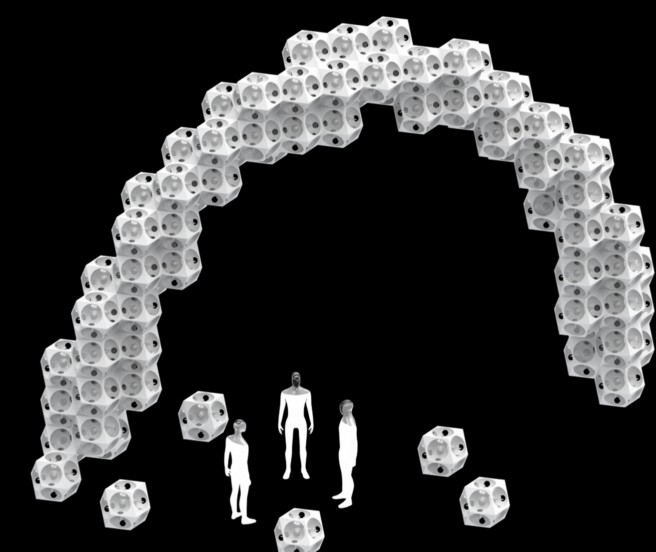
INTELIGENT STRUCTURE

The complete structure of the pavilion consists of individual independent units that are capable of independent movement. The entire pavilion is a cluster of robotic cells that can rearrange themselves according to a given algorithm and requirements. By combining them, an intelligent structure is created that can respond to the demands of its inhabitants.



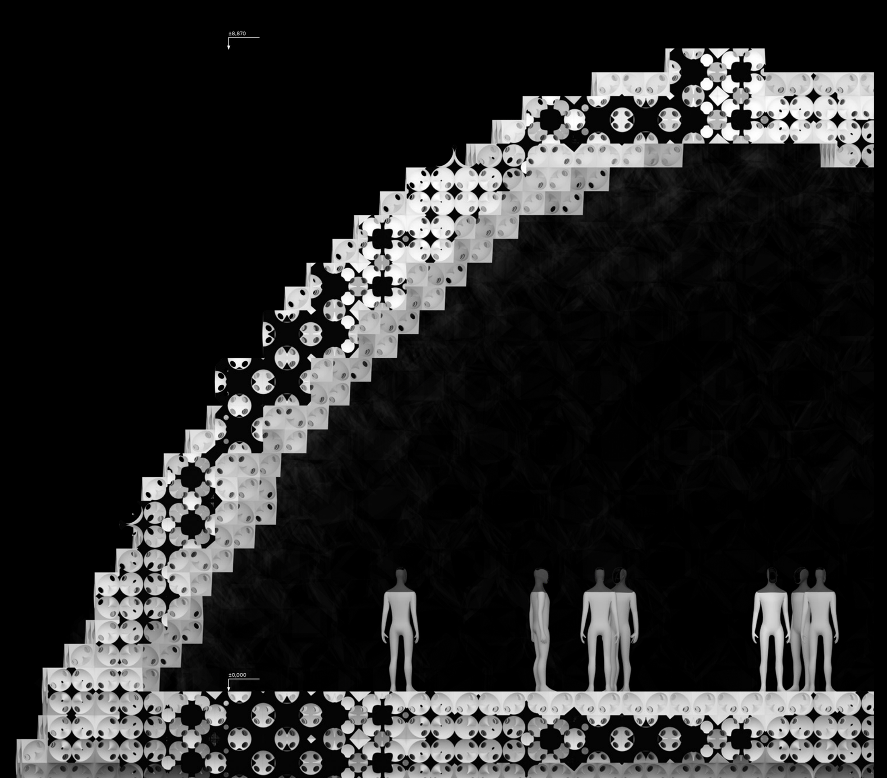
INTERNAL EQUIPMENT

The indoor space of these robotic pavilions is designed exclusively for the needs of humanoid robots, all facilities located inside are used exclusively for research and behavioral needs. The entire complex is powered by solar panels in the building shell. These are flexible solar panels.

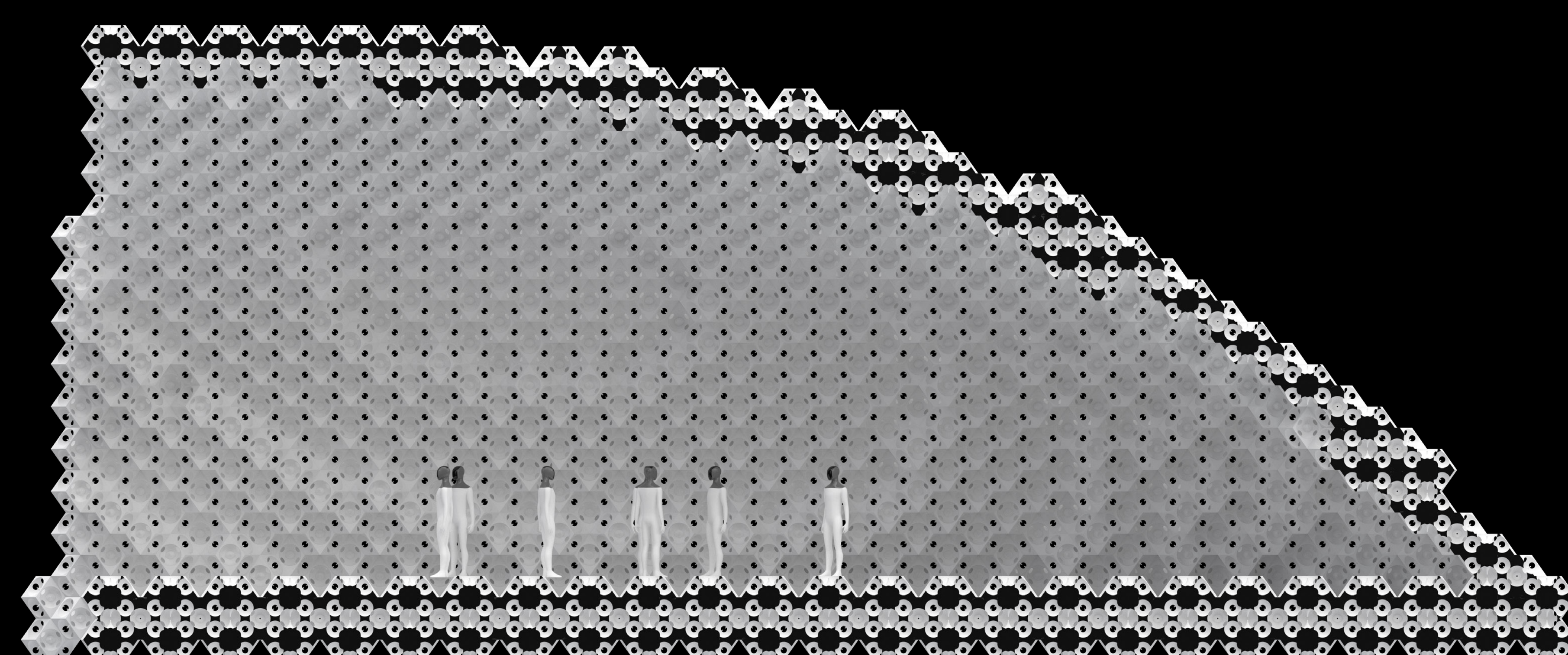


ANOTHER EXAMPLE OF USE

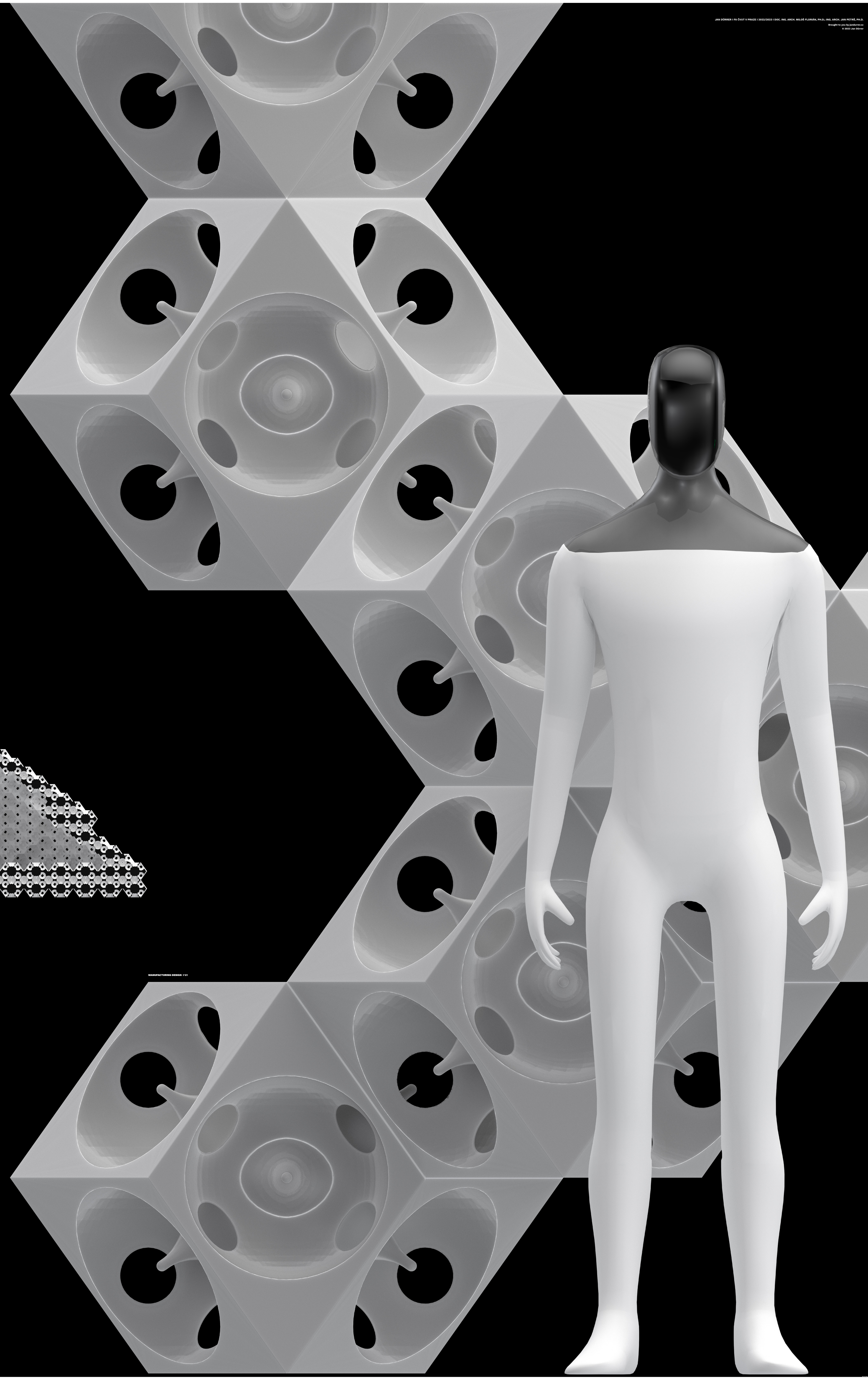
The system used allows great freedom of shape. It can be used to compose arbitrary structural units.



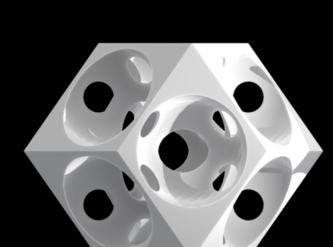
CROSS SECTION I 1:25



CROSS SECTION I 1:25

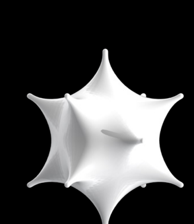


MANUFACTURING DESIGN I 1:1



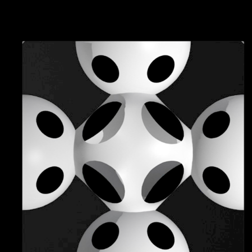
STRUCTURAL ELEMENT I 1:5

The Discrete Element Method (DEM) is a numerical method used to simulate the behavior of an ensemble of discrete elements such as particles, granules, or solids. In the context of architecture and robotic pavilion, DEM can be used to model and analyze the interaction between different elements and components of a structure. In this case, DEM is used to simulate the behavior for the construction of the robotic pavilion. These are structures created by robots that build and assemble elements into complex geometric configurations. DEM enables the simulation of the interaction between elements of the pavilion, for example between building parts or with connected joints. In this way, engineers and designers can test and optimise the pavilion structure to ensure stability, durability and safety.



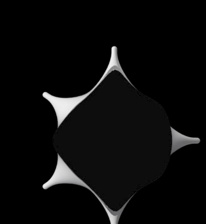
OPERATIONAL SYSTEM I 1:5

Robotic Construction: Develop autonomous construction robots. Efficient Execution: Ensure the robots can perform building tasks effectively. Material Handling: Implement advanced robotic systems for efficient material handling. Assembly and Installation: Design robots capable of precise assembly and installation. Operational System: Develop a system to coordinate and manage the actions of the construction robots. Task Efficiency: Focus on optimizing the robots' performance and productivity. Safety Measures: Implement robust safety features to protect workers and the environment during construction. Maintenance and Repairs: Create protocols for robot maintenance and repairs to ensure continuous operation. Adaptability: Design the system to handle various building types and adapt to changing construction requirements. Integration: Ensure seamless integration between the construction robots, system, and other building components.



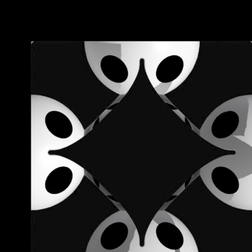
SECTION OF STRUCTURAL ELEMENT I 1:5

The element is made of 3D printed composite material. This manufacturing principle is chosen mainly due to the easy reproducibility and shape variability. Composite Material Cells focuses on the utilization of composite materials for constructing cells within a self-building building. Composite materials, made from a combination of reinforced concrete and carbon fiber, offer enhanced structural strength, durability, and flexibility. By integrating these composite material cells into the building's design, the self-building system can efficiently assemble and integrate these cells to form robust structural elements.



SECTION OF OPERATIONAL SYSTEM I 1:5

(CPU): Intel Core i7-10700K
(GPU): NVIDIA GeForce RTX 3070 8GB
Storage: 1 TB NVMe SSD
Connectivity: Gigabit Ethernet or Wi-Fi 6 (802.11ax)



SECTION OF COMPLETE UNIT I 1:5

The complete unit consists of two parts of the operating system, i.e. the core and the envelope which further constitutes the building structure itself.