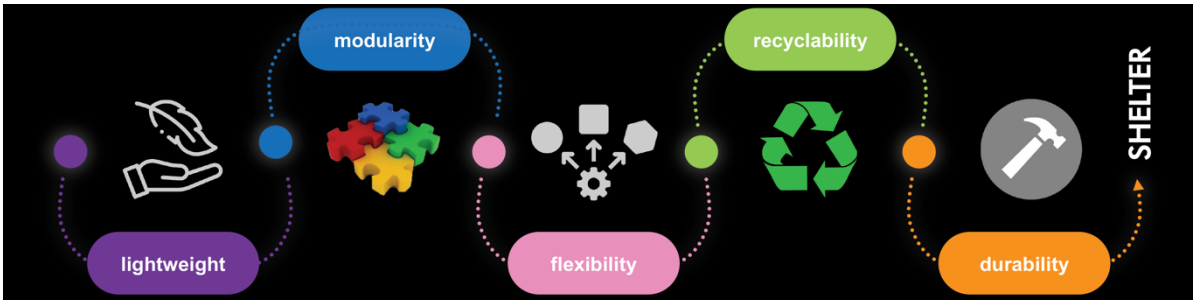
Design Studio • **Rapidly Deployable Shelter** • WS2022 • USTUTT

In the frame of the work package 5 entitled “3D printed optimized metal deployable structures to address the humanitarian crisis” a design studio and a seminar took place during the Winter Semester 2022 at the Institute of Lightweight Structures and Conceptual Design at the University of Stuttgart. The primary goal of this design studio was to design energy-autonomous and rapidly deployable structures that can meet urgent sheltering needs during humanitarian crises in different places around the world. The International Organization for Migration (IOM), International Federation of Red Cross, and Sphere Association minimum standards for shelter, materials specification, and minimum standards of the United Nations High Commissioner for Refugees will all be taken into consideration when designing the deployable shelter. The Deployable Shelter's fundamental features **include lightweight construction, modularity, flexibility, recyclability, durability, ease of handling, and transportability,** providing an engineering and architectural response to the post-crisis.



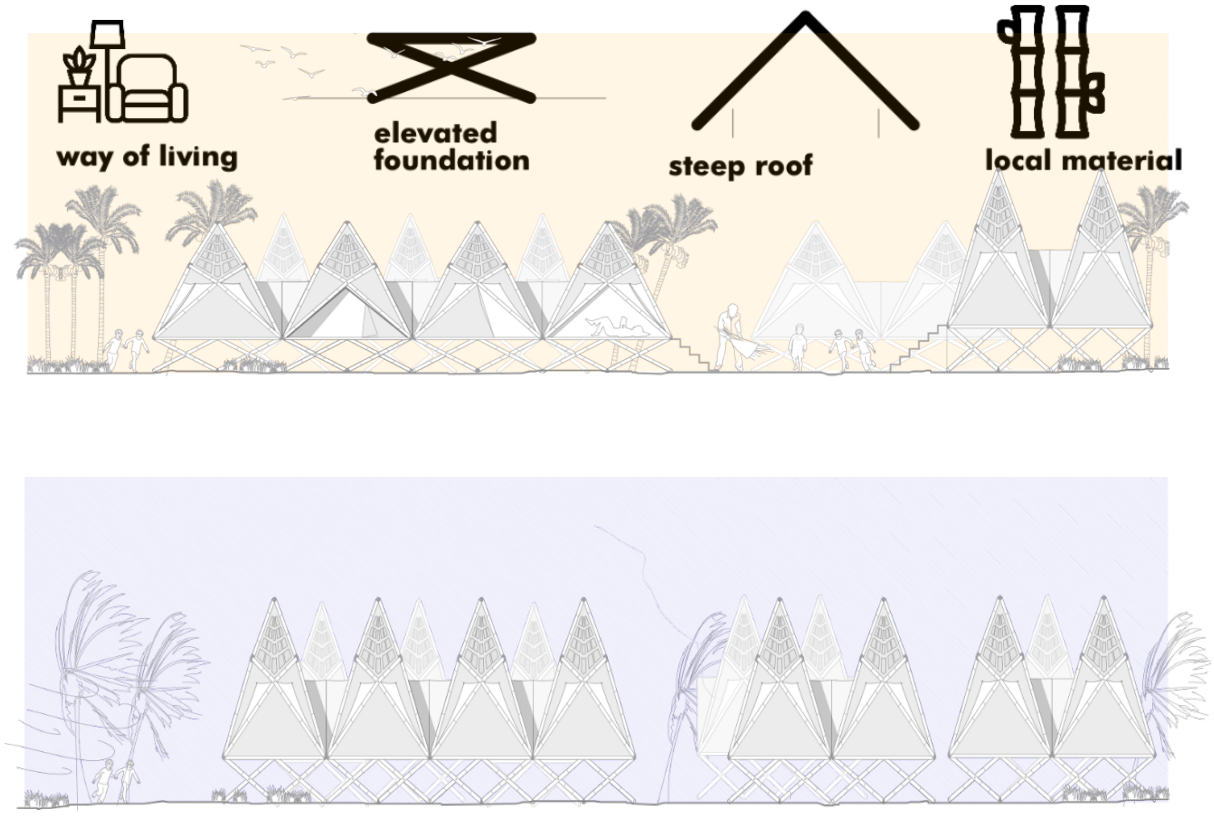
The design framework of the course involves the respective conceptualization, investigation, and analysis of deployable structures in physical models and geometrical simulations (Rhino/Grasshopper). As part of this design studio, nine design projects have been submitted showcasing different **structural typologies, building techniques, smart materials, and renewable energy systems**. For example, scissor-like structures, origami-inspired, and hybrid bar linkage structures. The next stage is to further design the structural joints in partnership with the industrial partner in order to integrate the kinetic features and manufacture them.

Teaching Assistant: Moon Young Jeong (ILEK)
Supervisor: Jun. Prof. Dr.-Ing. Maria Matheou (ILEK)

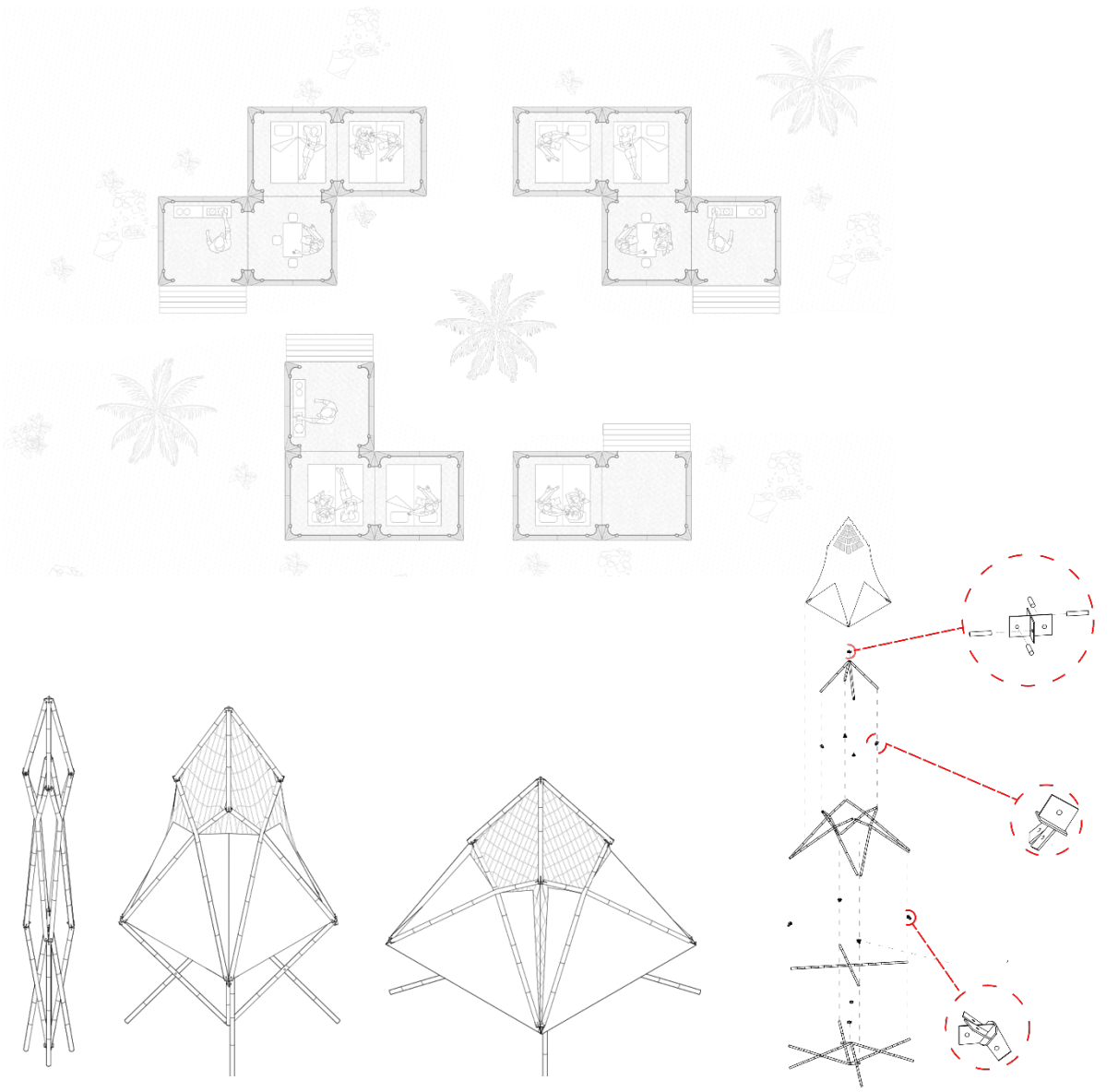
Acknowledgments
This research was supported by the ADDOPTML project: “ADDitively Manufactured OPTimized Structures by means of Machine Learning” (No: 101007595) belonging to the Marie Skłodowska-Curie Actions (MSCA) Research and Innovation Staff Exchange (RISE) H2020-MSCA-RISE-2020.

Bahay Cono, Philippines, Students: Eman Pagala, Weifeng He, Keiya Nakazato

The key idea of the Bahay Cono is a scissor-like deployable shelter that adapts to various weather conditions following a flood catastrophe in the Philippines. Rainy days in the Philippines, for example, require a steep roof and a higher floor to protect shelters from flooding. To tackle these environmental conditions, the Bahay Cono intends to create a reconfigurable scissor-like structure with an interlocking mechanism. Using local resources for the shelter's structural system, such as Bamboo profiles, reduce the environmental impact of transporting parts across long distances. Lightweight materials have been used to ease transportation and the assembly and disassembly processes. Solar thin films have been incorporated into the membrane envelope to provide an energy-independent housing. If the demands of the residents change over time, the shelter might be converted into a water collecting system for the community.



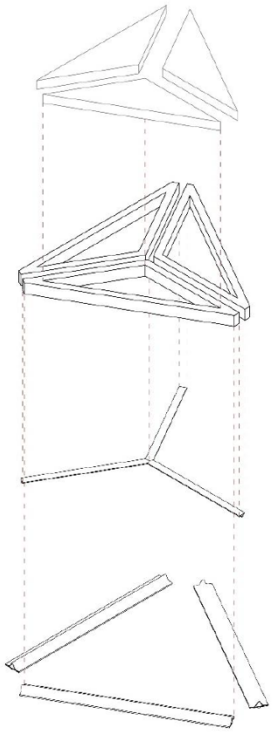
Two different configurations of the scissor-like shelter

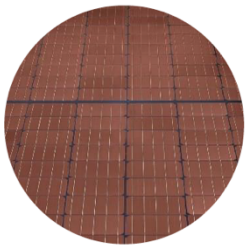


Shelter arrangements, construction details and a photorealistic view of the camp.

Origami-inspired Shelter, Ethiopia, Students: Sara Salkic and Wiona Schäfer

The modular architecture of the origami-inspired shelter allows for a number of various typologies to be erected while also allowing users to build their own shelter. The form of the shelter follows the vernacular architecture of the Afar dwellings. As illustrated, solar panels have been integrated into the envelope system to supply residents with a self-sufficient energy source. The solar panels' concave shape maximises their efficiency based on dish type collectors, with a 32% efficiency.

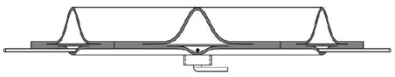


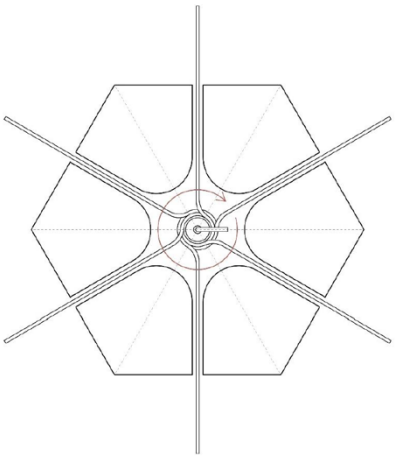


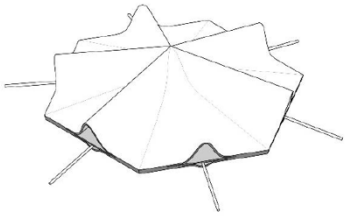
SOLAR PANELS
semitransparent, tinted

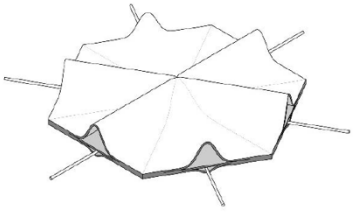
BIOPLASTIC
100% biobased & recyclable
i.e. **ARBOBLEND®**

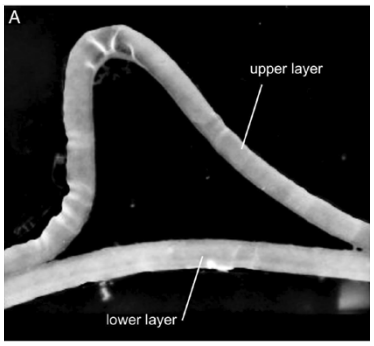
TPU
flexible, 3D printable, recyclable



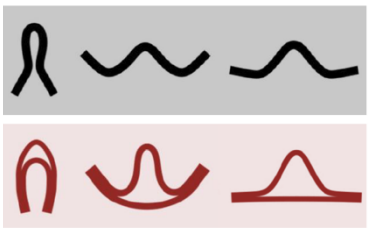








PNAS, Vol. 119 No. 45



Hinge inspired by beetle wings