FOLDED HOMES

LESSONS LEARNED IN PAKISTAN

Why We Developed the Folded Homes Yurt Family

Regarding Heating & Insulation, Water Tightness, Snow Loading, Ventilation & Condensation, Assembly Complexity, Tool Requirements, Robustness, Delivery, Cost, Modularity, and Customization.

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In December 2005, a medical NGO deployed 50 Icosa Village Pods to three remote Himalayan mountain villages heavily damaged in the October earthquake to serve as winter season medical clinics and personnel housing. 47 of the 50 shelters deployed survived the winter and were in use the following winter. Two of the larger Pods collapsed under snow loads. Robinson participated in the deployment, subsequently founded Folded Homes LLC, and lead the almost three-year effort to design and field test a family of improved emergency shelters; the LiteYurts, UtiYurts, and TekYurts.

Shelter Characteristics:

1 Heating & Insulation

Problem: We needed to ship a huge quantity of insulation to Pakistan (contributing considerable shipping cost & volume to the order). Pod structures have insulatable 6" thick walls, but uninsulatable windows and a relatively thin door. The unnecessarily large volume of the IcoPods (ceilings higher than strictly necessary) make them harder to keep warm. The resulting insulating capability was inadequate for the below freezing conditions in the Himalayas.

Solution: The FH Yurt design is kept compact with a roof only as high as essential for full head-room. The thickness of FH Yurt walls, roof, doors, and windows is standardized, affording equal insulation R-value throughout. FH TekYurts and UtiYurts have uniformally-thick 3" walls, roof, windows and doors. The volume of these smaller, more thermally efficient walls and roofs can be packed with any locally available biomass or with delivered insulation. Although LiteYurts do not have double-walled shells, like the UtiYurts and TekYurts, they come with a central vent/chimney flue for the installation of a wood-burning stove.

2 Water Tightness

Problem: The Pods frequently leak after first assembly because making them waterproof requires perfectly-applied seam tape and window compression seams and in Pakistan instructions about gluing of components together was ignored. Humans rarely do anything perfectly, some gluing was ignored, and stresses tend to weaken the tape seals over time.

Solution: Develop a human-fault tolerant design. Eliminate tape and glue. FH Yurts require neither. Water tightness is integral to the structure design. Waterproof 'gutters' connect the roof panels together. This eliminates problems due to assembly imperfections and if leaks occur, they can be fixed from the inside of the FH Yurt.

3 Snow Load

Problem: The IcoPods performed fine. They were among the very few temporary shelters that didn't collapse under snow load in Kashmir. The two assembled DecaPods collapsed under snow loads estimated in excess of three tons from the more than a meter-deep, single-night snows experienced at Leepa and Lamnian. There were assembly errors (none of the connecting flaps were glued together as specified), but probably they would have collapsed anyway because of the large unsupported surface area. A design flaw in the DecaPods was identified and corrected, but at the minimum, DecaPods require a central support column when installed in locations subject to heavy snow loads.

Solution: Keep emergency structures small. They are much more robust. Address size requirements with modularity. UtiYurts and TekYurts can be connected together to create multi-room structures and compounds. Similarly LiteYurts can be connected to other LiteYurts.

4 Ventilation & Condensation

Problem: Initially Pods were assembled at Hatian without their vents. The NGO team there thought vents would not be needed until spring, but the air-tightness of the design caused human body vapor to condense on the inside surface until the vents were installed. The tarps placed over the tops of the Pods to address leakage problems reduced the effectiveness of the vents.

Solution: FH Yurts have a metal storm vent in their roof that keeps rain out but lets air in. Windows and doors installed in TekYurts and UtiYurts can be cracked for ventilation and the overhanging eave keeps the rain out. Closing windows can be cut in the sides of LiteYurts.

5 Assembly Complexity

Problem: While cost of assembly was not a significant problem, the complexity of Pod design makes assembly times too long and prone to assembly errors for emergency applications. The assembly manual was so long that it was rarely read. The NGO relied upon on-site trainers. An ideal design for emergency disaster response is one that can be "pushed out the back of a helicopter" without further attention and assembled by the refugees themselves without having to read.

Solution: Solving the shelter challenge with Spartan simplicity was a core design goal for the Folded Homes Yurt shelter family. Offering a family of similar yurt structures means that one design doesn't have to address conflicting shelter requirements. Ensuring that all Folded Homes yurts can be connected to other yurts ensures that a single small efficient design can be scaled to address varying occupancy requirements.

Our simplest Yurt, the LiteYurt, suitable for environments where an uninsulated single-walled structure is adequate, is manufactured from only two panel parts making it both inexpensive to manufacture and very simple to erect. With its 'pictures-only' assembly instructions, it is a structure that disaster victims can assemble easily without outside help, tools, scafolding or the abillity to read. Our more complex double-walled UtiYurts and TekYurts are true four-season shelters that can be insulated with any locally available biomass. Our utility yurt, the UtiYurt, while retaining the basic features of the more sophisticated TekYurt, has fewer parts, reducing assembly time and complexity. Our fanciest yurt, the TekYurt, offers a variety of door, window and material features that make it a true semi-permanent house substitute.

6 Tool Requirements

Problem: The Pods require ladders, electric hot glue guns, and other simple tools for assembly. They also required a minimum team of three assemblers.

Solution: The FH Yurt design requires no tools or ladders for assembly. They are simply hand-folded and bolted together. One person can assemble a FH Yurt without help though it is easier to attach the roof with two or three people.

7 Robustness

Problem: Although they were still in use in their second winter, to keep costs down, the NGO chose non-UV-enhanced polypropylene for their Pods. This basic polypropylene has a reduced life span compared to the more expensive UV-enhanced polypropylene. Painting the Pods to eliminate UV-degradation would have required ladders and considerable additional effort. The translucent Pod windows tend to degrade faster than the non-translucent walls. Tape and glue holds the Pods together, and the Pods rely upon them for structural integrity. This means that how well the tape and glue is applied has a direct bearing upon how waterproof and strong the Pod will be.

Solution: Our high-end TeKYurts are always manufactured with UV-enhanced polypropylene roughly doubling their resistance to UV-degradation. The mid-range UtiYurts and the simple LiteYurts are manufactured from standard polypropylene. FH Yurts are not manufactured with translucent polypropylene and they can be entirely painted to completely block the possibility of UV-degradation. The ability to unbolt and remove the roof of any of our yurts. means that it can be painted without the need for ladders. FH Yurts are assembled with sets of bolts washers and wing nuts. They are impossible to pull apart.

8 Delivery

Problem: The Pods were shipped in large compact-car-size boxes that required fork-lifts or teams of men to manhandle. This made delivery difficult and lead to problems storing all the different parts once the boxes were opened.

Solution: The FH Yurt design requires fewer, smaller parts. UtiYurts and TekYurts ship in an individual box that can be carried by two people. LiteYurts can be carried by one person and are shipped either individually or as '5-packs' on 50" x 77" pallets.

9 Cost

Problem: For volume deployments in the humanitarian domain, cost is king. To be considered, a shelter must be cost competitive with tents currently used for emergency disaster relief.

Solution: Folded Homes offers a family of Yurt solutions with designs that are compact and efficient so that material and manufacturing costs are reduced. The higher-end TekYurts and mid-range UtiYurts provide greater creature-comforts, have fancier features and materials, and are suitable for extreme cold and heavy snow environments. The low-end LiteYurts, with their single thickness walls, are cost competitive with tents yet still provide the greater creature-comforts that a full headroom, rigid-walled shelter offers. They are suitable for environments which are not subject to extreme cold and heavy snow loads. All of the yurts are modular, creating the possibility to fine tune the shelter spaces to local requirements.

Feature Set Enhancements

10 Modularity

Problem: Deployed shelters are invariably subdivided, whether to meet the requirements of family groups, or those of NGOs delivering emergency services. Clinics have enclosed examination 'rooms'. Personnel need private spaces. Materials need to be stored in controlled locations.

Solution: All Folded Homes yurts can be combined to create multi-room structures and enclosed compounds. By placing their locking doors appropriately, access can be controlled and security ensured.

11 Customization

Problem: To accommodate varying needs and cost considerations, the ability to fine-tune shelters to their applications is essential.

Solution: FH Yurts are fully customizable. You can add doors and windows, connect the Yurts together in a plethora of combinations, and choose the materials used in construction.

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