GRADUATION PLAN

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Studio
Name of studio: Architectural engineering Studio 13
Teachers: Monique Smit, Pieter Stoutjesdijk, Maarten Meijs
Motivation: I believe that buildings in the future should be smarter, more flexible and more efficient in use of energy and materials. This studio offers me the knowledge and guidance to work on architectural innovations in this field, which is very exciting. An additional advantage of this studio is that it offers me the freedom to give shape to my own graduation project.

Title
THE DIGITALLY FABRICATED TRANSITIONAL SHELTER
An incremental shelter project from emergency relief to permanent dwelling

Graduation Project

Problem Statement
The most recent figures from 2013 show that there are 51.2 million forcibly displaced people worldwide. It is for the first time since the Second World War that this figure exceeded the 50 million. The increase of 6 million over the 2012 figures has mainly been driven by the war in Syria. By the end of last year, 2.5 million Syrians had fled across the country’s borders and 6.5 million were internally displaced – more than 40% of the population. Conflicts in the Central African Republic and South Sudan also contributed to rising numbers. The number of forcibly displaced people is so high that if they had their own country it would be the 24th most populous in the world. Displaced people are defined in three groups:
- Refugees (16.7 million people)
- Asylum seekers (1.2 million people)
- Internally displaced people (33.3 million people) (UNHCR, 2014)

When these people are displaced there are six settlement options to offer them temporary accommodation. These are: host families, urban self-settlement, rural self-settlement, collective centers, self-settled camps and planned camps. The last option has the preference of UNHCR because services can be provided to a large population in a centralized and efficient way and you prevent that people disappear in illegality (UNHCR, 2007). These six options are only temporary solutions though. There are three durable options for displaced people: repatriation, resettlement and local integration. Repatriation is often not possible because conflicts are becoming more protracted and complicated nowadays, making the chances on quick and direct repatriation to become smaller and smaller. In 1993, a refugee could expect to live in a camp for 9 years; by 2004, that had grown to 17 years — almost a year increase per year (Caritas, 2004).
With resettlement, when displaced people can get asylum in different countries than where they are temporarily accommodated, there is always a far greater demand than resettlement places available. In 2013 only 98,400 displaced persons were resettled. Local integration is a graduate and complicated process by which refugees legally, economically, socially and culturally integrate as members of the host society. The process of local integration should lead over time to permanent residence rights, a growing degree of self-reliance and becoming able to pursue sustainable livelihoods. Local integration requires large efforts from both parties concerned though. From the displaced people to adapt to the different culture and from the host society to welcome them and meet the needs of a more diverse population (UNHCR, 2014).

Although local integration is a slow and long-lasting process which requires a great deal of both parties it is the currently best durable option to house displaced people. These people have smaller and smaller chances of returning to their homes and resettlement places in alternative countries are nowhere sufficient to house everybody.

The problem with the current shelter types used is that they are designed to be temporary, but in reality they aren’t temporary but stay in use for years and even decades. The shelters have very limited options for upgrading their dwellings. A more permanent solution is needed.

To achieve this it would be very interesting to look at digital fabrication techniques. Digital fabrication has multiple advantages which can be very beneficiary for emergency situations and the period following that. Firstly mass customizable design can be achieved with digital fabrication, this will mean that the shelters can adjust to different sites and users. A higher efficiency can be achieved with standardization and modularization of the shelters. Secondly parts can be produced in series, on site. There is no need for transportation anymore, which can gobble up to 60% of the shelter budgets. Finally the shelters can be easily adapted to growing needs when they are modularized and digitally fabricated.

Objective
The objective of my graduation project is to design a sheltering system capable of adapting to different climates and contexts, which is more sustainable and addresses the needs of the inhabitants better than the tents currently used. Because forcibly displaced people are a problem worldwide one shelter type is not the answer. Climates, cultures and housing traditions are different around the globe. So instead of designing one type of shelter, a system has to be found in which different configurations can be made to produce different shelters adapting to the needs of the local people and to withstand the different climates. Using the UNCHR 2013 trend report as a framework three locations have been preselected: Colombia, the Central African Republic and Syria. For these three locations different configurations will be explored to demonstrate the adaptability of the system. These locations have been chosen because they are very divers in cultural and climatic circumstances. But also because here the highest numbers of Internally Displaced People are located. The graduation project will focus on this group of displaced people because their (political) situation is more likely to be fertile for a more permanent solution than those of refugees or asylum seekers.

Digital construction techniques are well suitable for building such a flexible building system. The designs can be updated and upgraded easily, the shelters can be produced and constructed rapidly without schooled workers and if designed properly the costs can be kept relatively low. Preferably the parts needed for building the shelters can be made locally, eliminating transportation costs. Per context local materials should be explored and used if possible.

By providing this new type of shelters a first statement is made to look for a more long-term visions of planned camps. When people stay in such a camp for up to seventeen years a transition should be made from emergency sheltering to more permanent dwelling types; the shelter solution should be able to accommodate the growing needs of the displaced people.
**Overall design question**
How can I design a transitional shelter capable of adapting to different contexts using digital manufacturing methods?

A more complete overview of the research that will be done during the research project can be found in the appendix A.

**Thematic Research Question**
How can subtractive digital fabrication techniques be used to make locally produced transitional shelters that can grow into permanent housing?

Sub questions:
1. What are the demands for an emergency shelter?
2. How can a transitional shelter grow into a permanent dwelling?
3. A. What are the constraints of introducing digital fabrication in emergency environments?
   B. What are the most promising digital fabrication techniques for the fabrication of transitional shelters?
   C. How are these techniques used to create shelter like structures?

**Methodologies**
The following methods and techniques of research will be used in my graduation project:

- **Literature study**
  First a literature study has to be done to gain knowledge on the refugee issue, problems in refugee camp lay-outs, refugee shelters and digital fabrication methods. It is important to get a clear image of current technical progress in the field and the different types of shelter already designed.

- **Reference study**
  To gain an insight in the range of emergency shelters already available. To get a good image they will be compared on: Durability, Material, Climatic performance, Adaptability, Costs and method of manufacturing.

- **Context analysis**
  The three chosen contexts should be analysed. The climate, culture and housing traditions are important to research, from this the requirements for the shelters are formed. These will be partly site-specific and partly universal.

- **Interviews with experts**
  To get more specific information about certain subjects, like long term strategies for refugees and information about the contexts, I will conduct interviews with experts.

- **Research by design**
  Acquired information will be directly implemented in the design process.

**Planning**
See appendix B.

**Relevance**
I am aware that my graduation project will not solve all the problems of forcibly displaced people, but hopefully it will be a start to the improvement of their living conditions. My project can be a statement on how to deal with this problem on the long term. The outcome will be a generic system which, in different configurations, can be used for specific contexts.
Literature used in this paper


Literature to be used in the remaining research

LOCATION A
LOCATION B
LOCATION C

LOCATION ANALYSIS:
1. Climate: Temperature, seasons, height of the sun, rainfall etc.
2. Culture: Housing tradition, size of families etc.
3. Architecture: Building systems, housing lay-outs, building technology etc.

HOW TO EXTEND AND UPGRADE?
Research on upgrading processes in existing refugee camps.
Research on incremental housing.

DEMANDS EMERGENCY SHELTER
Size, facilities, climatic performances, comfort, privacy etc.
What gets the priority?
What are functions or features that can be added later?

BUILDING SYSTEM
A building system has to be designed that can facilitate the growth and upgrading of the shelter.
Research has to be done on:
- Joints
- Construction systems
Focus will lay on adaptability and expandability.

CATALOGUE OF BUILDING PARTS
Different parts can be configured to create shelters that are suitable for different locations.

PRODUCTION / CONSTRUCTION PROCESS
The structures have to be assembled by hand with limited tools, by people with limited education.
Important is that in emergency situations the shelter have to be constructed in a limited amount of time.

APPENDIX A
GRADUATION PROJECT - RESEARCH OVERVIEW

TECHNICAL RESEARCH

ARCHITECTURAL RESEARCH

GENERIC
BUILDING SYSTEM
CатALOGUE OF BUILDING PARTS
PRODUCTION / CONSTRUCTION PROCESS

EMERGENCY PHASE
UPGRADING PROCESS

PRODUCT
Analysis of different construction types.
Framework of the catalogue
Framework of the construction process

PROJECT PHASE
Entire project
Design phase
Entire project

PRODUCT
Research paper
Research paper
Design phase

LOCATION
LOCATION A
LOCATION B
LOCATION C

RESEARCH
BUILDING SYSTEM
A building system has to be designed that can facilitate the growth and upgrading of the shelter.
Research has to be done on:
- Joints
- Construction systems
Focus will lay on adaptability and expandability.

RESEARCH
BUILDING PARTS
A catalogue of building parts. Different parts can be configured to create shelters that are suitable for different locations.

RESEARCH
HOW TO PRODUCE?
What machines are needed to produce the parts?

RESEARCH
HOW TO BUILD?
The structures have to be assembled by hand with limited tools, by people with limited education.
Important is that in emergency situations the shelter have to be constructed in a limited amount of time.

RESEARCH
DEMANDS EMERGENCY SHELTER
Size, facilities, climatic performances, comfort, privacy etc.
What gets the priority?
What are functions or features that can be added later?

RESEARCH
HOW TO EXTEND AND UPGRADE?
Research on upgrading processes in existing refugee camps.
Research on incremental housing.

RESEARCH
LOCATION ANALYSIS
1. Climate: Temperature, seasons, height of the sun, rainfall etc.
2. Culture: Housing tradition, size of families etc.
3. Architecture: Building systems, housing lay-outs, building technology etc.

PRODUCT
Design brief for emergency shelters
Global strategy for incremental process
Mapping of the three locations

PRODUCT
Research paper
Research paper
Design phase

PROJECT PHASE
Entire project
Design phase
Entire project

PROJECT PHASE
Design phase

PROJECT PHASE
Research paper
Research paper
Design phase
# APPENDIX B: PLANNING

| WEEK | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 1.10 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | X | 2.7 | 2.8 | 2.9 | 2.10 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 | 3.9 | 3.10 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 | 4.7 | 4.8 | 4.9 | 4.10 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| DEADLINES | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GRADUATION PLAN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fascination(s) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Defining Subject | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Writing Plan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Research | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Literature Study | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Context Study | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Case Study | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Research by Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Writing Paper | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sketch Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Architectural Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Detailing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Final Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| History Thesis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Writing Thesis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |