The maggie shelter

A solution when and where fixed structures are not permitted, practical or desired. The maggie is a sturdy, highly-insulated, sustainable shelter that is adaptable to all climates.

A temporary shelter with the benefits of a building.
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1. MAGGIE'S TOP FEATURES

- **LOW COST**
- **HIGH PERFORMANCE**
- **ADAPTABLE TO ALL CLIMATES**
- **LOW ENERGY**
- **EASY AND FAST TO ASSEMBLE/DISASSEMBLE**
- **LIGHT-WEIGHT AND COMPACT TRANSPORT**
- **HIGH DURABILITY**

2. CONCEPT - THE YURT REINVENTED

In a lot of situations fixed structures are not permitted, practical or desired. So we set out to create a temporary, low-cost shelter that has the qualities and advantages of a sturdy, insulated construction: a tent that acts like a building. The double-layered skin can easily be filled with local materials like sand, organic and regular insulation or even plastic waste. Local economies can cooperate with labour and materials to create this modern Yurt.
Medical Wards
Access to decent health care is a basic right and top priority. This means there is a need for sustainable constructions in which people can be taken care of in safe and humane conditions. Temperatures cannot exceed healthy minima or maxima and the structures should resist heavy weather conditions and offer a safe haven in conflict areas. Using insulation and sand, the inside temperature, safety and stability can be controlled. Using high-quality textile, the maggie is protected against dust, insects and can be easily disinfected. The maggie can be upgraded with shelves, beds and curtains using standard profiles to which elements can be attached. A fixed floor and techniques can be added for more desired comfort.

Schools
Children should always have access to modern education. They are the active population of tomorrow. Long-lasting conflicts or poverty can easily jeopardize the future of an entire generation by cutting off communication and education. This means there is a need for sustainable constructions in which people can go to school in safe and humane conditions. Temperatures cannot exceed healthy minima or maxima and the structures should resist heavy weather conditions and offer a safe haven in conflict areas. maggie has many features that allow it to function as a genuine classroom. The incoming light can be direct or indirect, depending on the positioning of the windows. Acoustic insulation, added functionalities and flexibility can improve schools in a camp.

Temperature controlled storage
Tons and tons of food are thrown away in hot countries because there is no infrastructure to maintain the quality of the food. The same problem occurs with complex medications (like vaccines) that are often needed in hot countries but which quickly lose their efficacy when stored in high temperatures. Hence there is a need for temperature-controlled warehouses in which medications and food can be stored for longer time periods without risk of rotting or deterioration. Goods and foodstuffs can be stored safely, protected against dust, rodents, heat and cold. Controlling temperature means using good insulating materials and sometimes additional techniques. Yet many times there are no structures available and farmers, for example, don’t have the legal certainty that they may build a fixed structure on a specific spot due to legalities and land ownership concerns. Therefore a temporary construction like the maggie that can act like a building is a perfect solution. Additions like shelves and lighting can be easily affixed to the maggie.

Operational & coordination centres
Conflict areas, big construction sites, rebuilding sites after disaster,... They all need safe havens or good visible central buildings to coordinate missions, teams and people so that communities can gather to engage. Again there is a need for safe, stable, sustainable but temporary constructions like maggie to work efficiently and let people organise their lives. Using different layers in the walls, combining safety and thermal comfort, the maggie can be operated as a highly safe and comfortable shelter.

3. MULTI PURPOSE - WHAT CAN MAGGIE DO FOR YOU?

Vocational training centres
Rebuilding an economy after disaster or conflict means investing in vocational training. People need to learn how to rebuild their homes and infrastructure. Therefore, vocational training centres can be a highly strategic way to act with determination and efficiency at a time when this is most needed. This means you need flexible and high-quality shelters that can be erected in a short period of time before the real rebuilding starts. Don’t lose time but invest first in the study phase and preparations in order to achieve both sustainable and efficient solutions. The maggie can be easily implemented as a vocational training and community centre. The quality of the building improves the quality of development.
WE BRING TOGETHER EXISTING KNOWLEDGE; WE DON'T AIM TO REINVENT EACH PIECE BUT ALL THE PIECES TOGETHER SUDDENLY FORM THE MAGGIE, A NEW AND YET OLD RECIPE RESULTING IN A STRONG HOLISTIC CONCEPT”

Benjamin Denef

4. DESIGN CRITERIA

4.1 The maggie versus existing alternatives

<table>
<thead>
<tr>
<th>BASIC COMPARISON</th>
<th>QUANTITY (150m²)</th>
<th>RESIDENTIAL COMPARE (100m²)</th>
<th>THE MAGGIE (150m²)</th>
<th>CONVENTIONAL BUILDING (150m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy efficiency</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>wind resistance</td>
<td>60–90 km/h</td>
<td>166 km/h</td>
<td>166 km/h</td>
<td>166 km/h</td>
</tr>
<tr>
<td>snow load</td>
<td>0 kg/m²</td>
<td>+41 kg/m²</td>
<td>+41 kg/m²</td>
<td>+41 kg/m²</td>
</tr>
<tr>
<td>transport weight</td>
<td>168 kg</td>
<td>1300 kg</td>
<td>196 kg</td>
<td>&gt;1000 kg</td>
</tr>
<tr>
<td>transport volume</td>
<td>1.5 m³</td>
<td>100 m³</td>
<td>4 m³</td>
<td>&gt;100 m³</td>
</tr>
<tr>
<td># elements in 42FI container (17m³/42F)</td>
<td>40</td>
<td>0.67</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>

When people buy products often they use only basic comparison to choose between alternatives. However, dealing with big evolutions like climate change, exploding population growth, shortage of homes,… a much more sustainable decision tool is needed. We shouldn’t agree in short term visions anymore. We need real sustainable and efficient solutions. This means a need for smart decision tools.

In our case a calculation of the "cost of ownership" (= total investment divided by the lifespan or period of usage) is the perfect and essential addition to the first basic comparison. This shows that investing in a more expensive structure in the beginning ends up in the cheapest annual cost over time. It has by far the smallest impact on the environment.

Special note: Statistics show that displaced people stay by average more than 12 years in refugee camps. So humanitarian aid has to think long term even when setting out for short term. Flexible and upgradable structures can cover both needs: a basic setting for the speedy first phase and after upgrading the same basis structure a long-lasting solution when the mission evolves to a long term situation (as often happens). Always buying new short term material after a few years is inefficient and is the most expensive over time.

<table>
<thead>
<tr>
<th>LOW-TERM COMPARISON (very sustainability)</th>
<th>QUANTITY (150m²)</th>
<th>RESIDENTIAL COMPARE (100m²)</th>
<th>THE MAGGIE (150m²)</th>
<th>CONVENTIONAL BUILDING (150m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial cost</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>transport cost</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>energy cost</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>lifespan</td>
<td>≤10y</td>
<td>&gt;10y</td>
<td>10y</td>
<td>&gt;10y</td>
</tr>
<tr>
<td>annual cost</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>overall cost of ownership (total cost/lifespan)</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
</tbody>
</table>
### 30 holistic criteria

<table>
<thead>
<tr>
<th>COMFORT</th>
<th>SAFETY</th>
<th>HYGIENE</th>
<th>DURABILITY</th>
<th>ADAPTABILITY</th>
<th>USER CENTERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat $T(i) &lt; 30^\circ$</td>
<td>Snowload 40 Kg/m²</td>
<td>Clean - washable - chlorine resistant - PH-neutral</td>
<td>Community involvement - teamwork - ownership/ respect</td>
<td>Different climates - adaptable - upgradable - evolution in time</td>
<td>Low cost importance of cost of ownership versus initial cost</td>
</tr>
<tr>
<td>Cold $T(i) &gt; 15^\circ$</td>
<td>Fire retardant M2 cladding - flame retardant - self-extinguishing</td>
<td>Fresh air CO2 &lt; 600 ppm ventilation 20m³/pp</td>
<td>Energy Friendly K35 &gt; K15 E60 &gt; E30</td>
<td>Multi-purpose - health &amp; education - community &amp; safety - storage</td>
<td>Services - site surveys - energy survey - interior design - custom made solutions</td>
</tr>
<tr>
<td>Rain 100% waterproof</td>
<td>Protection bulletproof anti theft &amp; vandalism</td>
<td>Anti insects mosquito net perfo &lt; 1.6x1.5 mm</td>
<td>Eco friendly - recyclable - waste processing</td>
<td>Modular combinations - flexible dimensions - compatibility - safety-clustering</td>
<td>Fast &amp; easy to assemble - construction = 1 day/6 p - filling Maggie = 1 day/6 p - 1 tool/1 bold-type</td>
</tr>
<tr>
<td>Acoustics 50 dB noise reduction</td>
<td>Strong winds adaptable 90-165 km/h</td>
<td>Anti rodents - fixed floor - underground barrier</td>
<td>Life span - structure &gt;15Y - textile (cladding): &gt; 660 g/m² UV-resistant</td>
<td>Local upgradability - local materials - local economies - local labour</td>
<td>Fast &amp; easy to disassemble - 1 day/6 p - 1 tool/1 bold-type</td>
</tr>
<tr>
<td>Daylight 300 lux</td>
<td>Natural forces pilotis structure earthquake proof</td>
<td>Anti dust - sluice system - airliness</td>
<td>Local repairability easy to repair on site</td>
<td>Compact transport air, sea, rail, road: strapped in bundles easy handling standard pallets</td>
<td>Light weight - 1 piece &lt; 25kg - transport weight &lt; 2 ton</td>
</tr>
</tbody>
</table>

### Natural forces
- Wind
- Earthquake proof

### Safety
- Heat
- Cold
- Rain
- Acoustics
- Daylight

### Hygiene
- Clean
- Fresh air

### Durability
- Snowload
- Fire retardant
- Protection
- Strong winds
- Anti insects
- Anti rodents
- Anti dust
- Life span
- Local repairability

### Adaptability
- Community involvement
- Energy Friendly
- Eco friendly
- Modular combinations
- Multi-purpose
- Environmental

### User Centered
- Low cost
- Services
- Fast & easy to assemble
- Fast & easy to disassemble
- Local repairability
5. TECHNICAL DRAWINGS AND INFORMATION

5.1 Plan, sections and elevations

PLAN

ELEVATION

FRONT ELEVATION

CROSS SECTION

LONGITUDINAL SECTION
5.2 Extruded profiles in aluminium

The structure of the maggie is constructed with custom-made, high-performance aluminium extruded profiles. This makes the transport weight as low as possible without compromising the overall strength.

Each profile has its own specific features. By designing the right cavities, bolts can easily be attached and textile can glide through the circular shaped edges (keder system).

For increased thermal performance, the keder profile is separated from the carrying beam by an insulating joint. This avoids condensation (and later fungus) around the profiles when the maggie is highly insulated.

Additional small profiles help to mount everything together and make the specific “twist shape” that typifies the maggie.

5.3 Smart design

5.3.1 Building manual - fast & easy to assemble/dissassemble

Responding to a crisis, disaster or conflict requires fast and easy solutions. Harsh climates demand a quick means of sheltering against nature. Reducing cost means that everybody should be able to assemble the construction without the help of expensive professionals.

The maggie is a building package that can be set up as a building-kit with 6 adults in 1 day. The next day the community can help to fill up the maggie with local insulating materials such as sand, organics and even waste.

All the parts can be mounted from the ground up. There is no need to work from an elevated height. No cranes or heavy tools are needed.
5.3 Smart design (continued)

5.3.2 Climate control

The maggie is developed to resist harsh climates and seasonal fluctuations because she can be filled with insulation and sand and has a high-performance skin that reflects UV and protects against rain and snow. Each climate has its own specific dynamics which should be taken into account when choosing the right amount and type of insulation.

- **Hot climate with cooler nights**: ex. medical ward in Chad desert

- **Climate controlled, permanent occupation**: ex. temperature controlled warehouse in tropical Congo

- **Seasonal temperature extremes**: ex. school in Syria steppe

- **Climate controlled, occasional occupation**: ex. community center in Pakistan mountains

The most efficient way to save energy or to control inside temperature is by using mass-inertia (sand - high thermal capacity) and light insulation (keeping the energy inside or outside depending on the situation). The combination of sand and insulation gives the best results. It has proven its efficiency through ages of building techniques starting with the yurt thousands of years ago until today’s buildings with concrete, stone and insulation. The maggie can do exactly the same by making an insulated wall with loose material (sand) and an insulation board.

After the maggie is disassembled, the sand can be returned to nature and the insulation can be reused.

Sand stabilises temperature fluctuations between day and night (desert climate) and the insulation keeps the optimal temperature inside once it achieved. To verify this information, the energy efficiency of the maggie was calculated via a special application, created in cooperation with the University of Leuven. The user can implement this data to get a highly sustainable solution and recuperate a lot of money over time that is normally spent on heating or cooling. This makes the maggie unique among temporary constructions.

The user determines their purpose, location and preferred minimum and maximum temperature and the specialised application does the rest.
5.3 Smart design (continued)

5.3.3 Materials

1. structure: aluminium 6060, T66. Possible to finish with an extra (coloured) coating. The aluminium is totally protected by surrounding cladding so it’s protected against outdoor influences.

2. cladding: tough PVC impregnated polyester fabric of 650 g/m². The sheets are sectioned in accordance with the modular measure of 3 m. Joints are waterproof and able to withstand vibrations caused by high winds. The fabric is coated to reach a M2 fire resistance. This means self-extinguishing and flame retardant. Virtually any colour is available on request, but our standard stock colours are white and Nato green. Logos can be printed on the canvas. Standard the windows are made of transparent fabric. For higher performance a sandwich panel is custom made by putting extra insulating layers of bubble wrap (to create air chambers) between two transparent fabrics. The cladding can easily be gilded into the same profile system around the maggie. Opening windows can be pre defined by the user.

3. foundations: The preparation of a site is usually the user’s responsibility. This could include site clearance and construction of the foundations. However, we can offer assistance in searching for the right solution on a ‘turn-key’ basis.

5.3.4 Upgradable structure

Each location has its specific wind characteristics. This means it’s not necessary to make each maggie equally strong. Otherwise a maggie in a windstill area would be totally over-dimensioned and users would pay too much for the structure.

Therefore the basic maggie can be easily upgraded with small add-ons to become stronger and stronger depending the location. This is easy engineering based on click-on details on the basic profiles.

The strongest “heavy duty” maggie is the one in which the walls are totally filled up with sand and the foundation is made by digging in the first 30 centimeters of the wall in the ground. It results in a maggie of 40 tons and a most efficient ground anchor. Finally extra storm cables can be clipped on the corners and anchored in the ground with spikes. Wind speeds can exceed 165 km/h.
5.3.5 Modular combinations

Combining maggies in a smart cluster creates safe and windstill areas where children can play safely and can be easily supervised. Clusters are also stronger against wind because they work together and break the storm.

5.3.6 Compact transport

All elements are strapped and affixed to pallets for easy handling and compact transport. They can be packed in ISO containers for shipping by sea, air, rail or road. 1 standard container can load up to 12 maggies of 100 m² for a total of 1200 m² in 40 ft container.

5.3.7 Insulation materials

The maggie ingeniously allows the use of local, freely available materials to be used as insulation. This can be sand (thermal capacity and stability), organic materials, recycled plastic waste or existing insulation products.

We also ship vacuum packed insulation to reduce the shipping volume.

Local economies can be triggered to produce small scaled pellets (capsules) from waste to fill up the walls.

5.3.8 Improving health quality

In refugee camps many people live together within a small area. These places are a source of diseases. Many people die due to lack of hygiene. Providing hygienic and insulated shelters is a way to reduce contamination and the risk of illness.

- Parasitic infections
- Respiratory diseases
- Temperature control
- Secondary infections
- Stability to local conditions
- Antiparasitic treatments
- Secondary diseases
- Adaptability to local conditions
- Cardio & cerebral complications
- Elementary comfort
- Local conditions

1 2 3 4 5 6 7 8 9 10 11 12

15.8 m 240 m
6. CUSTOMIZE YOUR MAGGIE (*standard Maggie features shown in blue below)

6.1 Basic settings

<table>
<thead>
<tr>
<th>SIZE</th>
<th>7 m</th>
<th>9 m</th>
<th>12 m</th>
<th>16 m</th>
<th>18 m</th>
<th>20 + 30m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 m²</td>
<td>50 m²</td>
<td>70 m²</td>
<td>90 m²</td>
<td>110 m²</td>
<td>30 + 30m²</td>
<td></td>
</tr>
</tbody>
</table>

| DOORS | | | |
|-------| | | |
| 1 door | 2 doors | side doors | combination |

| COMPARTMENTS | | | |
|---------------| | | |
| 1 sluice | 2 sluices | 2 sluices + 1 compartment |

| WINDOWS | | | |
|---------| | | |
| 0 windows | high windows | low windows | skylight | combination |

| FLOOR | | | |
|-------| | | |
| tarpaulin floor | fixed floor | Attic | combination |

| STRUCTURE | | | |
|-----------| | | |
| standard | extra windbracing |
6.2 Advanced options

6.2.1 Enhanced safety

A maggie filled with sand gives a lot of protection. Users searching for even more protection can glide a reinforced board (Kevlar, steel, wood,...) in the middle of the wall as a hidden protection. The board can simultaneously serve as both a separation between the insulation and sand filling and as a real, double-layered wall. It can easily be mounted with a clip in the standard cavity in our profile.

6.2.2 Floor

In difficult and remote locations the floor is often the weak spot in a shelter because the standard fabric floor doesn’t do the job. Rodents, moisture, mud, unstable ground surface, frozen soil... all cause unhygienic and inhumane situations.

The maggie can be upgraded with a fixed floor that uses the same aluminium profiles as in the rest of the structure. First an aluminium beam layer, then a load-spreading steeldeck plate (or aluminium) and then a hardboard finish. The hardboard can be topped with linoleum for extra hygiene and resistance.

Between the beams the floor can also be insulated with local materials or shipped insulation.

6.2.3 Techniques

Zero footprint or low energy solutions are no longer a utopian vision. People understand that long term solutions often show that the cost of ownership (the real cost of a solution over time instead of only the initial investment) is much lower if you invest in energy efficient constructions and renewable or low energy techniques. Huge amounts of logistics budgets are wasted on fossil fuels and tons of CO2 is pushed into the atmosphere. This is also true for low-cost solutions.

Medical wards will always need temperature controlling as does food storage. You cannot medically treat people in a tent of 45°C without risking that they dehydrate and suffer. You cannot store food without temperature controls.

Secondly remote operations need autonomous solutions. Therefore batteries and solar panels can be a solution to implement in a shelter to make it self sufficient. The maggie offers the possibility to add solar panels to provide energy. This way the maggie can operate independent of other energy sources. Space is foreseen in the ridge of the roof for cables and technical tubes. Extra lighting can be easily attached on the profiles in the roof. Depending on the positioning of the windows, the maggie allows natural light to enter directly or indirectly and there is an option to add a skylight.

6.2.4 Cooling and heating

6.2.5 Ventilation unit

In extreme climates or for very low energy energy, the maggie's ventilation becomes important. Each person needs 20m³ of fresh air per hour so by pulling fresh air from the outside a lot of energy is wasted. Aeropulmo (Belgium) has invented a low weight and highly-efficient ventilator that recuperates 95% of the energy out of the air that is pushed outside and inserts it again in the fresh air that is blown inside. In this way the energy efficiency of the shelter rises significantly and money can once again be saved over time. This unit can easily be hung on the ceiling of the maggie as shown in our case study for the refugees in Steenokkerzeel, Belgium.
6.3 Equipment and furnishing

The maggie team loves to design. We can offer users a custom-made plan with all kinds of features that makes the usage much more efficient and logical. Thanks to the specially-designed cavities in the aluminium profiles, all kinds of shelves, curtains, lesson boards, clothing bags and other equipment can be clipped on the walls and ceiling—something that is not very feasible in a normal tent.

6.4 Monitor your Maggie – how sustainable is she?

At the end of the day the facts count. Is the Maggie really efficient? How much energy do we save as users and how much do we ultimately gain? These questions can be easily answered by making smart measurements in a maggie. Getting data out of a building is very relevant these days. There is always a difference between the theoretical intentions and studies and the real result.

The maggie team is specialised in working out specific solutions for users, so don’t hesitate to challenge us to think about new features.

Therefore the maggie has partnered with a company (Byrubian) that monitors buildings and data from buildings. We are investigating how to implement this building intelligence in a maggie to monitor the efficiency and to learn from the daily usage to improve the maggie each time and provide users with feedback.
7. CASE STUDY – REFUGEE CENTER – FEDASIL BELGIUM

- program: education and community centre
- location: Steenokkerzeel, Belgium
- date: 3th of March 2016
- users: FEDASIL
- structure: aluminium
- surface: bruto 105 m², netto 95 m²
8. THE BROADER VISION: THE MAGGIE PROGRAM

The maggie program is the name of the broader platform within which the Maggie shelter plays an important role. The maggie program represents a comprehensive approach towards providing access to health, education and perspective for displaced people worldwide. The maggie program functions as a social platform that seeks and identifies urgent needs and improvements for displaced people across the planet. Once a need is defined, expertise is offered by companies like DMOA architects and engineers, Vermako (aluminium structure), Vervaeke (cladding) and institutions like IWT KUL, CENTEXBEL... This public private partnership is the key to fast and adequate innovation that can make a difference.

A recent partnership with Close the Gap vzw has opened new doors to implement solutions where they are most needed.

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(director)

SPECIFIC NOTE ABOUT THE MAGGIE AS A SOLUTION FOR REFUGEES

HEALTH ISSUES DUE TO EXPOSURE TO A HARSH CLIMATE

Forced displaced people have a disproportionately high rate of mortality, diseases and mental illness. Of the nearly 60 million displaced people, almost half are in a state of extreme vulnerability. A number of the causes for diseases amongst refugees are preventable when providing comfort for those at risk. The maggie shelter addresses the shortcomings of tents and is a solution against the elements of a harsh climate.

SAFETY ISSUES AMONGST REFUGEES

The refugee population is a mosaic of individuals, each with a personal history. They reconstitute their complex societies in the refugee camps and take with them the ethnic, cultural and religious rituals and convictions of their home country. The scarce resources and challenges for survival further exacerbate the divisional tension amongst refugees. Creating safe refuges within a camp for those at risk is a demanding task given the fact that countries hosting the refugees only allow for temporary settlements. Tents provide little protection against intruders.

THE NEED FOR EDUCATION AND SKILLS FOR REFUGEES

In the midst of conflict or sustained poverty education for the victims and displaced people is often seen as secondary to the struggle for food, aid and shelter. Providing education (children), vocational skills (adults) and capacity building helps refugees to get back on their feet and develop competences that allow them to return and build a better future.

“Education is often the only hope and ticket for change children have.”

Bart Peeters
9. INNOVATION PARTNERS