Tiny house-BIG IMPACT

C^2 (CUT AND CREASE) EMERGENCY SHELTER

This design is an investigation into a prefabricated deployable emergency shelter that comes in a flat pack. The intention of this conceptual shelter is to replace the traditional refugee tents and provide a habitation which is more comfortable and closer to a permanent home. The reason being that these "temporary" abodes can be used from a period of 5-months to upto 5 years! The design focuses on the most extreme case; the emergency shelter as the basic module, and can be scaled accordingly to budget adding as many luxuries as required.

The challenge was to conceive of a design that is easy to set up without prior knowledge of construction or the availability of special tools. The idea was taken from pop-up cards that once opened, sets up the house for a family, containing all the essentials for living. It can be packed up just as easily and reused for another location.

Pop-up cards use the art of Kirigami which is a cousin of origami-the art of paper folding. The difference being that Kirigami uses folds as well as cuts to create 3d shapes out of flat 2D paper. The paper transformations can be of various types; elastic deformations, rigid folding motions, and/or pop-up mechanisms. This ancient craft from Japan has been around for decades but recent research using the arts remarkable flexibility, diversity, functionality, generality, and reconfigurability has permitted much advancement in medical, robotics and engineering fields.

For this proposal precise rigid folds are manufactured and flat folded in a box that is transported to emergency site by trucks. To set up firstly preparation of the ground takes place, by clearing it and making it flat. Unskilled labour unfolds the box following step by step instructions to set up the shelter. Connectors for joints are provided; made from carbon-fibre reinforced polymers (similar to 3D printing) that attach without special tools. Essential furniture also folds out so this becomes a complete package. Origami roof folds out and is attached with butterfly anchors that are inserted on predrilled locations.

The main design challenge was to resolve folding on a metre scale. As a paper thin kirigami and origami structure; it is easy to crease and fold, but full scale applications present a whole new set of problems. The main structure is built out of composite sandwitch panels. These have a low density core making it lightweight and the skin is made of Aluminium giving it high structural rigidity. The joints for this part of the structure use mechanical hinges, but since it creates a slight gap in the fold, a self-adhesive flashing is applied from the outside to all seams. The proposed folded origami roof structure is made by giving gaps in precut cardboard triangles and joined by fibre glass tape. For waterproofing it is sealed with a coating of PTFE sheet on both sides.

In conclusion further explorations are proposed. The above suggested materials are what is easily available in the market currently. Ideally for future development, and for a sustainable approach; bamboo sandwitch panels should be utilized. Reasearch on laminated bamboo boards is ongoing in order to streamline it in the market, and using it as a composite panel will be ideal for the design. Another future research is to explore the rotational geometry in origami and kirigami folds to make more complex self-supporting structures, especially for temporary and reusable spaces.

Three different modules are proposed in the design. But the simple geometry allows multiple modules to be created especially for schools and clinics. The core can also be attached vertically to create multiple floors. The possibilities are endless, once a prototype of the basic module is constructed.

REFERENCES:

1. Katia Bertoldi, professor of applied mechanics at Harvard University, and her team showed a tent-like shelter of 2.5m × 2.6m × 2.6m in size can be produced from a folded form of 1.0m × 2.0m × 0.25m and be held in shape automatically with internal hinges without the need for continuous inflation. SEAS researchers have developed next-generation inflatable buildings that maintain their shape without constant input of pressure.
2. Glaucio paulino; professor, school of civil and environmental engineering, georgia tech.
3. Joseph Choma, assistant professor of architecture at Clemson University, who is spearheading research into the use of foldable composites for architectural and other applications.