

Accordien: Building a More Effective Refugee Shelter

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Background

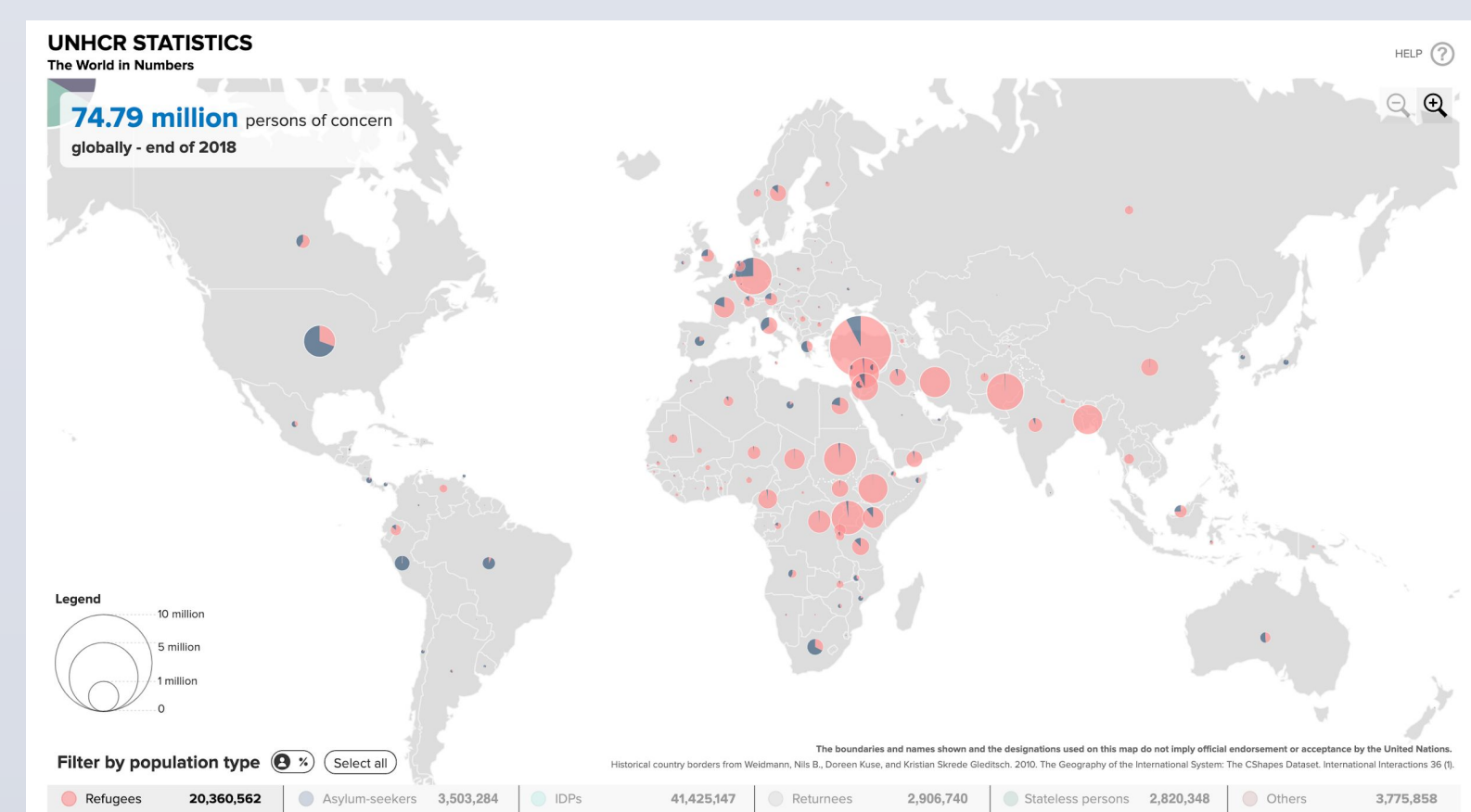
An Ongoing Crisis

In 2010, the United Nations High Commissioner for Refugees (UNHCR) counted 11.39 million people as either refugees or asylum seekers. In 2019, that number tripled to 29.4 million people. These statistics do not include those who are internally displaced and who are not housed by the UNHCR. However, these statistics do include over 13 million refugees under eighteen. The amount of orphaned children and families affected make the refugee crisis a unique one: while imminent danger may not always be a part of a refugee's life, it is important to consider the aspects of life which provide a sense of normalcy and facilitate independence and personal growth. Much of this lies in housing, an aspect of the refugee crisis often flooded with gimmicky designs or solutions that overlook cultural norms and geographical restrictions.

Problem

Today's Solutions: Tents, Rentals, Prefab Shelters

The UNHCR usually handles housing through one of three ways: standard canvas tents, prefabricated shelters, and rental properties in urban areas. UNHCR tents are meant to house families for a few weeks, but refugee families often find themselves staying in these tents for years. The yurt-like tents let in little natural light, offer no insulation, and demoralize their residents. Rental properties are very expensive, and are not always available. The UNHCR primarily uses IKEA's *BetterShelter* when implementing prefab shelters, but refugees and volunteers alike aren't happy with the design. While disabled refugees are more likely to receive prefab shelter housing, the *BetterShelter* is not wheelchair accessible. Complaints were also made about weight, difficult assembly, poor ventilation, small windows, and a very high cost. While prefab shelters can allow refugees a sense of normalcy, today's solutions are not doing enough.



Problem Summary

- Standard refugee tents are short-term, uninsulated, and flimsy.
- There are not enough tents or prefab shelters to house 30 million refugees and asylum seekers.
- Prefab shelters need to be weather-resistant, easily assembled, and made from globally available materials.
- The current leading shelter is by IKEA, costs \$1273, takes 4 trained people 4-8 hours to assemble, and is 188 square feet.

Design Process

Design Goals

Apart from UNHCR shelter guidelines below, my design goals include:

- Fire retardant
- Less than \$1000 per unit
- Wheelchair accessible
- Insulated
- Solid floor
- Assembled by <4 people in <5 hours
- Assembled with minimal training using only a screwdriver
- Lockable door
- Offer privacy
- Easily repaired

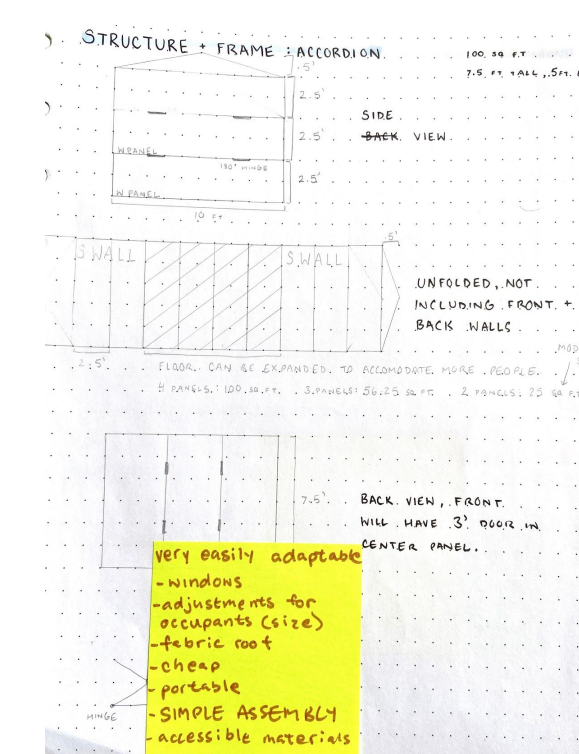
Key points

- Ensure minimum standards of covered living space per person are respected
- Shelter solutions should be adapted to the geographical context, the climate, the cultural practice and habits, and the local availability of skills as well as accessibility to adequate construction materials in any given country.
- The provision of core relief items is inherently linked to the adequacy of settlement and shelter. Core relief items may include shelter-related materials, as well as other domestic items.
- Consider the life span of shelter materials as they deteriorate with time. Further to the initial distribution, replacement, reinforcement or maintenance may be required.
- Individual family shelter should always be preferred to communal accommodation as it provides the necessary privacy, psychological comfort, and emotional safety.
- Whenever possible, persons of concern should be empowered to build their own shelters, promoting a sense of ownership and self-reliance.

UNHCR Shelter Guidelines

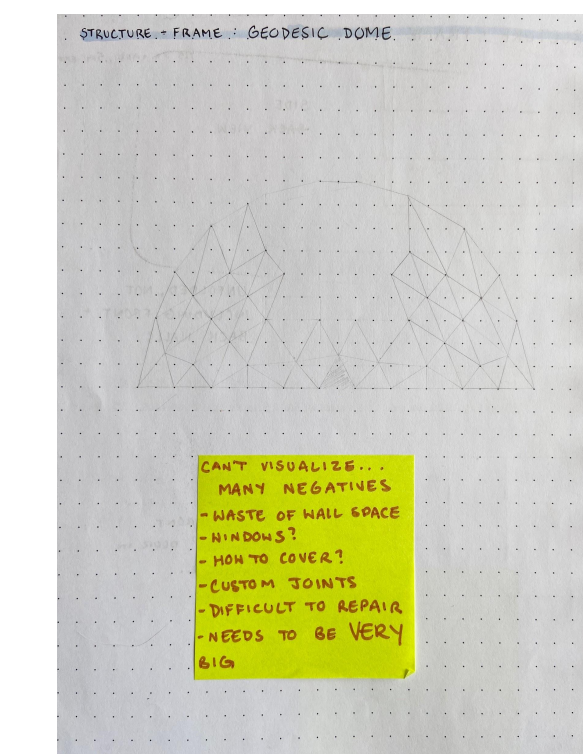
Design Evaluation

#1: Accordien Shelter



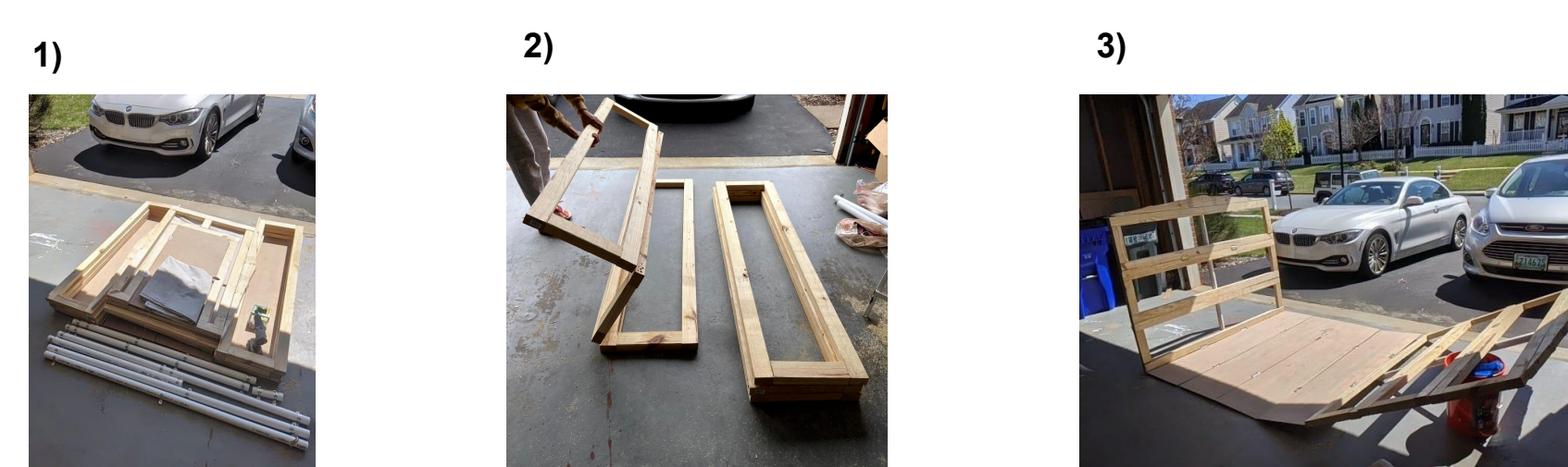
Minimalist assembly, scalable, readily available materials, easily repaired

#2: Geodesic Dome



Waste of wall space, difficult to cover or insulate, needs custom joints, oddly sized windows

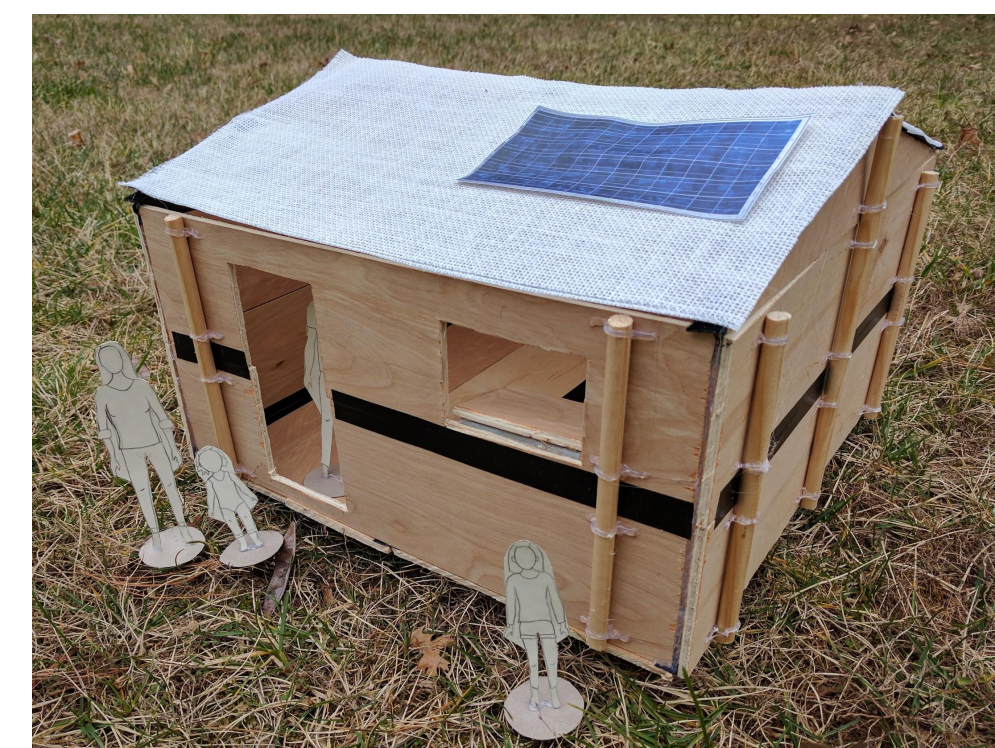
Efficiently Transported, Easily Assembled



- All supplies provided in the *Accordien Shelter* package. Side walls are folded over the floor, and the other two walls are folded in half separately.
- Side walls are unfolded, like an accordion, to be braced. They will be pre-attached to the floor, as shown in picture 3.
- Walls are braced with PVC pipes to counteract hinging while the shelter is in use.

Final Design and Build

Preliminary Model



(Intended to show design concept and allow for revision before building on a large scale)

- While panels hinge properly, what are the panels made out of?
- Room for insulation?
- Will PVC paneling be too expensive?
- Bracing helps to support hinges and add overall structure
- How many hinges are needed for each panel?
- Should panels be solid or hollow?

The Accordien Shelter



The Accordien Shelter

- Assembly: 3 untrained trained people, 1-2 hours
- 100 sq ft
- Made for two adults
- Up to three hinged windows with mosquito nets
- 8 feet tall, space to stand up straight
- USB Solar charger
- Lockable Door
- Made from wood, PVC, and tarp/canvas
- \$750 per unit, +\$180 to double size
- Easily repaired
- Wheelchair accessible

Panel Design



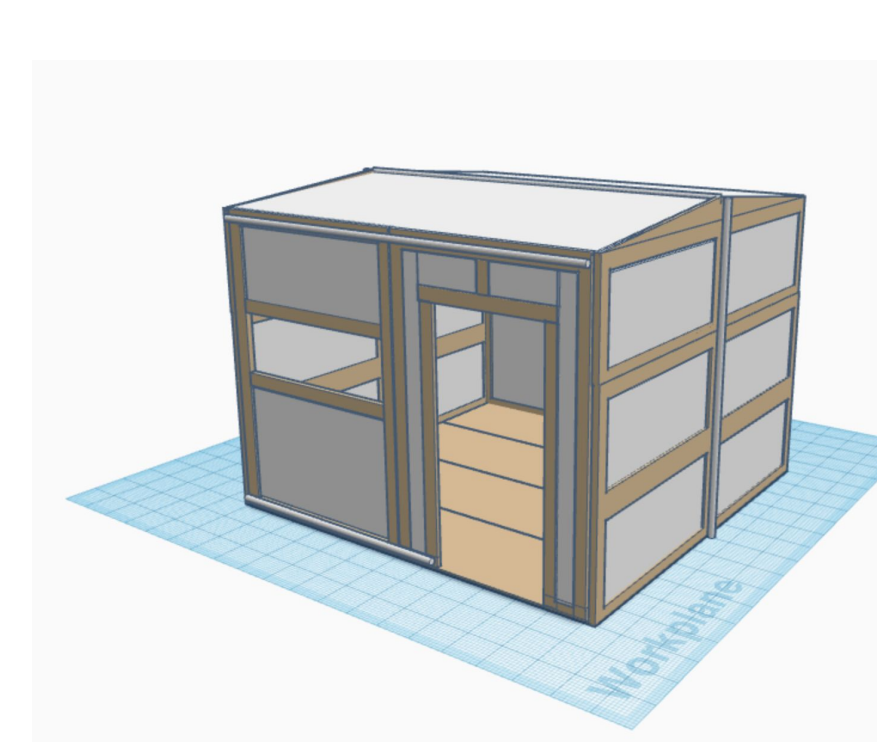
Wood frame

Insulation (foam panels) go HERE

Frame is covered on both sides with canvas. Tarp can also be used depending on regional availability.

Three panels are hinged together to form one side wall. They are braced with a PVC pipe for support.

Comparison With Current Products



Accordien Shelter



IKEA's BetterShelter



UNHCR tents

Conclusion

Further Comparison with *BetterShelter*

Accordien Shelter

- Assembly: 3 untrained people, 1-2 hours
- 100 square feet
- \$757.16
- 3 Windows
- 72W Solar Panel
- Lockable Door
- Raised, Solid Floor
- Insulated
- Scalable
- Made from globally available material
- Wheelchair accessible

BetterShelter

- Assembly: 4 trained people, 5-6 hours
- 188 square feet
- \$1273
- 4 Windows
- 4 Hour Solar Lamp
- Lockable Door
- Plastic Floor "Sheet"
- Heavy, uninsulated PVC panels
- Scalable
- Must be shipped from Europe
- Not Wheelchair Accessible

Cost Analysis

Main Structure (Hinges, Wood Planks, Screws, PVC Pipes, Conduit Straps, Plywood Panels)	\$354.04
Roof/Rain Gutters (PVC Pipes, Industrial Velcro, Poly Tarp, Plywood Panels)	\$130.37
Wall Coverings and Insulation (Poly Tarp, Insulation Panels)	\$187.79
Solar Panel (BigBlue 28W Solar Charger)	\$84.96

Total Cost: \$757.16

Cost to double size of shelter: \$179.80. Total cost of 200 sq ft shelter is \$936.96. Price info from Homedepot.com and Amazon.com.

Design Revisions

- Non-mortise hinges connecting the floor and walls needed to be repaired multiple times, as the floor panels were too thin for screws to maintain a hold. The hinges were also very small and could not withstand much torque. **Solution:** Replace corner hinges with larger hinges OR ship one side wall separate from floor, rather than shipping two walls attached to one floor.
- Screws attaching hinges to floor panels stuck out and needed to be covered to protect against injury. **Solution:** Use thicker floor panels (11/32" to 23/32")
- Shelter was not raised and does not protect against flooding. **Solution:** unused wood needed to cut large planks is put under the floor to raise the shelter. To keep the shelter wheelchair friendly, excess paneling from cutting the door and floor can be used as a ramp. The shelter becomes less wasteful while providing more to its user.

*All revisions involving replacing materials are reflected in the cost analysis.

Modifications & Future Research

- Weight: While the shelter is light enough for three people to safely assemble it, even local shipping may be expensive. I would like to look into lighter plastics to be used in the panel frame instead of wood. This would also be more sustainable, and would not contribute to deforestation.
- Connection shelters: Because each shelter has a solar panel, shelters can be plugged into each other and all energy not used daily can be stored in a community battery. Connecting shelters can also facilitate calls for medical emergencies and can assist volunteers with knowing what supplies are needed where.