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grace under pressure

investigating a design response in event of disaster

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thankyou

: Nico for your passion and enthusiasm encouraging me to dream every step of the way.

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: Thabang Thinda

'my praatklas mensies' Mariska + Lelani

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abstract

Keywords:

regional disasters

temporary grace

indigenous

flat pack

cardboard

folding

home

arrangement

identity

Architecture for Humanity[1] believes that "...where resources and expertise are scarce, innovative, sustainable and collaborative design can make a difference."

A study of local context has revealed that universal relief strategies are failing to meet the needs of those who have just lived through the traumatic experience of losing their primary dwelling.

Where as conventional 'donor' structures may economically shelter the body, they neglect to address issues of home and belonging.

The hypothesis argues that shelter after disaster is not just a temporary solution but rather a 'starter kit' with the potential of becoming a home.

Hence shelter is the beginning of a process, that involves first a sign of the event of dwelling before it can host a more complex scope of concerns.

While acknowledging that the design cannot be site specific, the proposal responds to regional disasters within greater Tshwane region, through a comprehensive investigation of context, climate and selected case studies.

Set within the reality of monotonous modular design the project seeks to provide a flexible and innovative shelter typology that can remain on site, providing a period of grace. Thus enabling the displaced to focus on rebuilding their homes without living with the fear of their tent being reclaimed.

The project conducts a critical investigation into rapidly deployable structure. The object of the study is to highlight the potential of cardboard as an alternative building material.

Architecture for Humanity glo dat: "...waar hulpmiddels en vaardigheid skaars is, kan innoveerende, ondersteunende samewerkende ontwerp 'n verkil maak.".

Die verhandeling ondersoek die rol van ontwerp in die geval van katastrofe. Studies het bewys dat universieële hulpondersteuning strategieë val heeltemal in die behoeftes van hulle wat sopas trauma beleef het tydens die verwoesting van hulle woonplek.

Waar konventionele 'skenker' strukture dalk ekonomies die liggaam beskut, skiet dit tekort aan die behoefte van 'n tuiste en gemeenskap.

Die hypotheses redeneer dat skuiling in die geval van 'n ramp meer as 'n tydelike opslossing is en liewers as 'n 'wegspring plek' gesien moet word met die potensiaal om 'n tuiste te wees. Dus is skuiling die begin van 'n proses, wat eers 'n teken van die skep van 'n tuiste vereis voordat dit 'n meer komplekse omvang van belange kan huisves.

Terwyl aanvaar is dat die ontwerp nie terrein-spesifiek kan wees nie, gee verhandeling gehoor aan rampe binne die grooter Tshwane omgewing, deur 'n omvangende ondersoek van konteks, klimaat en verkeie gevalle studies.

Binne die realiteit van modulere ontwerp soek die projek 'n plooibare en innoveerede oplossing wat op terrein kan bly, terwyl dit die geleentheid skep vir 'n tydperk van genade. Waartydens die verplaasde kan fokus om hul wooning en lewe te herbou sonder die angs dat hul tente terug geëis gaan word.

Die projek lei 'n kritiese ondesoek af omgaande spoedige ontplooibare strukture. Die doel van die studie is om die potensiaal van karton as 'n alternatiewe boumaterial uit te lig.

1 TEDtalks (2006)


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Figure 01 'Sometimes, having the best of intentions is not good enough especially if the other party is not understood' Goh (2007:[1of 5]) [redrawn by author]

grace under pressure

PROLOGUE

The phrase '*grace under pressure*' was first made famous by Ernest Hemingway, when asked in an interview to clarify what he meant by '*guts*' [courage].[1] It was recently reinterpreted by Paola Antonelli[2] in the title of her catalogue essay for the SAFE: Design Takes on Risk exhibition held by the Museum of Modern Art [MoMA]. She explains '*grace*' as elegance and questions the role of aesthetics in the design of emergency solutions.

This thesis pursues 'grace under pressure' in a quest to elucidate why so many goodwill projects in aid of disaster relief have not met the ideals they set out to achieve.

Figure 01 illustrates that often, despite the best of intentions, the grace provided today becomes the obstacle of tomorrow,[3] whether it be through inadvertently creating dependency relationships, or through imposing universal solutions that cannot relate to local needs. It is clear that a comprehensive understanding of situation and context is required for an appropriate sheltering response to develop.

Many of us can identify with the experience and shortcomings of, for example, finding a book when designing a library, or walking through a city when designing a master plan. The author cannot claim to understand the experience of surviving a disaster and in that sense can not identify with being a victim of such circumstances. But most can identify with the deep desire to help but being unable to do so when confronted with someone in need. This serves as the motivation for the research topic.

During the winter recess the author had the opportunity to take part in Global Studio 2008. This international collaborative provided a platform for first hand experience in working with communities in Diepsloot, Gauteng. During that time initiatives where undertaken to improve living conditions in the informal part of Diepsloot. Because of severe overcrowding the area is especially vulnerable to informal settlement fires, as well as flash floods and water-borne diseases carried by the Jukskei River.

The participation provided valuable insight into the local context and building practices that often aggravate the hazardous conditions in places where disasters most often strike.

1 The first published use of the phrase was in a letter dated April 20, 1926 which Hemingway wrote to F. Scott Fitzgerald. However, the phrase became famous after it was used in a profile piece written by Dorothy Parker for the New Yorker. 30 November (1929:28-31)
2 Wosk (2007:93)
3 Image description by Aaron Goh for the 2007 ShelterMe competition : Goh (2007:[1of 5])

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

TABLE OF CONTENTS

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

INTERIOR ARCHITECTURE

THE ACTIVITY OF DESIGN is not limited to architecture alone. It is the one act that all creative professions have in common. Yet every profession aligns the activity of design with the objectives inherent in the discipline. It is therefore necessary to clarify both the meaning of design and how it relates to Interior Architecture.

In his book The Synthesis of Form, Christopher Alexander[1] quotes D'Arcy Thompson as a foundation for his discussion of form. He states that 'to design is to give form' and goes on to define form as "an abstract diagram of forces" [context].

This is in essence what makes the activity of design so complicated as it hinges on the ability to identify and interpret context.

Design can be defined as the act of giving form; the purpose of design is to add value[2] depending on the objectives set out by the discipline concerned. Interior Architecture is a fairly young discipline in the profession of Architecture, but it is gaining ground and is in the process of finding its own identity. It was thought appropriate to issue Interior Architecture with its own document of identity to provide the user with the established principles posited by this particular profession as taught by the university of Pretoria.

CONTRIBUTION TO INTERIOR ARCHITECTURE

The topic of emergency shelter has long been discussed by architects and industrial designers, but not often developed with an interior architectural approach. Designing for disaster is similar to that of designing for an event; only this event is an unfortunate one.

This thesis builds on the premise that interior space is not an optional addition to, but rather the critical completion of architecture.

When space is quantitatively assigned as 3.5sqm per person, without considering the potential of the interior volume, the premise of efficiency is contradicted. It can be argued that the necessary extension into interior space could aid in mitigating both the physical and psychological losses that follows a disaster.

Shelter can be so much more than bare enclosure. Even with a limited budget the design of the interior space has infinite potential.

The temporal and micro scale of interior architecture has the benefit of experimentation and of testing the often conservative practices of architecture. This in turn affords the thesis opportunities to develop an alternative approach to meet the quantitative and qualitative needs pertaining disaster relief operations.

1 Alexander (1964:15)
2 *vide* (3.4:11)

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RESEARCH FIELDS

The thesis forms a bridge between two official research fields of the Department of Architecture at the University of Pretoria: Applied Technology and Product Design, and Housing and Urban Environments.

HOUSING AND URBAN ENVIRONMENTS

The unpredictable and undeterminable nature of disasters necessitates a different response than that of design in the built environment. It moves into the realm of portable architecture that, despite not being bound to place, can still convey meaning and be contextually relevant. Any temporary solution essentially becomes the precursor to the transitional and permanent settlement of the individual/community in need.

In the aftermath of a disaster space is a valuable resource. The project investigates methods of enabling efficient yet adaptable enclosure that takes into account realities such as phasing, privacy, variety and integration.

Likewise, the design of the interior should address issues such as economy, accessibility, ergonomics and flexibility. The perception that limited funds means poor quality should be challenged and content should be created that caters for the needs of all the sectors of the target population.

Such a response requires the introduction of an industrial design process to architecture.

APPLIED TECHNOLOGY AND PRODUCT DESIGN

Architectural product design is arguably more comfortable with exploring new or alternative technologies that offer innovative applications when applied across disciplines.

Shelter can be seen as architecture in the form of a product. The proposed solution would benefit greatly from employing key elements of the product design process such as; material exploration, manufacturing, economy, packaging, logistics, storage and assembly.

There are several recurring themes in Designed objects of the 21st century[1] driving the design of future objects, they are: 'the potential of new materials; the effects of new technologies, the need for simplification, emotionalism (the psychological aspects of design); and the tendency towards either individualistic or universal solutions.'

The thesis aims to apply research on product design and alternative materials to the requirements of a temporary housing typology.

It is by focusing on the similarities that the separate discourses evoke that analogies may emerge to inform and strengthen possible solutions.

1 Fiell *et al.* (2001:17)

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YUNIBESITHI YA PRETORIA

LIST OF FIGURES

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

CHAPTER 06

CHAPTER 07

CHAPTER 08

CHAPTER 09

CHAPTER 10

CHAPTER 10

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

LIST OF TABLES

grace under pressure

PART ONE

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YUNIBESITHI YA PRETORIA

"Invention is merely a way of seeing,

of reading accidents as signs and as opportunities"

: Paul Virillio[1]

01 | INTRODUCTION

There are few subjects in the whole field of building on which so much effort has been expended, so much money spent and yet, paradoxically, where so little is really known.[2]

...[d]espite the wide-ranging and diverse activity carried out into the problems of shelter after disaster, this work appears to have had minimal impact on the relief of human suffering on the ground.[3]

In this vein the thesis questions what an appropriate design response would be in the event of a disaster.

Whilst we as society should always strive to build better and healthier environments to create an ideal world, room should be made for asking how design could enable us to live in an unstable one.

Kronenburg4 maintains that "[e]ffective preparation has rarely been a part of disaster relief activities."

Disaster management concerns itself with two main objectives: disaster prevention and disaster preparedness. Disaster prevention entails identifying communities at risk, proposing various prevention strategies that run parallel with community-based initiatives, to work closely with improving the livelihoods of the target population.

Current measures have shown to be inadequate and could benefit from research and development in the field of disaster response/shelter provision.

In the light of recent events this modest investigation tries to identify the pressures that come with the desire to aid those who have just lost everything. The study involves moving the traditional role of the architect from post-disaster reconstruction towards pre-disaster preparedness.

Does shelter fall within the domain of architecture? The historic separation between settlers and hunter gatherers resulted in portable nomadic shelters such as igloos and tents. These have traditionally not been formally included in the definition of architecture.

What is the role of interior architecture in emergency relief and what can be gained from approaching shelter from the inside out instead of the outside in?

The thesis looks critically at the various pressures exerted on designing for post-disaster relief. The study investigates throughout the role of the designer in terms of the subject of shelter provision. It investigates and appropriates a local shelter typology.

1 Virilio (2006:5)
2 Ian Davis is a principal lecturer in Architecture at Oxford Polytechnic and has considerable experience disaster shelter as a member of a UN advisory team : Davis (1987:xv)
3 Kronenburg (2002b:101)
4 Kronenburg (2002b:102)

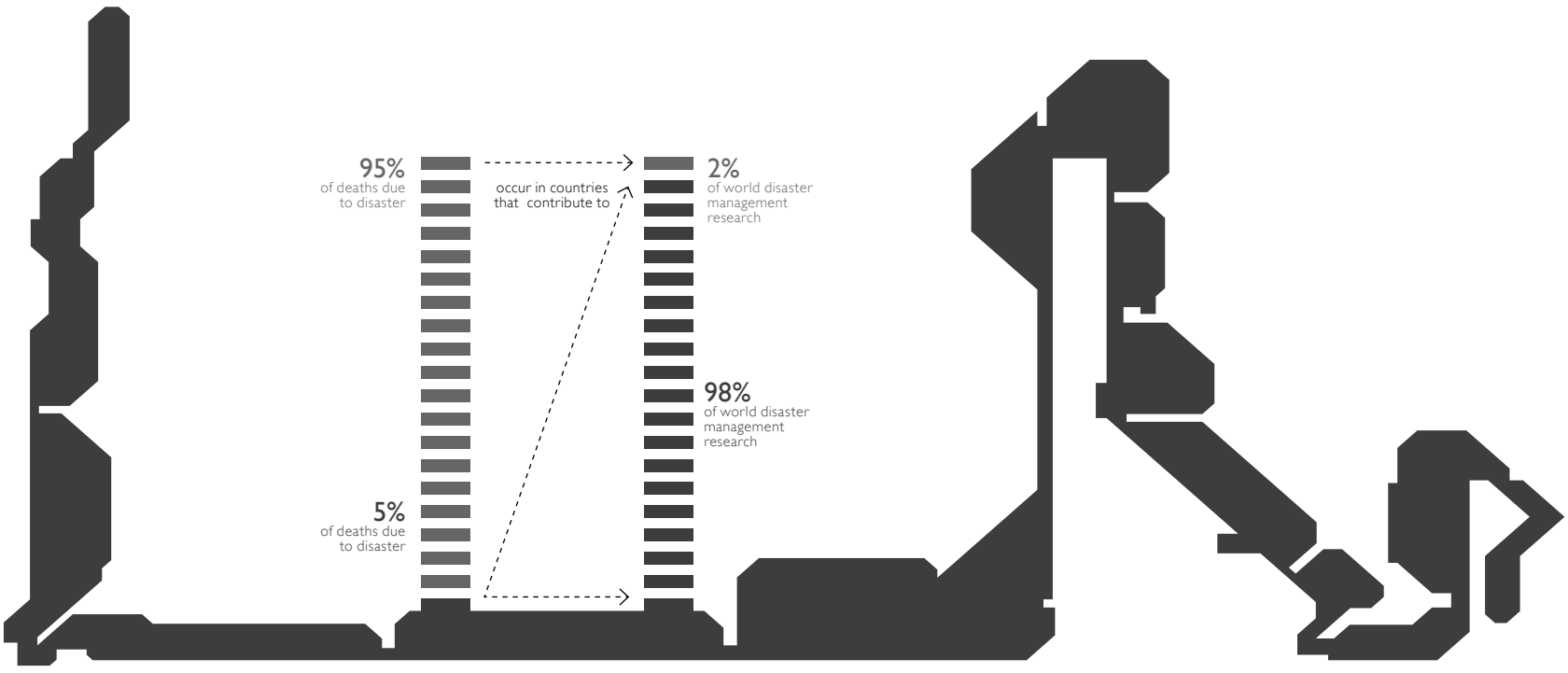

Figure 02 Graph showing percentage of disaster-related deaths in countries contributing towards disaster management research

1.1 OVERVIEW AND CLASSIFICATION OF CHAPTERS

CHAPTER 01 provides a brief introduction to the embodied elements of disaster. This serves to establish the premise of the problem statement and design intent discussed in CHAPTER 02. The aims and objectives set out in these first two chapters shall be subjected to a theoretical and contextual synthesis formulated in PART ONE. A further exploration of the concepts shall be developed in PART TWO, with an emphasis on application.

The following is a short overview of the topics considered:

- PART ONE discusses the design task and problem statement in terms of a theoretical approach [CHAPTER 03]. A brief overview of the local legislative framework is provided [CHAPTER 04], as well as the international minimum standards for emergency relief, so as to develop at a set of guidelines that is contextually relevant.

  The concept is further informed by an examination of context and climate, as well as the myths and realities regarding disaster response and recovery at the hand of local case studies and a-contextual sites / scenarios [CHAPTER 05]. This section aims to inform the design development undertaken in PART TWO.

- PART TWO interprets the ideas put forward in part one, with the emphasis on application. Portable architecture typology and their applications are evaluated, offering validity to conclusions of the framework and context This is followed by a review of similar projects and a study of design precedents pursued in CHAPTER 07.

  Working closely with material and manufacturing processes [CHAPTER 08], a design proposal will be developed [CHAPTER 08-11] to ensure that the goals set out in CHAPTER 02 are achieved.

1.2 BACKGROUND

Annually, disasters claim the lives of 250 000 people worldwide.[5] More than 95% of these deaths occur in developing countries. Although a wide range of factors contribute to this statistic it is a fact that most disaster management research is done in developed countries whilst only 2% of the research programs are initiated by developing nations [Figure 02].

The Red Cross Society South Africa [SARCS][6] best articulates the necessity of disaster management in the South African context:

> When disasters strike, years of development can be wiped out in a short space of time. Often, already fragile public services – such as health, water and sanitation – are further weakened.

The costs of mitigating the effects of disasters consume the much-needed resources intended for development.

It is estimated that since 2008 more than half the world's population would have become urban dwellers. This number is predicted to grow by two thirds by 2025[7].

Latent risks that exacerbate the occurrence of disasters in South Africa have become increasingly interlinked. It is the opinion of the South African National Disaster Management Centre[8] that disaster predictions correspond proportionately to rapid urbanization trends:

Declining livelihood opportunities intensify urban migration. This situation results in overcrowded and poor living conditions in areas often bordering industrial and manufacturing zones, a situation which amplifies the potential damage that can be caused by industrial disasters.

The increase in population growth puts pressure on the development of marginal or "at risk" areas such as arid zones and flood plains.

These statistics should be viewed against the fact that 57% of South Africans live below poverty line[9], which means that they live in domesticated structures that cannot withstand disasters.

5 German (1999:161)
6 South African Red Cross Society ([n.d]:1 of 1)
7 German (1999:162)
8 National Disaster Management Centre ([n.d]:1 of 1)
9 Schwabe (2004:[1of1])

1.3 DISASTERS IN CONTEXT

The declaration of an event as a disaster is not determined by the number of lives lost but rather by the potential of the event to cause loss of life, yet the effect an unfortunate event has on the individual remains the same.

The investigation contained in this thesis is therefore not bound by the definition of disaster alone but also considers events that are classified as major incidents, accidents and hazards.

1.3.1 LOCAL DISASTERS

According to the Tshwane Department of Disaster Risk Management, the most likely and recurring disasters in the region are categorized as natural hazards and these are:

- Informal settlement fires
- Floods (urban)
- Severe weather events
- Veld fires
- Sinkholes

The most recent and largest declared disaster in the region was the outbreak of xenophobic attacks in 2008. It is classified as a political disaster and the rehabilitation of the displaced persons are still ongoing.

This thesis aims to determine whether it is feasible to adopt a unified approach to emergency relief for both natural and political disasters.

1.3.2 RECOVERY PHASES

Response and recovery operations are comprised of various phases. For the purposes of this study they are identified and referred to as follows:

- EMERGENCY RELIEF PHASE
- TEMPORARY PHASE
- TRANSITIONAL PHASE
- PERMANENT PHASE

The scale and magnitude of the disaster would determine the need and duration of any or all of the above-mentioned phases.

1.4 DEFINING THE PROBLEM

It is a harsh reality that those who are least likely to recover from disasters are the most likely to experience them. It is also within this same demographic that one finds people who would never come into contact with the ideals of architecture.

This thesis pursues "grace under pressure" in a quest to elucidate why so many projects of goodwill in aid of disaster relief have failed to realize.

South Africa has as yet no formalised shelter standards and depends on a patchwork of universal solutions and local improvisation. With the accelerated rate of urbanization in African cities the threat of disasters yields staggering implications. There is an urgent need for research into disaster mitigation strategies. Factors that deem imported solutions inadequate are the same factors that could inform local, contextually relevant shelter typologies.

1.5 AIMS + OBJECTIVES

This thesis aims to quantify the present shortcomings relating to emergency relief and recovery, to identify the opportunities that could arise in the event of a disaster, and to investigate and contextualise spatial guidelines. It also aims to determine the feasibility of the approach instigated by the Department of Disaster Management and establish if collaborations with industry can host opportunities for commercial activities.

1.6 RESEARCH METHODOLOGY

- Framework: comparative study
- Context
- Case Studies
- Interviews
- Review of Similar Projects
- Material Exploration

1.6.1 THE PROCESS OF DESIGNING SOLUTIONS

The American Institute of Graphic Arts [AIGA] asks why do you design and put forward a process for designing solutions[10] [Figure 02]. With slight modifications this process forms the backbone of the approach taken for this thesis.

Figure 03 Process of designing solutions : American Institute of Graphic Arts (2005:13) [amended by author], Photograph of Klerksoord refugee camp : Pretorius (2008b:[7 of 10])

10 American Institute of Graphic Arts (2005:13)

“ UNDRO studies have shown that post disaster problems are aggravated by human error and lack of foresight and that disaster relief can without a doubt be made more effective through systemised planning and management carried out in the event of disaster rather than in response to it.[1]”

02 | DESIGN TASK:

REVIEW AND REASONING

2.1 PROBLEM STATEMENT

One does not need to delve deep to find the problems associated with universal ‘donor’ solutions. Current disaster response methods involve issuing the displaced victims with either a United Nations tent [designed for the use of refugees] or, if they are lucky, with what is termed a ‘starter pack’ consisting of ten sheets of corrugated iron, ten poles and two bags of nails.

Temporary shelter solutions aim to address the immediate need for survival. While relief measures can be quantified[2] in terms of water [20L per person per day] or food [0.2 tonnes per person per month], the extent to which shelter can aid emotional wellbeing remains unclear.

In a disaster both tangible and intangible losses occur, yet current measures only account for the physical. It is here where one of the first constraints - **or pressures** - in designing for disaster relief reveals itself. Psychological needs such as familiarity and finding a sense of place elude quantifiable definition, so how can design begin to account for the innumerable variations in the needs of victims?

This notion is reiterated upon evaluating the interior space of shelters. When shelter is allocated solely on the basis of the economy [3.5 sqm per person] without considering how the space is to be used, the premise of efficiency is contradicted. This presents a missed opportunity for the architecture of the interior to contribute to place at a time when the trauma of loss is at its peak.

Post-disaster relief and transitional efforts entail a fragmented process of isolated objects. The dearth of regional shelter guidelines means that decisions are made without considering the subsequent recovery phases, often resulting in prolonged relief operations and accelerated costs.

Tented solutions do not pre-empt the recovery phases that follow and are reclaimed after a certain period, leaving the inhabitants with very few or no options. Such universal solutions are not contextually suitable in terms of local building practices, climate and cultural relevance.

More complex portable architectural solutions often hinder recovery efforts more than they enable them. Prefabricated solutions, if not locally manufactured, take too long to arrive on site; they can be heavy and difficult to transport and very expensive. There are an infinite number of hidden pressures prohibiting design in humanitarian aid; this thesis shall attempt to identify the most prevalent of these.

1 Kronenburg (2002b:102)
2 Browne (1998:83)

2.2 HYPOTHESIS / DESIGN TASK

2.2.1 VISION

This thesis envisions creating a South African shelter typology, i.e. a well-rounded, adaptable sheltering process that embodies a holistic response to the physical and psychological climate and site conditions, that is culturally relevant and economically viable, and that makes use of local materials and manufacturers.

To arrive at such a result, the thesis proposes that several region-specific solutions be developed that can either remain indigenous to their regions or be synthesized into a national typology.

This project deals with formalizing a sheltering process within the climatic constraints and context of the greater Tshwane region; it proposes a temporary architecture that would fit into the existing urban fabric.

2.3 PROPOSAL

The success of the mitigating strategies following a disaster is dependent on a network of actors hailing from numerous professions. The hypothesis is focused on formulating an effective response within the capacity of design.

The emphasis of the project falls on filling the gap between short-term relief provided in an emergency and the time frame left over until [or whilst] reconstruction is taking place. This thesis refers to this temporary phase as **'a period of grace'.**

A responsive environment that aids emotional well-being and morale would enable the occupant to become self-sufficient. A shelter that is adaptive and flexible enough to be used independently would have the potential to morph into a new dwelling when more resources become available.

The project is a solution in itself as well as a building block forming part of a greater end result. The response is not intended for a time-specific scenario and location, but strives to formulate a relevant approach to reconcile the events of the past, the damages of the present and the opportunities of the future.

2.3.1 A THEORETICAL APPROACH

The aim is to clarify the ability of design to contribute to disaster recovery. Throughout the thesis the role of design in the event of a disaster is continuously redefined.

The hypothesis argues that interior architecture is a necessary extension of architecture, even in the case of limited resources. Insight gained from the theoretical discourse aims to provide a solution that is as creative as it is functional.

The argument draws out the differences between shelter and dwelling and explores how finding a sense of place after being rendered homeless can aid in recovering one of the many intangible losses experienced by disaster victims.

Learning from the opportunities that the elements of disasters present, the humanistic approach to Maslow's basic needs is interpreted as the hierarchy of design requirements in response to questions about the role of aesthetics in humanitarian design.

These topics are explored to formulate a theoretical approach to strengthen a design solution capable of moving beyond bounds of preconception.

2.3.2 A PRAGMATIC RESPONSE

Gordon Browne[3] of the Southampton Institute contextualises what Buckminister Fuller advocated. He raises the necessity for designers and manufacturers to work together with industry to provide inexpensive construction materials which can be locally manufactured, using indigenous materials and unskilled labour.

The focus of this project is a critical revision of rapidly deployable shelter systems that employ an unfolding / collapsible material system. The aim is to derive low-cost strategies that can be locally manufactured and be readily available. This is achieved through the exploration of alternative building materials and construction methods, resulting in an interdisciplinary approach.

The role of the interior architect falls within the realm of the temporary, and this is what the thesis project hopes to resolve completely, by providing a conceptual proposal for the preceding emergency and following transitional phases.

3 Browne (1998:82-87)

2.3.3 FUNDING

As stipulated by the National Disaster Management Act, every municipality is required to set aside a budget allowance for disaster response and recovery. This budget is reviewed annually as part of the Integrated Development Plan [IDP] and amended when necessary. The potential for funding can be increased in two ways:

(a) Collaboration with industry

To ensure that the best possible solution reaches those who need it most, it is the ideal to design open source architecture under the Creative Commons developing nations license – this would allow anyone to manufacture the product on the condition that it cannot be sold for profit within the field of emergency shelters. The solution can therefore be freely distributed and adapted, increasing its potential for evolution.

This does not however rule out the possibility of developing variations of the concept for other temporary applications such as site offices, voting stations, etc. The feasibility of such endeavours can most likely fund the production of these temporary shelters whilst becoming a viable business venture.

(b) Branding rights

In the aftermath of the March 2009 Soweto flash floods, Anglo American[4] donated R 1 000 000 in aid of the flood victims. Disasters attract a massive amount of press coverage that in turn encourages a wide range of donations. Proposals for funding can be put forward by private sector entities or volunteer organizations in exchange for branding rights.

2.3.4 TARGET POPULATION

The proposal deals with improving the lives of those who have just lived through the traumatic experience of losing their primary dwelling. They have in effect become internally displaced due to a disaster, which can be natural, for instance floods, or man-made, such as fires.

Such victims would typically be dependent on government and other goodwill organizations for relief, on the assumption that they do not have any other means of insurance.

2.3.5 LOCATION

The intended solution should befit a variety of scenarios and sites, and therefore involves a non-site-specific design proposal. It is however to be a local response as opposed to a universal solution. The ideas generated through research are thus applied to disaster shelters for victims located within the context and climatic constraints of the greater Tshwane Region.

2.3.6 DELIMITATIONS

- Political disasters such as xenophobic attacks and war are excluded from this study. Research has shown that refugees hold a unique set of characteristics that merit an entire study in itself. But because current mitigation strategies are the same for both situations [i.e. the UNHCF tent], examples of living conditions experienced by refugees were included where similarities between disaster victims and refugees presented themselves.

- The project refrains from proposing camp layouts on an urban scale for the reason that it is South African government policy not to maintain shelter camps. The recent emergence of refugee camps was born out of desperation, not protocol.

- Due to the fixed duration of the study course and the nature of the topic, opportunities for gaining insight into the most likely disaster scenarios where limited. Thus case studies from beyond the boundaries of Greater Tshwane were included.

2.3.7 ASSUMPTIONS

- Sanitation, food, and medical and cooking facilities are not to be formally addressed when designing for the post-disaster emergency and temporary phases. It is assumed that these needs have already been met by other means.

4 Anglo American (2009:[1of1])

2.4 AIMS + OBJECTIVES OF STUDY

This thesis aims to:

(a.) Define the role of design in terms of disaster response

(b.) Present the needs and shortcomings pertaining shelter provision

(c.) Identify the opportunities that arise in event of disaster that could provide better, more efficient modes of shelter

(d.) Initiate spatial guidelines for effective emergency relief, based on international standards, within the South African context

(e.) Determine if a collaboration with industry can be established that allows for shelter to be manufactured for emergency with the possibility of developing the same technology into other products for commerce.

2.5 REVIEW OF RESEARCH METHODOLOGY

2.5.1 FRAMEWORK

To establish the project within a legislative framework, a research proposal is developed in alignment with the objectives of the National Disaster Management Policy.

Possible South African shelter guidelines are initiated through a comparative study of the following:

- SABS Building Regulations
- International Shelter Standards
- Current practice: the UNHCR tent
- Commercially available products

2.5.2 CONTEXT STUDY

Context is defined through a series of studies, including the types of natural phenomena endemic to the greater Tshwane region, an investigation of associated risks, the likeliness of unfortunate events recurring, and climate and environmental conditions.

Through the use of case studies, site visits and interviews the research also considers the factors that contribute to vulnerable conditions, as well as the needs that derive from the current response methods.

2.5.3 CASE STUDIES

Site visits and analysis of relief and transitional efforts in:

- BRAAMFISCHERVILLE, Soweto
  Type: Flash floods
- KLERKSOORD, Akasia
  Type: Shelter camp for refugees displaced by xenophobic attacks
- CENTRAL METHODIST CHURCH, Braamfontein Type: Collective centre for refugees displaced after shelter camps where dismantled
- IRENE CONCENTRATION CAMP
  Type: Historic Case Study

2.5.4 INTERVIEWS

- Displaced victims of flash floods, Braamfischerville
- Red Cross Volunteers, Soweto
- Red Cross Volunteers, Pretoria
- Department of Disaster Risk Management, Tshwane Metropolitan Municipality
- Department of Housing, Tshwane Metropolitan Municipality

2.5.5 MATERIAL EXPLORATION

Exploration of materials by conducting the following experiments:

- Cardboard fire and waterproofing experiments
- Build a prototype to test strength and durability

2.6 OVERVIEW OF SIMILAR PROJECTS

Chapter 07 will discuss shelter typologies in terms of the theoretical discourse. These will include:

- Concept derivatives
- Temporary shelters
- Folding shelters
- Sheltering elements
- Surfaces + Textures

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“ Embodied within acts of destruction

is the potential for creation.

Within one catastrophic event

the human condition is reduced to its most primal state

while being brought to the threshold of possibility[1] ”

Figure 04 Running before the fire: residents at the Ramaphosa informal settlement try to salvage building material before the blaze overtakes them : Botes (2008:[1 of 64])

Figure 05 The heat of the fire exposed the seed of the King protea : Farm 215 (2009:[7 of 20])

03 | THEORETICAL DISCOURSE

What follows are questions investigating a design response in the event of a disaster. During the course of this discussion this dissertation will look at the current role of design in general, the embodied elements of disaster, and the sociological impact these events have.

The argument points out the differences between shelter and dwelling, and identifies and interprets opportunities in terms of an appropriate design reaction.

3.1 THE CURRENT DEBATE ON DESIGN

It seems uncanny that one woman can so accurately foresee the trajectory of design trends. Yet when listening to Li Edelkoort[2] one realises very quickly that her remarkable ability to observe provides a subtle perspective on things we've unconsciously known all along.

The concept of osmosis becomes a useful analogy in understanding the evolving role of design today as a strong urge/need for consensus. She explains that there will be no more black and white but only discernment between different shades of grey.

Gray is a mentality, presenting the notion of collaboration between separate entities. The desire to belong will continue to increase. The world is uniting against new-found enemies whether they are natural disasters or the fluctuating economy. Just as the ashes in Figure 04 tell of an unfortunate moment for the King Protea it is a necessary one for it to realise its potential.

In a recent lecture Anthony Dunne[3] suggested that, when we design for debate, design becomes a reflective medium within which we speculate. The questions derived from such speculation, even if they are not always feasible, are questions that only design can ask.

Designers have to innovate. Innovation means generating the right questions and asking them profusely.

The profound comment by French anthropologist Claude Lévi-Strauss[4] can be interpreted to say "[t]he **designer** is not a person who gives the right answers, he is one who asks the right questions."

At the present time a climate of debate prevails. It is important to define the role of design and to always continue to do so. These thoughts were confirmed by the words of Anthony Dunne and Fiona Raby: "no longer can design change the world, the world is changing design."

1 Sadler (2004:[abstract])
2 Lecture at the Design Indaba Conference 25-27 February 2009, Cape Town

3 Anthony Dunne, head of the Interaction Design department at the Royal Collage of the Art, in a lecture at the 2009 Design Indaba, Cape Town.
4 ['scientist' replaced with designer]. Claude Lévi-Strauss developed structuralism as a method of understanding human culture and society : Lévi-Strauss ([n.d]:1 of 1)

3.2 ELEMENTS OF DISASTER

Incidents, accidents, disasters, catastrophes and crises are essentially events that have the potential to cause great damage or loss. The differences between them emerge in the aftermath of the occurrence. This is why one would often hear of an area being **declared** a disaster zone. Disastrous events are classified according to the scale of damage or loss they inflict, their potential to cause fundamental change, and their ability to be contained by disaster management strategies.

Why do these events occur and what are their implications?

3.2.1 INSTABILITY

When disaster strikes that, which provides our grasp on stability is shaken. The trust in the tangible is lost and a new relationship between the physical and psychological needs to be established in the post-disaster efforts.

Verb Crisis[5] articulate this issue particularly well when they define crisis / disaster as:

> ...a turning point, a decisive moment when tensions and instabilities peak and change becomes inescapable. Crisis implies the questioning of beliefs and habits; it demands adjustments in perceptions and in modes of action.

Paul Virillio[6] maintains that we live in a world of perceived stability, "a landscape of events concealing future collisions". Our perception of stability is like saying that only one side defines a coin. One can not truly understand its identity unless both sides of the coin are taken into account.

Virillio[7] calls this the "integral accident". Therefore, whenever one creates something, be it a house or a train, one inadvertently creates its potential failure. Accidents and disasters lurk in the shadow of every invention.

5 Ballesteros (2008:[cover page])
6 Virilio & Der Derian (1998)
7 Virillio (2006:47)

3.2.2 CHANGE

According to Gilles Deleuze, every actual thing is subject to an infinite set of continuing and open-ended transformations and recreations. This concept is also expressed in art. Williams[8] explains identity thus:

> **There can be no limited and clearly defined actual thing whose existence does not presuppose a set of past and future catastrophic changes.**

Identity is born from instability and change. Identity in itself is never static but is continually redefined by change. It is because of this potentiality that anything exists.[9]

Change is therefore proportionate to the scale of the event that creates it.

The truth in life is that the only constant it contains is change. Disaster is merely an unexpected and accelerated form of change yielding unforeseen consequences. Michael Barkun[10] defines disasters as the "long term and fundamental destruction of the primary environment", and accidents as "episodes that may severely affect a community but that do not lead to fundamental social change".

3.2.3 OPPORTUNITY

Virillio argues that 'invention is merely a way of seeing, of reading accidents as signs and as opportunities' [insert reference]. Accidents and disasters both have the power to make society see things differently.

By relating Virillio's statement in terms of architecture we see that accidents and disasters are types of unpredictable collages of everyday life. They can be ignored or embraced to heighten visual engagement and release-hidden associations. [11]

8 Williams (1997:233)
9 Williams (1997:233)
10 Higgins (2004:16)
11 Porter (2004)

3.2.4 CREATION

Deleuze advocates catastrophe. He is of the opinion that from great destruction comes the opportunity for creation.

In the study of semantics it is understood that an incident can be defined as an event that has the potential to cause damage but doesn't. The same potential lies in the basic unit of survival: shelter. The process of loss that is embedded in the event of a disaster requires one to move past the hapless reality towards a counter-actualization through the act of shelter.

The seemingly humble act of shelter brings with it the embodied potential to cause fundamental change, as well as the opportunity to dwell, to feel at home and re-establish an identity with the self and one's surroundings.

The sense of home, familiarity, and ownership are intangible concepts most often neglected in the effort to regain stability. A shelter is not just a building; it has to enable a new relationship between man and his environment to grow.

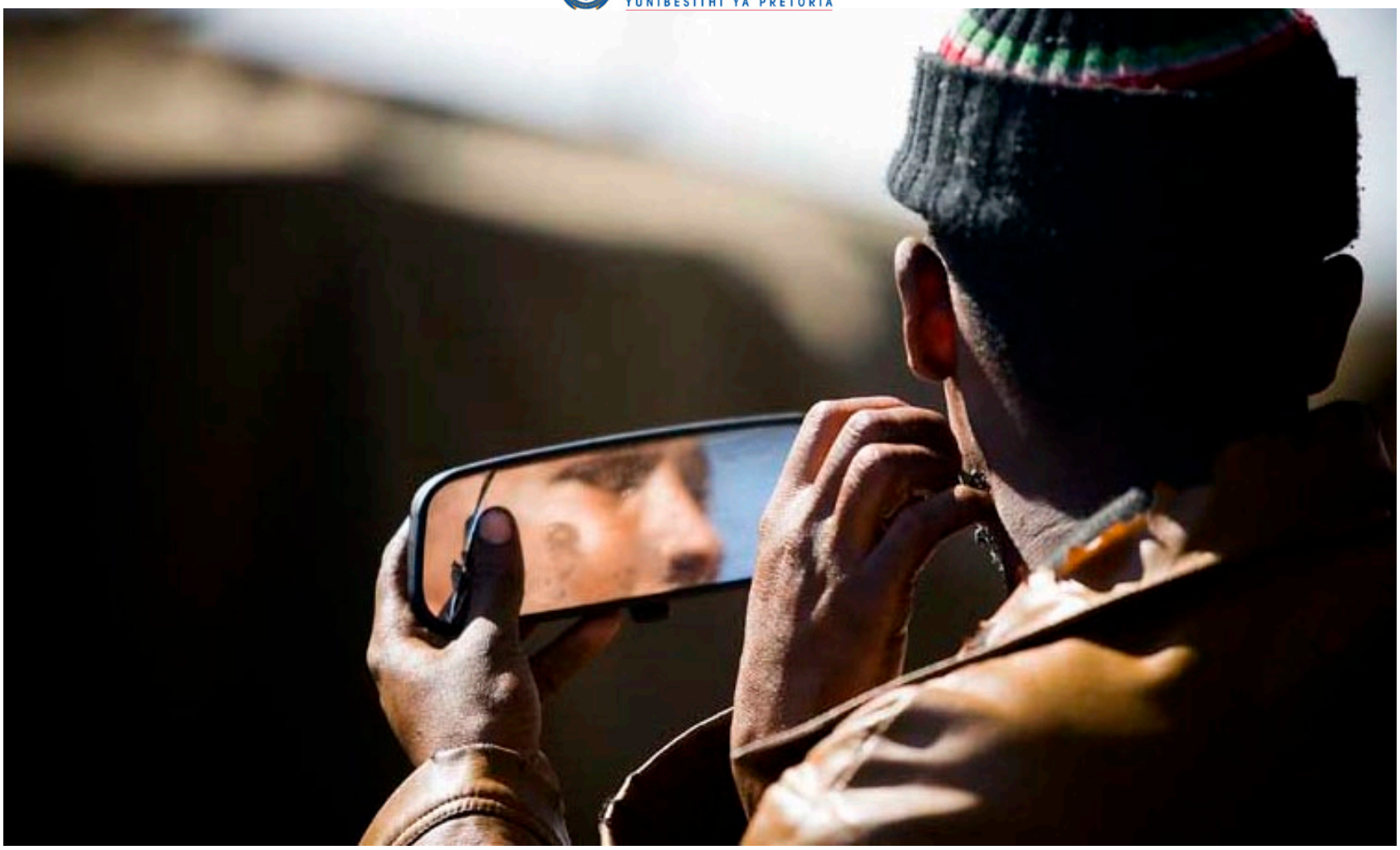


Figure 06 Man shaving at Klerksoord shelter camp : Pretorius (2008b:[2of10])

3.3 ENVIRONMENTAL PSYCHOLOGY

Environmental psychology[12] is *the study of how our surroundings and circumstances influence how we act and how we feel.*

In the wake of disaster both tangible and intangible losses occur. Sudden changes in environment and situation have a great impact on how relief efforts are carried out and experienced. The potential of space to aid emotional well-being is overshadowed by limited time and resources in the case of an emergency.

The process of loss that transpires is often prolonged by new environmental stresses, and space allocated is based on efficiency not human conduct. It is evident that the role of design is not only to gain insight about how space influences behaviour, but also to synthesize basic human needs and elements of environmental psychology into an efficient solution.

3.3.1 THE PROCESS OF LOSS

Being homeless and/or displaced can be identified as a process of loss[13] in terms of both the tangible and intangible:

Tangible losses: personal items, documentation, clothes, utilities, loved ones, money, assets, equipment, vehicles, houses, livestock, businesses, property, land.

Intangible losses; identity, home, community, networks of social relations / institutions, familiar surroundings, daily activities, security, ownership, livelihood, wealth and, in the case of refugees, loss of one's country.

It is evident that losing one's primary dwelling entails losing more than just a roof over one's head. Being deprived of the temporal and spatial structuring of everyday life as well as one's identity ultimately decreases the chance of having a flexible, autonomous and ongoing way of life.

3.4 THE HIERARCHY OF NEEDS

The argument contained in this thesis draws on knowledge generated by two distinct theories on human nature, in order to attain a more comprehensive understanding of human needs and how they can be accounted for spatially.

(a) Maslow's Humanist theory:

> The humanistic approach may be conceptualized as a phenomenological one because it stresses the importance of the 'subjective, unique experiences of each person and the potential all of us have for self-fulfilment through spontaneity, creativity, and personal growth'.[14]

According to Abraham Maslow (as evident in the emergency phase) basic human needs have to be satisfied before any other prerequisites for self-actualization can be fulfilled.

Table 01 illustrates the order of human needs. Newmark and Thompson[15] discuss various types of shelter in relation to Maslow's theory:

Firstly, **physiological** needs that constitute reasonable shelter from the environment depending on the acceptable cultural standard; secondly, **safety** and security of occupants and their possessions; thirdly, **social** needs pertaining to shelter serving as the background for defining daily activities and intimate relationships in and around the shelter; fourthly, **self-esteem** and ego needs – these refer to the purpose of housing as a symbol of status within a society – and finally, **self actualization.**

The principle of hierarchy in design is based on Maslow's theory. It is argued that the perception of value attributed to a designed object [or space] is dependent on the level of needs it satisfies. The order of needs can be interpreted as design criteria:[16]

- **Functionality**: Does the design meet the primary requirements?
- **Reliability**: Does the design behave in a stable and consistent way?
- **Usability**: Is the design simple and forgiving to use?

12 Hayes (2004:255)
13 Staples (2007:218)
14 Papalia & Olds (1988:464)
15 Newmark & Thompson (1977:8-12)
16 Lidwell *et al* (2003:106)

Table 01 Maslow's Hierarchy of Human Needs **:** Swartz, De La Rey & Duncan (2004:175)

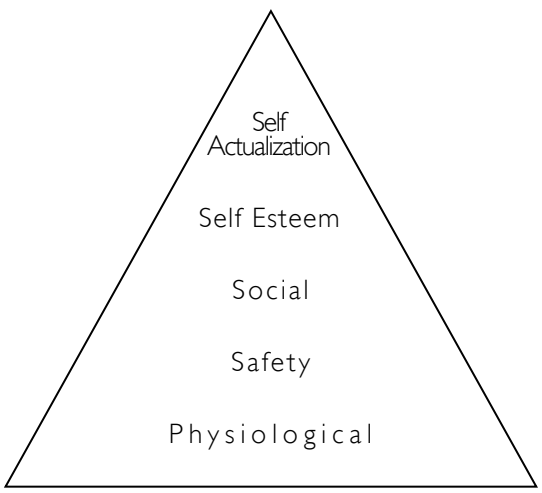
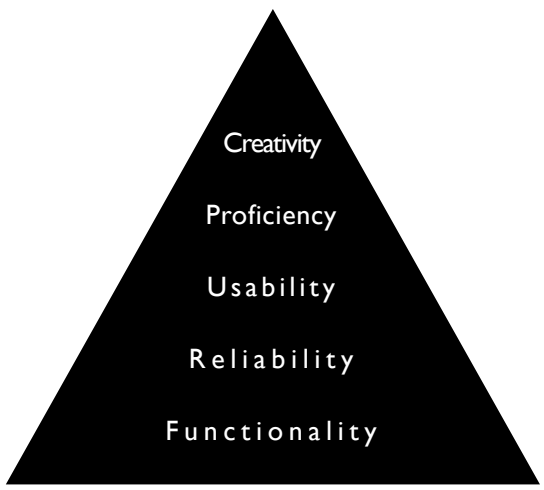


Table 02 Hierarchy of Design **:** Lidwell, Holden & Butler (2003:107)



- **Proficiency:** Does the design enable the user to do things better?
- **Creativity:** Does the design encourage interaction in innovative ways? Was the design used to explore and create areas that extend both the design and the person using it?

(b) Skinner's behavioural theory:

Behaviourists consider environmental factors to be very important. The premise of behavioural theory[17] is that a person is the product of his/her environment, but also that this person possesses the ability to change or create new environments.

Frederic Skinner[18] postulates that there are three aspects that stimulate our actions: "…the frequency of behaviour, the situation in which the behaviour occurs, and the reinforcement associated with the behaviour."Such is the case with Sophronia.

3.4.1 ASPECTS THAT INFLUENCE HUMAN BEHAVIOUR

(a) Personal Space

The person must be comfortable in the company of others. Not having the ability to control personal space causes anxiety.

(b) Distance

Space or distance is a form of "non-verbal communication.[19]" Table 03 gives an indication of the varying zones of personal distance. The measure of acceptable personal space depends on the cultural background of the individual.

Table 03 Zones of personal space **:** Hayes (2004:256) [redrawn by author]

INTIMATE [0-45cm] →
: for lovers, very close family (such as mother and child). or ver close friends

PERSONAL [0.5-1.2m] →
: for friends, or family members

SOCIAL [1.2-3.5m] →
: for a business conversation, or a discussion with a relative stranger

PUBLIC [3.5-7.5m] →
: for public meetings and ceremonies, with speakers and audiences

Whilst the proxemics of different cultures differ from each other, this is an aspect of human nature that should not be ignored.

(c) Privacy

The concept of privacy is different for everyone. It is very difficult for a person too loose the socially defined construct of privacy.

(d) Territory

(e) Factors of environmental stress

Changes in the environment and the accompanying noise levels can be deeply stressful. When combined with overcrowding the inherent lack of control over the given situation can be doubly stressful.

(f) Post-traumatic stress disorder

Post-traumatic stress occurs when a person has lived through a severe emotional trauma[20], such as experiencing a disaster. Post-traumatic stress disorder was previously referred to as shell shock, especially amongst soldiers.

The components of grief are:

1. shock
2. disorganisation
3. denial
4. depression
5. guilt
6. anxiety and/or panic attacks
7. aggression
8. resolution
9. reintegration

17 Butler-Bowdon & Pratt (2008:chapter 47)
18 Swartz, De La Rey & Duncan (2004:177)
19 Hayes (2004:255)
20 Hayes (2004:267)

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The city of Sophronia is made up of two half cities. In one there is the great roller-coaster with its steel humps, the carousel with its chain spokes, the Ferris wheel of spinning cages, the death-ride with crouching motor-cyclists, the big top with the clump of trapezes hanging in the middle. The other half-city is of stone and marble and cement, with the bank, the factories, the palaces, the slaughterhouse, the school, and all the rest. One of the half cities is permanent, the other is temporary, and when the period of its sojourn is over, they uproot it, dismantle it, and take it off, transplanting it to the vacant lots of another half-city.*

And so every year the day comes when the workmen remove the marble pediments, lower the stone walls, the cement pylons, take down the Ministry, the monument, the docks, the petroleum refinery, the hospital, load them on trailers, to follow from stand to stand their annual itinerary. Here remains the half-Sophronia of shooting galleries and the carousels, the shout suspended from the cart of the headlong roller-coaster, and it begins to count the months and days it must wait before the caravan returns and a complete life can begin again.

* Excerpt from CALVINO, I. 1974. *Invisible cities*. New York: Harcourt Brace Jovanovich, translated from Italian by William Weaver.

3.5 THEORETICAL PRECEDENTS

3.5.1 SOPHRONIA

In Valcino's depiction of Sophronia[21], the city is made up of two halves that exist in a state of constant flux. In the one half a perception of stability prevails, and the architecture alludes to the manifestation of institution, religion and commerce. It represents the physical presence of order.

The other half is inhabited by the eternally young. Life in this part of the city is free from responsibility and is dominated by an almost childlike naivety. It remains in this state partly because of choice and partly because it is treated in a manner that prevents it from growing up.

It is only when the half-city of authority departs that the utter dependence of the carousel lifestyle is revealed. All might not be lost in this crucial moment if the inhabitants remember that they have a choice if given the opportunity.

And so without the means of initiating a livelihood, what remains of the half-city of Sophronia is left waiting with nothing more than unrealized potential.

The African city bears much resemblance to Sophronia. The fate of our cities lies in their ability to create opportunity and then choosing to make something of it.

This situation is as true of African cities as it is of their disaster relief strategies. Without an enabling shelter process the luxury of choice cannot be exercised. Although it is beyond the means of any project to make such a crucial decision, it has the capacity and responsibility to design for opportunity.

3.5.2 TENT CITIES, SEATTLE

The tent city movement in Seattle posits a fundamental question. It argues that success is not determined by the number of people that do or do not sleep on the street but rather by how we as a society are able to adapt to living in an unstable world. Although their objective predominantly concerns the homeless, the rationale behind the movement can be applied to disaster relief.

The first tent city appeared in 1994 in downtown Seattle as a protest against the city's policies regarding the homeless. Tent City 1 was set up in clear view of the highway, and become a very public protest. It was not long before the city of Seattle sent bulldozers scattering the inhabitants. Four years later Tent City 2 emerged to illustrate how the city's harsh actions have failed to solve the problem of homelessness.

The third Tent City was established at the Crown Hill United Methodist Church in 1999. Here a situation similar to that of the refugee settlement at the Central Methodist Church in Braamfontein is presented. Matthew Allen[22] explains why this type of event is not uncommon: "This situation tends to give the encamp-

21 Groák (1992:59)

22 Allen (2005:44)

ment political credibility by situating it within the widely understood framework of missionary work,.."

The Church provided the movement with the right to belong, albeit temporarily.

The outcome of the tent city movement is an approach that gives the homeless the right to occupy a site under a three-month lease agreement. The inhabitants are issued with permits, and on fulfilling certain terms and conditions the permits are renewed and they are allowed to relocate to another selected site. This has become an inclusive solution that provides the homeless with the opportunity to become recognised citizens of the city.

3.6 NOMADIC PORTABLE ARCHITECTURE

In architecture the discourse of shelter and the discourse of dwelling derive from two separate schools of thought. Nomadic architectures represent a third discourse. Based on the philosophy of Deleuze and Guattari, Allen[23] suggests that:

> Nomadic architecture turns out to be an effective alternative to an untenable architecture of stability and permanence, either in the form of an individual Dasein (as in the case of dwelling) or of a rational system (as in the case of shelter).

23 Allen (2005:3)

Nomadic and temporary architecture carry meaning through events. Enclosure is not a prerequisite for place or dwelling. Heidegger[24] purposefully uses an illustration of a bridge instead of a house to explain the concept of place. Enclosure does however provide an 'address' to identify the event of dwelling.

When a temporary structure is placed on a site, it signifies a physical manifestation of place. Shelter reflects a similar function by enabling the act of dwelling through temporarily providing structure.

Kronenburg[25] maintains that: "…the power of the experience rather than its duration is more important in gauging its meaning and effect".

3.6.1 EPHEMERAL QUALITIES OF SPACE

The ephemeral qualities of space becomes the focus of the interior atmosphere which carries meaning through experience without being bound to place.

In terms of disaster, although temporary in duration, the impact of the event can be lasting. Likewise the nature of temporary shelter has the potential to be the beginning of a new experience.

Architecture in terms of the act of building encapsulates the ephemeral essence of dwelling. When dwelling entails the meaningful relationship between man and a given environment, architecture becomes the gathered work enabling man to dwell [as a certain way of being] between earth and sky.[26]

24 Kronenburg (1998:7)
25 Kronenburg (1998:7)

Norberg-Schulz exemplifies dwelling as consisting of orientation and identification. He suggests that concrete place can satisfy this need [for orientation and identification] by means of organized space and built form. He goes on to say that "when dwelling is accomplished, our wish for belonging and participation is fulfilled".[27]

> '[a] good environmental image gives its possessor an important sense of emotional security'. Kevin Lynch says that: 'which is the obverse of fear that comes with disorientation'.[28]

Organized space [interior architecture] brings other activities that grow to define the home in order. Hence shelter is the beginning of a process, that involves first a sign of the event of dwelling before it can host a more complex scope of concerns.

3.6.2 PRESERVATION OF THE FAMILY UNIT: HOME

The significance of the ephemeral qualities of home and the concept of dwelling is evident during post-disaster

26 Norberg-Schulz (1985:13)
27 Norberg-Schulz (1985:7)
28 Norberg-Schulz (1985:20)

Figure 07 Habitat logo - www.habitat.co.uk (2009)

recovery operations, when victims cling to the family unit in an attempt to regain something of what was lost. This provides insight into the complex relationship between shelter and dwelling and is a fundamental characteristic to consider when designing shelter.

House can be described as the "physical objective environment" whilst home is understood in terms of "subjective psychosocial" activities.

Newmark and Thompson[29] explains that "[h]ouses become homes when we use shelter and share in its space with a group of intimates in a special meaningful way".

The company logo of the Habitat stores so clearly and simply communicates the complexities of home. The icon made up of a single line marries the separate impressions of house and home as a united and interlinked entity.

One very important activity of dwelling is that of arrangement. Kronenburg[30] explains that "we rearrange the objects and possessions we carry around to establish our personal sense of place". Arrangement helps us organise our surroundings in a familiar way.

The Afrikaans word for this is 'nesskop' which translates into nesting, i.e. establishing a place of safety, comfort and familiarity. Nesting is an important intangible quality not usually taken into account when designing temporary structures.

Norberg-Schulz[31] regards the house as the center of personal life. "In general, the center represents what is known, in contrast to the unknown and perhaps frightening world around. It is the point where man acquires position in space as psychic being, the point where he 'lingers' and 'lives' in space". [check quote]

Finding a sense of place after a disaster is an important step in recovering one of the many intangible losses experienced by displaced individuals.

3.7 INTERIOR ATMOSPHERES AND AESTHETICS

Can one ever truly account for the requirements for survival through only quantifiable physical elements? The hypothesis of this study argues that one cannot.

It often happens that the self-determination and morale of the complex human psyche surpasses all rationality in the goal to survive. It is with this quality that the interior atmosphere of the proposal hopes to connect.

Visually stimulating designs ease anxiety and help us to 'embrace our fears'. A similar theme appeared in design during the nineteenth century, where new and foreign technologies were masked behind elaborate ornamentation. Wosk explains that "Industrial steam engines designed as classical temples evoked an aura of calm in an era of rapid technological change".[32]

Wosk[33] questions the 'provocative' role of aesthetics in designing for disasters. At what point does visual appeal trivialize the austere realities of safety and survival?

Humanitarian design can be both beautiful and functional as long as it adheres to the hierarchy of design. This hierarchy is ranked from the lowest to the highest, beginning with functionality and ending with creativity. Unless lower-level requirements are met, a design rarely succeeds in achieving the desired aesthetics without becoming superficial and frivolous.

This is in essence the dilemma of designing for disaster relief. The process is tediously subjected to the severe reality of economy and efficiency before any other needs can be addressed. Designers have to employ innovative and low-cost tactics to portray beauty and elegance in objects and environments intended to ease some of life's most pressing conditions.

John Maeda[34], founder of the Simplicity Consortium at the MIT Media Lab, writes about the laws of simplicity that "more emotions are[sic] better than less". He uses the example of the ipod as the nexus of minimalism and function. The appearance of the ultra sleek ipod instigated a multitude of accessories for one to personalise and 'attach emotion to'. Even the invention of the smiley face ;-) exemplifies the human need for better emotional expression.

'Tactics' for designing with emotion:

Philipe Starck[35] interprets design as the poetry of humanity's story of existence. He tries to design objects that 'profit' the end user and not the manufacturer by imagining the society, the person, the part of that persons's body that will use or experience the product. In doing so the product becomes a part of that persons story, revealing the poetry of everyday life.

Starck maintains that "Humour is the most beautiful symptom of human intelligence". He finds meaning in objects that display intelligence, poetry and humour. Design cannot change someone's life but it does influence it.

Surface plays an important role in the acceptance of new materials. Cardboard in architecture can be seen as being the new technology (or rather new application of old technology) within the contemporary built environment.

Marcel Wanders recalls a time when he came up with over 30 words to describe ornament and decoration just because he was afraid of being perceived as frivolous.

Any of the affiliated designers under the Droog Design umbrella display a similar ethos in everyday objects using low-cost, industrial, or recycled materials.

29 Newmark & Thompson (1977:2)
30 Kronenburg (2002a:20)
31 Norberg-Schulz (1985:13)

32 Wosk (2007:96)
33 Wosk (2007:93)

34 Maeda (2006:63)
35 Starck (1996:522)
36 Fraser (2002:[n.p])

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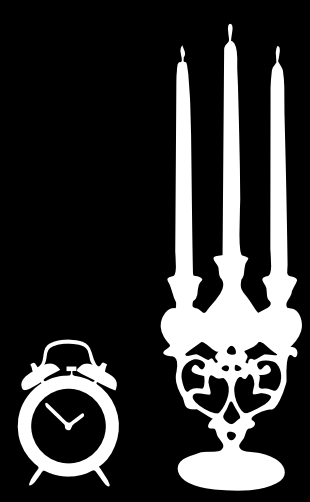
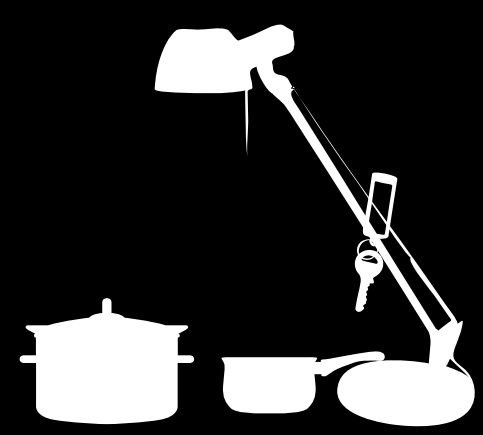
“It is very important that even though a building may only be for temporary use, it has to be pleasing to the eye - something of beauty.

A person has to be able to feel that this is my home.”

: Shigeru Ban[36]





04 | FRAMEWORK

The project is established within a legislative framework which enables the research proposal to develop in alignment with the objectives of the National Disaster Management Policy.

This chapter provides a brief overview of the broader framework of which disaster response and recovery form a part. The study aims to provide an understanding of the Tshwane Disaster Management Plan, as well as of how disasters are mitigated, who is involved, and what national guidelines are proposed.

It outlines the phases of recovery and several proposed displacement options.

By analysing international shelter standards, local building regulations, and current commercial cardboard shelters, a comparative study was undertaken to establish a possible South African derivative.

This study would ultimately establish criteria against which the proposal can be measured.

4.1 LEGISLATION

In South Africa the procedures involved in Disaster Management are governed by the Disaster Management Act No.52 of 2002. The Act stipulates that every municipality is responsible for drafting its own Disaster Management Plan in accordance with the National Policy Framework for Disaster Risk Management of 2005.

4.1.1 POLICY FRAMEWORK FOR DISASTER RISK MANAGEMENT

Disaster Risk Management[1] is defined as:

> ...integrated multisectoral and multidisciplinary administrative, organisational and planning processes and capacities aimed at lessening the impacts of natural hazards and related environmental, technological and biological disasters.2

The primary objectives outlined by the policy framework are to develop and implement the following: an integrated institutional capacity for disaster risk management; disaster risk assessment; disaster risk reduction; response and recovery; information management and communication; and education, training, public awareness and research [Table 02].

Coherent development is essential. These objectives are therefore evaluated and structured on three levels: municipal, provincial and national.

In cases where the scale of the disaster exceeds the capacity of an existing contingency plan, other actors may become involved to mitigate the situation [Table 01].

During reconstruction and rehabilitation the organ of state tasked with the primary responsibility for a known hazard must facilitate the establishment of project teams for this purpose. For example, the Department of Housing is responsible for shelter and approved collective centres, and the Department of Water Affairs and Forestry would take responsibility for road and infrastructure repairs in the case of flooding.

1 Term used interchangeably with 'disaster management' as stipulated in the Disaster Management Act, but preferred because it is more consistent with the use of the term internationally.

2 Disaster Management Act (No. 52 of 2002)

Table 04 Roles and responsibilities according to the Tshwane Disaster Management Plan

The procedures involved in disaster management is governed by the Disaster Management Act No. 52 of 2002 and stipulates the various parties are involved as follow.	
Hierarchy according to disaster scale and classification:	Actors involved during various stages:
Local Municipality [as part of Integrated Development Plan]	Tshwane Municipality [Department of Protection Services]
District	District Municipality
Provincial	Provincial Government
National	National Government
	South African National Defense Force [SANDF]
Non Governement Organisations [NGO's]	Red Cross Society [SARCS]
	St Johns
	Greater Good Foundations
	United Nations High Commission for Refugees [UNHCR]

Table 05 Key Performance Areas as indicated by National Policy Framework for Disaster Risk Management of 2005

INTEGRATED INSTITUTIONAL CAPACITY FOR DISASTER RISK MANAGEMENT
DISASTER RISK ASSESSMENT
DISASTER RISK REDUCTION
RESPONSE AND RECOVERY
INFORMATION MANAGEMENT AND COMMUNICATION
EDUCATION, TRAINING, PUBLIC AWARENESS AND RESEARCH
FUNDING ARRANGEMENTS FOR DISASTER RISK MANAGEMENT

4.1.2 KEY PERFORMANCE AREAS

Outlined in the framework policy are the key areas where development is encouraged. The aims and objectives of the thesis align with the objectives of the response and recovery component of the policy:

- **Relief Measures:**[3]

  [Key Performance Area 4, Section 4.4]

  The regulation of relief measures initiating the development of regulations to standardise the practice of relief operations in keeping with international standards.

- **Education, Training, Public Awareness And Research:**[4]

  [Key Performance Area 6, Section 6.5 and 6.6]

  Encourages research into the process of auditing existing research initiatives, in order to gain an understanding of DRM processes, and to provide insight into effective disaster risk reduction strategies and measures.

3 Department of Provincial and Local Government (2007:128)
4 Department of Provincial and Local Government (2005:175)

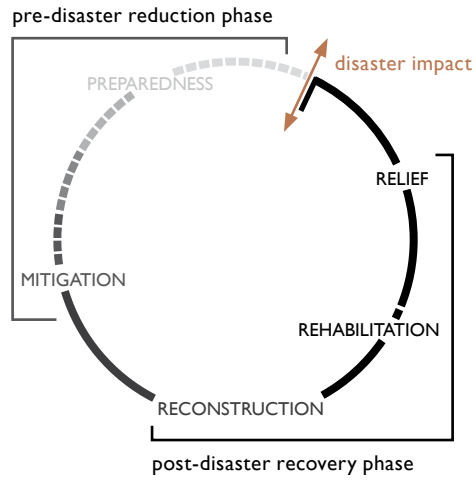


Figure 08 Disaster continuum : Kesten (2004:18) [redrawn by author]

4.1.3 DISASTER MANAGEMENT PLAN

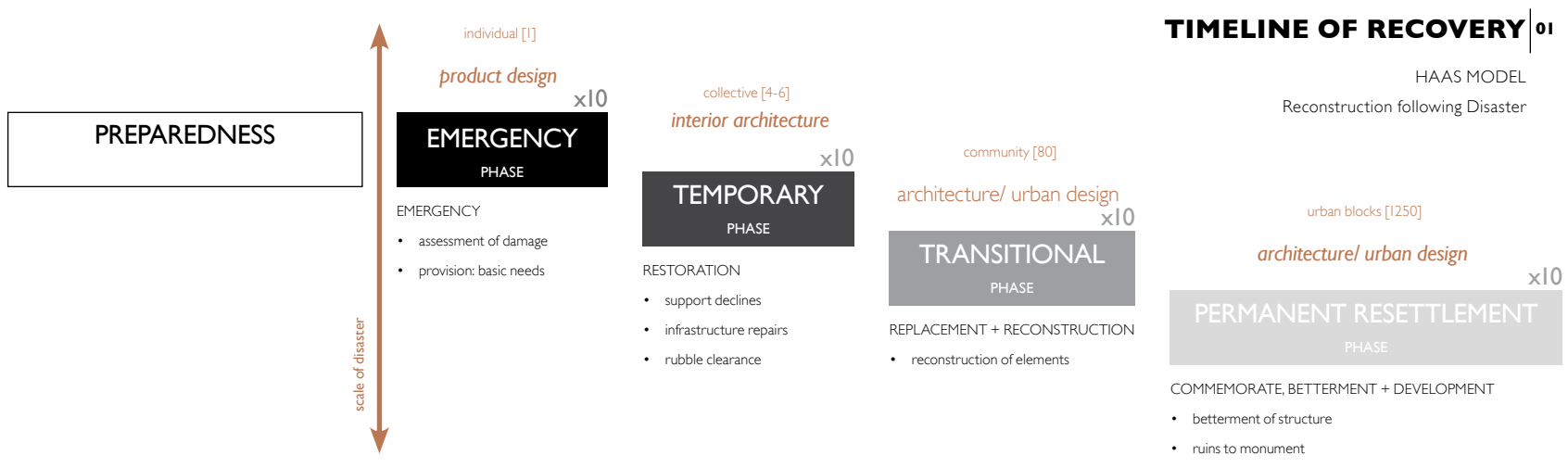
The Metropolitan Municipality of Tshwane is responsible for drafting a Disaster Management Plan as part of the city's Integrated Development Plan [IDP]. Such a plan is administered by the Department of Disaster Risk Management [DDRM] which falls under the Department of Protection Services.

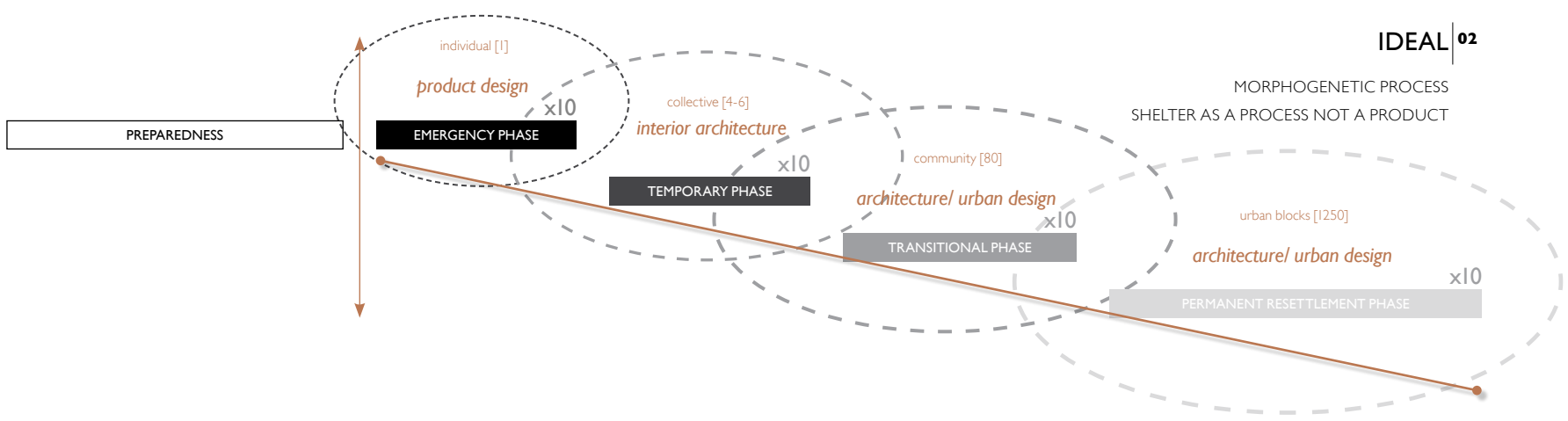
Figure 06 illustartes disaster management as a continuum consisting of pre-disaster reduction [preparedness] and post disaster recovery strategies.

The primary objectives of the plan is:[5]

- Preventing and reducing risk and vulnerability;
- Mitigating disaster severity;
- Ensuring preparedness;
- Promoting rapid and effective responses;
- Ensuring the provision of relief;
- Implementing rehabilitation and reconstruction measures consistently ensuring a developmental focus.

5 City of Tshwane Metropolitan Municipality (2005:588)





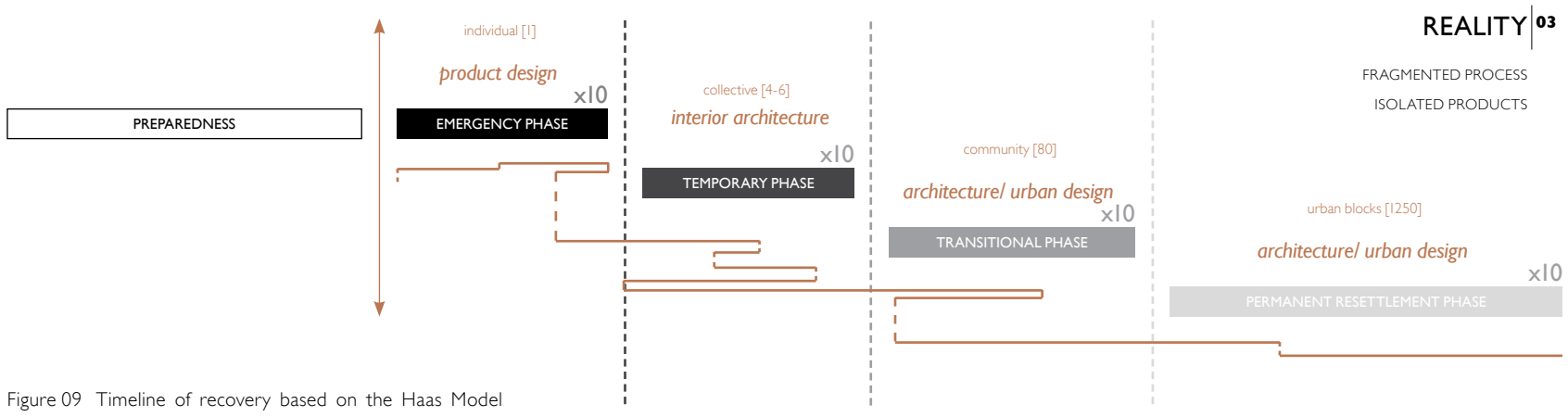


Figure 09 Timeline of recovery based on the Haas Model
: Sadler (2004:20) [adapted and redrawn by author]

4.2 TIME LINE OF RECOVERY

4.2.1 TERMINOLOGY

Clarification of relevant terminology for the purposes of the discussion:

- **Preparedness:**[6]

"Means to ensure in times of disaster appropriate systems, procedures and resources are in place to assist those affected by the disaster and enable them to help themselves."

(UNDP: Overview of Disaster Management: 1992)

- **Response:**[7]

"...in relation to disaster, means measures taken during or immediately after a disaster in order to bring relief to people and communities affected by the disaster"

- **Recovery**:

"Refers to those actions after a disaster, which attempts to bring order to the disaster site and aids in bringing the situation back to normality."

(UNDP: Overview of Disaster Management: 1992)

- **Reconstruction**:

"Are the actions taken to re-establish a community after a period of rehabilitation subsequent to a disaster. "

(UNDP: Overview of Disaster Management: 1992)

- **Mitigation:**[8]

"...means measures aimed at reducing the impact or effects of a disaster"

6 Kesten (2004:xi-xii)
7 Disaster Management Act (2002:10)
8 Disaster Management Act (2002:8)

4.2.2 RECOVERY PHASES

Response and recovery operations comprise various phases. Based on the Haas[9] Model, they are identified as follows:

a.) EMERGENCY RELIEF PHASE

b.) TEMPORARY PHASE

c.) TRANSITIONAL PHASE

d.) PERMANENT PHASE

The scale and magnitude of the disaster would determine the need and duration of any or all of the above mentioned phases. However it is suggested postulated that each phase lasts roughly 10 times as long as the preceding phase.

Figure 07 illustrates the ideal situation where each of the various phases become integrated into a morphogenetic process with re-usable elements that can adapt to benefit the phases that follows.

Davis[10] stresses that it is vital not to design in isolation; "It is important to emphasize at the outset that shelter must be considered as **a process, not as an object**."

In reality the recovery process consists of a fragmented and isolated series of products and interventions.

The hypothesis encourages designers to stop viewing shelter as only a temporary solution, but to rather see it as a starter kit with the potential of becoming a home.

The emphasis of the project falls on filling the gap between short-term relief provided in an emergency phase and the time frame left over until [or whilst] reconstruction is taking place.

The thesis therefore investigates an appropriate response for the temporary phase (period of grace)..

The temporary phase represents the crossover between the emergency relief phase (which can last anything from a couple of hours to a few days) and the transitional phase.

9 Sadler (2004:20)
10 Davis (1978:33)

Because temporary solutions are designed before knowing the scale of the damages it needs to mitigate, it is required to have the greatest amount of flexibility. The shelter has to be used within the emergency phase if for any reason relief efforts would require. It should be able to sustain the relocation option ,if required, for an acceptable amount of time within the function of providing a period of grace.

4.2.3 The proposed solution should be able to be used in various situations to mitigate a variety of damages. It should be flexible enough to be used independently with the potential to morph into a new dwelling when more resources become available.

4.2.4 HOUSING DAMAGE

Figure 10 shows the five categories of damage[11] to housing and the respective modes of action.

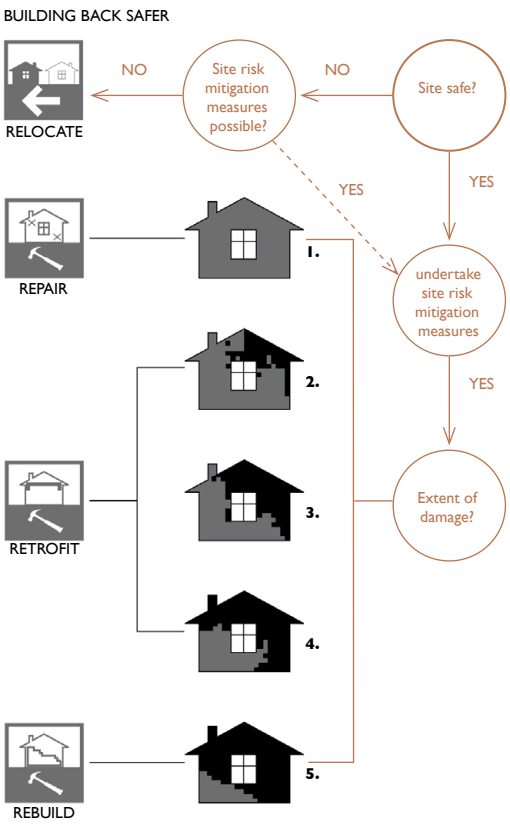


Figure 10 Categories of housing damage : United Nations (2008:142) [redrawn by author]

11 United Nations (2008:142) [field edition]

4.3 STAGES OF DISPLACEMENT

Displacement due to disaster should be avoided whenever possible. It prolongs the emergency and temporary phases, hindering reconstruction initiatives and self-sufficiency.

In cases where displacement becomes unavoidable, the United Nations[12] transitional settlement and reconstruction principles suggest six main displacement options. These alternatives are briefly discussed, ranging from micro-displacement options to the last resort.

Examples of the types of disaster victims as well as recent refugee related displacements are included to illustrate the application of such options in the local context.

4.3.1 HOST FAMILIES:

+ Integration with the surrounding community remains the best option for sudden settlement needs in the case of micro-displacement. Displaced persons filter into the existing infrastructure and services, and they benefit from having a local support network and being able to remain close to family and friends.

- The weakness of this option is that it becomes difficult for government and aid organisations to reach a dispersed community in need, which may still be far from the necessary medical services and other aid. Given that some areas have already fragile public services, the durability of such a solution becomes dependent on how long the extra load can be sustained by the surrounding community.

4.3.2 COLLECTIVE CENTRES:

+ Collective centres[13] [such as community halls] are a good option for immediate shelter needs as they can be pre-identified and can therefore be better equipped for such situations. The affected community is easily identified and much needed services can be homogeneously distributed.

- This option is not as durable as that of host families. In principle such centres should operate for a short time. Prolonging the duration of this type of solution increases the risk of creating dependency relationships, as the community is isolated from its social support network.

- There is also the probability of overcrowding and the unfamiliar communal setting may not be compatible with the local culture. Lack of privacy and other environmental stress factors aggravate the situation.

4.3.3 RURAL SELF-SETTLEMENT

+ Rural self-settlement has similar benefits to those of host families: integration, support, and encouragement of livelihoods to develop.

- There is a big risk involved in disrupting the livelihood patterns, land-use patterns and natural resource management[14] processes of the surrounding area. Dispersed communities, as in the case of the host family option, are difficult to access.

- It is also of concern that once people settle in an area it becomes very difficult to relocate them to more appropriate locations. In such events evictions should be avoided or arrangements made beforehand for alternative accommodation.

4.3.4 URBAN SELF-SETTLEMENT

+ It is always beneficial if displaced communities are able to remain in environments they are accustomed to. Independence is encouraged, and close proximity to services and work is a positive factor. If an urban community becomes displaced the familiar environment of urban self-settlement provides stability.

- Ownership rights may become a problem. It is also difficult to upgrade a settlement once a community becomes dispersed.

As is the case with rural self-settlement, it is very difficult to relocate people once they have settled in.

4.3.5 SELF-SETTLED CAMPS

+ This option increases the potential for self-sufficiency and self-determination. Shelter is arranged according to the existing social construct, although potential hazards inherent in the construction methods and materials used can cause disaster to happen again.

- As the land in this instance is not provided and approved by the government there is the risk of harassment and exploitation by the owner. Concentrated volumes of people in extreme poverty breed competition and violent outbreaks over food, work and other limited resources can occur.

4.3.6 PLANNED SHELTER CAMPS

+ Government-allocated sites for planned camps can be provided rent free. Under these circumstances it would be much easier to evaluate the needs of the affected population and distribute relief supplies accordingly.

+ Camp layouts affect successful occupation and the general wellbeing of the inhabitants. Attention should be given to circulation, permeability, clustering of family units, and localized cooking and sanitary areas at safe distances to prevent the spread of fire and disease.

- Unless diligently run, such camps should remain the last resort. Sites have to be pre-defined and prepared to absorb the excessive strain on services. If the camps are located far from transport and other services, livelihoods are difficult to maintain and dependency relationships are created that cripple self sufficiency and undermine the desire to reconstruct former dwellings.

12 United Nations (2008:92-108) [field edition]
13 At the time the study was conducted listings of pre-identified locations could not be made available for security purposes due to the recent xenophobic attacks. It could however be said that all community halls are reserved for this purpose but that schools are not. Public property such as churches, gymnasiums and sport stadiums reserve the right to open their doors at their discretion.

14 United Nations (2008:98)

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Photo by Dennis Farrell

Central Methodist

Figure 14 Collective Centres : Farrell (2008:16of24]). The image is an example of what happens when collective centres such as community halls and churches are used for longer than its capacity allows for.

Photo by Daniel Born

Kruger Park Flats

Figure 13 Fire at Kruger Park flats : Born (2008:[1of1]). Urban Self-settlement: It is unclear how many residents very legally occupying the building but severe negligence by the owner of the property allowed the building to deteriorate into such a state that it became unsafe to occupy.

During the July eviction of residents of the Kruger Park flats a fire was alledgedly started by angry residents. The disaster took the lives of 6 people tried to escape the fire by jumping from their balconies to escape the fire. No alternative living accommodation option were made available to the former residents.

New Europa House

Figure 12 Housing development in Hillbrow : Madulamoho Housing Association (2007:2). They offer a variety of residential units ranging from emergency accommodation [available for 72 hours], transitional accommodation [available for 18 months], communal units and bachelor units for longer term rental. This is a good example of safe and financially viable urban resettlement.

Photo by Philani

Planned Camp

Figure 15 A temporary refugee camp created for the victims of xenophobia - Johannesburg (2009) : Philani (2009:[1of1]) Planned Camps: Klerksoord Shelter Camp went from being a planned camp much like in the image of a temporary shelter camps in Johannesburg, to a version of a self settlement.

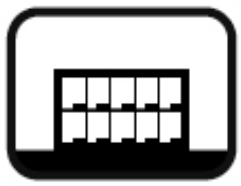
Photo by Halden Krog

Klerksoord Camp

Figure 11 Woman searching for anything to salvage : Krog (2009:[16of17]) Residents were forcefully removed after they refused to be relocated after government officially closed the camp and withdrew all support.

HOST FAMILIES

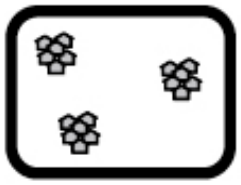
COLLECTIVE CENTERS



RURAL SELF-SETTLEMENT

URBAN SELF-SETTLEMENT

SELF-SETTLED CAMPS



PLANNED CAMPS

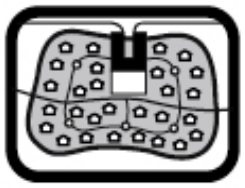


Figure 16 Six transitional reconstruction options : United Nations (2008:110)

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4.4 COMPARATIVE STUDY

One of the objectives of the National Disaster Management Framework is to conduct research into the shortcomings not yet addressed by legislation. A comparative study was undertaken to collate [where possible] South African Building Regulations with International Shelter Standards to establish how shelter differs from building. The data was also compared to current practice [the light-weight emergency tent] and two precedent studies of cardboard shelters that are currently available commercially.

The resulting differential would assist in establishing a possible South African derivative. This will be used both to establish the program and as a reference in the following chapters, in order to explore and justify why standards where adopted or found irrelevant.

SOUTH AFRICAN NATIONAL BUILDING REGULATIONS	INTERNATIONAL SHELTER STANDARDS	
A 23 TEMPORARY BUILDINGS Local authorities may grant provisional approval for the erection of a temporary building subject to the fulfilment of the following sub regulations and provisions: 2. a). statement of proposed duration b.) site plan c.) layout drawings showing general size, form, materials and use. 3. may be provisionally approved to be determined at later 4. if public has access to such building applications should has a certificate signed by a professional engineer or other approved competent person to indicate if structural system is satisfactory.	The Preliminary Draft for Shelter Standards* - January 2008, is the most current international standards proposed by the Shelter Standards Consortium for the provision of transitional family shelter. The consortium aims to provide donor governments and implementing humanitarian organizations with a set of accepted standards to facilitate and coordinate international relief efforts. The Preliminary draft is currently open for comment by the manufacturing community. * Shelter Centre (2008)	
N/A	4.1.1 COST	
CLASS OF OCCUPANCY OR BUILDING H3 - Domestic Residence: two or more dwelling units on a single site H4 - Dwelling House: a single dwelling unit on its own site	4.1.2 TOTAL WEIGHT + PACKAGE SIZE *Complete shelter package mass* *Complete shelter package volume* *Longest dimension of packed shelter* NOTES: • *The total shelter shall be in one package which contains smaller packages broken down into parcels of weights suitable for transport by two people*	
N/A	4.1.3 STORAGE *Shelf life:* *STORAGE: 120 x 80 cm Euro pallet: PACKED:* *STACKED:*	
N/A	4.1.4 MARKING *Shelters shall have space to mark:* NOTES: • *Markings to indicate if shelter is mosquito proof* • *Exterior material shall make allowance to print the humanitarian organisation/donor logo on the outer fly and door of the shelter*	
N/A	4.1.5 AVAILABILITY NOTES: • *The shelter shall be easy to obtain from different manufacturers under competitive bidding* • *The shelter shall be capable of being produced fast enough to respond suitably to a humanitarian crisis*	

	The following members of the consortium have agreed with the preliminary standards; CARE International Oxfam GB, [DFID], [SDC/HA] [IFRC], [UNHCR], [JICA], [UN/OCHA], [MSF-B] Nederlands Red Cross.
	40 - 80 kgs 0.3 m3 - 0.5m3 > 2 000 mm
	5 years fit at least 4 YES
	1. which particular design it is 2. size of usable area 3. how many people it can accommodate 4. means of transport 5. time + conditions of storage 6. name/trademark of manufacturer 7. date of manufacture Instruction Language: English, French, and other appropriate language

Figure 17 Light Weight Emergency tent : Architecture for Humanity (2006:62)

Figure 18 6sqm Meter Shelter : Global Village Shelters Llc. (n.d.)

Figure 19 Octagonal shelter : Sago Mokazai (2009)

UN LIGHT WEIGHT Emergency Tent	GLOBAL VILLAGE 6sqm SHELTER	OCTAGONAL SHELTER
LOCATION: Universal application for warm/ tropical climates DATE: 2005 USER: Refugees / displaced persons DISASTER: Political and temporary shelter in the case of natural disasters MANUFACTURER: Made all over the world but not South Africa. DESCRIPTION: tents to house refugees	LOCATION: Grenada DATE: 1995-2005 USER: Displaced residents of Grenada DISASTER: Hurricane DESIGN FIRM: Ferarra Design, Inc. MANUFACTURER: Global Village Shelters LLC DESCRIPTION: More than a 100 different experimental forms were designed before finding the right method for this design.	LOCATION: Japan DATE: 2008 USER: Displaced residents of Grenada DISASTER: Earthquakes DESIGN FIRM: Sago Mokuzai MANUFACTURER: Sago Mokuzai
$ 80	**$ 500**	**$ 1350 (150 000 yen)**
41.5 kgs 1 part	**77 kgs** 3 parts	**82 kgs** 1660 mm 2 parts
YES NO: STOCKPILED	NO YES	NO YES

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PHYSICAL REQUIREMENTS
4.1.6 INTEGRITY

The erected shelter wind speed with all doors and windows closed
snow load
cover minimum water column
ground sheet minimum water column

NOTES:
- *The structure shall have sufficient redundancy so that if the covering or one fixing fails, the shelter will remain upright*
- *In warm, humid climates: reasonable roof slope for rain water drainage*
- *Provision to trench the sod cloths into the ground to increase the stability of the shelter*

4.1.7 DURABILITY

From moment of deployment structure shall last for:
covering and liner shall last for a minimum of:
The shelter shall withstand temperatures between:
minimum resistance to natural sunlight.:
the breaking strength and the resistance to penetration by rain:

NOTES:
- *Inner fabrics shall have a minimum breaking strength of 30 daN for warp and weft when tested in accordance with ISO 13934-1 or ISO 1421*

4.1.8 USABLE AREA

The shelter shall be large enough for a family of five and have between 3.5m² and 4.5m² of covered living area.
The standing height:

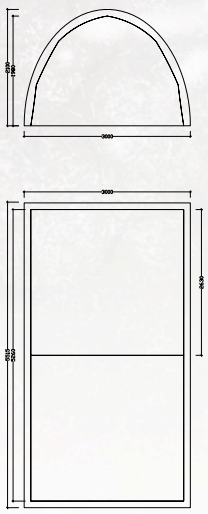
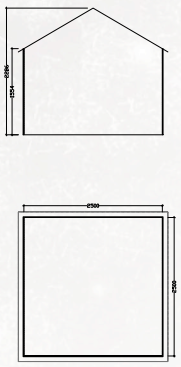
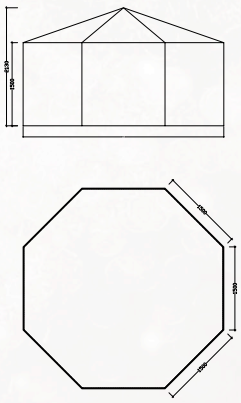
NOTES:
- *The design shall allow for the introduction of fuel burning stoves, including a fireproof and waterproof flue manifold*
- *It shall be possible to insulate the floor, walls and roof of the shelter*
- *Provision will be made for semi-enclosed and shaded cooking areas and provision for fixed minimum ventilation of the interior, to reduce cases of Acute Respiratory Infections (ARIs)*
- *Storage pockets shall be integrated into the inner liner of the shelter*
- *There shall be no guy ropes, or other trip hazards around the shelter*

DESIGN POPULATION
Hotel [H1] and Domestic Residence [H3]- 2 persons per bedroom
Dormetory [H2] - 1 person per 5 sqm

ROOM AREA
Any habitable room other than a kitchen, scullery or laundry shall consist of a minimum 6sqm with no linear dimention less that 2m. Excluding the area covered by a built in cupboard/cabinet.

ROOM HEIGHT
bedroom: 2.4m for a floor area of 6sqm with a clear head height of 1.8m at any point more than .75m from the edge of the floor space.
other habitable rooms: 2.4m over 70% of floor area with not less than 2.1m over the remaining area

FLOOR AREA
The floor area of any temporary dwelling house shall not be less than 15sqm or 30sqm in the case of any permanent building.

				
	18m/s in any direction 1,500 N/m² 1500mm 1500mm			
	36 MONTHS 18 MONTHS -30 °C to +55 °C ISO 4892-2 >30% below the minimum value applicable to the shelter	**18 MONTHS**	**18 MONTHS**	**6 MONTHS**
	covered space shall be a minimum of 1.8m over at least 60% of the covered floor area	**16.5 sqm** 4-5 persons required to have a standing height of at least 1.8m over 33% of covered area. 120 mm diameter chimney outlet [apron] only floor canopy: 1000mm x 1500mm **NO** ropes necessary 	**6.25 sqm** 2-3 persons option available **YES** no canopy no ropes 	**10.83 sqm** 5 persons [Culturally accepted] **NO** **YES** no canopy ropes but no trip hazard 

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	4.1.9 VENTILATION *Minimum ventilation shall be achieved through* *maximum air changes per hour* *minimum air changes per hour* NOTES: • *Ceiling to provide an adjustable air gap for insulation and ventilation* • *All doors and openings shall be adjustable to control light, heat gain or loss* • *In hot, dry climates the shelter should have a double skinned roof with ventilation between the layers to reduce radiant heat gain. The distance between the layers should be a minimum of 100mm* • *In warm, humid climates the shelter design shall maximise air flow.* • *In cold climates, air flow through the shelter shall be kept to a minimum, while also providing adequate ventilation for space heaters, or cooking stoves.* • *In cold climates, the shelter shall have internal compartments in order to minimise heat loss through infiltration.*	
	4.1.10 FIRE SAFETY *Fire Rating:* NOTES: • *The shelter shall have two opposite doors to facilitate escape in the event of fire* • *It shall be possible to exit the shelter within 30 seconds when all doors are fully closed* • *The shelter shall not ignite when tested in accordance with ISO 6940 and exposed to a test flame for 10 seconds, in the new condition and also after artificial weathering in accordance with ISO 4892-2*	
	4.1.11 VECTOR CONTROL *All doors and openings shall be protected against insects such as:* NOTES: • *The shelter shall have a 10cm vertical edge around the base of entry points in order to impede the entry of insects* • *The shelter must be mosquito proofed in an area long and broad enough for the intended occupancy to sleep in* • *There shall be fixings for additional or replacement mosquito nets to be hung*	
N/A	**4.1.12 ENVIRONMENTAL TOXICITY:** NOTES: • *Shelters shall not involve materials that are toxic to humans, even when cut or modified for later re-use* • *The environmental impact resulting from the manufacturing or disposal of shelters shall be minimised* • *Shelters shall not involve materials that are toxic, by burning or burying, and shall not pollute the ground water table or enter the food chain*	
N/A	**4.1.13 COLOUR:** *Refrain from using:* NOTES: • *Not all colours have the same meaning to all people, care must be taken to ensure the colours used in shelters are culturally appropriate.* • *Cultural and political sensitivities shall be taken into account, for example in the use of colours used in national or factional flags.*	

				
	unobstructed aperture with a total area 0.01m² > 7 < 14	**YES** 120mm gap between skins **YES** **N/A** **N/A**		
	ISO 6940 and ISO 4892-2	CPAI - 84 1955 fabrics used in tents are rarely made fireproof as such coatings are expensive - they are however made fire retardant. 2 doors	1 door	1 door
	mosquitos, rats, flies, pests: snakes, scorpions + termites	fabric stabilized against decomposition WHO standards		
				NON TOXIC LOW EMBODIED ENERGY BIODEGRADE
	Military or camouflage colours (green and beige, and white in winter)	UN BLUE + WHITE	WHITE	RAW CARDBOARD

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N/A	4.1.14 PRIVACY: NOTES: • *It shall be possible to sub-divide the internal volume in order to increase visual privacy, whilst maintaining cross ventilation* • *A fully closed shelter shall allow sufficient light to enter without compromising privacy* • *At night, it shall be possible to use artificial lighting within the shelter without compromising privacy*	
N/A	4.1.15 BUILDABILITY: NOTES: • *It shall be possible for two untrained adults to assemble the shelter without expert supervision* • *The shelter shall be distributed complete, ready to put up, with all components included and all appropriate tools* • *Each shelter shall be accompanied by instructions for use with explanatory sketches or drawings, suitable for multi-cultural/multi-lingual use in a variety of climatic and physical contexts, including different topographies/ ground conditions.* • *In particular, these instructions shall ensure that erection and maintenance are well understood by an untrained adult. Shelters shall also be accompanied with instructions for the safe disposal of the components*	
N/A	4.1.16 ADAPTABILITY + REPAIR: NOTES: • *It shall be possible to connect the shelter to another of the same type to increase the covered area* • *The design shall facilitate the local adaptation of wall and roofing materials, such as mud brick side walls, local matting, or thatch* • *The frame shall be strong enough to take the weight of sheet roofing and of hanging family objects from it* • *The number of different types of components shall be kept to a minimum* • *The total number of components shall be kept to a minimum* • *Components shall be interchangeable where possible* • *Components shall be available globally, or appropriate materials, tools and skills should be available for their local manufacture and repair* • *Insulating materials shall be incorporated into the shelter when temperatures fall below a comfortable level* • *The design shall maximise the number of components and materials that can be maintained and repaired with nonspecialist skills and equipment* • *The shelter shall include a repair kit, with appropriate tools, spare components and material* • *The design shall maximise the number of component materials that are suitable for later re-use, upgrading, modification or reconstruction on return* • *Use of zippers and fixing methods such as proprietary clips and Velcro shall be minimised for use in functions that must be used frequently, such as doors and windows*	
N/A	4.1.17 SECURITY Lockable Unit	

			
	1 X INTERNAL PARTITION	**NO**	**NO**
	YES **YES** **YES** **YES**	2 PEOPLE: 20MINS **YES** **YES** **YES**	4 PEOPLE: 2 HRS **YES** **YES** **YES**
	NO **NO** ROOF NO OBJECTS YES **YES** **YES** **N/A** **YES**	**NO** **YES** UNDETERMINED **YES**	**NO** **YES** UNDETERMINED **NO**
	NO	**YES**	**NO**

05 | CONTEXT

Alexander defines context[1] as anything that has influence on the form-giving activity of design. He argues that if "...form is the solution to the problem, the context defines the problem." This chapter aims to identify the factors that can not be solved by universal solutions, and to obtain a set of constraints to inform the design of a temporary shelter. The goal is not to derive a site-specific solution but rather to make an embodied proposal contextually relevant to the greater Tshwane region that can also be applied to a matrix of scenarios.

5.1 CHAPTER OVERVIEW

One of the most encompassing interpretations of disaster is given by Philip O'Keefe[2] of the Disaster Research Unit at Bradford University, UK. In his opinion "disaster is the interface between a **natural or man-made hazard** and a **vulnerable condition**".[emphasis by author]

This chapter will discuss context on the basis of this definition. First the study will look at the types of natural phenomena prevalent in the greater Tshwane region, investigate the risks associated with different areas and the likeliness of unfortunate events recurring.

A further investigation of the local climate will help to determine the environmental conditions the proposed solution would have to withstand.

A brief overview of historic references looks at the development of traditional shelters and how they have evolved into more permanent dwellings due to the changes in climate.

The thesis also refers to the 'first' shelter camps in the history of South Africa and looks at situations where large quantities of shelter was required and the living conditions that stemmed from it.

The second part of this chapter investigates the myths and realities and the resulting needs that derive from the current response methods. It considers the factors which contribute to vulnerable conditions that create the circumstances for disaster to occur. These conditions are further examined through three case studies:

(a) Diepsloot, Johannesburg

(b) Klerksoord Shelter Camp, Akasia

(c) Soweto Flash Flood, Johannesburg

1 Alexander (1964:15)
2 Davis (1978:2)

94

FIRE: GRASS/ RUBBISH 10 879 HOUSE 1 684 VEHICLE 1 414 BUILDING 1 391 SHACK 1320 OUTBUILDING 646 LAMP POLE/ TRANSFORMER 375 ELECTRICAL 385

ACCIDENTS: VEHICLE 16 600 PEDESTRIAN 5492 MOTORBIKE / BICYCLE 1453 TAXI 1038 HEAVY VEHICLE 602 DEPARTMENT VEHICLE 425 BUS 134

DISASTERS: FLOODING 203 **AMBULANCE TRAUMA:** ASSAULT 152 **STANDBY:** SPECIAL SERVICES 1244
GAS LEAK: SPECIAL SERVICES 109 **SPILLAGE:** SPECIAL SERVICES 108

07

Figure 20 List of events that Emergency Services have responded to between 1994 & 2007 **:** Department of Disaster Management (2008:5)

5.2 NATURAL AND MAN-MADE DISASTER IN THE URBAN CONTEXT

5.2.1 LOCAL DISASTERS

According to the Tshwane Department of Disaster Risk Management, the greater Tshwane region is most vulnerable to the following natural hazards:

(a) Informal settlement fires

(b) Floods (urban)

(c) Severe weather events

(d) Veld fires

(e) Sinkholes

The most recent and biggest declared disaster in the region was the outbreak of xenophobic violence in 2008. It is classified as a political disaster and the rehabilitation of the displaced persons are ongoing.

The chapter will discuss the needs of xenophobia victims only when the characteristics of this type of event serves as an example of a worst-case scenario.

5.2.2 RISK PROFILE

Each ward within greater Tshwane is analysed and assigned with a risk profile. These risk profiles provide an overview of potential disasters in each area.

Every ward profile includes an analysis of historical events based on information gleaned from sources such as Weather SA and GIS based probability analyses, and vulnerability based on socio-economic statistics such as employment, income, age and gender.

5.2.3 VULNERABLE CONDITIONS

McDonald[3] states that:

> Through the advances of the technological age, introduction and implementation of building codes and regulations man has attempted in preventing the effects of natural disasters in the built environment.

Yet it is through the same technology and science that the 'integral accident' is born. "For whatever is invented the inherent failure thereof is unconsciously invented simultaneously."[4]

Cities are the crux of this hidden landscape and accidents are unfortunate part of everyday life. Figure 21 represents the Tshwane Emergency Call Register. It indicates that fires and floods are the most prevalent types of disasters in the Tshwane region and that prevention strategies have not succeeded.

Disasters have an unforgiving influence on the built environment. The built environment must continually anticipate and adapt to prevent such tragedies.

3 McDonald (2003:1)
4 Virilio (2006:47)

Some of the main factors that contribute to the high flood and fire risks in Tshwane are:

(a) Inadequate storm water and flood management

Because the problems associated with a lack of proper storm water management[5] only present themselves when it rains, the development and upgrading of a comprehensive storm water drainage system has been neglected in Tshwane.

There is an immense need for storm water drainage master plan. Due to urban densification, outdated design criteria a large percentage of storm water drainage systems are under capacity.

(b) No master drainage plan

No integrated data on run-off peaks and volumes or digital flood lines along major watercourses were available for the CTMM area. This data is required for developing an integrated catchment management plan for both present and potential future development.

(c) No local storm water master plans

Except for the Klip-Kruisfontein area no storm water master plans exist in the northern region. The former Pretoria, Centurion and Akasia areas have local storm water master plans for most areas.

5 City of Tshwane Metropolitan Municipality (2006:86-87)

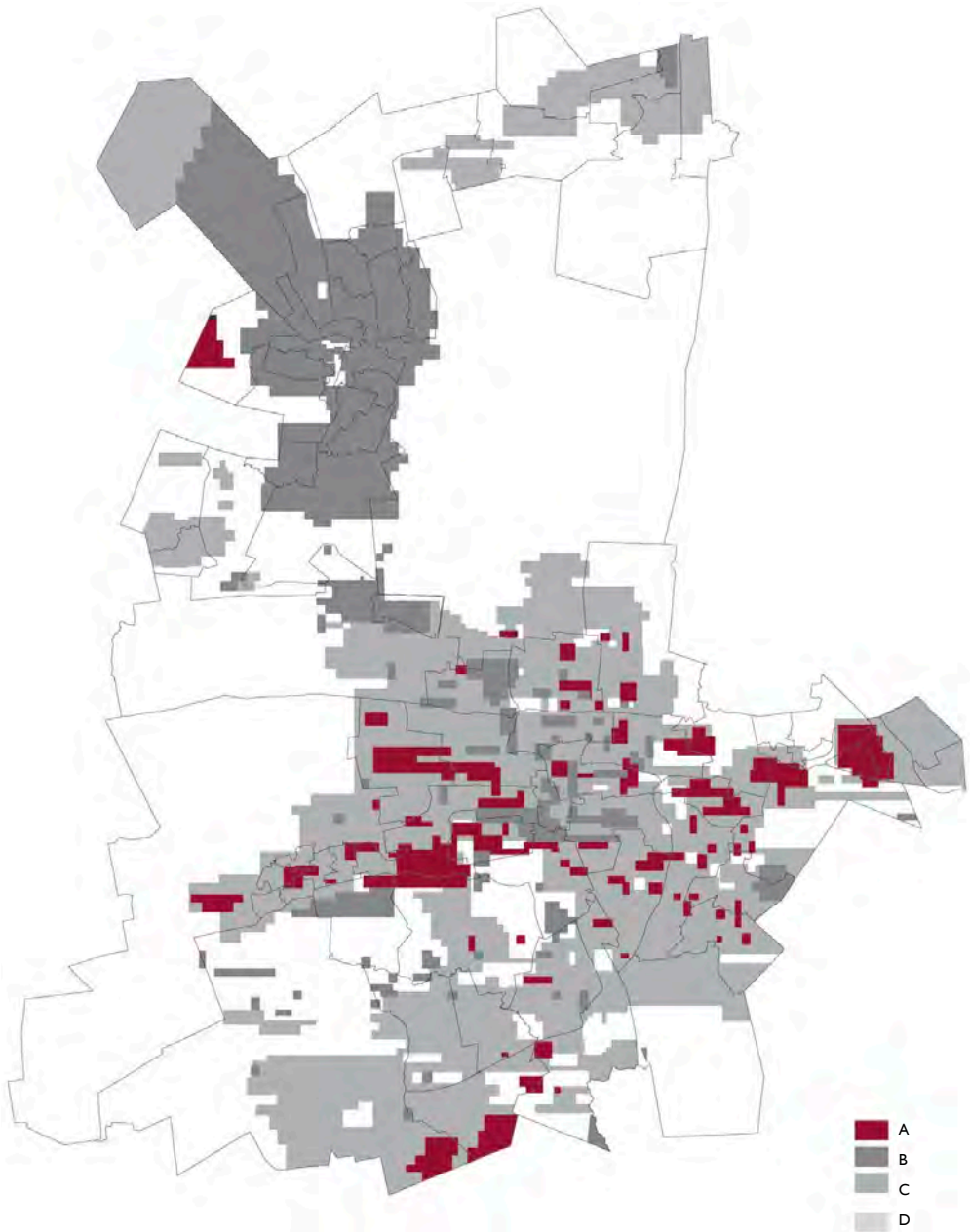


Figure 21 Map of fire risks according to classification : Tshwane Metropolitan Municipality (2006:113) [redrawn by author]

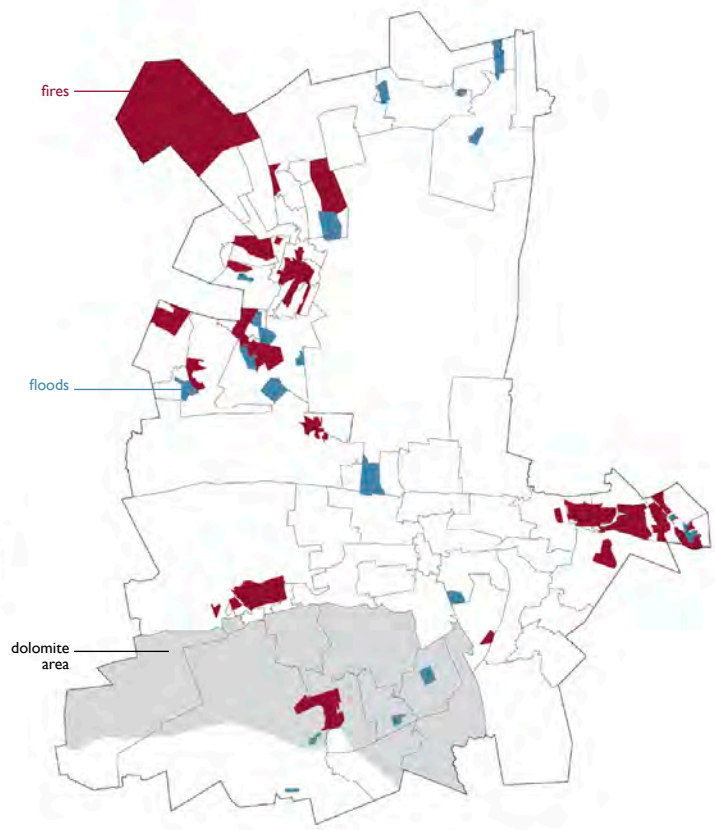


Figure 22 Map of Hazards in Tshwane for the year 2007/2008 : Department of Disaster management Services [compiled by author from various sources]

Table 06 Fire risk catagories : Tshwane Metropolitan Municipality (2006:111-112) [redrawn by author]

CLASS A HIGH RISK - URBAN	CLASS B MEDIUM RISK - URBAN	CLASS C LOW RISK – URBAN	CLASS D LOW RISK – RURAL	CLASS D1 HIGH RISK– INFORMAL	GRASS
Areas where the risk to life and property due to fire occurrence and spread is likely to be high. : Tshwane CBD, Sunnyside, etc.	Areas where the risk to life and property due to fire occurrence and spread is likely to be moderate. : Silverton	All structural hazards not included above, but excluding rural. Includes residential areas of conventional construction. : Fearie Glen, Moreleta Park, etc.	Primarily natural surroundings but also involves rural areas of limited buildings and remote from urban areas : Winterveld, Dwellings, Small, Holdings to thenorth	Predominantly densly informal housing –mostly non-brick structures. : Some areas within Mamelodi	Grass No dwelling, just grass land : Rietvlei Dam Nature Reserve **RESCUE** : Rescue Special risk class for areas with rescue sites Mine shafts, open dams, etc.

(d) Building near flood lines

Tshwane has almost 1100km of natural watercourses. Of these approximately 30% have 1-in-50 year flood lines data and 5% have 1-in-100 year flood lines data. The severe shortage in up to date flood line information results in building projects being approved in potentially hazardous areas.

Many RDP housing schemes and informal dwellings have been erected in high-risk flood areas. Ambitious building projects and unforeseen weather circumstances have accounted for the rise in the number of major incidents over recent years [Figure 25]. The often poor quality of these RDP houses is intrinsic to the damage caused, especially in the case of flash floods.

(e) shortage in bulk power supply

The analysis of the shortage in bulk power supply[6] in Tshwane shows a correlation between the income status of inhabitants and the choice of energy source used. Use of alternative energy sources over electricity is more prevalent in areas with lower incomes; this can be associated to the varying costs of each energy source.

Informal settlement fires occur because of accidents caused by paraffin or candles and the use of non-fire-resistant building materials. The close proximity of shacks rapidly increases the risk of fires spreading and difficult access to these dense areas makes it hard for fire engines to reach them in time. It is also unfortunate that some areas with high fire statistics, such as Mamelodi [Figure 24] do not have a local fire station and are dependant on the neighbouring Silverton branch.

5.3 CLIMATE

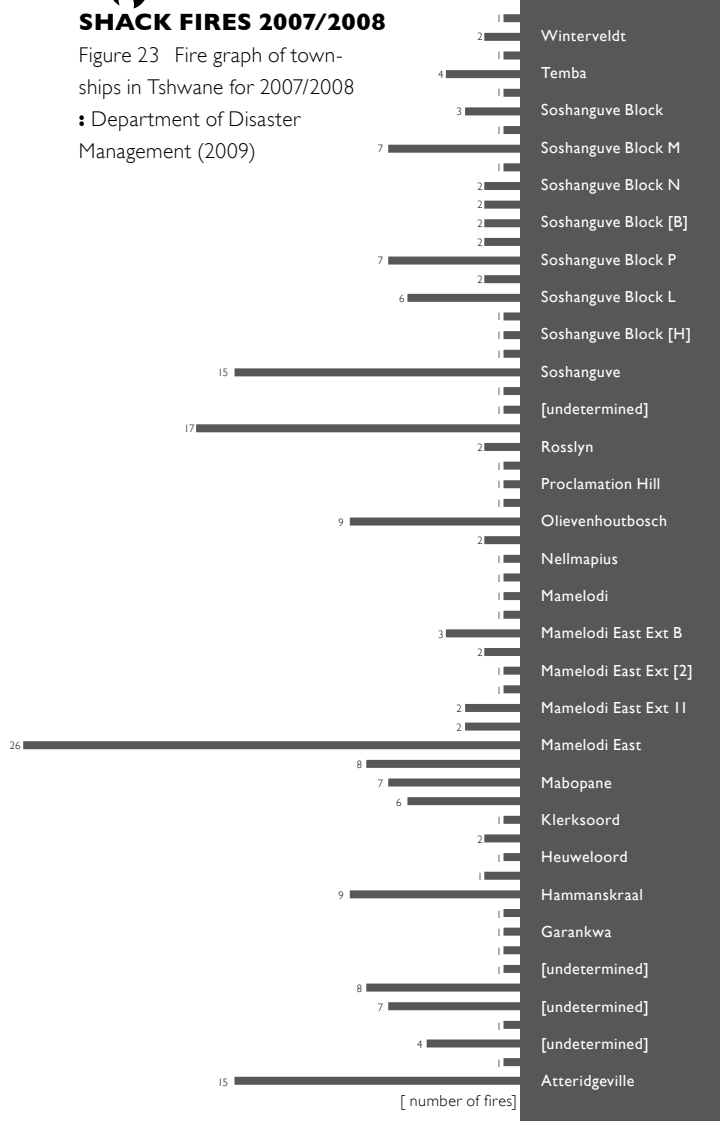
Figure 29 shows the likeliness of a particular weather condition appearing at least once a year. The results are rather unnerving when shown.

The climate of a place is determined by using the collective data from 30 years or more. Where possible the climate data from three weather stations in the Tshwane region is used for the analysis. It should be

6 Tshwane Metropolitan Municipality (2006:96)

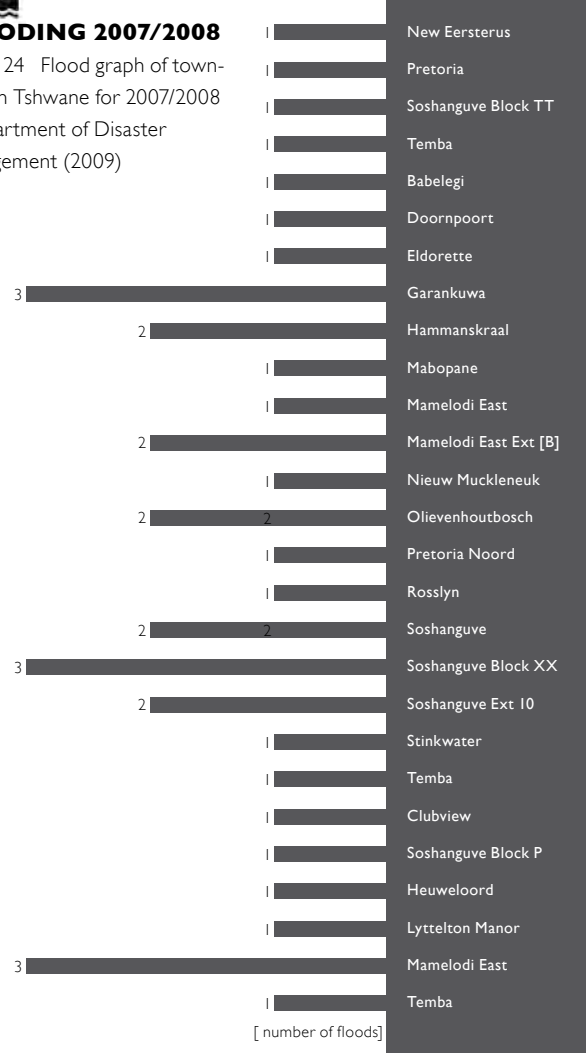
SHACK FIRES 2007/2008

Figure 23 Fire graph of townships in Tshwane for 2007/2008 : Department of Disaster Management (2009)



FLOODING 2007/2008

Figure 24 Flood graph of townships in Tshwane for 2007/2008 : Department of Disaster Management (2009)



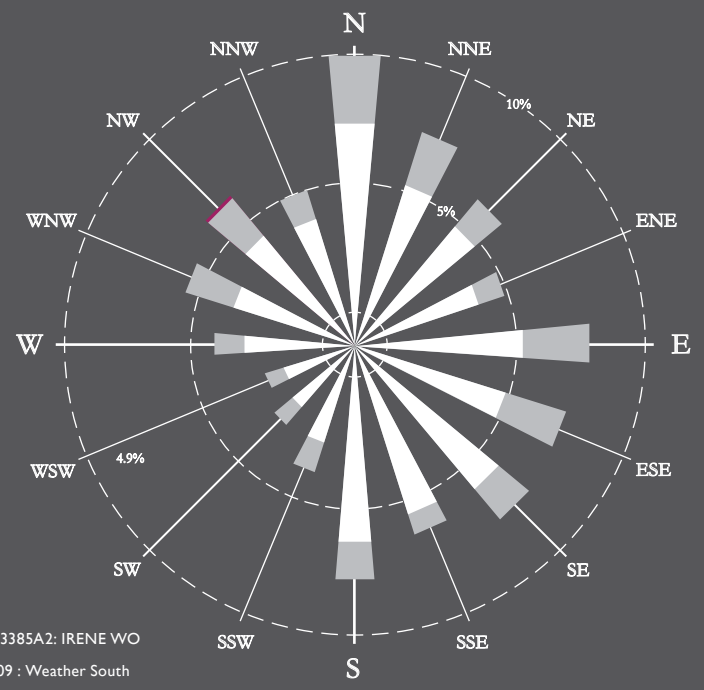


Figure 25 Irene wind rose - 0513385A2: IRENE WO YEAR AVERAGE PERIOD 1993 - 2009 : Weather South Africa (2009)

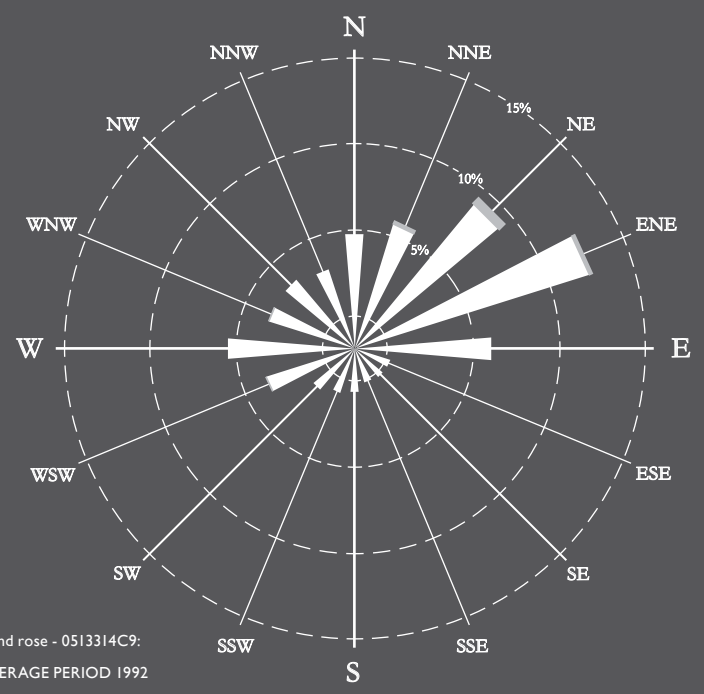
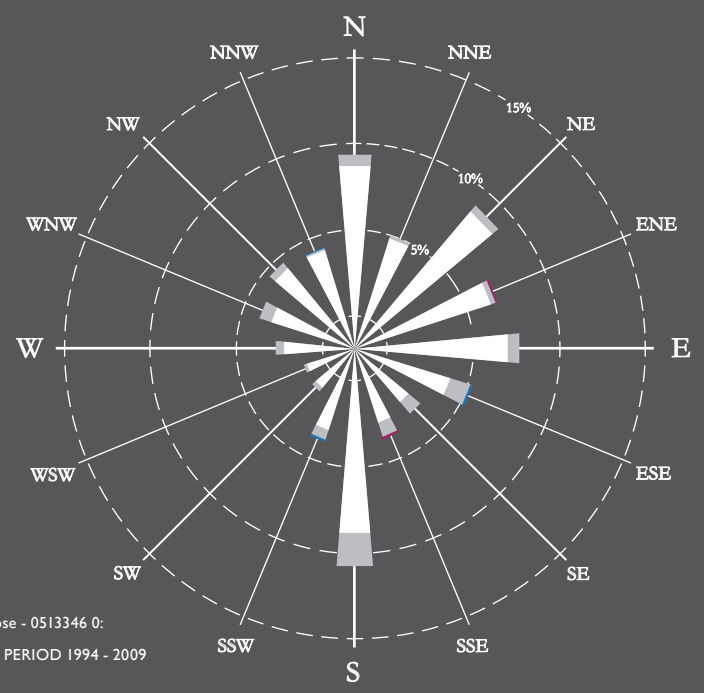


Figure 26 Pretoria Eendracht wind rose - 0513314C9: PRETORIA EENDRACHT YEAR AVERAGE PERIOD 1992 - 2009 : Weather South Africa (2009)



WIND SPEED [m/s]

- 0.5 - 4.0
- 4.0 - 10.0
- 10.0 - 13.0
- 13.0 - 20.0
- 20.0 - 100
- >100

Figure 27 Pretoria Unisa wind rose - 0513346 0: PRETORIA UNISA YEAR AVERAGE PERIOD 1994 - 2009 : Weather South Africa (2009)

noted that not all of the stations opened at the same time and the introduction of new technologies also influence the readings.

The other issue is that we have changed our instrumentation over the years from thermometers to sensors. Wind speeds are never averaged, maximum and minimums remain in

Tshwane has three distinctive temperature regions that vary with within 2 degrees of the announced daily temperature.

5.3.1 CLIMATE CHANGE

Climate change is calculated using a variety of data and not just weather analysis. It is very difficult to evaluate changes in climate (a consequence of global warming) through measured data alone.

As mentioned before to establish the weather of a particular place 30 years worth of data needs to be collected. This 'cluster' of data is then compared to subsequent 30 year periods to evaluate if there are any changes. South Africa has only been measuring weather conditions for a relatively short time.

Climate models predict that the global temperature will rise by about 1.4 to 5.8°C by the year 2100. This statistic refers to global changes, therefor on a local level some places may become warmer or cooler within this range.

Local predictions estimate that by 2050 the average temperature will have risen by 2°C, the minimum winter temperature by as 3°C.[7]

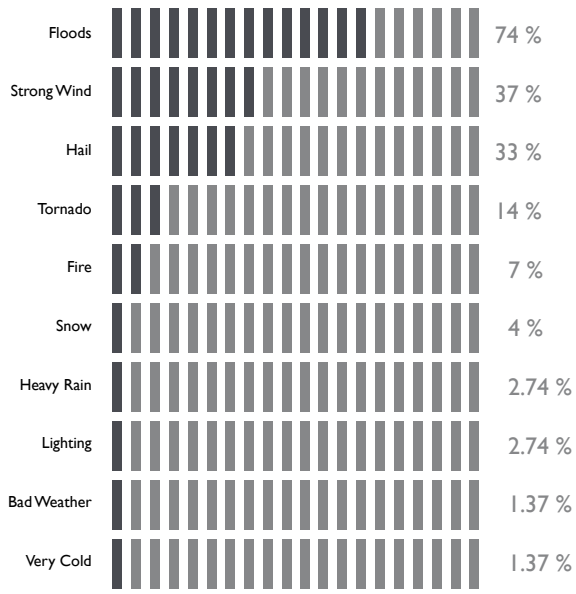


Figure 28 Likelihood that weather related events might occur at least once a year : Department of Disaster management (2008:5) [redrawn by author]

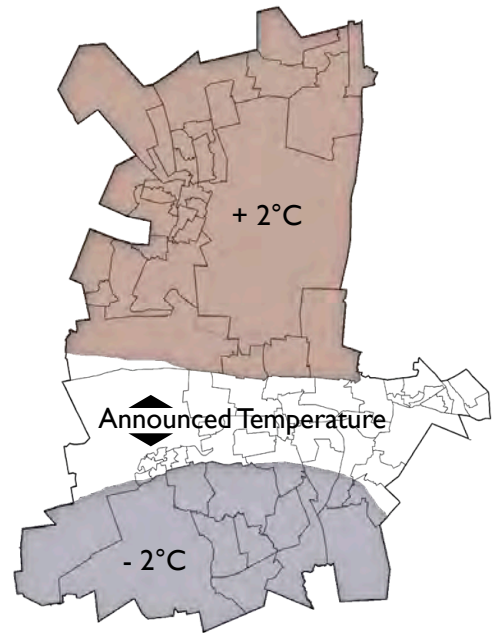


Figure 30 Climate differences in Tshwane : Tshwane Metropolitan Municiplality (2004:10) [redrawn by author]

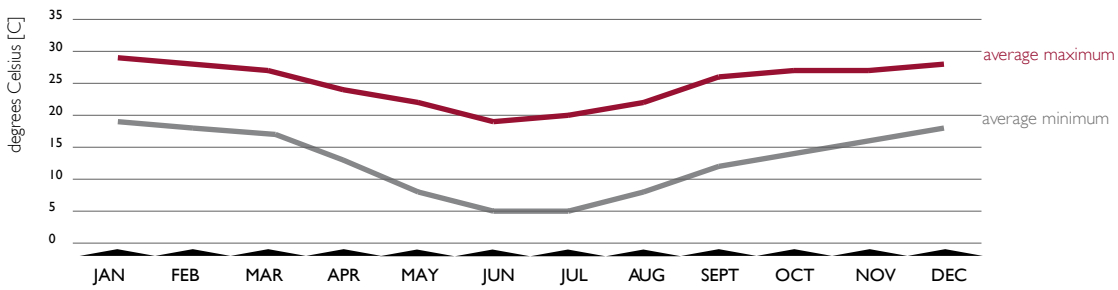


Figure 29 Average daily maximun and minimum temperatures : Tshwane Metropolitan Municiplality (2004:9) [redrawn by author]

5.4 HISTORIC PRECEDENTS

5.4.1 NOMADIC ROOTS

SOUTHERN AFRICAN RURAL VERNACULAR presumably derived from a generic nomadism. Predominant site conditions gave rise to the development of two distinct technologies that grew into the various typologies recognized today.[8]

These are characterized by the preferred form of construction and materials used, namely:

GRASS-ORIENTATED CONSTRUCTION seen in east Drakensberg regions where rain is prominent and many grass types are abundant

WATTLE AND DAUB CONSTRUCTION found in the drier highveld regions where rainfall is likely to erode exposed walling, and waterproofing technologies are in less demand.

The evolutionary building process and gradual adaptation of building techniques show how changes in the environment where accounted for. This proves that if a hazard for example heavy rains are prominent throughout the year building practices will adapt.

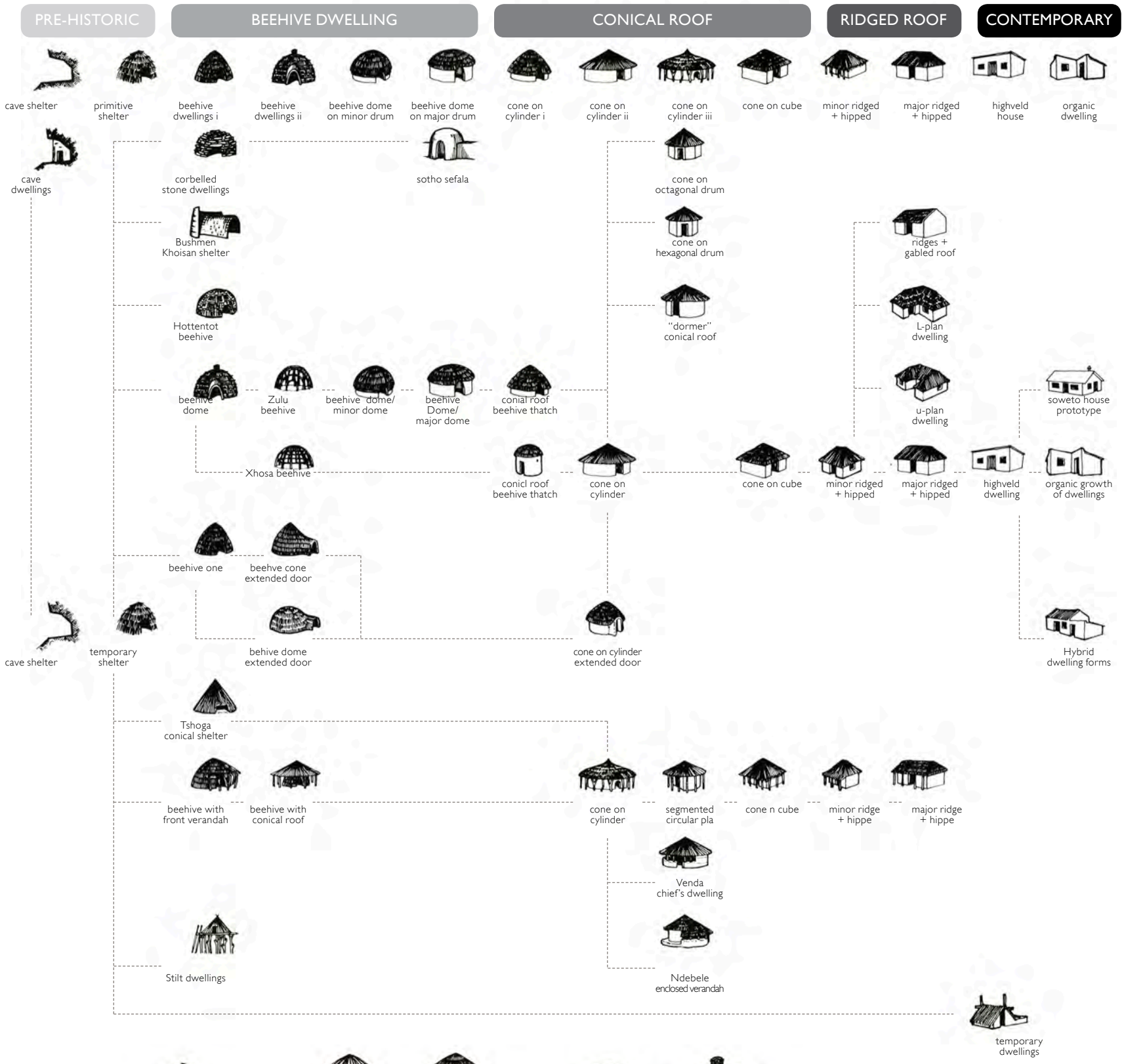
The current form of building most popular in informal settlements is corrugated iron constructions, that had their birth out of efficiency.

This type of building does not allow for a natural progression towards safer and more suitable building practices as evident in vernacular building forms.

7 Van Niekerk et al (2009:2)

8 Frescura (1981:11)

Table 07 Development of rural vernacular : Frescura (1981:20)



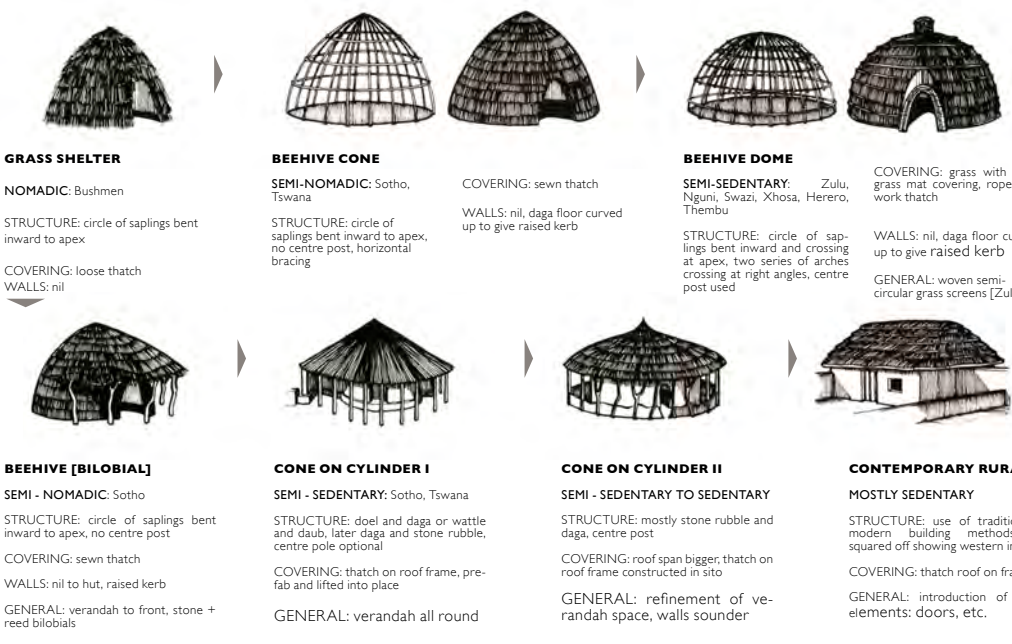


Figure 31 Development of two distinct technologies : Frescura (1981:12)

5.5 IRENE CONCENTRATION CAMP

LOCATION: Irene, Centurion
DATE: 1899-1902
RESPONSIBLE PARTY: British Troops
PRISONERS: Boer men, woman and children captured during the Anglo-Boer War
DESIGN: British Military
MAJOR FUNDING: British Military

No precedent[9] existed when the English first conceived the idea of encamping the Boer woman and children in an attempt to deprive the Boer Commandos from supplies and intelligence. These camps where laid out according to crude military guidelines and was operated by the troops until control was passed over to civil society. Much can be learned from the mistakes made by the English military and serves as unfortunate but very relevant precedent on shelter camps.

The term 'concentration camp' derives from the concentration a large number of people in an enclosed space.

BOUNDARIES

An article in the Icon Magazine[10] suggests that barbed wire was first used to enclose human beings [as opposed to cattle] by the English troops. Although it should be noted that in this instance barbed wire was used to prevent the inhabitants from escaping, barbed wire around the xenophobia refugee shelter camps were used as a means of security to keep the ill intended out.

SHELTER

The introduction of principles such as influx management is apparent in the placement of a 'observation camp' introduced to screen new arrivals for disease before settling in the main camp.

This camps adhered to the basic amenities and its is easy to point out why this exact location was chosen. The camps was positioned close to the train station and the river for washing, bathing, cooking activities. These basic principles still apply today.

9 Hattingh (1967)

10 Wiles (2007:25)

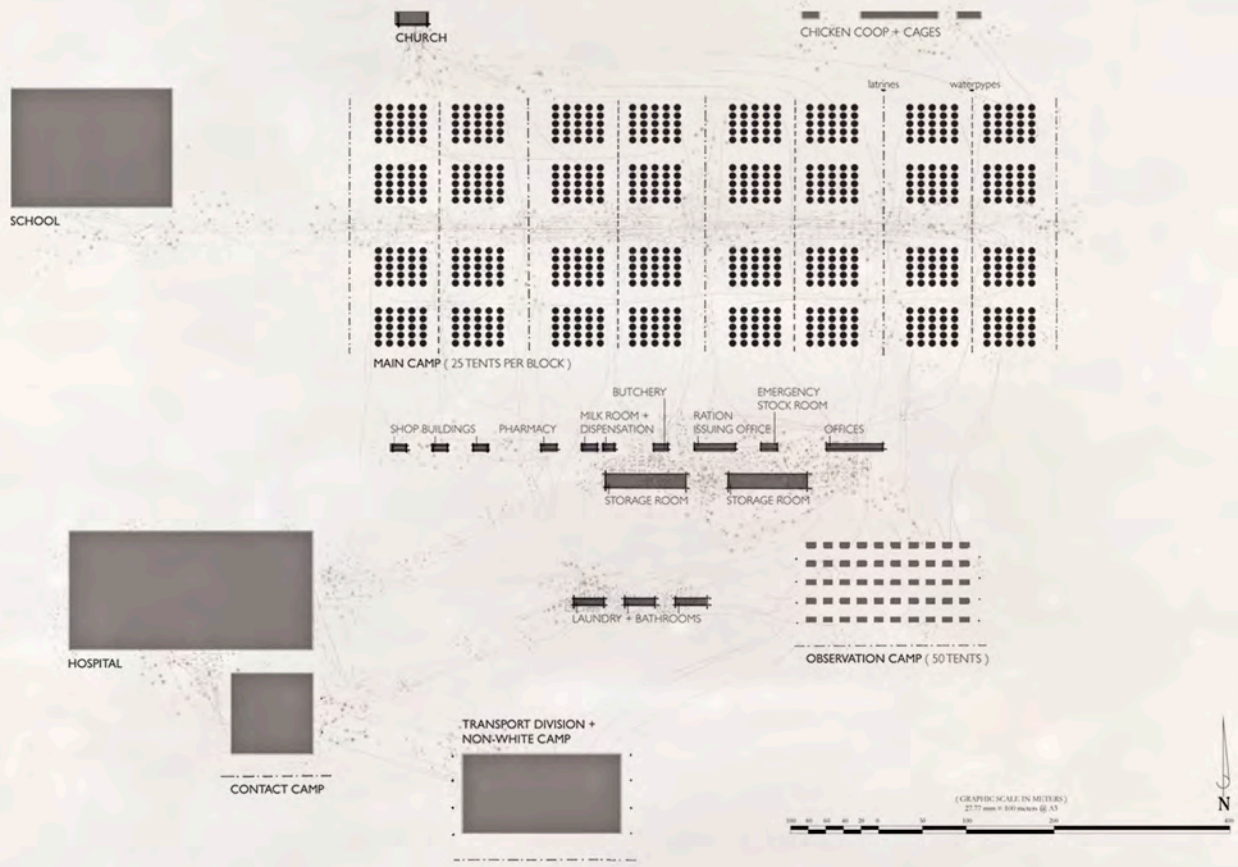


Figure 34 Typical concentration camp layout : Hattingh 1967:[n.p]) [redrawn by author]

Due to severe winters and insufficient means of shelter, disease ravaged the camp. Lack of proper dietary supplements and unhygienic habits contributed to the downward spiral of unfortunate events.

From this Fig. 35 shows how the camp layout was finally amended in an bid to prevent disease from spreading. Livestock and ablution facilities where kept separate from the main camp and an observation area was [in-flux management]

Figure 36 Nolli Map of Irene 2009

Figure 35 Irene Concentration camp (1902:[59of 171])

5.5 MYTHS + REALITIES

Shelter after Disaster is a comprehensive study by Ian Davis, principle lecturer of architecture at Oxford Polytechnic and expert of shelter provision. He has proven certain myths wrong surrounding the topic of shelter in the event of disaster, particularly in the developing countries.

In order to guide the development of the research text where selected to serve as a guideline in an attempt to explain elements that where not possible to experience first hand. Where possible statements are compared and justified with local scenarios.

Davis explains these myths and realities[11] in terms of the following categories.

5.6.1 VULNERABILITY

Disasters do not strike everyone equally. Disasters tend to strike the poor as can be seen from the case studies.

5.6.2 SOCIAL ATTITUDES

Despite the panic shown in the media there is no evidence to suggest that disaster victims fall into a 'state of inactivity'. Given the exception of isolated cases it has been proven that a 'strong self-preservation instinct' takes over when someone has just survived an unfortunate event. The effects of such events are further discussed in the Soweto case study.

5.6.3 SHELTER NEEDS

The perception that official shelter is preferred was proven false. It was suggested that displaced victims have the following clear preferences:

1. host families/ friends

2. improvised shelters

3. converted buildings

4. official shelter

It is therefor important that the project develops a shelter typology that has the flexibility to be used in as many of the before mentioned scenarios.

Possibly the thesis should be looking at smaller units for the flexibility required. This would enable multiple units to be used for larger families. The ability to be used on site or next to a host family, or start of an improved shelter would be advantageous. It should be able to stand alone in converted buildings (or collective centres such as community halls, gymnasiums etc.)

Communal shelters have proven to be ineffective. In the aftermath of disaster societies tend to clutch to the family unit and remain in a familiar setting/community. The premise of larger shelter units that cater for families (4-6) is challenged as demographics show [Figure 54-55] more or less an equal ratio of families versus single persons. A smaller 2 person unit is therefor suggested that can cluster to become a family sized shelter.

5.6.4 RECONSTRUCTION

It is a clear understanding that in South Africa reconstruction will commence regardless of protocol, or relocation initiatives. The crucial mistake made is that in the rush to erect shelter, the exact same mistakes will re-occur and the living conditions might even become more dangerous.

In the event that the starter kits arrive on time the quality of living it is able to provide is nothing more than the most basic sheltering of elements. No insulation, no waterproofing, no proper foundations and nothing to help in regaining a sense of home and wellbeing to counteract the severe losses that have incurred.

5.6.5 RELOCATION

Another factor in the provision of emergency shelter is the acceptance that it cannot be reclaimed once it has been issued. It is therefor required that a donor shelter typology be developed that will remain with the disaster victim and become part of the reconstruction process.

5.6.6 THE PROVISION OF AID

This section stresses the importance of a collaborative approach between the various aid entities. The Disaster Risk Management Framework contains the required analysis for determining the measure of aid and funds to be allocated in emergency situations. It is important for aid to be distributed following the proposed protocol as stipulated in the local Disaster management plan.

It helps in preventing situations where aid is provided in response to 'perceived needs'. A high influx of aid can potentially inhibit local recovery initiatives and create 'dependency relationships'.[12]

It is therefore imperative that the proposed project becomes a part of the contingency plan with clear understanding of when it should be deployed.

11 Davis (1987:26-30)

12 Davis (1987:30)

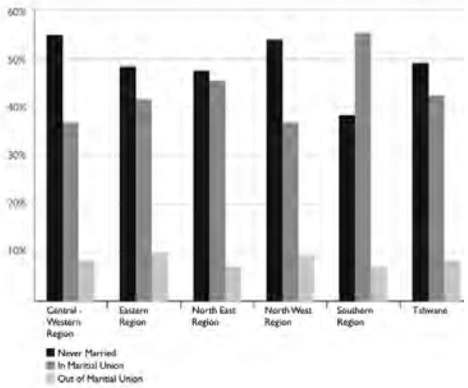
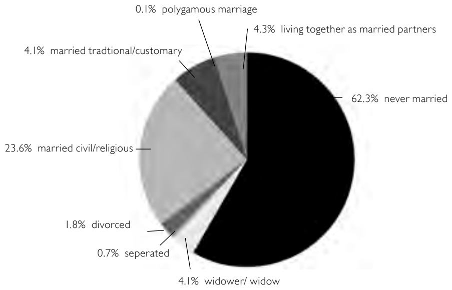
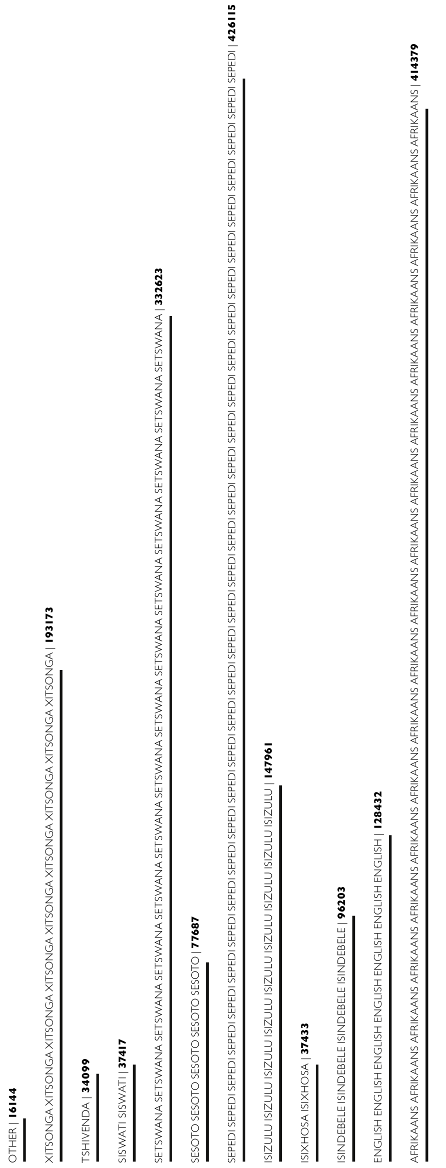


Figure 54 Percentage distribution of people 16 years old and over by marital status and regions **:** Tshwane Metropolitan Municipality (2008:23)



MARITAL STATUS IN TSHWANE

Figure 55 Percentages of people co-habitating or living together in Tshwane **:** Tshwane Metropolitan Municipality (2004:44)[redrawn by author]



HOME LANGUAGES IN TSHWANE

Figure 56 Home languages spoken in Tshwane **:** Tshwane Metropolitan Municiplality (2004:44) [redrawn by author]


Figure 38 Refugees inside a makeshift shelter camp outside a Johannesburg police station **:** Monsters + Critics (2008:[2of6])


Figure 39 Man waiting for transport outside camp **:** Krog (2008:[14of14])


Figure 40 Refugee camp on Vickers Road at night **:** Krog (2008:[13of14])


Figure 41 Interior scene at the Central Methodist Church, Braamfontein Johannesburg **:** Farrell (2008:16of24])


Figure 42 Refugees waiting to be relocated **:** Skuy (2008:[5of14])


Figure 44 Refugees sleeping in the stairwell **:** Austen (2009:[22of22])

Figure 43 Child sleeping in the open air in Musina camp **:** Delay (2008:[22of24])


Figure 45 Woman sleeping in the open air in Musina camp **:** Delay (2008:[22of24])


Figure 46 Woman feeding her baby **:** Oryxmedia (2009:[14of15])


Figure 47 Child hiding in a cupboard at Methodist Church **:** Born (2008:[13of24])


Figure 48 Woman washing clothes **:** Oryxmedia (2009:[11of15])

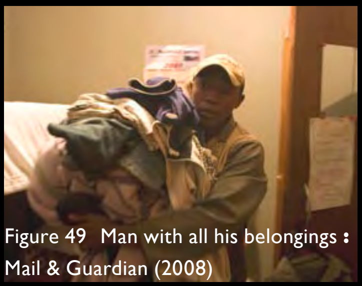


Figure 49 Man with all his belongings **:** Mail & Guardian (2008)


Figure 50 Man washing clothes **:** Oryxmedia (2009:[13of15])

Figure 51 Laundry hanging on the security fence **:** Mashiloane (2008:[8of14])

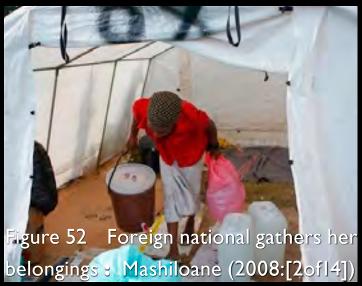


Figure 52 Foreign national gathers her belongings **:** Mashiloane (2008:[2of14])

Figure 53 Foreign national get ready to be move **:** Mashiloane (2008:[2of14])

CASE STUDY

5.7 DIEPSLOOT, JOHANNESBURG

Diepsloot[13] was established in 1995 and is today home to around 150 000 residents. It was initially intended to be a temporary transit camp for 7 000 families. Due to rapid urbanization the sprawling township has a severe lack of infrastructure and formalized housing. It is estimated that nearly 16 000 families live in informal dwellings consisting of ad hoc materials.

Housing is constructed by occupants themselves most commonly using corrugated iron sheets. Whilst this type of building material is affordable, easy to transport, and quick to assemble, the disadvantages of this type of constructions are a lack of thermal insulation and energy efficiency.[14]

Figure 57 Locality Map of Diepsloot

13 Global Studio (2007:113)
14 Mathews et al. (1995: 427-432)

5.7.1 VULNERABLE CONDITIONS:

Two observations made by Davis[15] can be understood in the context of Diepsloot:

"First, people build their homes in response to their everyday needs - their occupations, their wealth, their traditional construction techniques and their cultural patterns."

"Secondly, the return period of most forms of disaster is so infrequent that it has no influence whatsoever on local construction techniques or sitting of settlements."

It is well known that the urban poor tend to inhabit the worst land in the densest and most dangerous part of the city such as building near riverbanks in areas with high flood vulnerability.

Failure in understanding how and why certain circumstances are hazardous. Inhabitants need education in potentially dangerous locations.

5.7.2 STRATEGIES FOR IMPROVEMENT

Initiatives such as Global Studio have shown that there is great opportunity for education and training in the affected areas. Communities are eager to be involved.

Global Studio Johannesburg started a Shack and Housing improvement initiative. The initiative trains people to improve amongst other things the thermal quality of their dwellings through low cost methods.

Leaking drains and fetid water in the streets are a health hazard, a problem which some local residents were trained to address themselves; as well cleaning up garbage in and around the dwellings to mitigate fire spreading [figure 64-66].

Initiatives to further educate inhabitants in modifying building techniques to be safer.

5.7.3 CARDBOARD INSULATION

15 Davis (1978:6)

Davis[16] recognises "...that these unfortunate events target the very poor members of our society it is necessary to reflect that it may cost 15% more to construct a safe house."

It may initially require higher capital cost to amend these construction methods just enough to prevent and mitigate the effects of disasters.

A recent study about the energy efficiency of ultra low cost housing in Pretoria has shown the potential of inexpensive modifications to have significant effects on the temperature extremes experienced in corrugated iron dwellings.

It was found that "[t]he people who can least afford it have to pay the highest percentage of their earnings to make their lodgings habitable." [17]

Cardboard insulation showed the most potential from an economic and energy efficient point of view.

A study was conducted looking at the amount of energy consumed by homes from different building materials. Corrugated iron proved to be the least efficient building material when used without any type of thermal insulation [Table 09].

It was found that by adding 20mm of cardboard insulation the total energy consumption during the winter months would decrease by as much as 75% [Table 10].

16 Davis (1987:10)
17 Mathews et al. (1995:427)

CARDBOARD COST + SAVINGS

Table 09 Simulated energy consumption for different building materials and concepts (heating season : Matthews et al (1995:429)

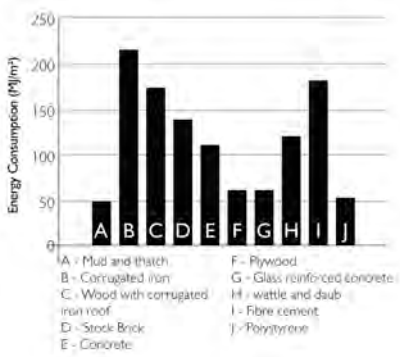


Table 08 Simulated energy consumption for different insulation materails : Matthews et al (1995:430)

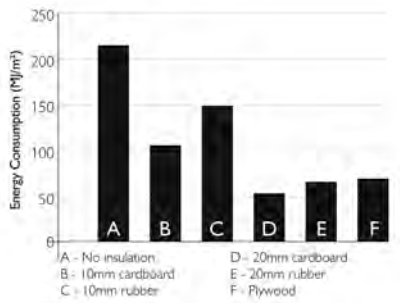


Table 10 Material cost and yearly savings for different cardboard insulation materials : Matthews et al (1995:430)

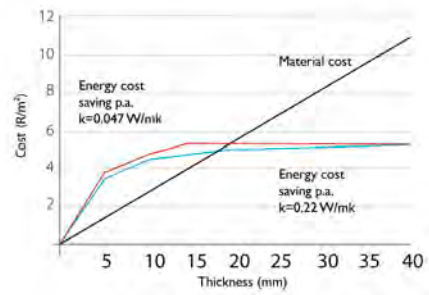



Figure 58 Debris on roof that conribute to hazardous conditions : Global Studio (2007:14)


Figure 59 Installing cardboard insulation : Global Studio (2007:84)

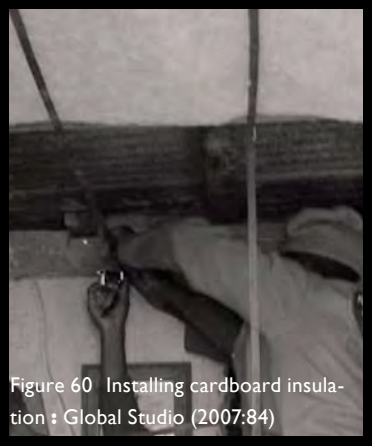


Figure 60 Installing cardboard insulation : Global Studio (2007:84)


Figure 61 Residents waterproofing a roof of a dwelling : Global Studio (2007:83)


Figure 62 Cheerful resident after instalation : Global Studio (2007:84)

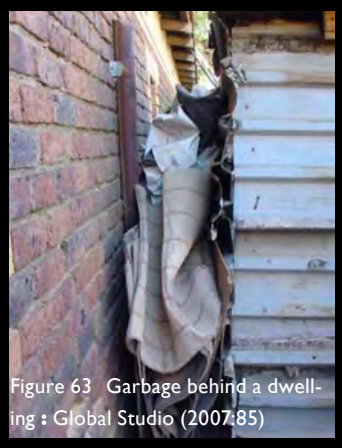


Figure 63 Garbage behind a dwelling : Global Studio (2007:85)


Figure 64 owner clearing garbage behind dwelling : Global Studio (2007:85)


Figure 65 Safer environment : Global Studio (2007:85)

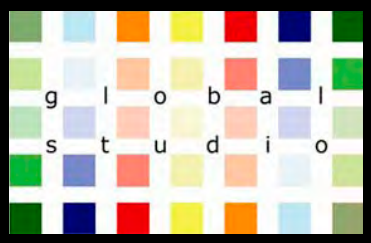



Figure 66 Residents cutting cardboard for insulation : Global Studio (2007:83)


Figure 67 Residents help improve their own homes : Global Studio(2007:83)

Figure 68 Aerial photo of Klerksoord, Akasia : Googlemaps (2009a) [compiled and edited by author]

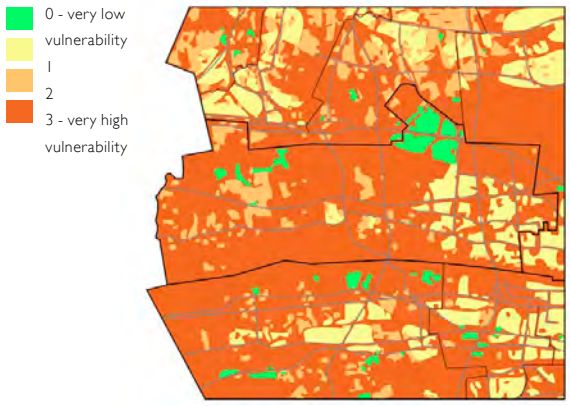


Figure 69 Environmental Vulnerability map : Department of Disaster Management Services (2008:4)

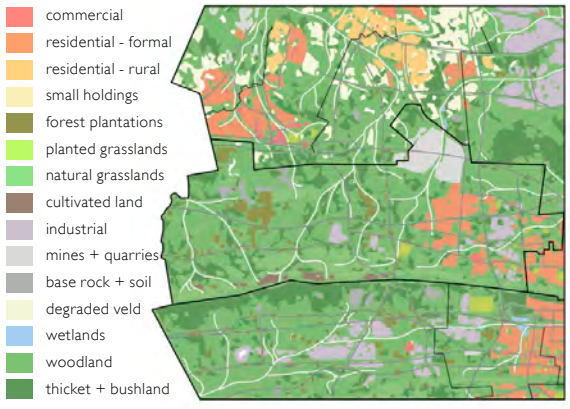


Figure 70 Landuse map : Department of Disaster Management Services (2008:4)

CASE STUDY

5.8 KLERKSOORD SHELTER CAMP

TEMPORARY SHELTER CAMP, AKASIA

Figure 71 Locality Map of Klerksoord, Ward 4, Akasia

The outbreak Xenophobic violence during May 2008 caused wide scale displacement of foreign nationals within various regions in South Africa. When temporary collective centres exceeded their capacity to contain the situation the government announced that Centres of Safe Shelter [CoSS] were to be established to mitigate the situation. On 26 May 2008 some 500 internally displaced people [IDP] were effectively relocated on to a site in Klerksoord, Akasia.

Reports[18] state that the residents were initially provided with two tents, 15 blankets [but no bedding], five toilets, two water points, 100 cans of food. From here on aid was predominantly provided by small NGO's, religious groups and individual volunteers.

In June, 56 military canvas tents were supplied by the municipality to accommodate the influx of people from the closure of two other sites.

The camp was to be closed in October 2008. But after failed attempts to convince the inhabitants to leave, they were forcefully removed in March 2009.

5.8.1 OBSERVATIONS

The Klerksoord shelter camp was located an environmentally sensitive area that was systematically being damaged as residents salvaged materials for shelter.

Risks associated with the area include environmental vulnerability, risk of veld fires due to a significant proportion of the area being grasslands and industrial hazards:

Notes on refugee situations:

Refugee situations have a different set of characteristics and shelter camps for this purpose are designed to keep refugees separate from the host population. Both internal and external security threats have to be taken into consideration.

Shelters are designed to encourage people to return home and not to settle permanently. Isolated locations prevent refugees from instigating their own livelihoods and dependency relationships are purposefully created.

From the recent xenophobic event it is clear that South Africa has very little experience in the provision of shelter camps. This is partly due to the fact that the country does not currently maintain any refugee camps.[19]

It should be noted that South African government policy advocates reintegration and that the much denied emergence of 'shelter camps' was a result of unprecedented political events, an immense backlog in asylum grants, severe poverty, lack of planning and the failure to provide and implement proper reintegration guidelines.

18 CoRMSA (2008: 13)

19 CoRMSA, (2008:28)

TIME LINE OF REFUGEES STATUS IN SOUTH AFRICA

1993

SA recognises refugees for the first time

1994

First speculation of Xenophobic attacks

1998

Refugee Act governing the admission of asylum seekers was passed

2000

Refugee Act becomes affective

MAY 2008

First Xenophobia attacks

26 May - Klerksoord opened

OCTOBER 2008

UNCHF pulls out

06 OCT 2008

Klerksoord camp dismantled by RED ANTS

08 OCT 2008

Inhabitants refuse to leave

19 OCT 2008

800 inhabitants remains

08 FEB 2009

600 inhabitants remains

03 MAR 2009

Klerksoord camp demolished

and inhabitants forcefully removed

Figure 72 Messages written on military canvas tents by refugees at the Klerksoord camp : Pretorius (2008)

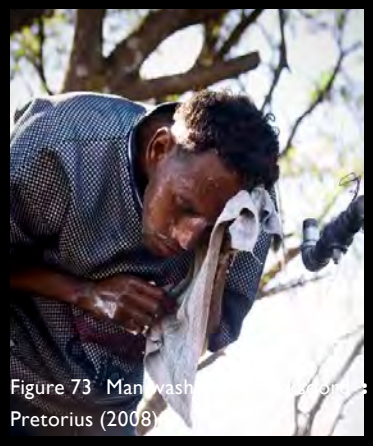


Figure 73 Man wash[illegible] Pretorius (2008)


Figure 74 Children playing : Pretorius (2008)


Figure 75 Drying clothes providing much needed colour : Pretorius (2008)


Figure 76 Make shift shelter from the sun : Pretorius (2008)


Figure 77 Woman waiting for transport outside camp : Pretorius (2008)

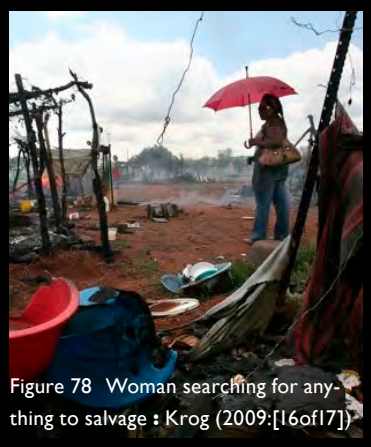


Figure 78 Woman searching for anything to salvage : Krog (2009:[16of17])


Figure 79 Temporary place of worship Klerksoord, Akasia : Pretorius (2008)


Figure 80 Red Ants dismantling temporary shelters : Mashiloane (2009:[10 of 17])


Figure 81 Red Ants burning shelters : Mashiloane (2009:[8 of 17])

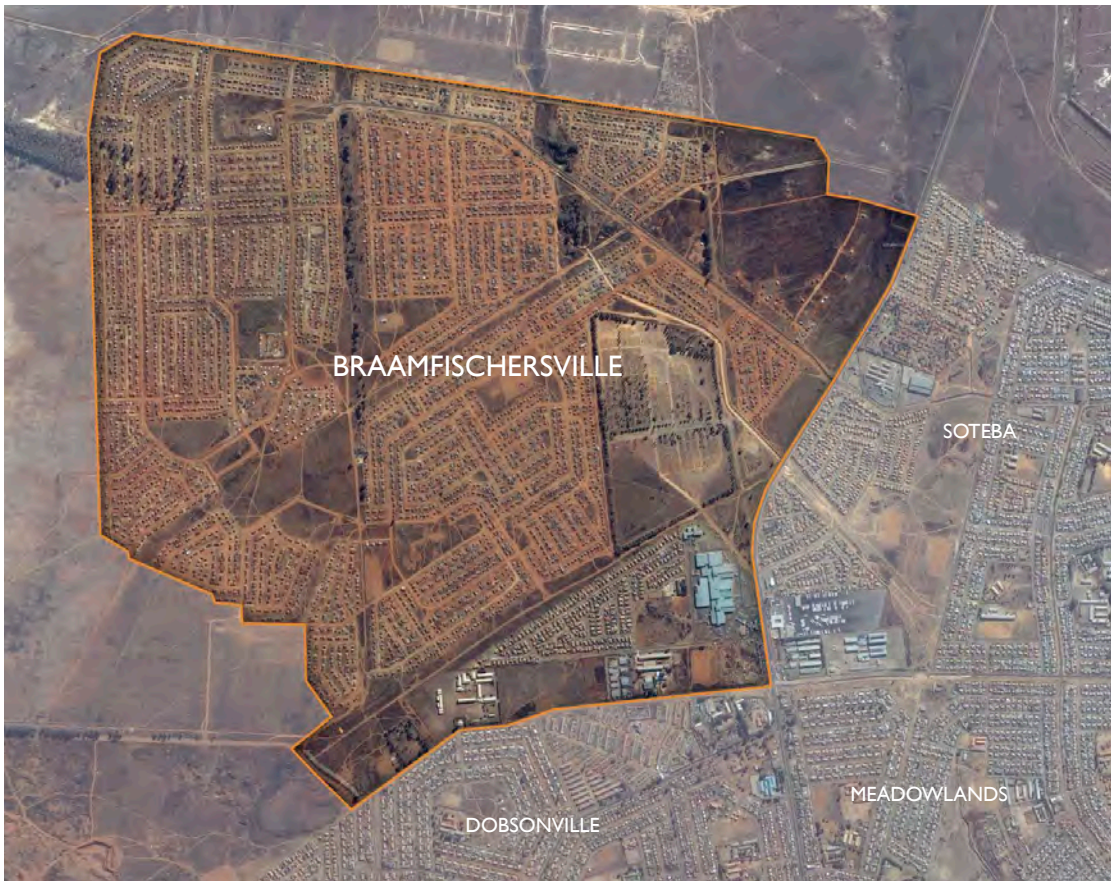


Figure 83 Aerial photo of Braamfischersville, Soweto : Googlemaps (2009b) [compiled and edited by author]

CASE STUDY

5.9 SOWETO FLASH FLOOD, 2009

BRAAMFISCHERSVILLE, SOWETO

Figure 84 Locality Map of Braamfischersville, Soweto, Ward 44, 49 & 50, Region C, City of Johannesburg

Around 200 families[20] from Braamfischersville, Mercy Park, Dube, Dobsonville, Mofolo, Meadowlands and Dlamini had to be temporarily evacuated after a fierce storm broke out on the afternoon of the 26th of February 2009. Heavy rains caused severe damage to infrastructure and private property, claiming the lives of two people.

Gauteng premier mr. Paul Mashatile declared the area a disaster zone[21] after damage assessment was completed four days later.

A site visit to the affected areas in Braamfischersville provided much needed insight into the differences in actual needs, versus the perceived needs proliferated by the media.

Kronenburg[22] attains that the misconceptions posted by the media are one of the main reasons for the mismatch between proposed solutions and the problems involved in designing for disaster relief.

It was interesting to compare the differences in articles written on the day of the event as compared to a week afterwards.

In speaking with the volunteers from the Soweto Red Cross they described that victims were keen to return to there homes and that reconstruction commenced as early as the next day.

Residents where very angry at City Parks maintaining that the damage caused by the flooding river was exacerbated by uncleared debris from tree cutting the day before, which had blocked culverts.

A team of volunteers and government officials assisted residents with the task of cleaning dirt filled and damaged houses.

Although the disaster did not render anyone homeless the extent of the damage in terms of household items, electrical appliances and sewerage was quite severe.

5.9.1 OBSERVATIONS

(a) Interior

The apparent lack of shelving and wall mounted storage increased the extent of domestic losses.

Important items such as birth certificates were destroyed which makes one wonder what height is 'safe' for storing important documentation.

In such areas where seasonal flooding is a possibility water outlets should be incorporated into walls that can be opened if the alarm is raised [figure 83]

Developments in high risk areas would benefit from raised platforms. Temporary container structures in the flood area survived with minimal damage because they are raised 400mm above ground level [figure 91].

(b) Exterior

It was also noted that most of the building failures can be attributed to poor soil conditions and improper foundations [figure 84-86]. Again one sees that people construct their homes to meet their everyday needs and not for the event of a disaster.

The risk of immediate reconstruction [being the desired response] is that in most cases people rebuild using the exact same techniques thereby increasing the risk of the disaster being repeated.

20 Thakali (2009:[front page])
21 Fourie (2009:7)
22 Kronenburg (2002:101)

FLOOD LINE DAMAGES

3.000mm

2.500mm

2.000mm

1.5000mm

1.000mm

important documents

photos

food

clothes

cars

< 500mm

> 500mm

0.500mm

damage to furniture

damage to wet services

> 300mm

almost electrical appliances:

fridge, tv, radio,

> 0.000mm

need to replace all floor surfaces

internal doors rot

0.000mm

Figure 85 Community member assisting in rebuilding a wall of one of the victims

Figure 95 Temporary structures raised on platforms survived flood

Figure 86 Temporary drain dug to mitigate flood water away from property

Figure 87 Ventilation grill broken out to drain water in one of the homes

Figure 88 Temporary shuttering erected whilst reconstruction commences

Figure 89 Temporary shuttering erected whilst reconstruction commences

Figure 90 View of building failure due to poor construction methods

Figure 91 Inside the bedroom of a victims house clearly showing the water level of the flood

Figure 92 Resident's possessions laid out to dry

Figure 93 Flood level in bathroom

Figure 94 Flood level in the hallway

grace under pressure

PART TWO

06 | TYPOLOGY + APPLICATION

BENEFITS of PRE-MANUFACTRING

PREFABRICATED ELEMENTS

Having established the realities of disasters in the local context, this chapter reviews shelter typologies with the emphasis on application. From this, pertinent criteria was derived and formulated towards rendering an effective design proposal.

The investigation points to a highly adaptive solution that can respond to the various phases[1] of recovery.

Deployable (collapsible) structures offer an effective solution to constraints such as the economy of manufacture, storage and transportation.

Shelter for disaster is a vary basic form of portable architecture. Figure 40 illustrates the various shelter typologies and their applications. All portable systems are categorized as either deployed [structures] or prefabricated [elements].

According to Brookes[2]; 'deployment' concerns not the pre-manufacture of **elements** but more or less pre-assembly of an **entire structure** in a factory and the unfurling or deploying of the structure on site."

► The premise of prefabrication is to decrease the need for skilled labour onsite (as well as speed and simplicity of erection often under trying conditions) through the use of factory produced structures. This approach also provides greater economy and better quality control over the final product.

1 *vide* (4.2.2:20)
2 Brookes (1998:116) [emphasis by author]

Brookes[3] suggests that there are six main types of deployable structures: tensegrity structures, membrane systems, pantograph, pneumatics; flat packed and pods or capsules.

► Deployable structures are usually based on the principle of collapsibility. The premise of collapsibility[4] is that an object or structure has "one **folded passive state** and one or more **unfolded active states**" with the objective to save space.

This is achieved through the application of one or more principles of collapsibility. A set of 12 principles[5] describes the action by which the structure or object is either collapsed (creasing, nesting, hinging, rolling, folding); expanded (assembling, fanning, stress, inflation, sliding) or in some cases, the structure itself (bellows, concertina).

Collapsibles however exclude self-assembly and knock down furniture as it is argued that self-assembled furniture is not collapsible, it is just not yet completely manufactured.[6]

Although any of these typologies could provide feasible sheltering solutions, some systems are more suitable to the context and constraints than others.

6.1 SELECTION CRITERIA

Two people had a strong influence on the selection criteria for of a structural system:

The first is the sound advice given by a lecturer[7] who was involved in a transitional relief effort run by the Canadian Red Cross. He recommended to make sure that if any new or foreign technology or construction method is used that it is comprehensible to the level of construction skills available. If this is not the case, make sure that the structural integrity of the proposed shelter is easy to inspect afterwards.

This advice is based on his experience in Indonesia were concrete structures designed to withstand earthquakes failed when another earthquake devastated the same area. It was later found that instead of crossing the steel

3 Brookes (1998:116)
4 Mollerup (2001:24) [emphasis by author]
5 Mollerup (2001:30)
6 Mollerup (2001:22)
7 Adams (2009)

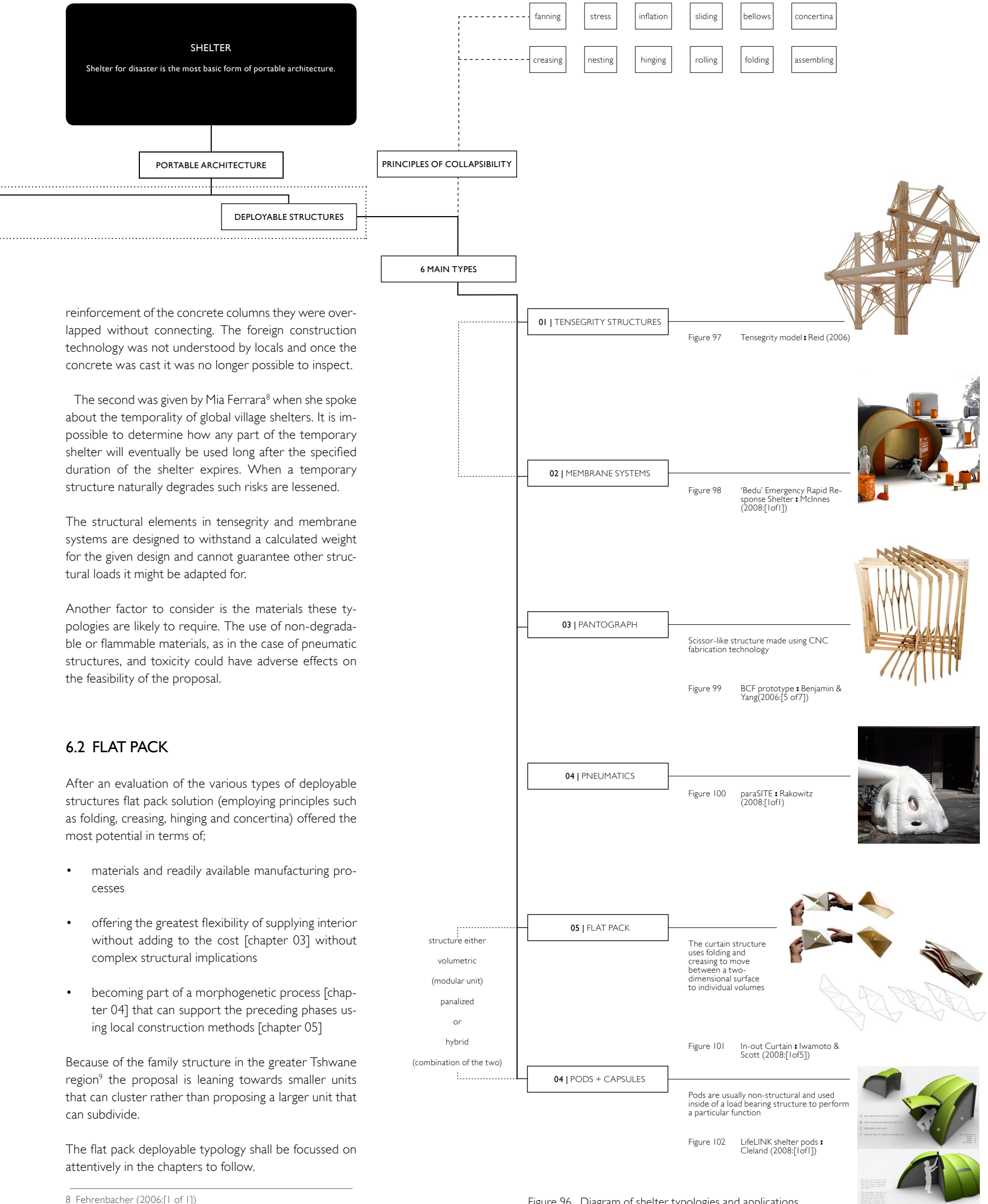


Figure 96 Diagram of shelter typologies and applications

reinforcement of the concrete columns they were overlapped without connecting. The foreign construction technology was not understood by locals and once the concrete was cast it was no longer possible to inspect.

The second was given by Mia Ferrara[8] when she spoke about the temporality of global village shelters. It is impossible to determine how any part of the temporary shelter will eventually be used long after the specified duration of the shelter expires. When a temporary structure naturally degrades such risks are lessened.

The structural elements in tensegrity and membrane systems are designed to withstand a calculated weight for the given design and cannot guarantee other structural loads it might be adapted for.

Another factor to consider is the materials these typologies are likely to require. The use of non-degradable or flammable materials, as in the case of pneumatic structures, and toxicity could have adverse effects on the feasibility of the proposal.

6.2 FLAT PACK

After an evaluation of the various types of deployable structures flat pack solution (employing principles such as folding, creasing, hinging and concertina) offered the most potential in terms of;

- materials and readily available manufacturing processes
- offering the greatest flexibility of supplying interior without adding to the cost [chapter 03] without complex structural implications
- becoming part of a morphogenetic process [chapter 04] that can support the preceding phases using local construction methods [chapter 05]

Because of the family structure in the greater Tshwane region[9] the proposal is leaning towards smaller units that can cluster rather than proposing a larger unit that can subdivide.

The flat pack deployable typology shall be focussed on attentively in the chapters to follow.

8 Fehrenbacher (2006:[1 of 1])
9 *vide* (5.6.3:39)

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“ Always design a thing by considering it in its next larger context - a chair in a room, a room in a house, a house in an environment, an environment in a city plan. ”

: Eliel Saarinen[1]

07 | PRECEDENT STUDIES

The focus of this thesis falls within the parameters of rapidly deployable shelter systems. The shelter form will ultimately be determined by the structure type and method of construction.

This chapter is a critical revision of flat-pack deployable structures. Precedent studies were selected accordingly to gain an overall understanding of the diversity of applications that are both temporary and transitional.

Architect and shelter advisor Elizabeth Babister[2] uses the example of her Transitional Community project in Sri Lanka to describe the difference between temporary and transitional:

> These are ‘transitional’ as opposed to ‘temporary’. Emergency shelter is temporary and is intended just to provide shelter for survival. Transitional implies something that is longer-term and gives you space to carry out livelihood activities rather than just surviving.

1 Fletcher (2001)
2 Babister was the shelter advisor for the Transitional Community project in Tangalle, Hambantota, Sri Lanka, 2005. Architecture for Humanity (2007:99)

7.1 OVERVIEW OF PRECEDENT STUDIES

Table 01 shows a wide range of available sheltering options. South Africa currently employs the uses two: the UNHCR light-weight emergency tent and military canvas tents [centre pole and ridge type].

The discussion of precedents ranges from the very general to the specific. This order seemed to be the most logical. The chapter starts by explaining four different concepts derived and explained at the hand of different precedent studies that propose an alternative approach to shelter. These concepts are to be further challenged and explored in the chapters to follow.

It then continues with a critical revision of the main influences that contribute to the synthesis of the proposed solution.

Table 11 Summary of precedent studies and other sheltering typologies

Figure 103 Uber Shelter
: Smith (2007[1of7])

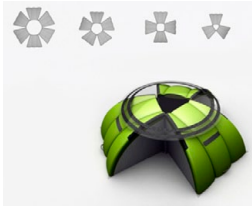


Figure 104 Lifelink Shelter Pods
: Cleland (2008:[1of3])

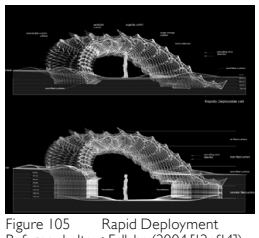


Figure 105 Rapid Deployment Refugee shelter : Fallaha (2004:[12of14])

Figure 106 Sustainable cardboard shelter : Super Colossal (2008:[1of12])

Figure 107 Basic House Project
: De Azúa (1999:[1of5])

Figure 108 'Graph' : Rintala Eggertsson Architects (2009:[2of11])

Figure 109 Global Village shelter
: Global Village Shelters Llc. (n.d.)

Figure 110 Niigata Paper House
: Shigeru Ban Architects (2004:[1 of 1])

Figure 111 Hexayurt at the Burning Man Festival : Hexayurt Project (2003)

Figure 112 Water Shelter
: Nightingale (2007:[1of1])

Figure 113 Sanctuary
: Standard (2007:[1of4])

Figure 114 Salvaged Shelters, Atlanta
: Architecture for Humanity (2006:177)

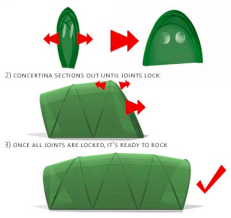


Figure 115 Lightweight Emergency Shelter: Pwharram (2007:[2of3])

Figure 116 Emergency Drum
: Yanko Design(2007:[1of2])

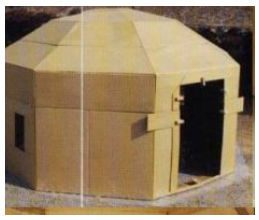


Figure 117 Octagon Shelter
: Sago Mukazai (n.d)

Figure 118 UN Plastic Sheeting
: United Nations (1985)

Figure 119 UN Canvas Military Tents : (2009:[1of1]

Figure 120 Light Weight Emergency tent
: Architecture for Humanity (2006:62)

SA shelters

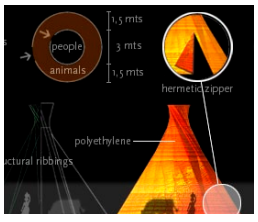


Figure 121 Limnic Eruptions
: Cancino (2007[2of4])

Figure 122 Cocoon Emergency Shelter : Moriarty (2007)

Figure 123 SuperAdobebyNaderKhalili
: Architecture for Humanity (2006:104)

Figure 124 Shelter Cart
: Timlin et al (2006)

Figure 125 Paper Tube Emergency Shelter : Shigeru Ban Architects

Figure 126 Paper Log Houses, Kobe
: Shigeru Ban Architects

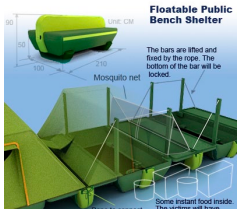


Figure 127 Floatable Public Bench Shelter : Yifeng Du (2007:[3of4]))

Figure 128 House of the Future
: Stutchbury & Pape (2004:[1of1])

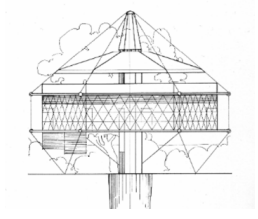


Figure 129 Dymaxion House [1929]
: Winston (2008:[1of1])

Figure 130 Ha-Ori Shelter
: Student (2003:1of1])

Figure 131 Folding Shelter
: Schipper (2008:[1of2])

Figure 132 reCover Shelter
: Malone (2008:[1of1])

Figure 133 paraSITE by Michael Rakowitz
: Architecture for Humanity (2006:193)

Figure 134 Doca Autunno table
: Laissezfaire (2007:[1 of 1])

Figure 135 Low Tech Balloon System
: TechnoCraft (1999)

Figure 136 Dome Village by C. Chamberlain
: Architecture for Humanity (2006:182)

Figure 137 Deployable GeoShelter
: www.deployablegeoshelter.com

Figure 138 SHELL house
: Pino (2007:[n.p])

Figure 139 Milan 2009 - House of furniture parts for Droog **:** Studio Makkink & Bey (2009:[1 of 5])

7.2 CONCEPT PRECEDENTS

The conceptual thinking of the proposed shelter is best explained at the hand of the following precedent studies:

CONCEPTUAL DERIVATIVE 7.2.1

In relation to the thesis topic this concept presents a promising idea that one could either have shelter or one could have furniture. It provides a flexible situation wherein, no matter what, one would always have what one needs most.

CONCEPTUAL DERIVATIVE 7.2.2

Proposes that elements evolve as the time line of recovery increases. This would require more permanent components with flexible applications.

CONCEPTUAL DERIVATIVE 7.2.3

Provision of a partially complete shelter that encourages completion with materials of the user's choice.

CONCEPTUAL DERIVATIVE 7.2.4

The development of cardboard as a viable building material has come a long way. This marks the first ever cardboard building to be built. It met very strict UK building codes and fire regulations and has a life expectancy of 25 years.

7.2.1 ADAPTABILITY

House of Furniture Parts

LOCATION: Via Alserio, Milan
DATE: 2009
DESIGN FIRM: Studio Makkink and Bey
MAJOR FUNDING: As part of the development of Droog Studio's Staircase project for their New York store.

DESCRIPTION:

A fun element used to create a small space within larger office or public spaces. Dezeen Magazine[3] describes it as:

> Enclosure made of plywood and with walls of stool, bench and table parts that easily come out and assemble, the functionality and character of the house can be changed as more or less furniture is used. A poetic vision for efficient production and material use, House of Furniture Parts transports flat and can be made to suit different functions, produced locally and customized.

The versatility of end uses that the concept can be adapted for are endless. All materials and processes are locally manufactured.

3 Etherington (2009:[1 of 1])

Figure 140 Water Shelter - Sustainable shelter solutions
: Nightingale (2007:[1 of 1])

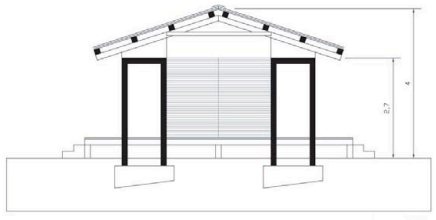


Figure 141 Safe[R] House
: MIT (2005:[2 of 2])

Figure 142 Exterior and interior school **:** Buro Happold (2001:[1 of 1])

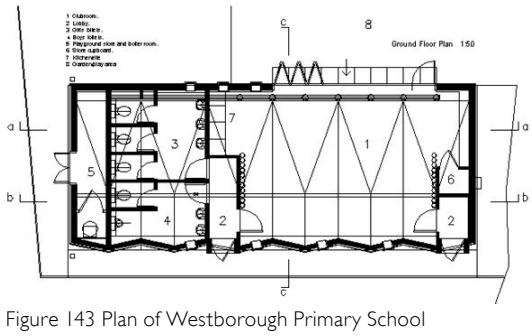


Figure 143 Plan of Westborough Primary School
: DUBS (2007:1 of 1)

7.2.2 EMERGENCE

Water shelter

LOCATION: Zambezi basin in Sub-Saharan Africa
CLIENT: UNHCR and NGOs in Mozambique and Zambia
USER: Displaced residents of Dodanduwa, Sri Lanka
DESIGNER: Robert Nightingale
MAJOR FUNDING: UNHCR and NGOs in Mozambique and Zambia

DESCRIPTION:

The design meets four basic needs: shelter; drinking water; transportation and product information; promoting healthy behaviour by recycling water through its roof construction. The topic of emergences is supported by a three phase strategy:[4]

(a) Transit: temporary tent structure for habitation whilst travelling to safer area.

(b) Transition: after arriving at the final destination the design allows the incorporation of local materials to increase in size and volume.

(c) Rebuild: the design becomes a structural template for future construction

4 Nightingale (2007:[1 of 1])

7.2.3 TRANSITION

Safe[R] House

LOCATION: Sri Lanka
DATE: 2005
CLIENT: Prajnopaya Foundation
USER: Displaced residents of Dodanduwa, Sri Lanka
DESIGN TEAM: Harvard Graduate School of Design, SENSEable City Laboratory, Massachusetts Institute of Technology [MIT]
MAJOR FUNDING: Architecture for Humanity, Prajnopaya Foundation
COST PER UNIT: $1,500
AREA: 37 sqm

DESCRIPTION:

The Saferhouse was designed to resist the force of a tsunami. It replaces the core of the house with four C-shaped concrete structures.[5] These core structures are what was of interest as they allow the occupant to complete their dwelling with their own choice of materials and style.

This slight modification of traditional building techniques helps communities build their homes back safer which is a very important longer term goal.

5 Architecture for Humanity (2006:126)

7.2.4 ALTERNATIVE MATERIALS

Westborough Primary School

LOCATION: Westcliff-on-Sea, Essex, UK
DATE: 1999-2002
CLIENT: Westborough Primary School
USER: Displaced residents of Dodanduwa, Sri Lanka
ARCHITECT: Cottrell & Vermeulen Architects, UK
ENGINEER: Buro Happold
QS: Buro Happold
CONTRACTOR: CG Franklin Building Ltd.
CONTRACT VALUE: £177,157[6]
AREA: 91 sqm
LIFESPAN: 20-25 years

DESCRIPTION:

The project marks a breakthrough for cardboard as a viable building material. The collaborative approach between built environment professionals, the client, manufacturers and other research partners resulted in a building constructed of 90% recycled and recyclable materials.

Inspired by origami the project successfully encapsulated the structural properties inherent to folded paper structures.[7]

6 Royal Institute of British Architects (2002)
7 Fuad-Luke (2002:238)

7.3 FLAT PACK SHELTER

7.3.1 Global Village Shelters

LOCATION: Grenada
DATE: 1995-2005
USER: Displaced residents of Grenada
DISASTER: Hurricane
DESIGN FIRM: Ferarra Design, Inc.
MAJOR FUNDING: Architecture for Humanity; Weyerhaeuser, Inc.; Ed Plant; and other individual donations.
COST PER UNIT: $400
AREA: estimated 6 sqm
LIFESPAN: 8-12 Months
DESCRIPTION:

More than a 100 different experimental forms were designed before finding the right method for this design.

Made from laminated corrugated cardboard, the hut can be erected in less than an hour by two people using only a set of diagrams and common tools.[8]

The shape relates to the archetype of a typical western house and it remains questionable whether the design is suitable to the context it was designed for.

8 Architecture for Humanity (2006:74)

Figure 144 6sqm Meter Shelter: On site assembly instructions **:** Global Village Shelters Llc. (n.d.)

Figure 145 Niigata Paper House **:** Shigeru Ban Architects (2004:[1 of 1])

7.3.2 Niigata Paper Shelter

DESIGNER: Shigeru Ban Architects

DESCRIPTION:

Shigeru ban has long been using of cardboard in his designs. The design is made up from square cardboard tubes and was developed after the Niigata earthquake to be an internal shelter allowing privacy in the large spaces used to house those affected by the disaster.

Figure 146 Hexayurt at the Burning Man Festival **:** Hexayurt Project (2003)

7.3.3 Hexayurt

DESIGNER: Rocky Mountain Institute

DESCRIPTION:

This modern interpretation of the classic Central Asian nomad housing uses modern materials, such as insulation board, to create a shelter that can be easily assembled for disaster relief in developing countries. The design has been worked out so to minimal cutting is required of the materials and the components can be assembled simply with tape.

Figure 147 Octagon Shelter **:** Sago Mokuzai (2009:[2of5])

7.3.4 Octagon

DESIGNER: Sago Mokuzai, Japan

DESCRIPTION:

This deployable shelter comprises of a series of precut cardboard panels that slot together to form an octagonal dome. The shelter is transported flat pack in two boxes weighing 40kg each. Once assembled the boxes used for transport can be cut and used as a floor covering. The shelter is kept dry through the use of reflective waterproof membrane and is estimated to last for 6 months.

Figure 148 reCOVER Shelter : Malone (2008:[1of1])

reCOVER Shelter

DESIGNERS: Matthew Malone, Amanda Goldberg, Jennifer Metcalf and Grant Meacham

DESCRIPTION:

The shelter is designed for rapid deployment in disaster relief. It is said the 100% polypropylene structure can be erected in minutes by one person. This seems highly unlikely as it is rather large and made from a single sheet. Structural stability, ventilation, fire retardancy and ground sheeting elements are not addressed. It is however highly adaptable to various environments and its flexibility in transport and configuration has merit. The shelter can be folded into a flat sheet for shipping, or collapsed into a horse shoe shape.

Figure 149 Ha-Ori Shelter : Student (2003[1of1])

7.3.5 Ha-Ori Shelter

DESIGNER: Joerg Student of IDEO

DESCRIPTION:

The Ha-Ori shelter was created by Joerg Student for his masters at Royal college of Art. Developed from nature (hornbeam leaf) the folds and rigid structure of the leaf started to develop ideas of a collapsible shelter. It is made from one sheet of polypropylene which is folded into the designed shape. Roughly 2.4 feet high when folded out and weighs 36 Kg makes it easy to transport.

Figure 150 Transmitter diagram and assembly of SHELL HOUSE : Pino (2007)

7.3.6 Shell House [living portable]

DESIGNER: Open Architecture Network

DESCRIPTION:

SHELLHOUSE-[living portable] is a collapsible, recycled cardboard shelter for homeless people. The idea is to provide mobile communications to those who do not otherwise have access to peer contact. Each shelter comes equipped with a radio device providing the occupant with a portable address.

This design displays an innovative use of low tech and temporary elements.

Figure 151 Folding Shelter : Schipper (2008:[2of2])

7.3.7 Schipper

DESIGNER: Daniel Schipper, Netherlands

DESCRIPTION:

Origami inspired folding shelter made from misprinted milk packaging. Tetrapak is very durable compared to raw cardboard and can therefore have a longer life span.

Figure 152 Extreme Housing : Architecture for Humanity (2006:121)

7.3.8 Extreme Housing

DESIGNER: Deborah Gans, Matt Jelacic, Philadelphia

DESCRIPTION:

Gans and Jelacic have looked into Extreme Housing for people displaced in many forms. Using an array of materials from lightweight structural ceramic foam to bamboo. This scheme, completed for the Transitional Housing competition, describes a reconstituted house using a ruined wall.

The volumetric units / pods

Figure 153 Red + Housing : Redhika db (2009:[8of19])

7.3.9 Red + Housing

DESIGNER: Obra Architects

DESCRIPTION:

Red + Housing incorporates both the advantages of fast-response solutions with that of transitional solutions.

The design adheres to '10 points of architecture on the edge of survival' put forward by the design team: universal application, effective performance, economical, transportable, ease of assembly, renewable materials, digital pre-fabrication, open work, urban/rural application and flexibility of use.

“ designed objects:

beauty beyond prettiness

value beyond usefullness

passion beyond

affection ”

: Geometrical Manifesto[9]

7.4 SHELTERING ELEMENTS

Almost immediately after the event of a disaster the sheltering process starts with elements that shelter the body: bandages, blankets, clothes, etc. The process of recovery begins with humble elements that grow to define interior space, even before the exterior shell is inhabited.

Kronenburg[10] explains that “we rearrange objects and possessions because it helps us establish a sense of place.”

This sense of place is one of the many intangible losses experienced by displaced individuals. Seemingly simple objects can become an important step in the recovery process through arrangement, adaptability, flexibility and change.

As is often the case with emergencies, anticipated volume exceeds capacity and thus a product is proposed to mediate between such situations by utilising limited space more effectively and providing the displaced with much needed privacy.

9 Denzel (2008:[1of1])
10 Kronenburg (2002a:20)

EMOTIONALISM: COGNITIVE PATH OF PRODUCT

In the last section of this chapter precedents are selected to investigate the importance and cultural significance of surface in interior architecture.

Emotionalism is an important part of what drives our consumerist society, it is often emotion that determines whether or not to engage with an object. Designed products connect emotionally with the end user are usually assigned a high value.

Figure 154 Interior of the De Heredia Winery : Etherington (2007:[1 of 1])

7.4.1 R. Lopez de Heredia winery

DESIGNER: Zaha Hadid

DESCRIPTION:

An elegant example of how structural elements come to define the interior atmosphere. The the wall carries through function to become shelving and storage.

Figure 155 Inside the Kid's Republic activity room : Kim (2009:[1 of 1])

7.4.2 Kid's Republic bookstore

DESIGNER: SKSK Architects, Beijing

DESCRIPTION:

Kids Republic is a children's bookstore in Beijing. The innovative use of colour cultivate an atmosphere of curiosity and play.

Figure 156 Inside the Lilja portable chapel : (2006:57)

7.4.3 Lilja Portable wooden chapel

DESIGNER: Vesa Oiva, Finland

DESCRIPTION:

Although not collapsible or deployable the wooden chapel remains under the portable category as it is made up of prefabricated plywood panels, allowing the structure to be dismantled and reassembled at different locations.

The simple yet delicate addition of a plywood tree motif provides the structure with the ephemeral qualities becoming of a meditative space.

Figure 157 Furniture made from a single sheet of plywood : Urbanist (2008:[1 of1])

7.4.4 desFURNITURE

DESIGNER: desFurniture Group

DESCRIPTION:

desFurniture[11] likes their pieces to: *"push the boundaries of efficiency while maintaining craftsmanship."*

Many of their designs originate from a single sheet of plywood using no fasteners, adhesives or tools. Such principles are ideal for emergency situations where tools and assembly skills are limited.

Figure 158 Doca Autunno coffee table : Laissezfaire (2007:[1 of 1])

7.4.5 Doca Autunno coffee table

DESIGNER: Italy

DESCRIPTION:

This flat pack table from cardboard made from two sheet. The table uses the principles of origami to fold together without the need of any tools.

Figure 159 + The Portananos crib : Sabine7 (2008:[1 of 1])

7.4.6 +The Portananos

DESIGNER: Mark Sapetti, Spain

DESCRIPTION:

The Portananos is a lightweight crib for babies up to six months. Made from recycled cardboard the flat pack principle allows for easy transport and assembly.

11 Urbanist (2008:[1 of1])

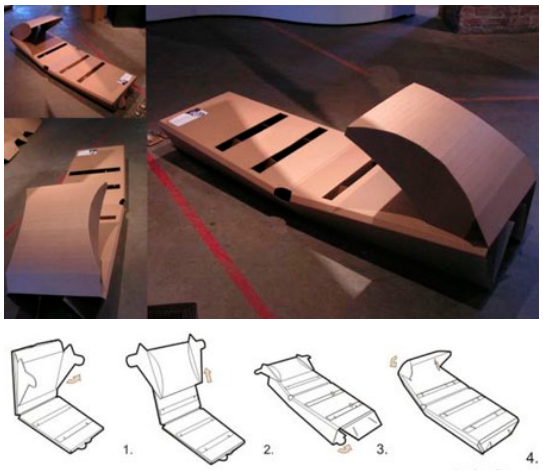


Figure 160 Assembly of disposable cardboard bed **:** DesigneRoof (2008: [1 of 1])

7.4.7 Disposable Cardboard Bed

DESIGNER: Nikolay Suslov, Russia

DESCRIPTION:

A cheap and disposable bed[12] made from corrugated cardboard sheet, and treated with a waterproof substance. It folds up and is easy and light to carry.

When in the reclined position the bed is 20cm high, successfully keeping the user away from the cold floor.

Figure 161 Assembly of Itbed **:** http://www.it-happens.ch/eng/bett_1.html (n.d:[1 of 1])

7.4.8 Itbed

DESIGNER: Design It, Switzerland

DESCRIPTION:

The bed frame consists of foldable triangular sections that can be flat packed for storage and unfolded when needed.

Made from 7mm thick corrugated cardboard it serves as simple application of the basic structural properties of cardboard.

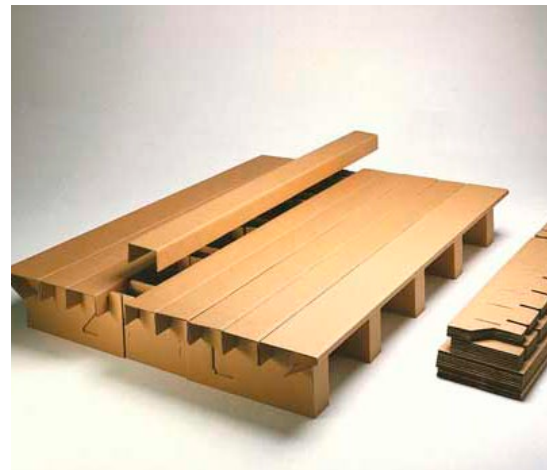


Figure 162 Bett "Dream" Assembled bed illustrating structural components **:** Stange Design (Art no. 2010)

7.4.9 Das Original Pappbett

DESIGNER: Stange Design, Berlin

DESCRIPTION:

A complete flat packed product that sets up into a bed base from precut and scored elements. Designed in such a way that allows for extra storage space, with the option of purchasing accompanying roll out drawers.

The application of folded elements provided a sturdy and reliable long term solution.

12 DesigneRoof (2008: [1 of1])

Figure 163 Chair of textures **:** Tjep (2006:[1 of 1])

7.4.10 Chair of Textures

DESIGNER: Tjep

DESCRIPTION:

Chair made out of layers of stainless steel, lasorcut and folded to the user's discretion.

Figure 164 A collection of pillows **:** Ganszyniec (2008:[1 of 1])

7.4.11 A collection of Pillows

DESIGNER: Maja Ganszyniec, Poland

DESCRIPTION:

A collection of pillows in various shapes and sizes with holes and cut outs. The design was inspired by the unique and different way every individual sleeps.

The design takes a very mundane object and makes it very personal and encourages play.

Figure 165 Red + Housing **:** Redhika db (2009:[6of19])

7.4.12 Red + Housing chairs

DESIGNER: Obra Architects

DESCRIPTION:

Plywood chairs were designed to join together like puzzle pieces. The fabrication method allows for detailing assembly details directly on chairs.

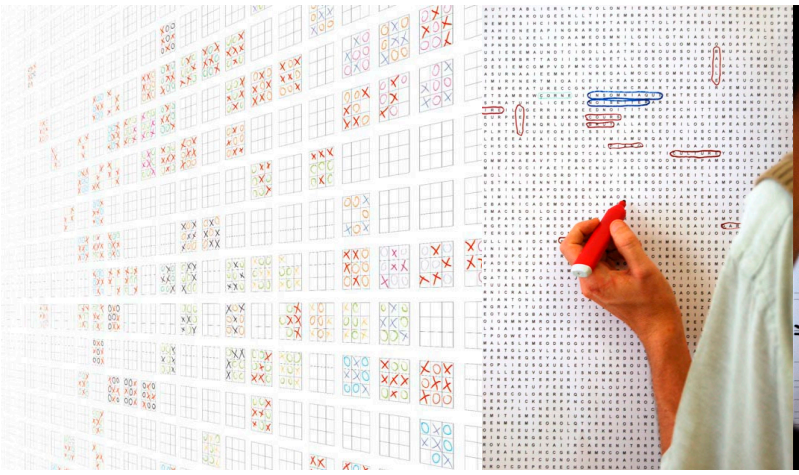


Figure 166 Wallpaper games-Morpion-édition Lutèce-2006 **:** 5.5 Designers (2006a:[2 of 3])

7.1.1 Wallpaper Games:

DESIGNER: 5.5 designers, France

DESCRIPTION:

Referred to as 'expression surfaces' the wallpaper provides the canvas for spontaneous interaction, encourages play allowing the each space to take on a unique character depending on the colour pens used.

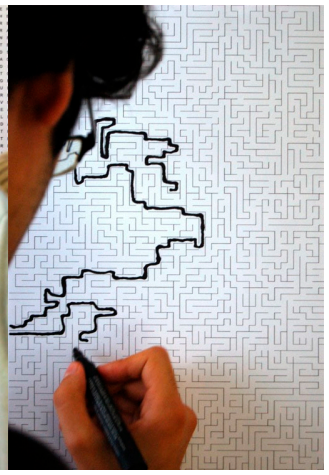


Figure 167 Wallpaper Games-mots mêlés-édition Lutèce-2006 **:** 5.5 Designers (2006b:[1 of 6])

7.1.2 Wallpaper Games: Maize

DESIGNER: 5.5 designers, France

DESCRIPTION:

Wallpaper maizes.

Figure 168 Do frame tape by for Droog **:** Guixé (2006:[1 of 4])

7.1.3 Do Frame tape

DESIGNER: Martí Guixé,

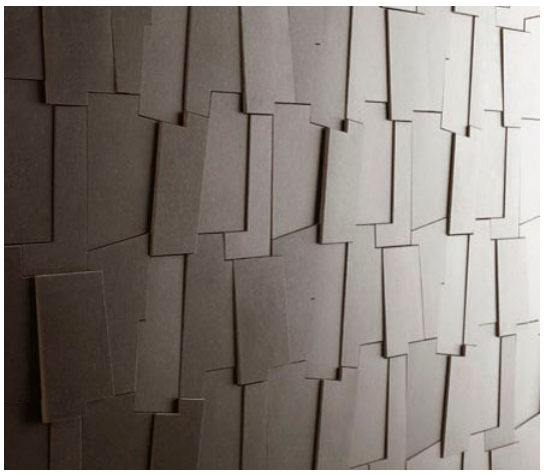


Figure 169 Soho tiles **:** Marazzi USA (2008:[36 of 37])

7.1.1 Soho Tiles

DESIGNER: Marazzi, USA

DESCRIPTION:

Decorative porcelain wall tiles mimicking the texture of over paper overlapping.

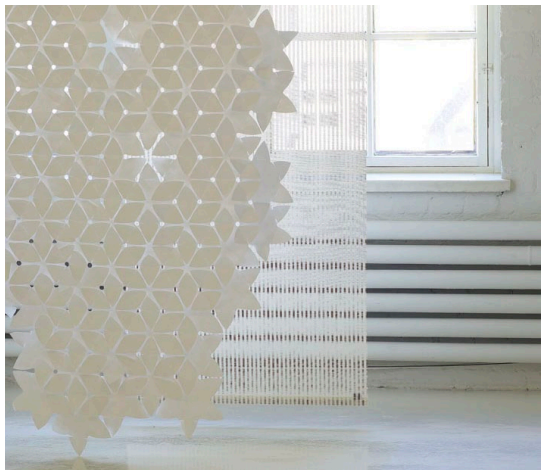


Figure 170 Flake curtain **:** Cullin (2007:[1 of 1])

7.1.2 Flake Curtain

DESIGNER: Mia Cullin, Switzerland

DESCRIPTION:

Flake and flower patterned curtain made from Tyvek that can also act as a partition.

Figure 171 Tableau tablecloth for Droog **:** Scheltens (2005:[1of 1])

7.1.3 Tableau tablecloth

DESIGNER: Maurice Scheltens, The Netherlands

DESCRIPTION:

Dutch photographer created a table cloth decorated with the aftermath of a dinner party. Made using a photogram technique.

Figure 172 Avocado box: dotted lines indicate structural design elements that increase the overall strenght of the box

08 | MATERIAL SELECTION

The rationale for investigating cardboard as a feasible alternative was instigated by the structural integrity demonstrated in an avocado box and gradually developed to become the primary material in the development of the design proposal.

Cardboard is in the process of developing from a packaging material into a structural material with it's own language in terms of architecture. This chapter provides the grounds for establishing cardboard as a viable building material.

The construction of a seemingly innocuous avocado box is intriguing; a well engineered product designed to withstand the cold and damp of a refrigerated container, the lateral forces of a ship rolling at sea and the pressure of a ton of other boxes on top of it, all within strict material economy.

The box serves as an remarkable example of the strength and resilience that cardboard can achieve. The technology is there and available for use in the architectural field, it's just not entirely accessible. Eekhout,Verheijen & Visser[1] Maintains that:

> The paper and cardboard industry has a lot of knowledge about these products, but in an entirely different field of application and on a completely different scale than in the building industry, where materials are described with mechanical and physical characteristics and accepted rules (like tensile strength, bending strength and classification of quality).

Van Dooren & Van Iersel[2] describes this difference as a difference in thinking:

> An architect thinks in square metres and a paper manufacturer in grams; for the architect A4 is 210 x 297 mm, for the manufacturer 80 grams.

The unknown qualities of cardboard requires it's own architectural language.[3]

> In further research, the demanded mechanical and building physical characteristics, standards, design rules and guarantees will have to be determined. Each industry has it's own 'language', with specific definitions and values. Cardboard, as it's currently produced, is meant for packaging etc. The machines and mind set are aimed at just that.

The use of cardboard in the building industry would require the adoption of architectural standards and terminology for the development of a variety of 'building grade' cardboard.

The thesis aims to contribute to the feasibility of cardboard as a building material through employing an interdisciplinary approach. For this a certain degree of working knowledge is required to encapsulate the principles of the packaging industry into a plausible architectural solution.

8.1 WHY CARDBOARD?

Up till now research has revealed some of the most prevalent pressures involved in disaster response. Establishing a framework of shelter guidelines and context have provided sufficient parameters for concept generation and material selection. The following attributes were deemed important in PART ONE.

8.1.1 ADVANTAGES:

(a) Economy

It goes without saying that economy will always be a primary concern when it comes to developing sheltering solutions. This is not just to the advantage of the relief organization/ donor but could also have great potential in offering the end user with an adaptive longer term use.

1 Eekhout,Verheijen & Visser (2008:44-45)

2 Van Dooren & Van Iersel (2006:58)
3 Van Dooren & Van Iersel (2006:58)

Studies[4] have shown that when cardboard is used/applied [as insulation] in conjunction with other typical low cost construction materials, the improvement in thermal insulation can decrease annual energy expenditure by up to 75%.

Another benefit in designing with a low cost material is that it provides a reasonable margin for experimentation and testing of ideas and applications.

(b) Weight

The light weight of the material is very desirable for transport and handling during assembly.

(c) Availability

Cardboard is essentially a recycled product. It is readily available just about anywhere. The manufacture of cardboard is a huge industry in South Africa and has one of the highest recycling rates of any material, employing a virtual army of the very poorest in the collection for recycling.

(d) Manufacturing

Corrugated cardboard is manufactured in standard size 3-3.6m x 2.4m sheets that are available in a wide range of thicknesses [paper weight] and profiles.

Die cutting is a very flexible and low cost, high volume process. It uses steel rulers attached to either a 'roller' or a flat plate to cut and crease corrugated cardboard sheets into the designs. Tens of thousands of the same patterns can be cut from a single die.

(e) Post production: colour printability

It must be said that once the functionality of the product could be proved the flexibility of die patterns and graphic design presented the most exciting opportunities for the interior atmosphere.

The freedom of providing endless variations of interior spaces, at minimum cost, enables the project to improve the living environment disaster victims mostly have to contend with.

4 Mathews *et al* (1995:)

(f) Sustainability / life span

Sustainability is imperative. Sinclair[5] maintains that:

> [w]hen you are living on survival, sustainability is not a choice its a way of life; you have to know where your energy and your resources come from and to use them in the most efficient and innovative way.

Cardboard is a natural material from a renewable resource - in essence it is already recycled and can be recycled again and again once its served it's purpose.

Untreated cardboard is an environmentally positive material. There are various additives and coatings available that can be added during and after the manufacturing process to enhance the material properties.

Although "In a number of cases when the properties of cardboard improves the ability of the material to be recycled decreases".[6]

It is important to be aware of these implications - shall be discussed later in this chapter.

(g) Strength

In an interview with Verb Crises Shigeru Ban[7] points out that; "the strength of a structure is not dictated by the strength of the individual materials."

Cardboard displays similar properties to that of wood. It is an anisotropic material (strong dependant on direction of use) Hence Ban referring to cardboard as 'evolved wood'.[8]

For the purposes of the study the following rules of thumb[9] suggested bu Van Dooren & Van Iersel where used:

> Actual rules of thumb or calculated data, used in the building industry for the mechanical properties of materials, have not yet been acquired. For now we can only give a coarse direction. The compression and tensile strength differ depending on fibre direction; parallel to the machine the strength is greater than perpendicular to it (anisotropy; comparable to the character of wood).

5 TEDtalks (2006)
6 Eekhout, Vermeijen & Visser (2008:43)
7 Verb Crises (2007:120-121)
8 Van Dooren & Van Iersel (2006:16)
9 Van Dooren & Van Iersel (2006:66)

The strength of cardboard primarily depends on the raw material composition, method of production and material structure.

Material can either be from virgin fibers [VF] or recycled fibers [RF]. Virgin fibers demonstrate a slightly higher resistance to moisture than recycled fibers. The production method influences the fiber direction.

Some of the main cardboard products available in South Africa are:

Figure 173 Corrugated cardboard profile

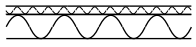


Figure 174 Roller die used to cut shapes out of flat sheet corrugated cardboard, Nampak Corrugated

Figure 175 Dufaylite is an expandable honeycomb structure used in hollow core doors, Disaki

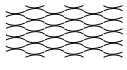


Figure 176 Xanita board is made from layers of corrugated cardboard

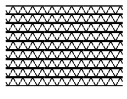


Figure 177 Stacked angle boards at the Disaki factory, Wadeville

Figure 178 Stacked cardboard tubes at the Disaki factory, Wadeville

L O

8.1.2 CONSTRAINTS

At first glance moisture and flammability are the most prominent issues constraining cardboard from being used in buildings.

(a) Creep

Cardboard is susceptible to creep[10], limiting the span it can effectively achieve. This can be overcome through choosing a structural system [construction method] that strengthens the material and increase rigidity.

Eekhout, Verheijen, & Visser[11] have found that "[w]ith a folding construction relatively large spans can be made because of the form stiffness achieved by the shape of the structure".

Cardboard's susceptability to creep depends on the type of board and medium, where the pressure is applied and relative humidity the cardboard is exposed to.

(d) Poor moisture tolerance

Cardboard has a relatively low moisture tolerance which greatly influences it's structural properties. Van Dooren & Van Iersel[12] explains that "[u]ntil about 7% of water inside the cardboard it retains its basic strength. This equals the humidity of a 'normal' indoor climate. When the amount of moisture exceeds 7%, the strength diminishes rapidly."

Humidity can be mitigated through additives and coatings such as PE foil (multished) or waterproofed with a polyethylene film (PET). UV light breaks down the top protective layer within 3-6 months. The use of polyethylene is not ideal as South Africa has rather severe sun exposure - globally South Africa constitutes 60% of the total countries receiving more than 6kW/hours per day.

(c) Vulnerable to concentrated loads

Glued connections are the most stable. Because of cardboard's fiber structure point load connections should be avoided. The packaging industry use a variation of gluing, stitching [stapling] and tape to distribute the load the package has to withstand.

(d) Insects

Cardboard is a cellulose material and again, as in the case of wood, requires protection from insects and pests. This can also be solved by applying additives during the manufacturing process.

These constraints should be seen as a design challenge that can open up new possibilities and juxtaposition.

10 Eekhout, Vermeijen & Visser (2008:42)
11 Eekhout, Verheijen, & Visser (2008:35)
12 Van Dooren & Van Iersel (2006:70)

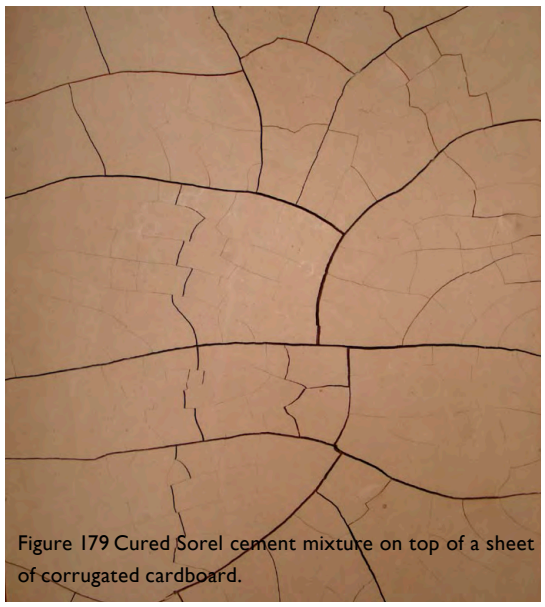


Figure 179 Cured Sorel cement mixture on top of a sheet of corrugated cardboard.

8.2 MATERIAL EXPERIMENTS

8.2.1 FIRE RESISTANCE

Sorel cement is a mixture of magnesium oxide and magnesium chloride. It is lighter than other cement products, has excellent fire resistance properties but poor water resistance.

Sorel cement is widely used in[13] industrial floorings, fire protection products, grinding wheels, abrasive stones and artificial stone ornaments.

DESCRIPTION:

A mixture of Sorel cement was applied to a corrugated sheet to evaluate how it bonds to cardboard and how it reacts to an open flame.

CONCLUSION:

Sorel cement becomes brittle upon setting which does not work well with the flexibility of the cardboard sheet. The mixture is too thick to penetrate the cardboard, and instead forms a layer on top of the sheet. The water content of the mixture drains quickly leaving the cardboard soggy and causing the cement to cure too fast.

Given this, the layer of Sorel cement provided an excellent fire resistant coating, even under extreme temperatures the cardboard did not singe or catch fire.

13 Nedmag Industries Mining and Manufacturing B.V (2009:[1of1])

Figure 180 Brittleness of Sorel cement after curing on cardboard

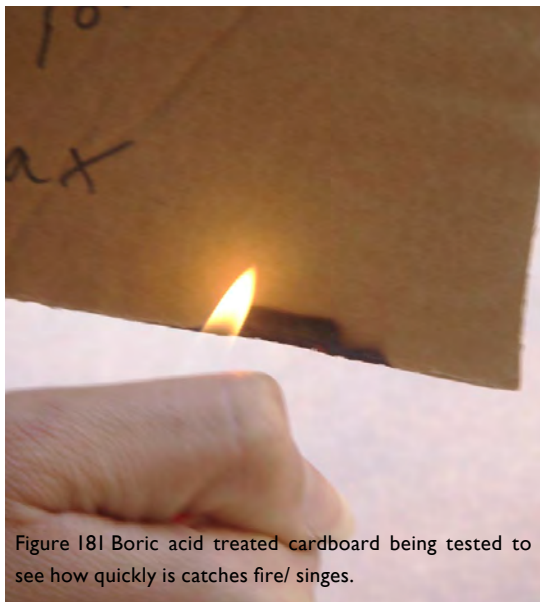


Figure 181 Boric acid treated cardboard being tested to see how quickly is catches fire/ singes.

8.2.2 FIRE RETARDANTS

Boric acid is a salt of the Borax compound [also known as sodium borate, sodium tetraborate/ disodium tetraborate]. It is a water soluble white powder consisting of soft colourless crystals.

Boric acid is used in a variety of applications[14] such as weatherproofing and fireproofing fabrics, ointments, eye drops, soaps, as a preservative, in the manufacture of cements, glass, leather and artificial gems, as an insecticide for cockroaches and carpet beetles, and in fungus control for citrus fruits.

The Smart Living Handbook[15] suggests soaking cardboard in a solution of boron as a low cost fire retardant before installing it as insulation.

DESCRIPTION:

Two experiments were conducted one using a 4% solution of Borax and the other a 8% solution. The cardboard samples were soaked in a boric acid solution and left to dry before being tested for rate of ignition.

CONCLUSION:

Both the 4% and the 8% treated cardboard showed significant resistance to burning. Although the 4% singed quicker than the 8%.

14 Australian Government: Department of the Environment, Water, Heritage and the Arts (2009:[1of1])
15 Sustainable Energy Africa, Amathemba Environmental Management Consulting & City Of Cape Town (2009:60)

Figure 182 Cardboard samples being tested (4% and 8% boric acid solution)

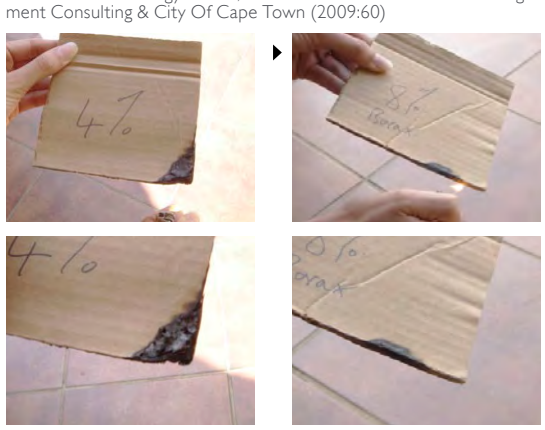


Figure 183 Cardboard frames with various coatings being tested for water permeability

8.2.3 WATER IMPERMEABILITY

DESCRIPTION:

This experiment was intended to be a quick exercise applying as many different coatings with materials commonly found around the house.

The goal was to investigate rate of structural decay when cardboard is exposed to outdoor conditions.

CONCLUSION:

Experiment clearly indicated that where the internal corrugation layer was sealed the integrity of the material remained intact for longer. It is therefor imperative that where possible cardboard should be kept away from the ground unless sealed and used in conjunction with other anchoring materials.

The stone sealant performed remarkably well as did the cardboard shell covered with the self-adhesive film.

◀ DAY OF INSTALATION AFTER 7 DAYS ▶

NONE [control]

[raw material]

AEROSOL PAINT

Plascon Aerolak [gloss black]

TYPICAL APPLICATION: indoor and outdoor use for any spray painting or touch ups

INTERIOR PAINT

Plascon double velvet [dove grey]

TYPICAL APPLICATION: indoor wall finishing

SELF-ADHESIVE FILM

AVERY GRAPHICS [gloss white] PVC FILM: 70 microns ADHESIVE : acrylic solvent based adhesive.

TYPICAL APPLICATION: 3 indoor signage and limited outdoor advertising, year outdoor life.

MASKING TAPE

HSTM.COM [general purpose 18mm]

TYPICAL APPLICATION: General purpose packaging, bundling, holding,splicing masking and labeling for home, school and industry.

WAX PAPER

[semi-translucent]

TYPICAL APPLICATION: used in baking and cooking for its non-stick properties.

STONE SEALANT

GENKEM NOVA 2 Slasto 'n Stone Sealer [clear]

TYPICAL APPLICATION: indoor and outdoor "slasto" and porous stone sealant.

CLING FILM

[clear]

TYPICAL APPLICATION: sealing food items to keep fresh.

WOOD GLUE

HENKEL PONAL Wood Glue: extra strong [clear]

TYPICAL APPLICATION: : suitable for most types of woods and wooden materials, also bonding paper, cardboard and cork - water soluable.

ALUMINIUM FOIL

[silver]

TYPICAL APPLICATION: packaging food and other chemical products.

VASELINE [petrolium jelly]

[clear]

TYPICAL APPLICATION: skin care lotions, general lubricant [eg. rubic's cube].

8.3 COATINGS AND TREATMENTS

FIRE RETARDANTS

WATERPROOFING

INSECTICIDES

UV DEGRADATION

MOST DURABLE COMBINATION OF COATINGS

CeramiBoard®

Is a liquid mixture applied as a coating that impregnates the cardboard becoming hard on curing. It provides the cardboard with a 60 minute fire rating.

This coating increases the cardboard's strength four fold and provides excellent acoustic and thermal ratings. It is estimated that this type of cardboard can last between 20-30 years.

Product can be grounded up and recycled back into the pulping process. The this product competes with materials such as concrete, fibre cement and plaster board that can not usually be recycled.

Ceramiboard is an Australian product. They are currently in the process of commercializing the manufacturing of the product and is of yet not commercially available in South Africa.

Fire retardant additive : Morgan Paper Coaters

Morgan Paper Coaters supplies a fire retardant additive that prevents paper and cardboard products from igniting.

It is locally available yet very expensive for the quantity required for the shelter.

Intumescent coatings: Micon Intusayf

Intusayf is a water based intumescent paint that provides fire resistance to structural steel but has been successfully tested on cardboard. It has an acceptable degree of water resistance and excellent thermal insulation properties. This product is non toxic and environmentally acceptable.

It works by expanding 20 times it's applied thickness, foaming and forming an insulated foamed carbonised char that protects the surface when fire breaks out.

Timber Sealant

As an ad hoc solution some companies[1] apply a timber sealant to provide the cardboard with the neccesary waterproof properties.

1. Willemse (2009)

Polyphen

Polyphen is a plastic coating added during the manufacturing process. It is very durable indoors but would be susceptible to UV degradation when used outside.

This type of coating does not allow cardboard to be recycled into the pulping process again.

Wax Coatings

Self Adhesive Films

HydraBan®

HydraBan® is water based treatment for kraft paper. It imparts a high degree of water repellency while remaining printable and gluable.

Because this treatment is water based treated cardboard can be recycled and repulped.

The product does not increase the strength of cardboard but it enables material to retain its original structural properties under more severe circumstances.

It durability could not be determined but Nampak Corrugated[1] disclosed that they built a fish tank out of Hydraban treated cardboard that retained its integrity for more than a week. It does however remain an expensive product.

1. Van Lingin (2008)

VaporCoat®

VaporCoat® is a recyclable water-based moisture barrier coating for corrugated cardboard and paper. The product protects the substrate from water whilst allowing the transmission of water vapour. VaporCoat® can replace costly, non-recyclable curtain coating, poly-laminated linerboard and plastic bags in many applications.

This coating also provides excellent grease resistance.

Vapourcoat is sold by Morgan Paper Coaters, Durban and costs the same as Hydraban.

Although these products are not made locally they both Hydraban and VaporCoat are commercially available in South Africa.

MOST SUSTAINABLE

Boric Acid

Boric acid is an organic compound of boron. It is a water soluable powder that can be added during the pulping process or as an spray on coating.

Boric acid is commonly used as an ingredient in insecticides for agricultural purposes as well as domestic. It is also applied to cellulose insulation as a fire retardant and insecticide.

Experiments have proven that a 8% solution would suffice for the purposes of the shelter.

Sugarcane Lignin

Australian chemists[1] have developed a new waterproof coating from sugarcane lignin (the organic component that gives the sugarcane plant its structural strength). This new development could potentially replace conventional coatings such as wax and plastic.

This new coating is completely recyclable and can be reused in the pulping process to produce recycled paper. Although not commercially available the product has had very promising test results.

1. ANI (2008:[1 of 1])

BreatheCoat

BreatheCoat is a paint that uses a membrane technology to prevent water from coming in but allows vapour to pass through.

It is a water based paint that requires no under coat and can be painted on wet surfaces. The product is solvent free, nontoxic and environmentally friendly.

Because BreatheCoat paint is supplied in powder form it is easy to transport and can therefor be applied after assembly to extend the life span of the shelter.

CORRUGATED CARDBOARD PROFILE

The basic corrugated sheet consists of two linerboard facings and a corrugated medium (flute)

The liners are usually made from natural kraft (light brown) but bleached kraft is also used (mottled/ white).

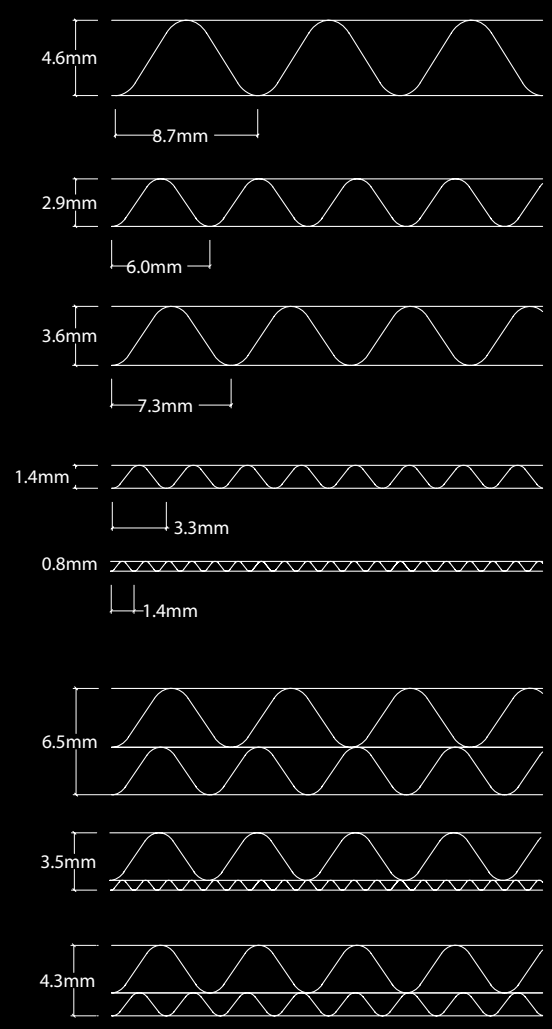


Figure 184 The various corrugated cardboard profiles

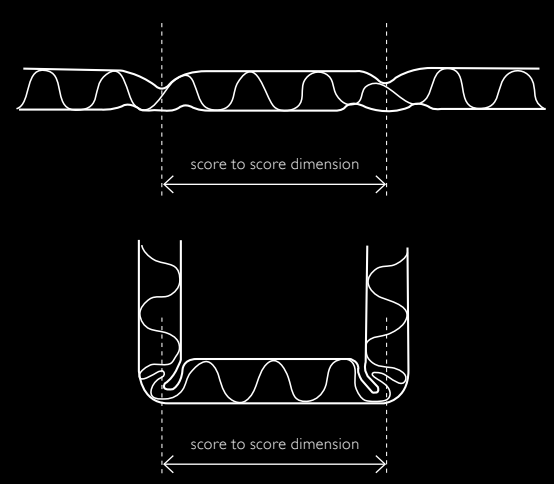


Figure 185 Scoring allowances **:** Kelsey, Forcinio & Hanlon (2005:466) are based on the thickness (caliper) of the corrugated board. *To achieve the given interior dimention the score dimentions should be one thickness farther apart to account for 'inside gain' and 'outside loss'. When the board is folded on the score lines, the scoring dimention fall in the center of the wall.*

FLUTES

Flutes are named in the order of their invention and not according to their size.

A - flute : the original flute and has the highest arch height. Excellent stiffness and short column crush resistance and is most widely used for its cushioning properties.

B - flute : good all round compression strength, compactness, printability and cost effectiveness. Also handles complex die cuts very well.

C - flute : larger than B but smaller than A. It is by far the most commonly used flute type with an estimated[1] 80% of the worlds containers made of C flute cardboard. Although it has greater compression strength but can be more easily crushed.

E - flute : fine flute that provides excellent crush resistance and printability.

F - flute : is just over half the thickness of the E - flute. It is the newest addition to the packaging industry and offers the lowest fibre content of all the other flutes.

BC - flute [double wall] : the combination of B and C flutes offers greater compression and stacking strength.

EB - flute [double wall] : the combination of E and B flutes merging the good compression strength of the B flute with the crush resistance of the E flute with excellent printability. It takes up less space than the EB profile.

BF - flute [double wall] : very strong crush resistance and rigidity as well as excellent printability. It has the lowest combined fibre content of all the double wall profiles, yet remains one of the most expensive.

1 Enviroman (2003:[1of1])

Figure 186 Folded concept model

8.4 LANGUAGE

To successfully posit cardboard in the field of architecture, cardboards requires its own language. One can therefor ask this humble material what it wants to be and Cardboard answers: *Fold me I want to be strong.*

Folding in principle can be approached in a qualitative and a quantitative sense. This project draws inspiration from both.

8.5 FOLDING

8.5.1 MORPHOGENETIC PROCESS

In architecture folding is a **morphogenetic process.** It is generative and essentially experimental.

"Folding[17] is not concerned with creating a new style but rather with searching for links". It is not a linear process, every fold allows you to retrace your steps, every step is a test or exploration of unknown possibilities, becoming a 'map of its origination process'.

In order to progress one has to make choices, therefore within the limitations of folding also lies its innovation.

The fold is more intrinsic than origami as it excludes the logic of the narrative in favour of associative coherence, a language for design. Yet origami remains a powerful tool in analyzing, understanding and manipulating the fold, once the desired pattern has been developed during the experimental process.

To conclude Vyzoviti[18] suggests that: "...we can appreciate the function of folding as a design generator by phase transitions, that is, critical thresholds where qualitative transformations occur."

This view can be adapted and interpreted directly to the problem statement:

We can appreciate the function of ***design*** as a generator of phase transitions, that is, critical thresholds where qualitative transformations occur ***within the long term post disaster relief operations.***

8.5.2 PRINCIPLES OF ORIGAMI

It's just a mater of math. In Lang's opinion[19] someday "all the myriad components of a building might be made from the same simple sheets, folded in myriad ways."

Origami is the Japanese art of paper folding, only one sheet (a square) and no cuts. Kirigami works in a similar way except that small cuts are allowed in the process of folding. Origami revolves around crease patterns. Lang suggests that there are four basic laws that allows one to fold just about anything: using math and engineering principles with the help of advanced computer technology. These 'laws' according to Lang[20] are:

(1) Crease pattern properties

2 colourability: any crease pattern can be colored with just two colours, without the same colour meeting

(2) Mountain valley counting

at any interior vertex M-V = +/- 2: at any vertex the number of valley folds and the number of mountain folds will always differ by 2 [either two less or 2 more]

(3) Angles around a vertex

if you number the angles around a fold in a circle, all the odd numbered angles will add up to 180° and all the even numbered angles will add up to 180°

(4) Layer ordering no self-intersection at overlaps

no matter how folds and sheets are stacked - a sheet can never penetrate a fold

16 Fletcher (2001)
17 Vyzoviti (2006:6)
18 Vyzoviti (2006:8)
19 Holland (2009:27)
20 TEDtalks (2008)

"To express is to drive.

And when you want to give something presence,

you have to consult nature.

And there is where Design comes in.

And if you think of Brick, for instance,

and you say to Brick,

'What do you want Brick?'

And Brick says to you

'I like an Arch.'

And if you say to Brick

'Look, arches are expensive,

and I can use a concrete lentil over you.

What do you think of that?'

'Brick?'

Brick says:

'... I like an Arch' "

: Louis Kahn[1]

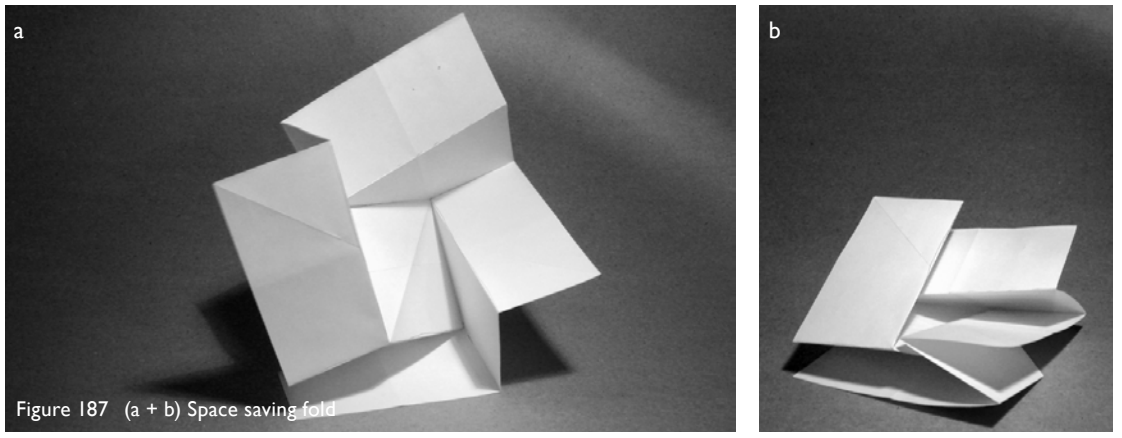


Figure 187 (a + b) Space saving fold

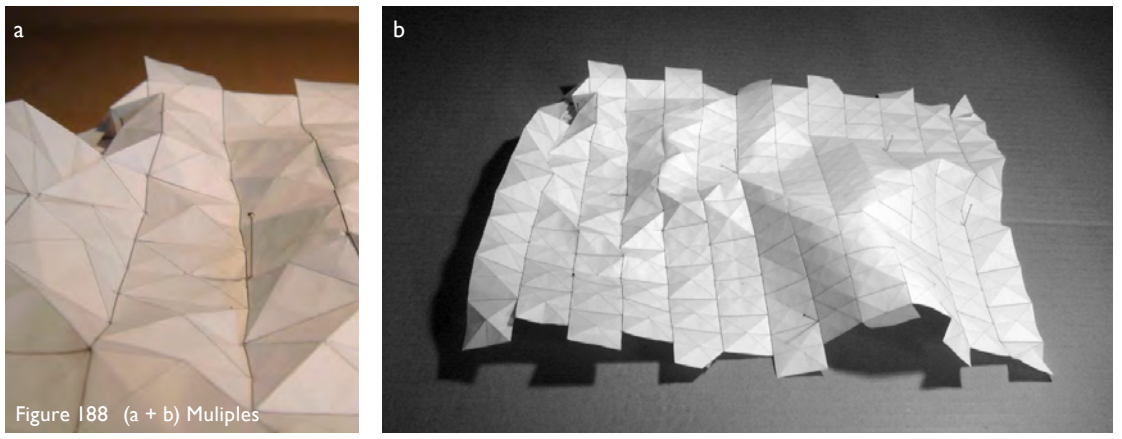


Figure 188 (a + b) Muliples

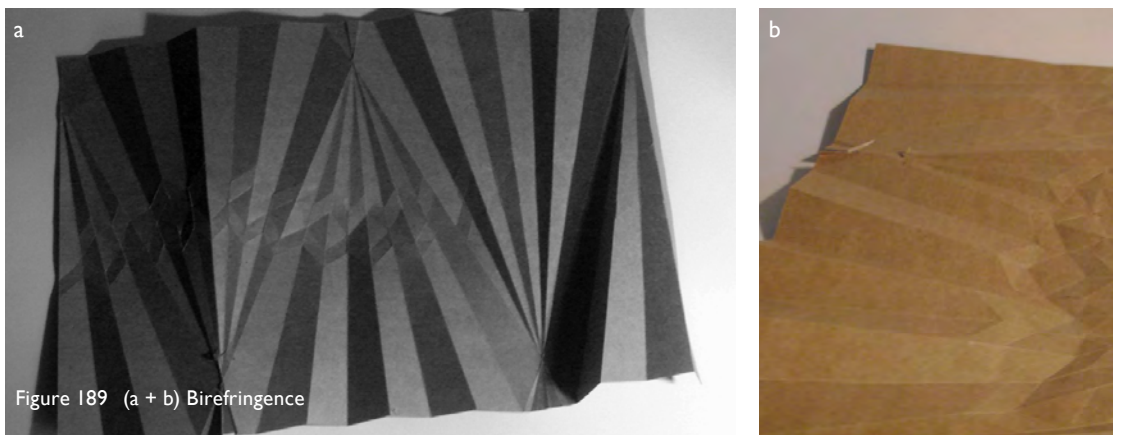


Figure 189 (a + b) Birefringence

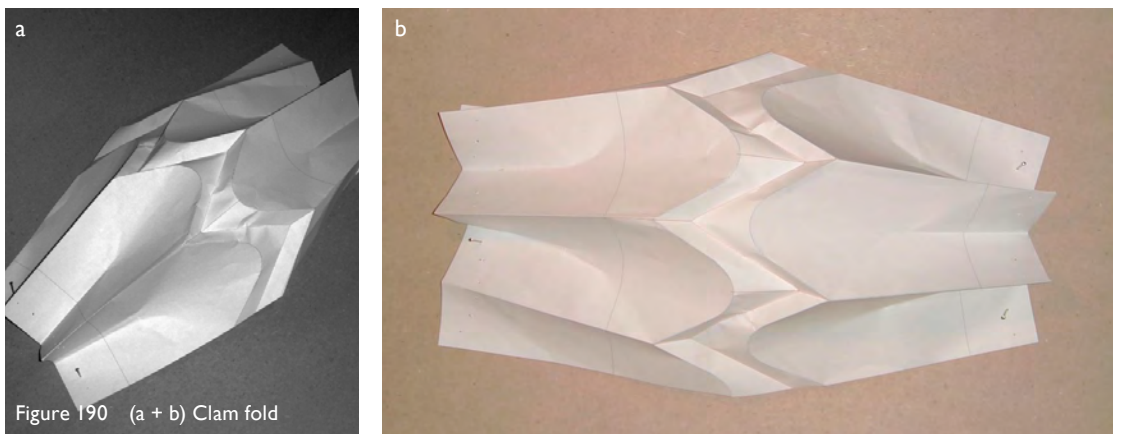


Figure 190 (a + b) Clam fold

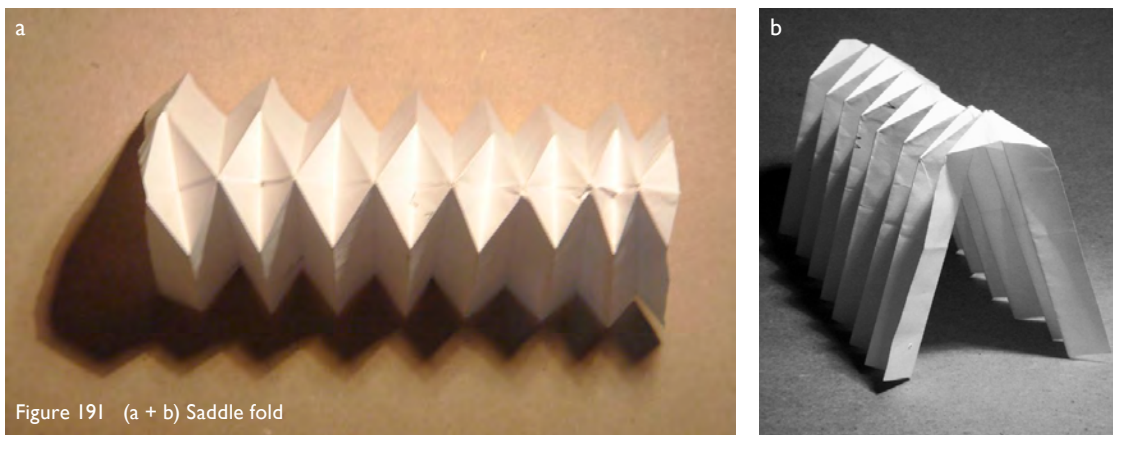


Figure 191 (a + b) Saddle fold

▶ **Functionality**: Does the design meet the primary requirements?

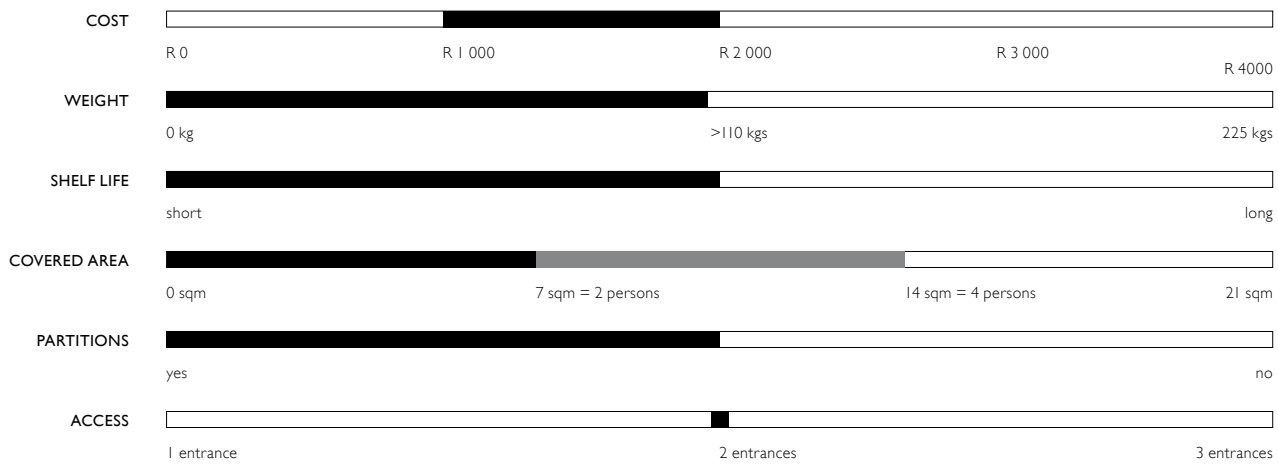
Reliability: Does the design behave in a stable and consistent way?

Usability: Is the design simple and forgiving to use?

Proficiency: Does the design enable the user to do things better?

Creativity: Does the design encourage interaction in innovative ways? Was the design used to explore and create areas that extend both the design and the person using it?

Table 12 Basic requirements



09|DESIGN DEVELOPMENT

The concept development process relied on a series of sketches, paper models, computer generated images and scaled prototypes to investigate the subject matter in terms of Maslow's hierarchy of design needs. Starting with the most basic functional design requirements the following chapter summarizes the main decisions made during the development of the design, addressing needs such as functionality, reliability, usability, proficiency and creativity.

The material chapter has already established a variety of feasible coatings and films to enable cardboard to withstand the prescribed fire resistance, vector control as well as ideas on how to improve water resistance.

So far research has provided the design with the following constraints [Table 12].

The project proposes a shelter unit that is small enough to fit into a room of damaged property or attach onto it. In the event that displacement is necessary the design should be flexible enough to be used as an extension to host families, be set up inside a collective centre, or in worst case scenario clustered to form part of a rural/ planned camp.

9.1 DEFINING A MODULE

9.1.1 3.5sqm ANALYSIS

DESCRIPTION:

In the event of emergency guidelines require 3.5sqm covered space per person. This concept was challenged through evaluation of 3.5sqm in plan, volume and surface area to see:

(a) variations of modular system

(b) most efficient use of material

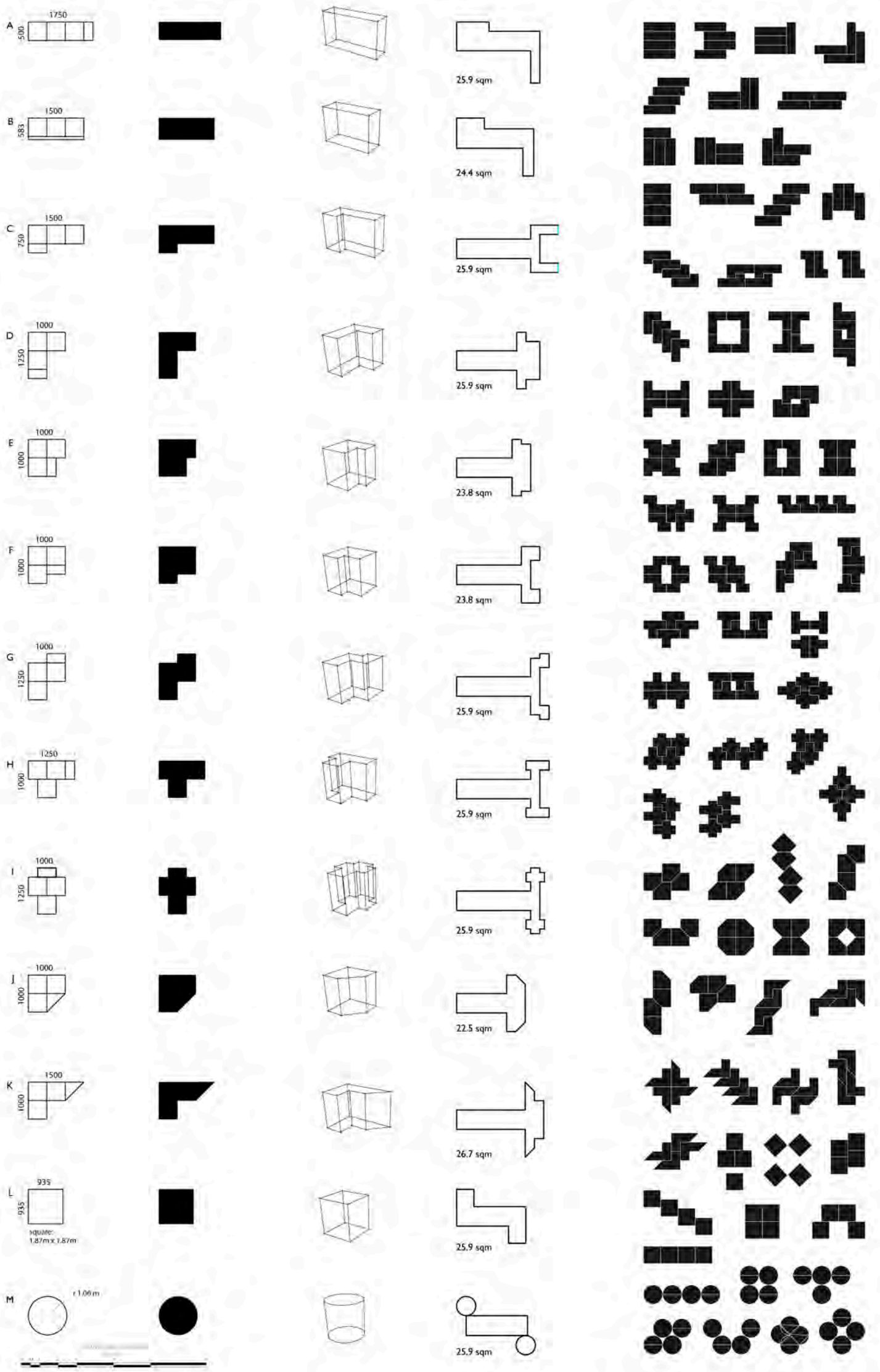
(c) most configuration potential

CONCLUSION:

Option J proved to be the most efficient use of material as well as having the most potential in terms of flexible and practical configurations.

However it was found that single shelter units would be more tedious and expensive to design and further development is focussed on developing 2 person units.

Table 13 3.5sqm Analysis ▶


A
1750
500
25.9 sqm
B
1500
583
24.4 sqm
C
1500
750
25.9 sqm
D
1000
1250
25.9 sqm
E
1000
1000
23.8 sqm
F
1000
1000
23.8 sqm
G
1000
1250
25.9 sqm
H
1250
1000
25.9 sqm
I
1000
1250
25.9 sqm
J
1000
1000
22.5 sqm
K
1500
1000
26.7 sqm
L
935
935
square:
1.87m x 1.87m
25.9 sqm
M
r 1.06 m
25.9 sqm
DIMENSIONS
AREA
VOLUME
SURFACE
CONCEPTUAL COMBINATIONS

Functionality: Does the design meet the primary requirements?

▶ **Reliability:** Does the design behave in a stable and consistent way?

▶ **Usability:** Is the design simple and forgiving to use?

Proficiency: Does the design enable the user to do things better?

Creativity: Does the design encourage interaction in innovative ways? Was the design used to explore and create areas that extend both the design and the person using it?

9.2 CONCEPT A

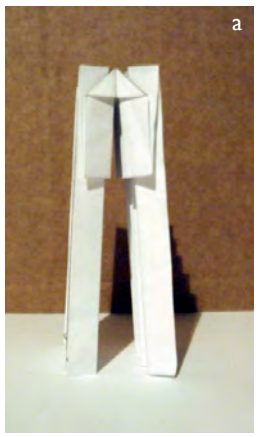
PROCESS:

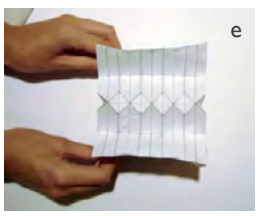
The folding exercise shown in chapter 08 help define possible folds that could become structural.

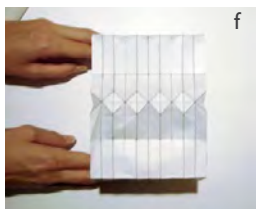
From this the saddle fold was selected and the crease pattern modified to serve as an unfolding roof.

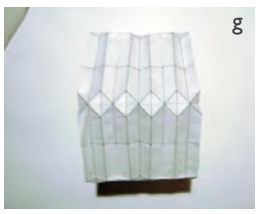
CONCLUSION:

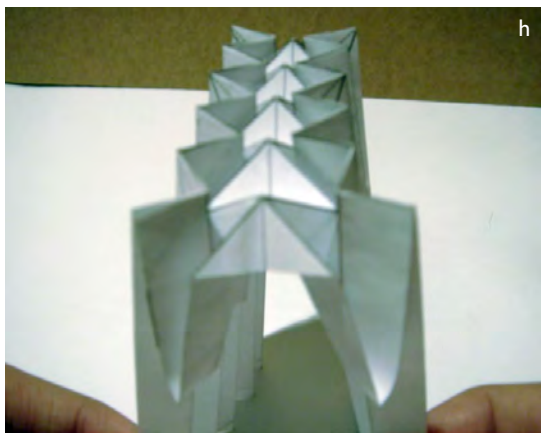
Whilst this type of construction is simpler and easier to assemble - most creases have to fold both ways (in one direction to achieve its passive flat packed state and in another direction to assemble). This is not ideal as it weakens the structure and risks premature failure.

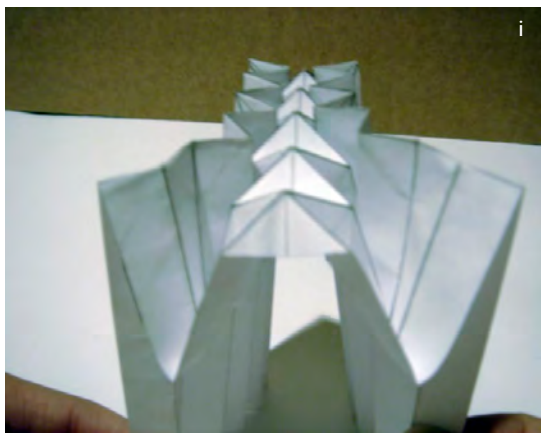


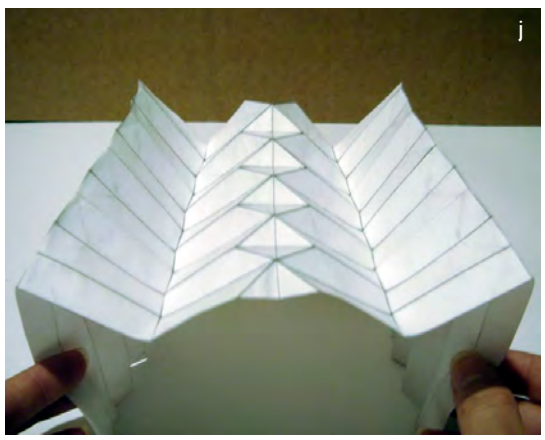


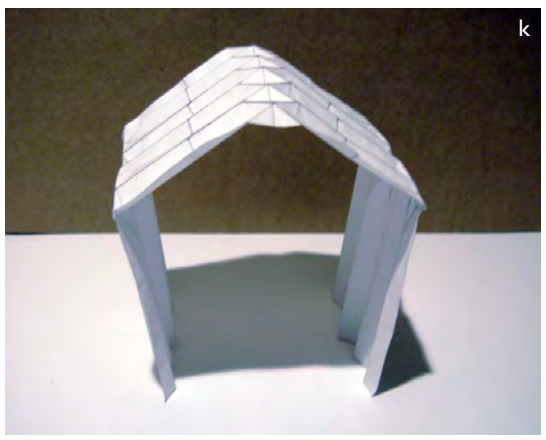


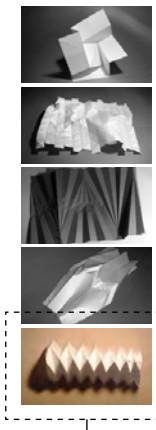


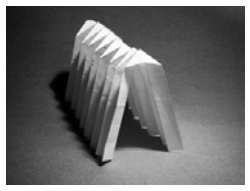


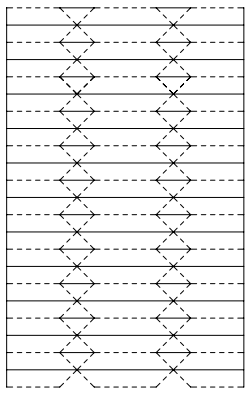


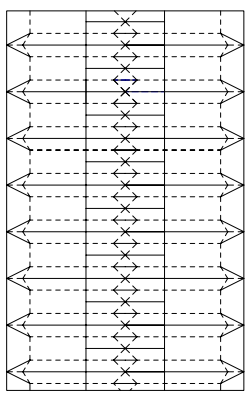












◀ Figure 192 (a-k) Assembly of paper model

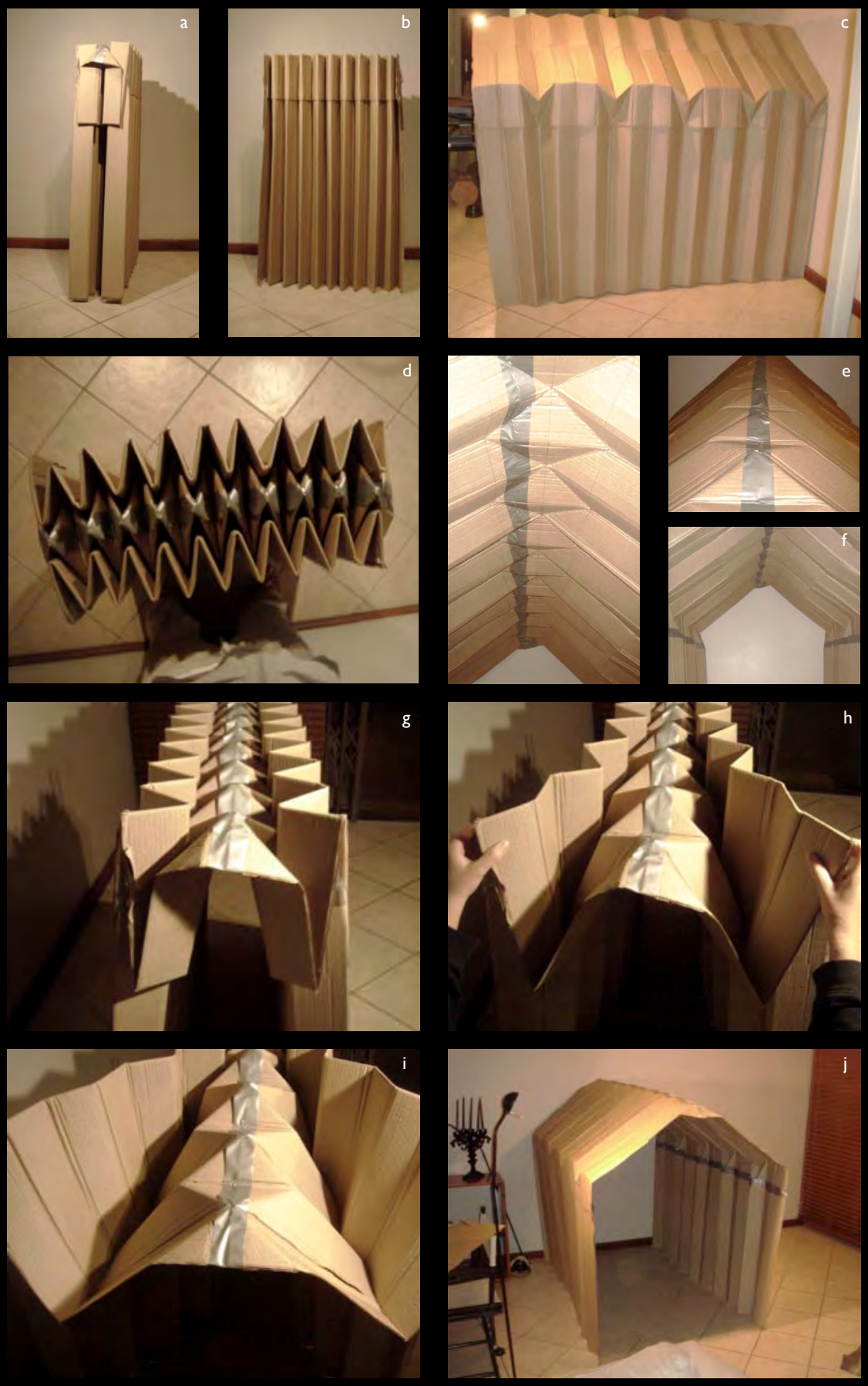


Figure 193 (a-j) Assembly of scaled prototype ▶

Functionality: Does the design meet the primary requirements?

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9.3 CONCEPT B

PROCESS:

A flat roof structural enclosure was developed to evaluate whether it would be more stable than concept A.

The initial concept entailed a structure made of 3 skins (a waterproof skin, a fire resistant skin and an interior skin). The notion was to have the structure pre-assembled in 3-4 sections that can be unfolded joined together on site.

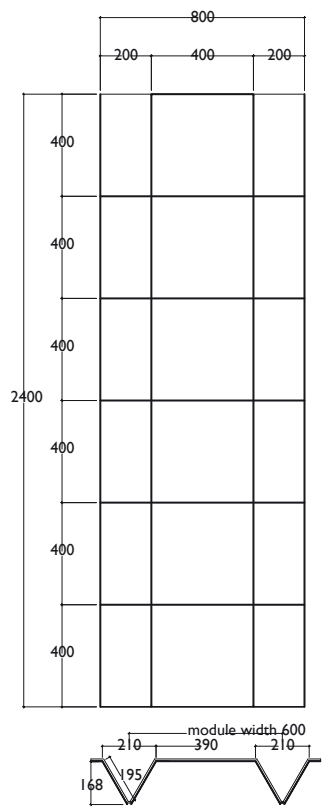


Figure 194 Conceptual module

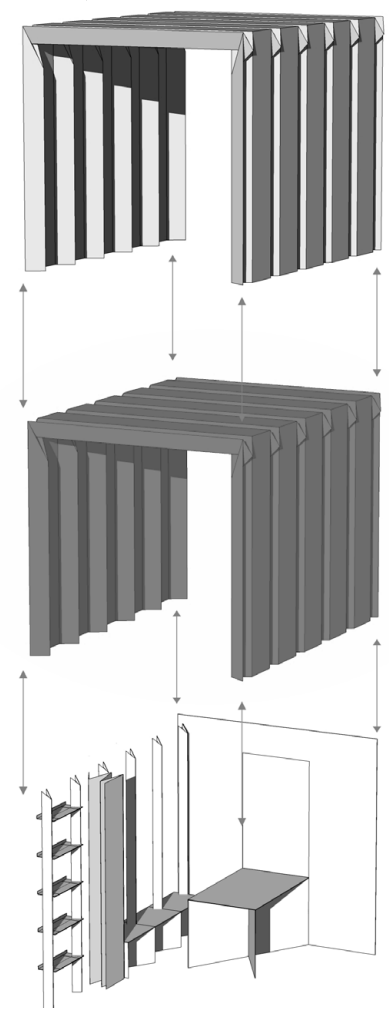
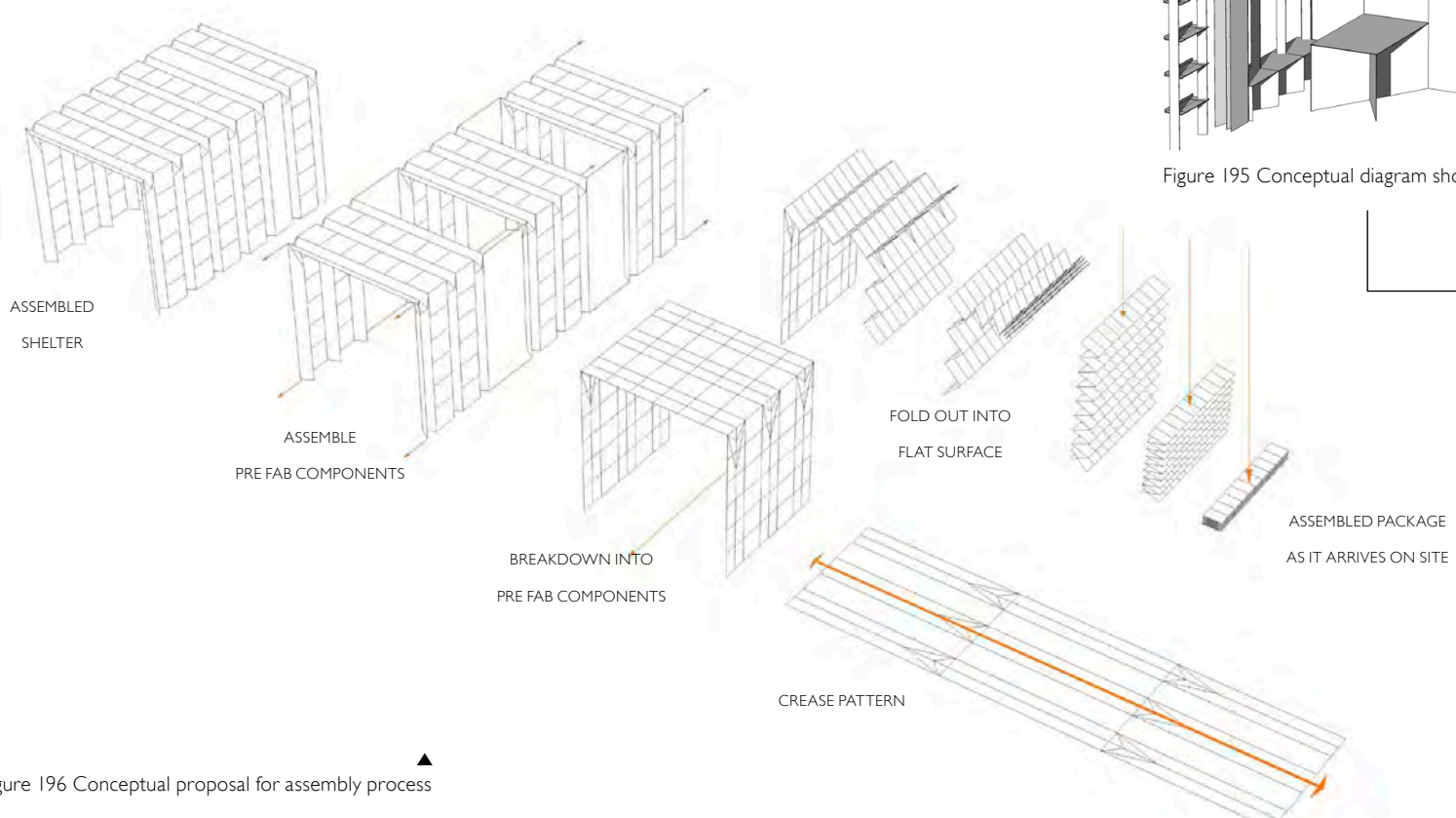


Figure 195 Conceptual diagram showing skins



▲

Figure 196 Conceptual proposal for assembly process

9.3.1 SHELVING CONCEPT

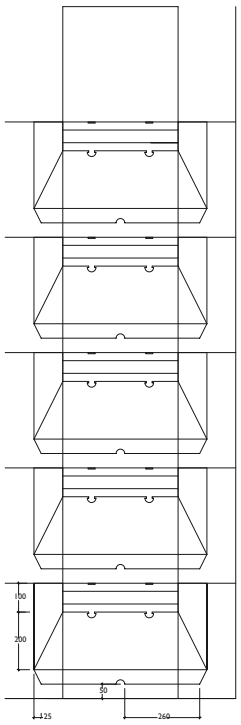


Figure 197 Shelving type A

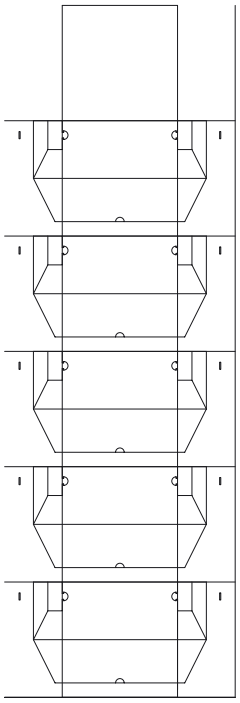


Figure 198 Shelving type B

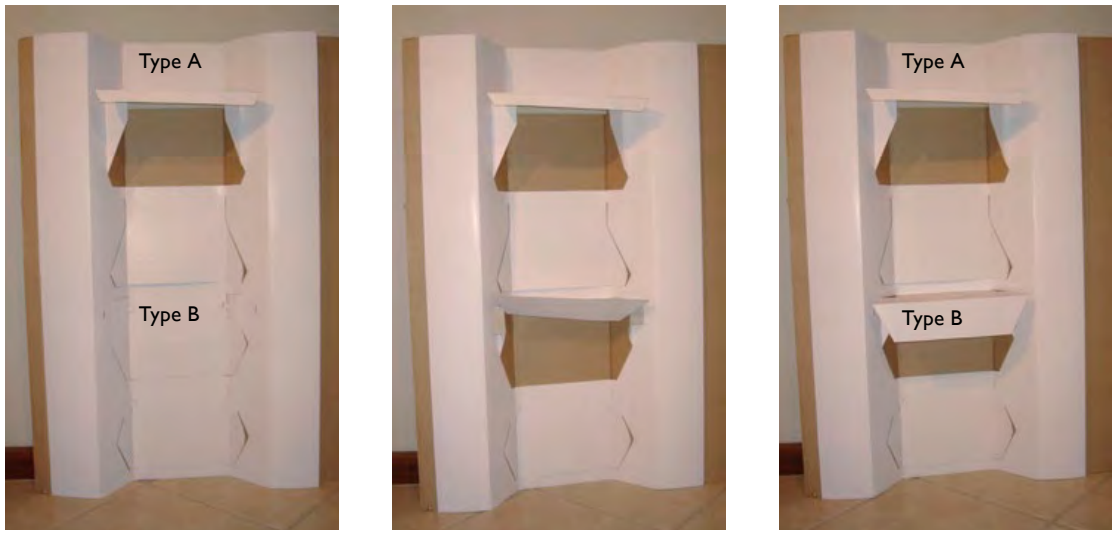


Figure 199 Half scale prototype of shelving component

9.3.2 PAPER MODEL 01

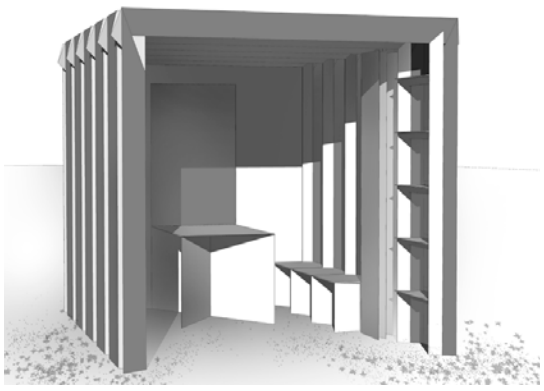


Figure 200 Concept section

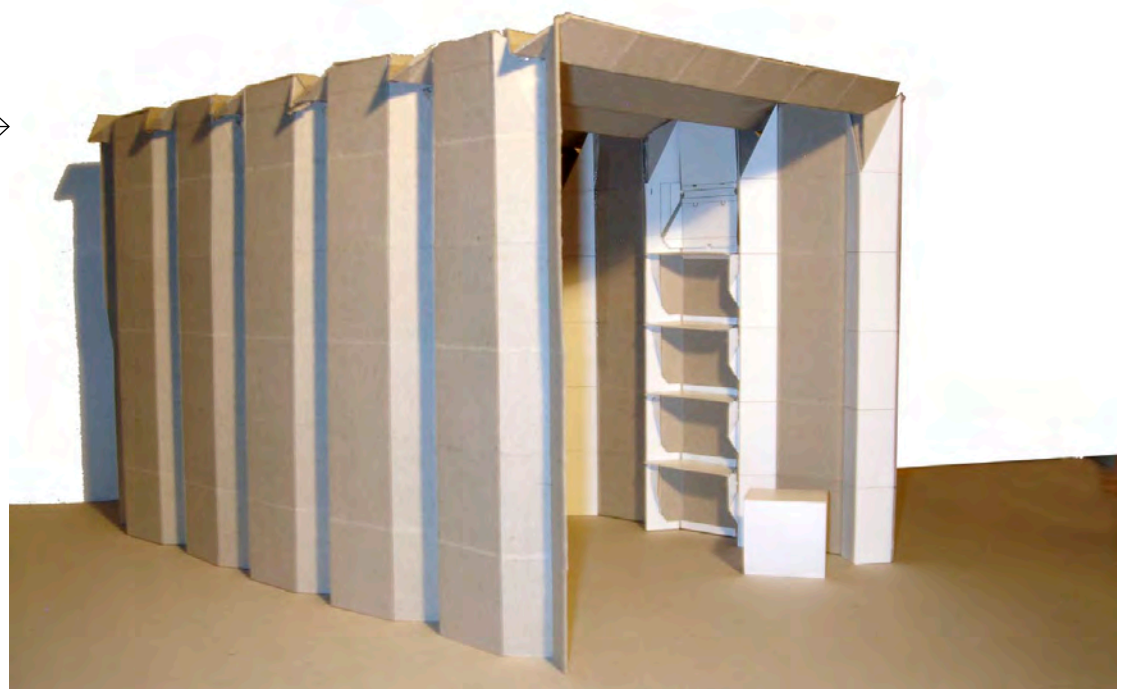


Figure 201 Cardboard model section

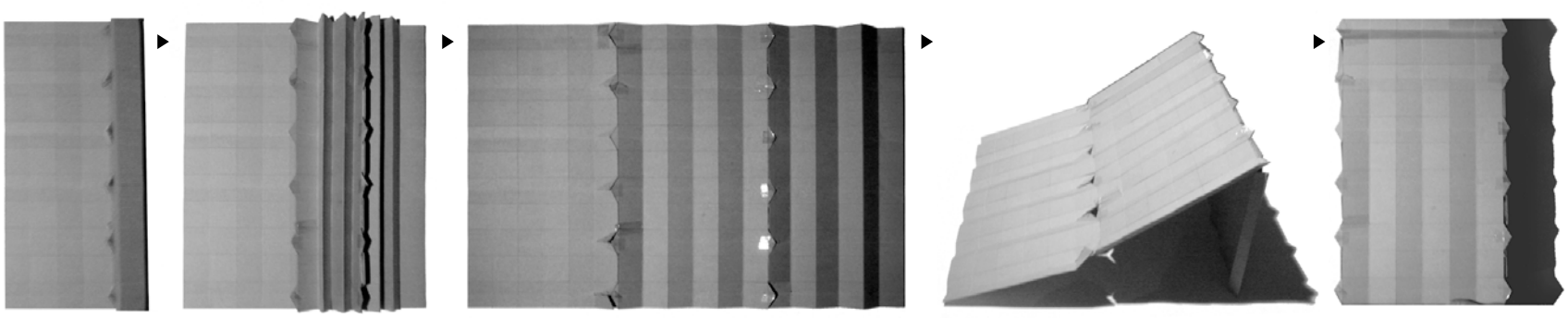


Figure 202 Folding sequence of shelter model: from flat pack to 3D

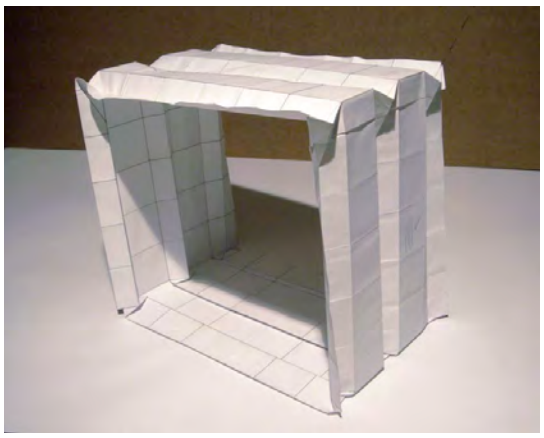
Functionality: Does the design meet the primary requirements?

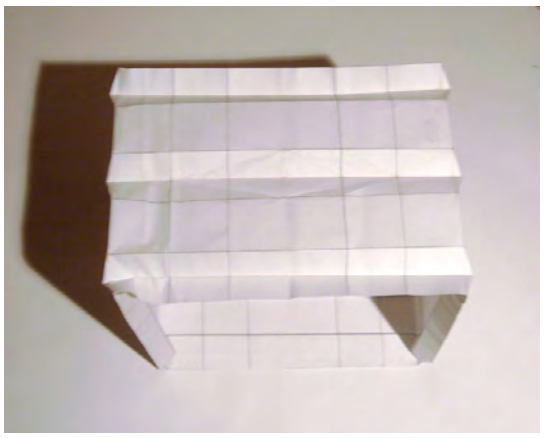
- **Reliability**: Does the design behave in a stable and consistent way?
- **Usability**: Is the design simple and forgiving to use?

Proficiency: Does the design enable the user to do things better?

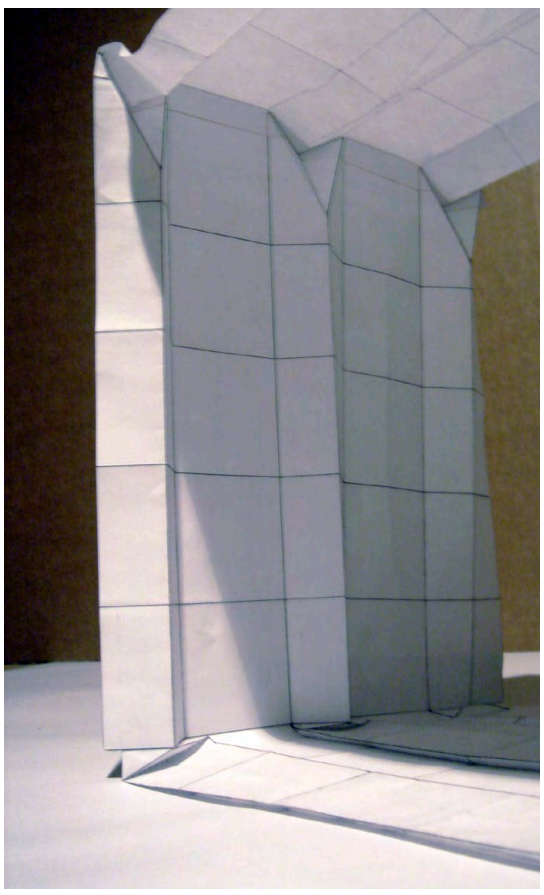
Creativity: Does the design encourage interaction in innovative ways? Was the design used to explore and create areas that extend both the design and the person using it?

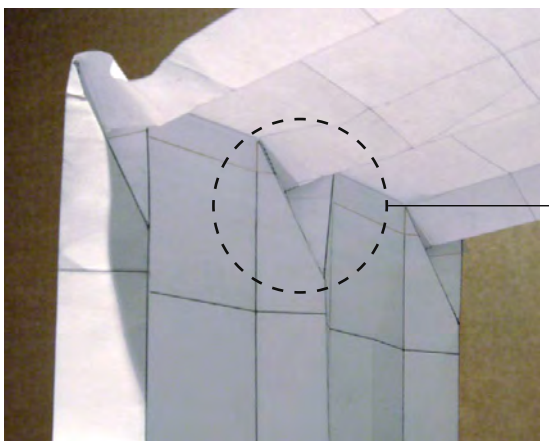
9.3.3 PAPER MODEL 02





◀ Figure 206 The triangular ribs give the shelter its structural strength by exposing the anisotropic properties of the material.





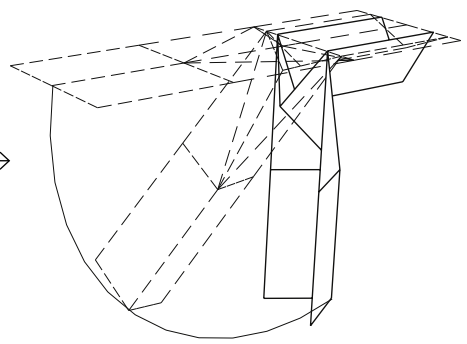
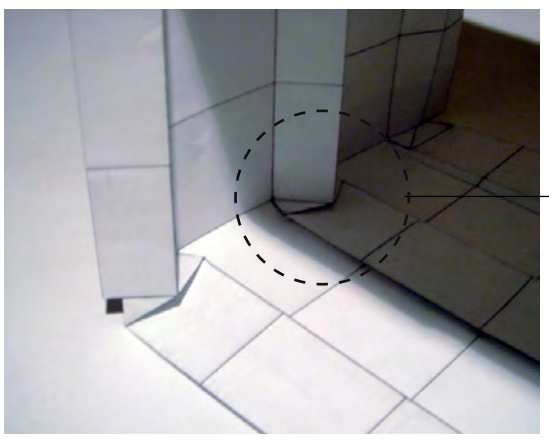


Figure 203 Detail of roof/wall connection fold



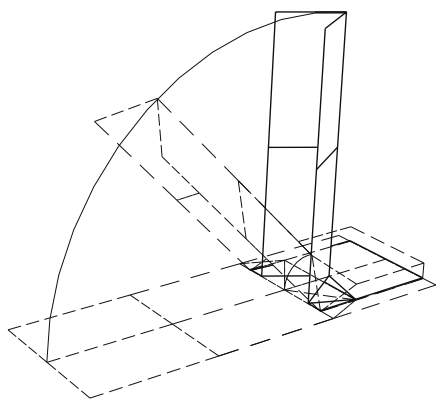
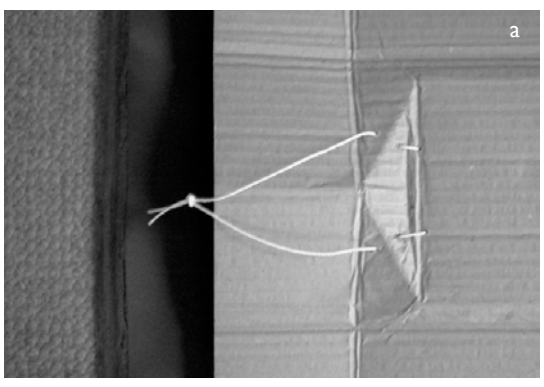


Figure 204 Detail of floor/wall connection fold



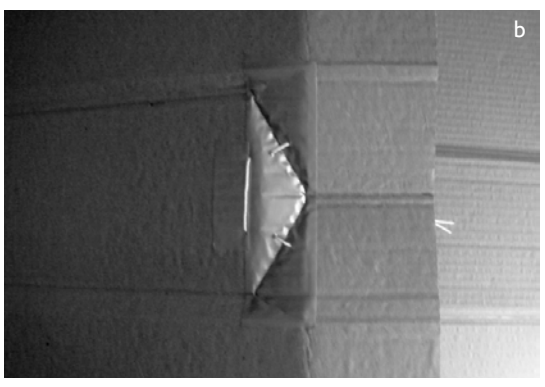


Figure 205 Details a + b show the floor/wall fold. Prototyping was a valuable exercise as the fold does not work as effectively in corrugated cardboard as with paper.

9.3.4 PROTOTYPE B

Figure 210 Half scale prototype of concept B

9.3.5 DEVELOPMENT OF PARTI FOLD

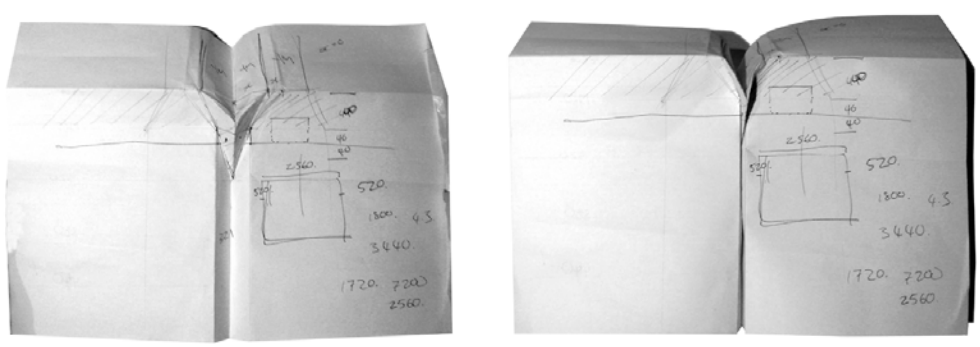


Figure 207 Fold Parti

Figure 208 Paper model of parti

Figure 209 Prototype of parti

Functionality: Does the design meet the primary requirements?

Reliability: Does the design behave in a stable and consistent way?

▶ **Usability**: Is the design simple and forgiving to use?

Proficiency: Does the design enable the user to do things better?

Creativity: Does the design encourage interaction in innovative ways? Was the design used to explore and create areas that extend both the design and the person using it?

10.1.1 ASSEMBLY

CONCLUSION:

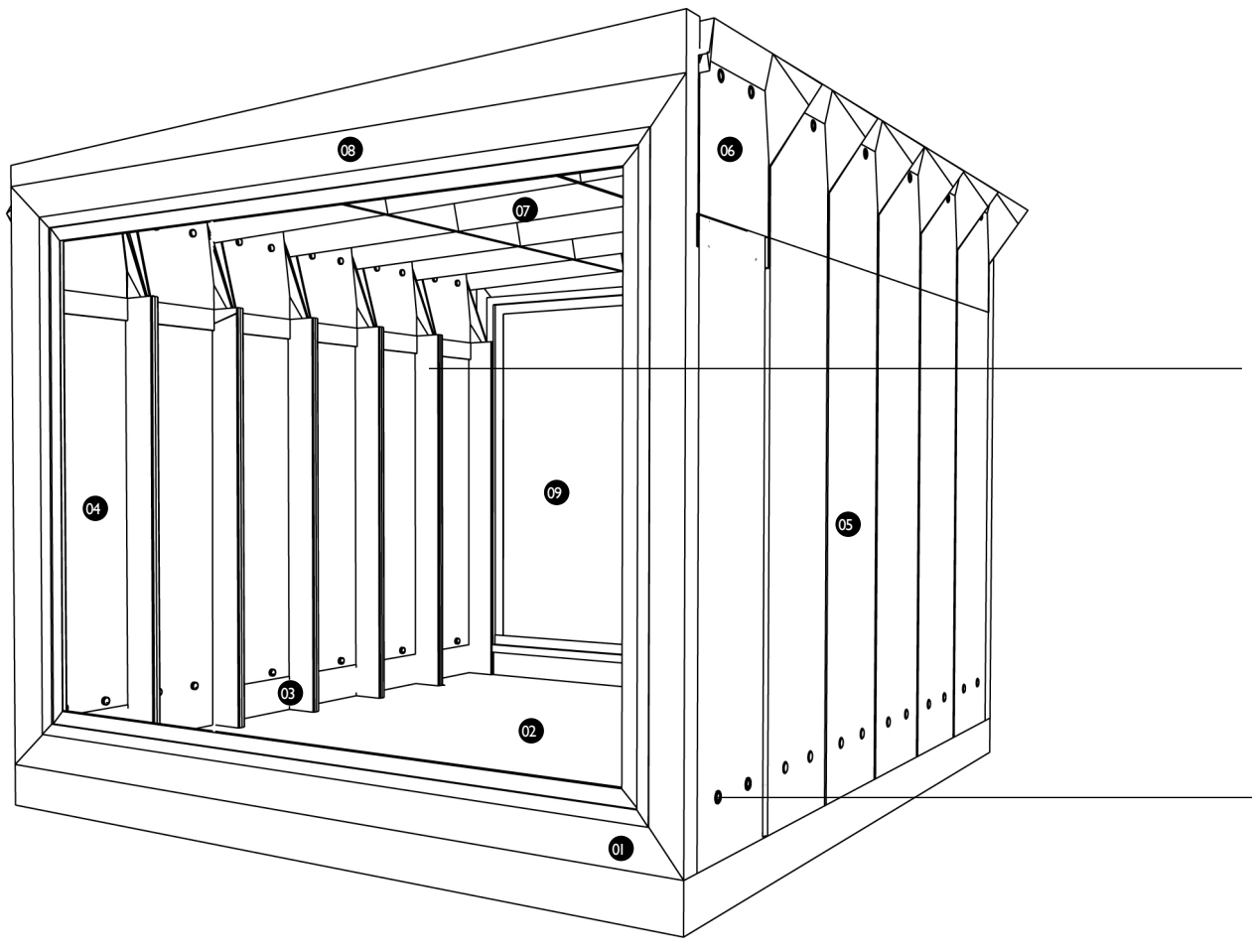
The concept requires both primary (parallel to the corrugations) and secondary folds (perpendicular to the corrugations) which is not ideal. The assembly, which seemed simple to do with paper models, proved much more difficult in real life.

Figure 211 (a-l) Assembly of flat roof prototype

The proposal responds to disaster by developing a 2 person [or single parent and 2 small children] shelter. A rapidly deployable flat pack shelter made of an insulating , renewable resource. The flat pack shelter has varous iinterior componenets that

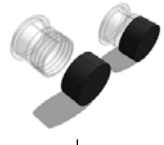
10 | DESIGN SYNTHESIS

Figure 212 PHOTOGRAPH Fire in Rietvlei : Holtphoto (2008:[1of53])



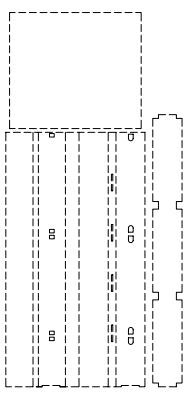
2 part plastic studs
40 + 2 extra

ventilation caps
48 + 2 extra



10.1 KIT OF PARTS

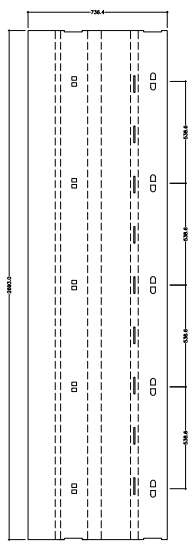
01



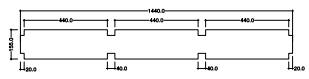
PACKAGE PART 01:

volume: 0.04m3
dimensions: 780mm x 1800mm x 30mm

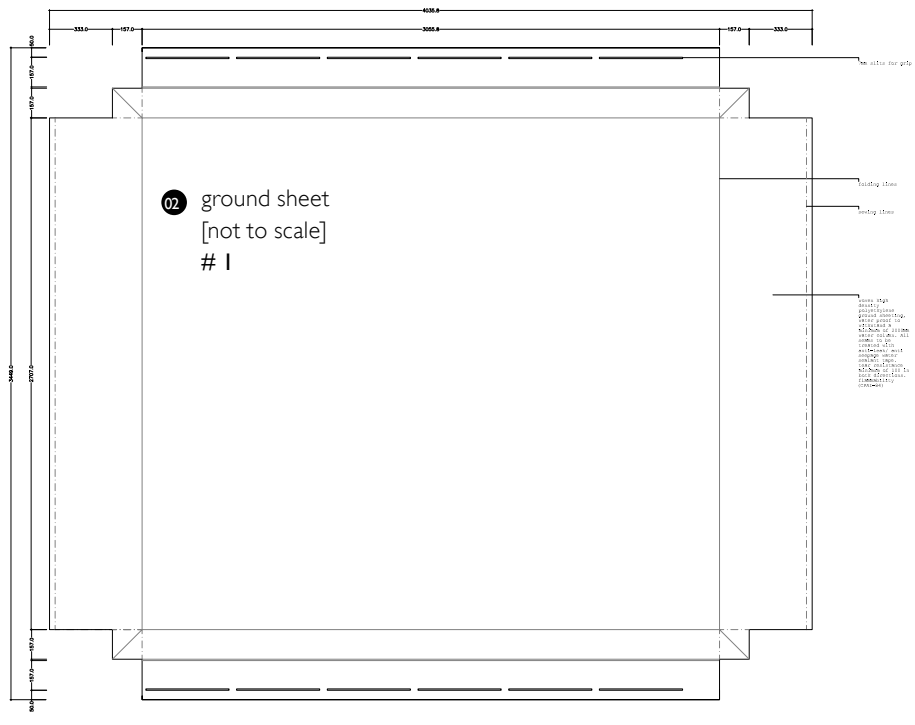
01 floor beams
[not to scale]
2

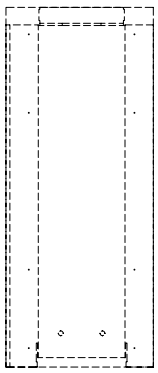


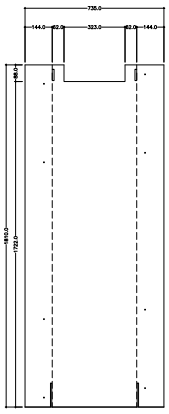
03 wall braces
[not to scale]
4



02 ground sheet
[not to scale]
1

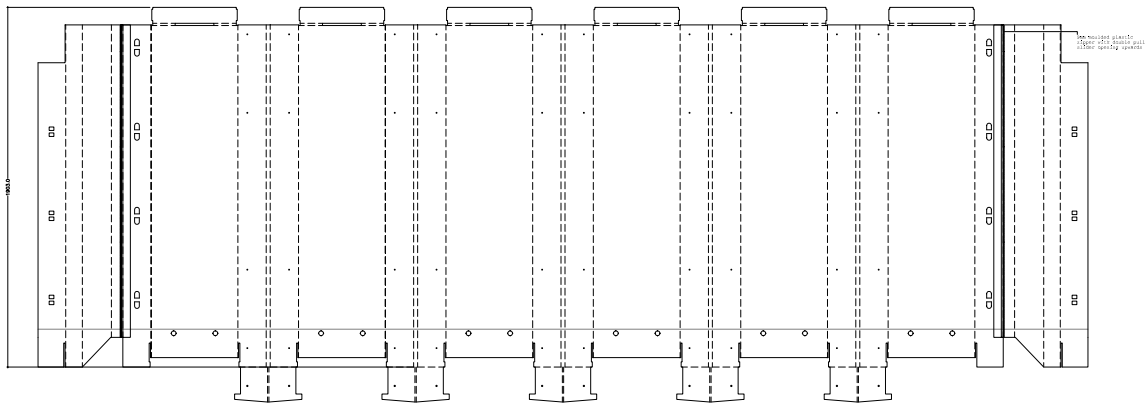






04 interior components
[scale 1:20]
12

05 external wall sections
[scale 1:20]
2

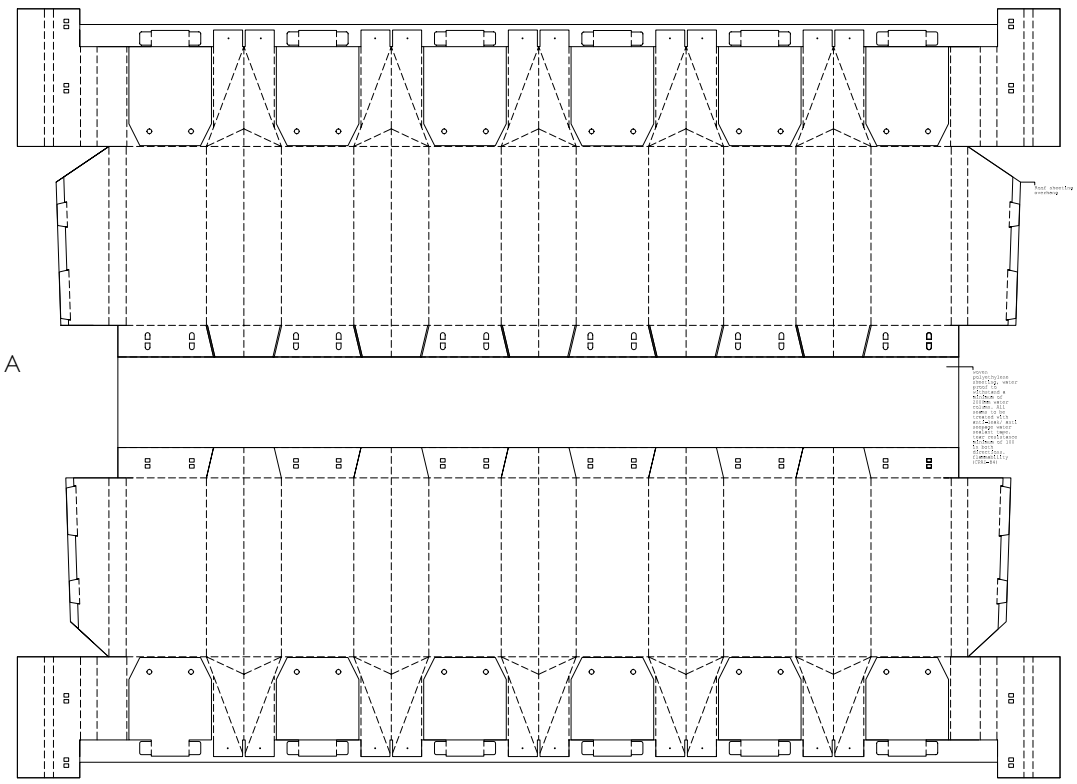


02

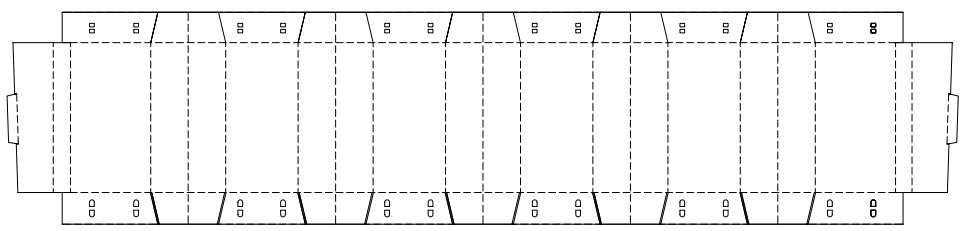
PACKAGE PART 02:

volume: 0.17 m3
dimensions: 1903mm x 787mm x 115.5mm

06 roof section A
[scale 1:20]
1



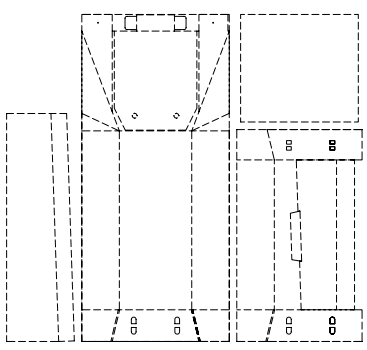
07 roof section B
[scale 1:20]
1



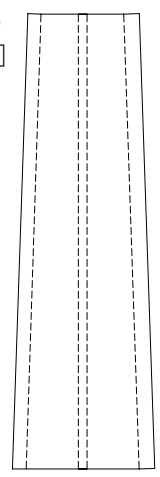
03

PACKAGE PART 03:

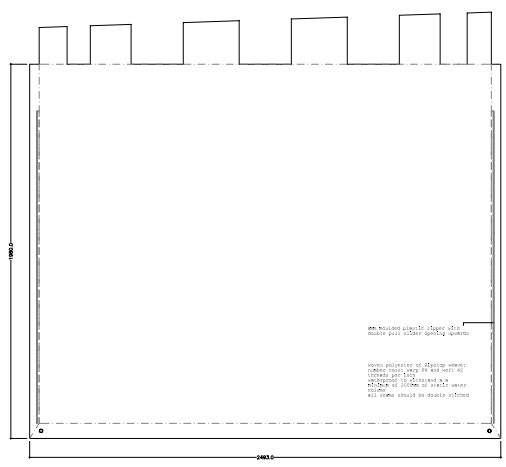
volume: 0.22 m3
dimensions: 1730 mm x 782mm x 168mm



08 roof brace
[scale 1:20]
2



09 closer panel
[scale 1:20]
2



10.1 ASSEMBLY

10.1.1 TRANSPORTATION

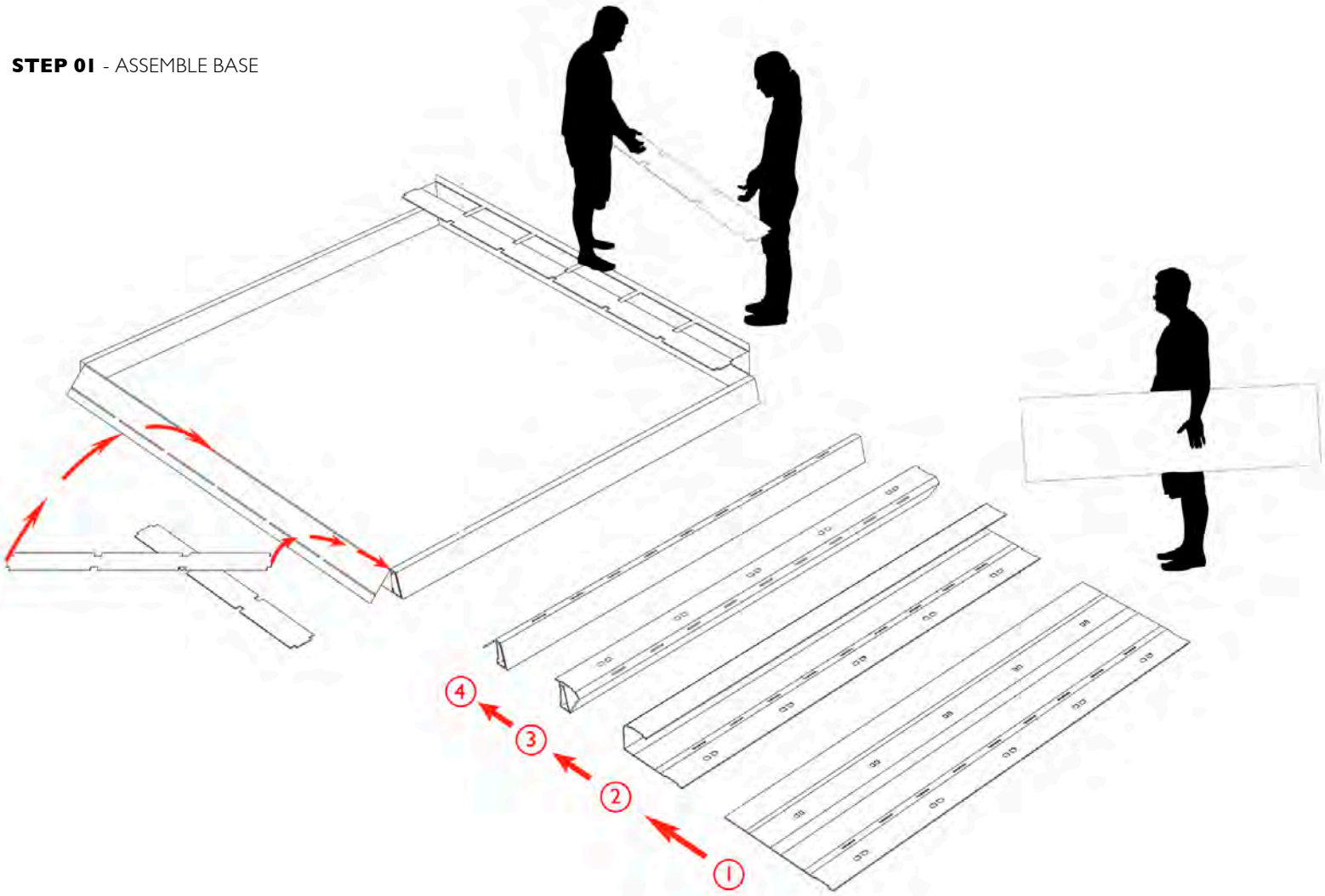
[fitting in a standard 20ft shipping container]

GROSS PACKAGE SIZE:

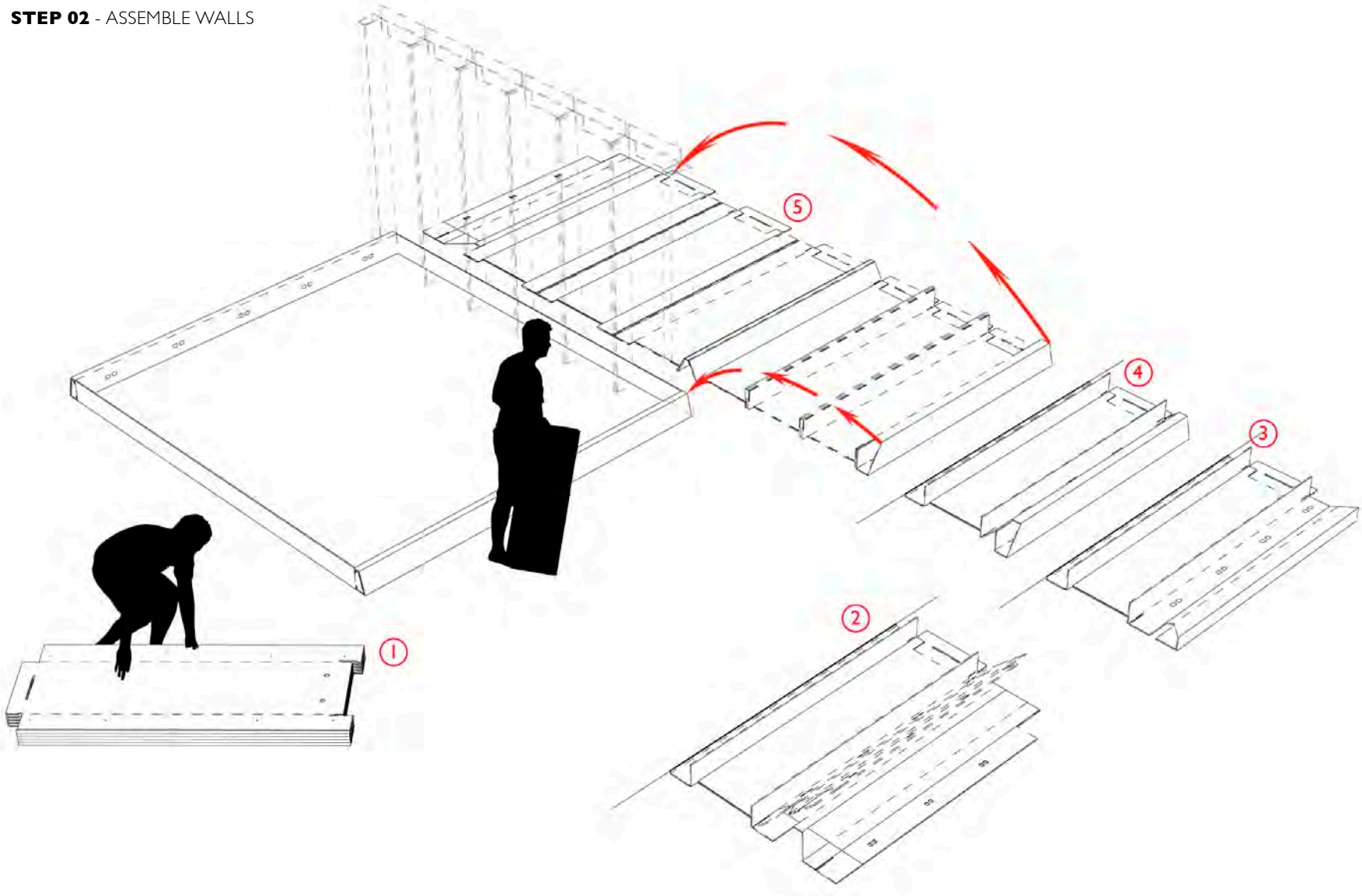
VOLUME: 0.6 m^3
WEIGHT: 74 kgs
DIMENSIONS: 1903mm x 787mm x 429mm

10.1.2 ASSEMBLY INSTRUCTIONS

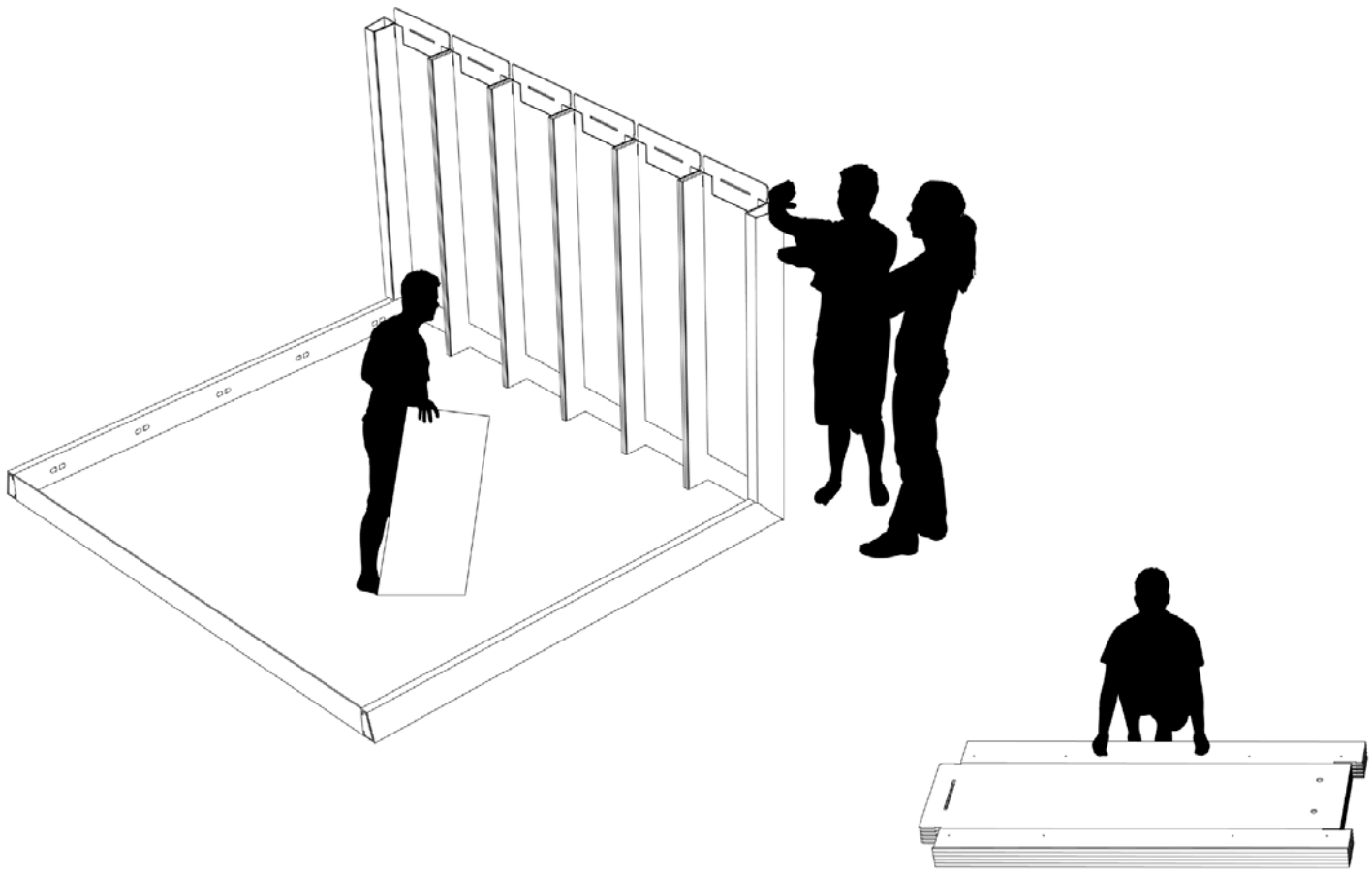
STEP 01 - ASSEMBLE BASE



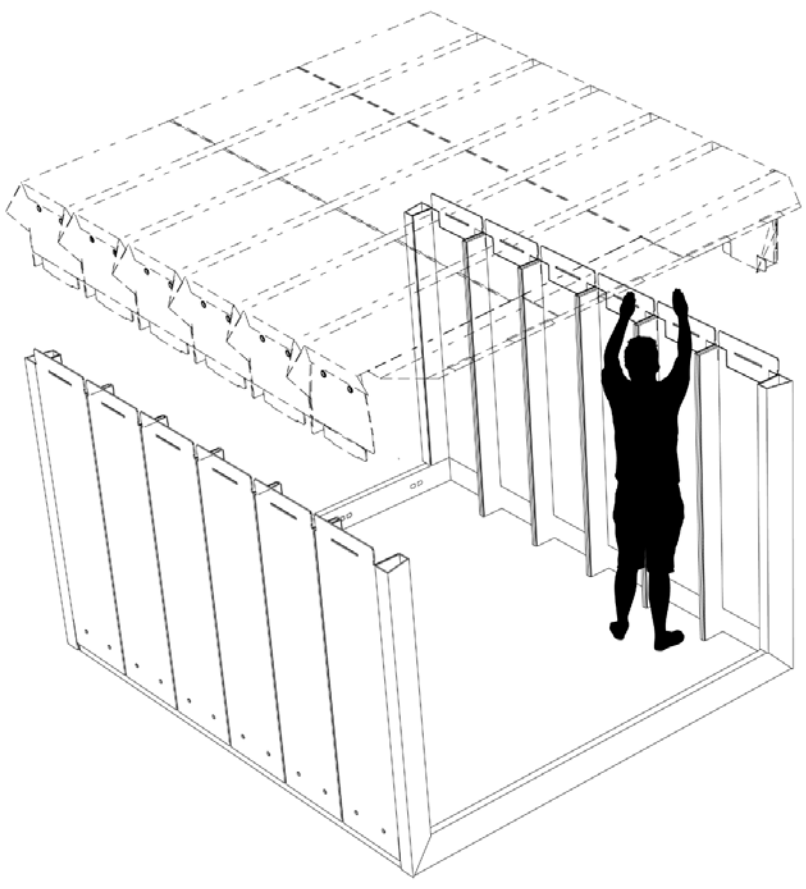
STEP 02 - ASSEMBLE WALLS



STEP 03 - LIFT WALL SECTIONS ONTO BASE + SECURE WITH PLASTIC STUDS



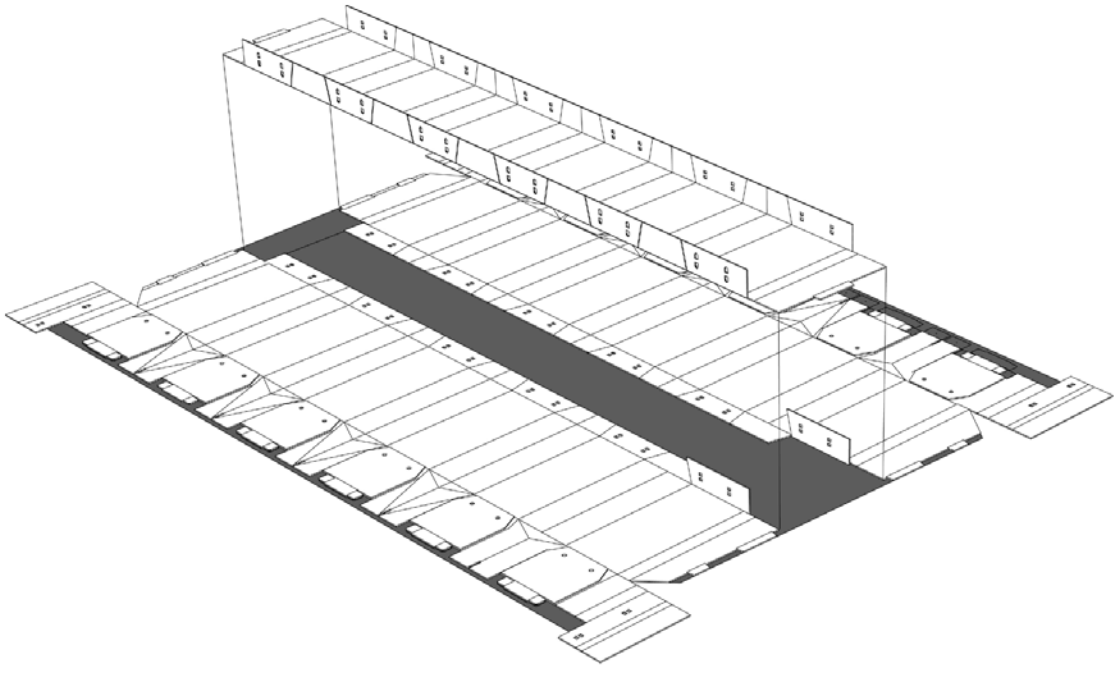
STEP 05 - PLACE ROOF ONTO WALLS AND SECURE TO ROOF FLAPS

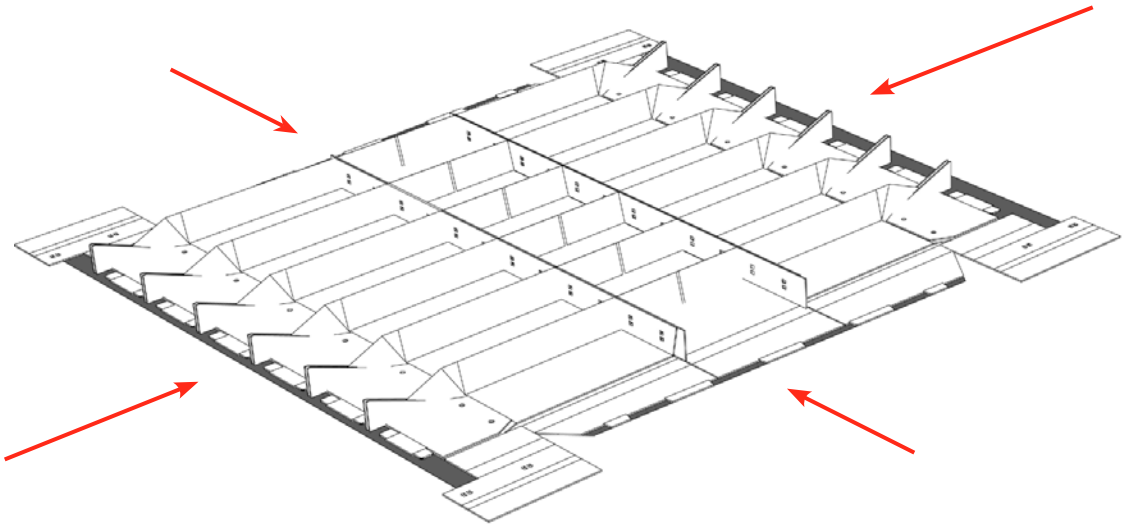


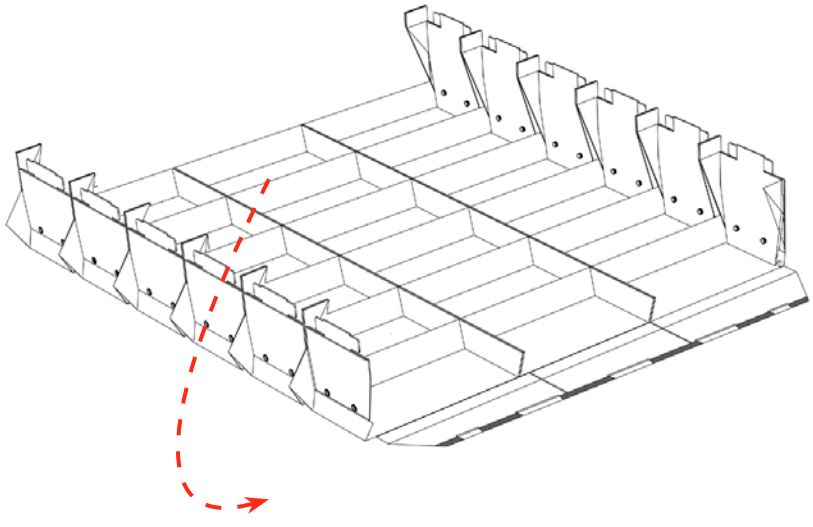
STEP 04 - UNFOLD ROOF PACKAGE + PLACE-PART B ONTO PART B.

START IN A CORNER AND ASSEMBLE PRE-DEFINED FOLDS AND LOCKS

WHEN ROOF IS COMPLETE TURN OVER AND PLACE ONTO WALLS



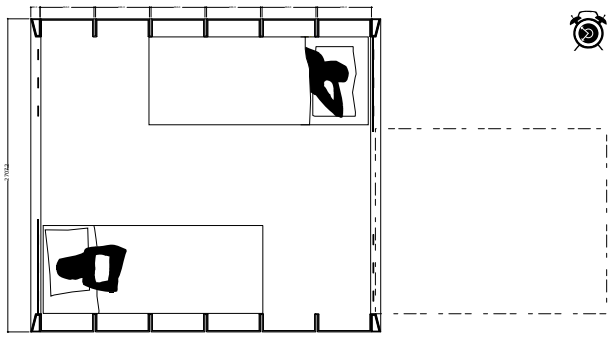


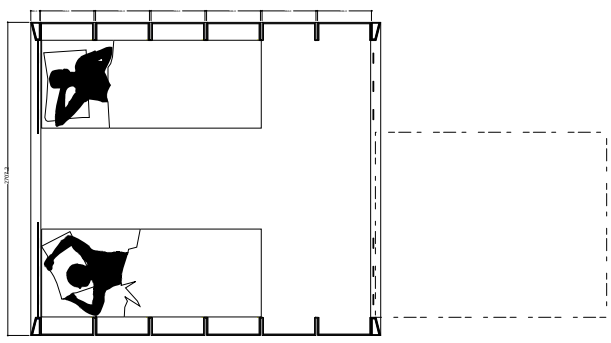


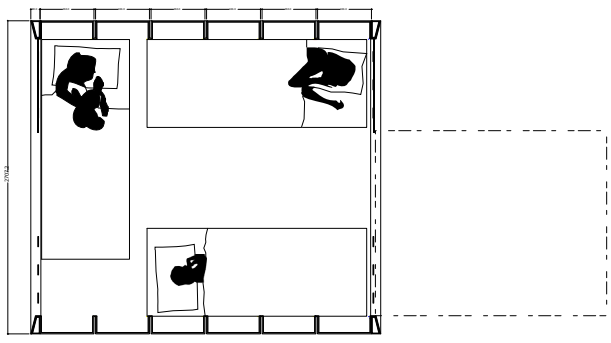
Conceptual options for the front and back panels. The connection details will ultimately influence the clustering variations.

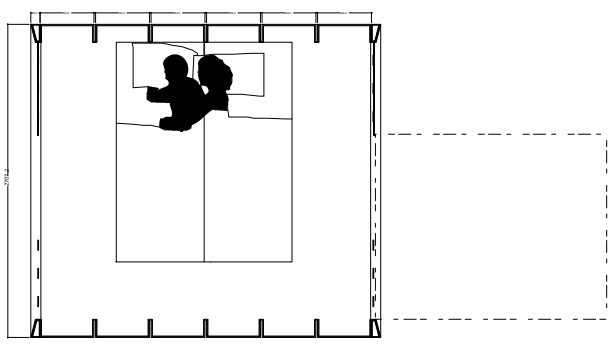
10.1 FRONT + BACK PANEL OPTIONS

plan variations @ night



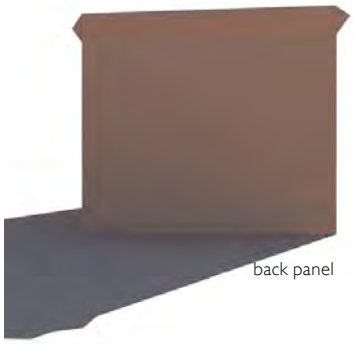




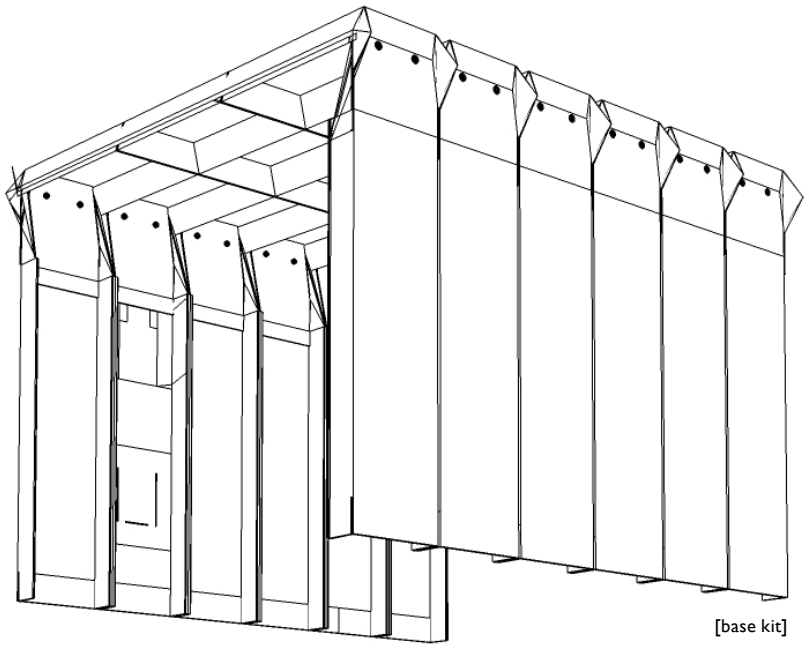


A

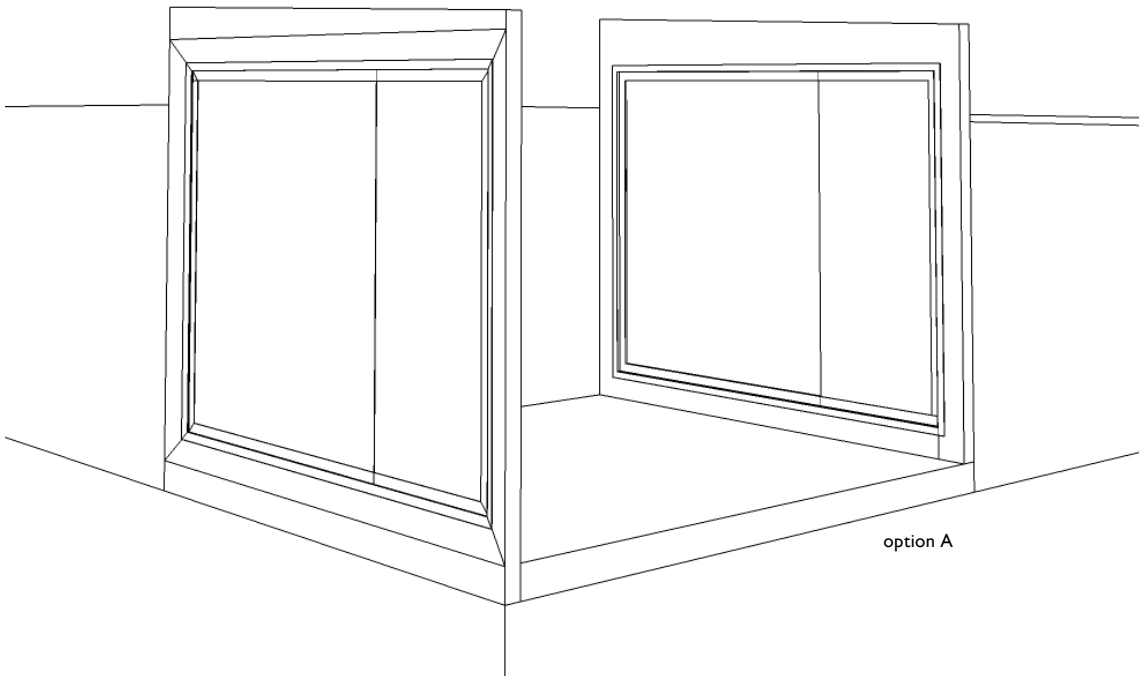
front panel



back panel

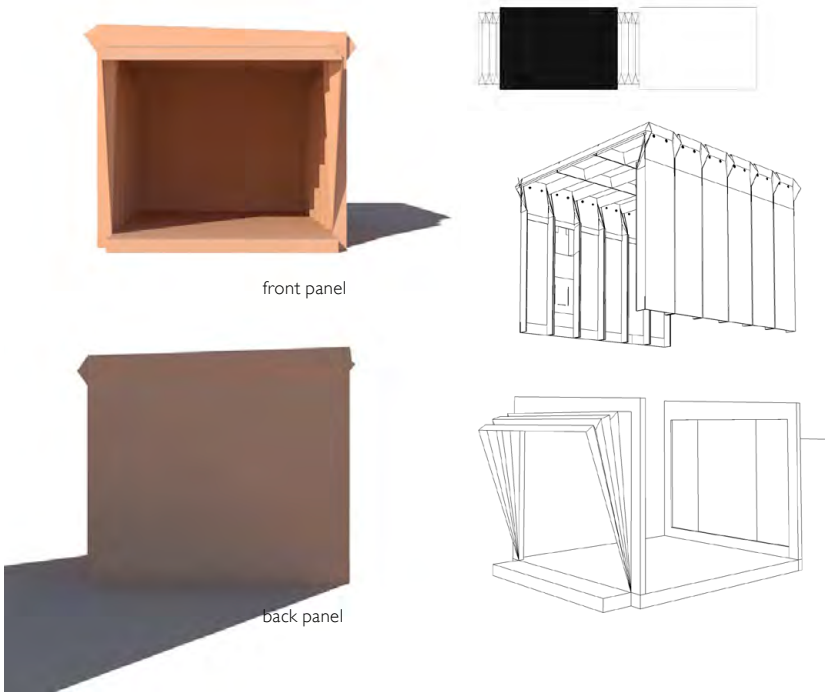


[base kit]

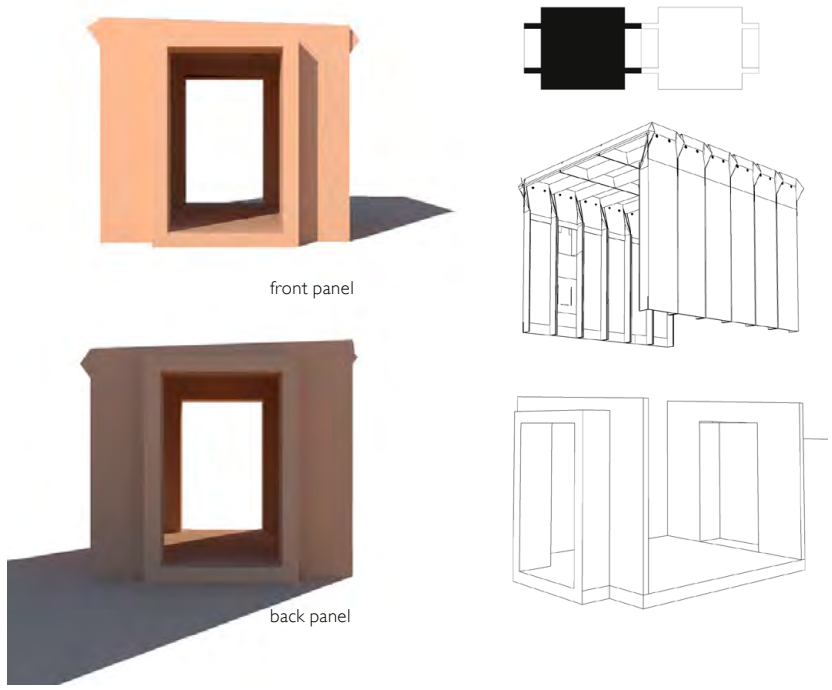


option A

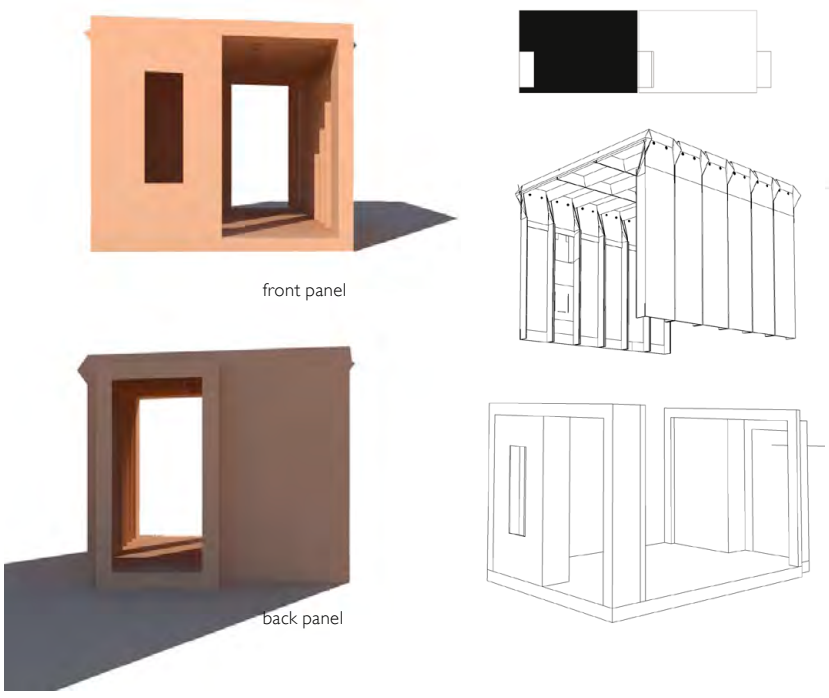
B


front panel
back panel

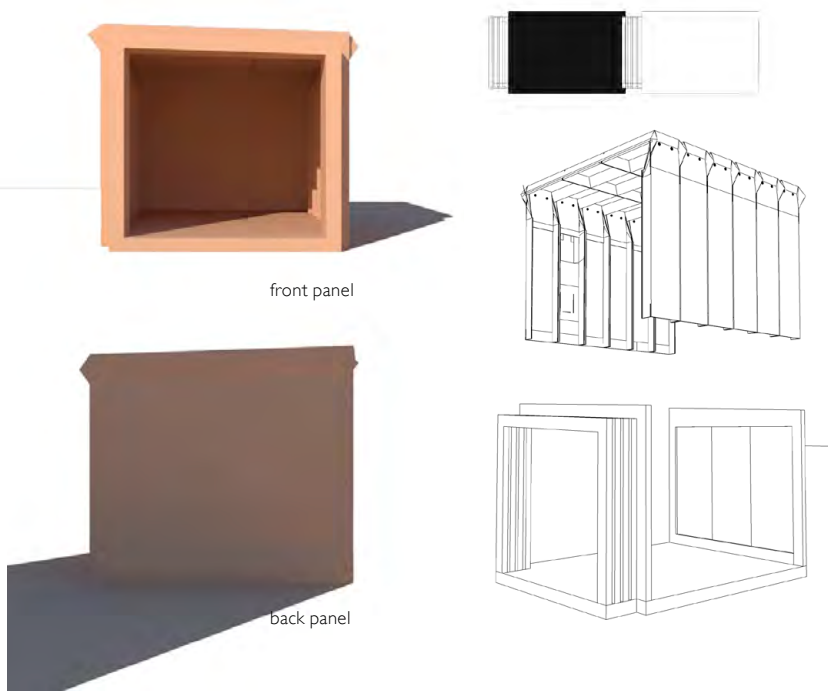
C


front panel
back panel

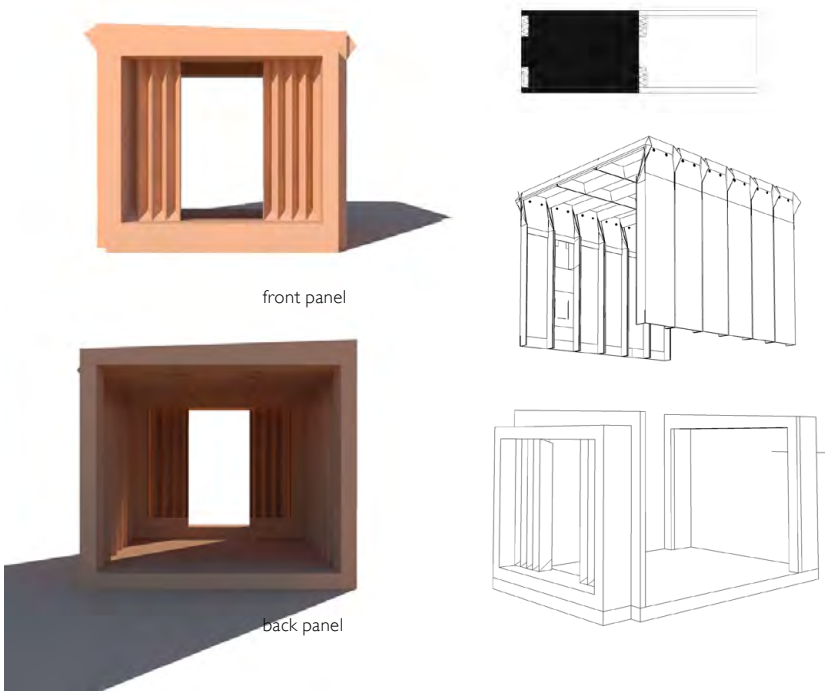
D


front panel
back panel

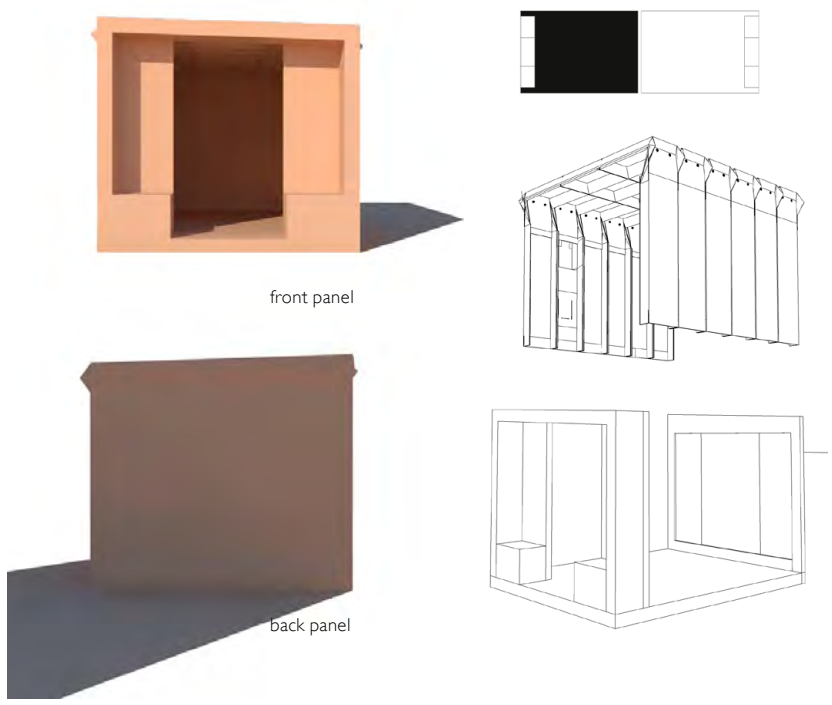
E


front panel
back panel

F

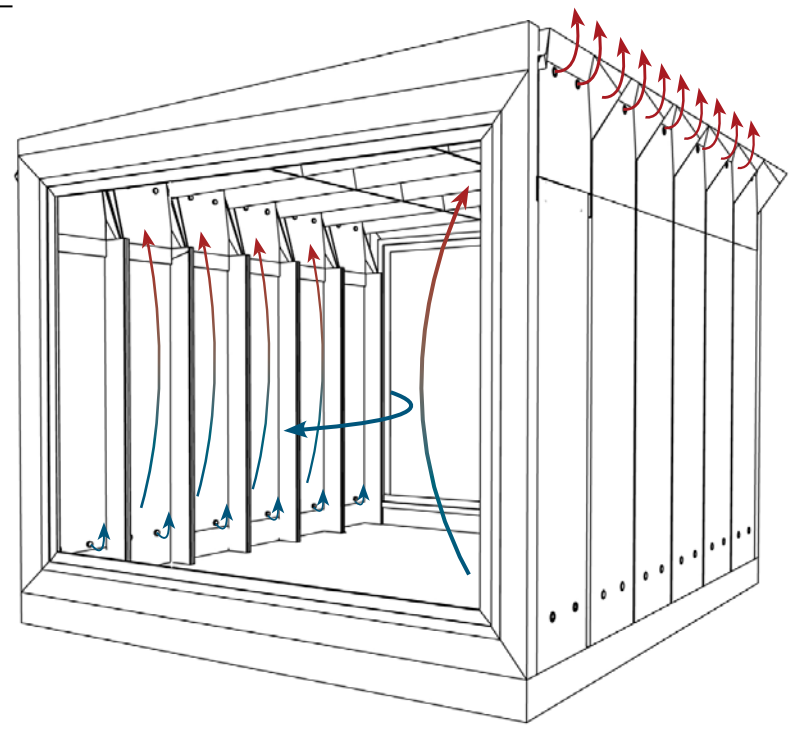

front panel
back panel

G

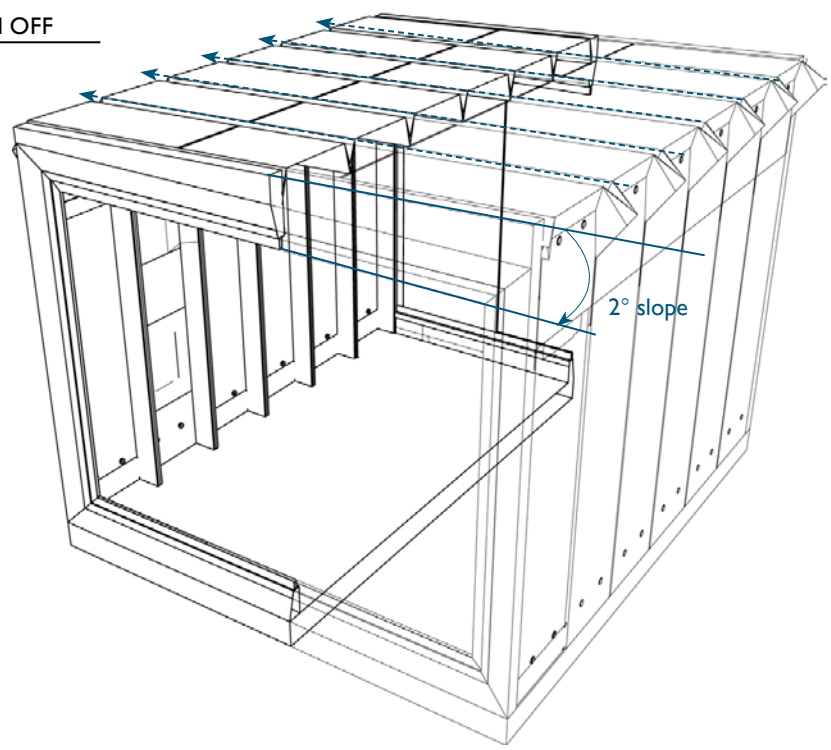

front panel
back panel

10.1 ENVIRONMENTAL COMFORT

VENTILATION
[not to scale]

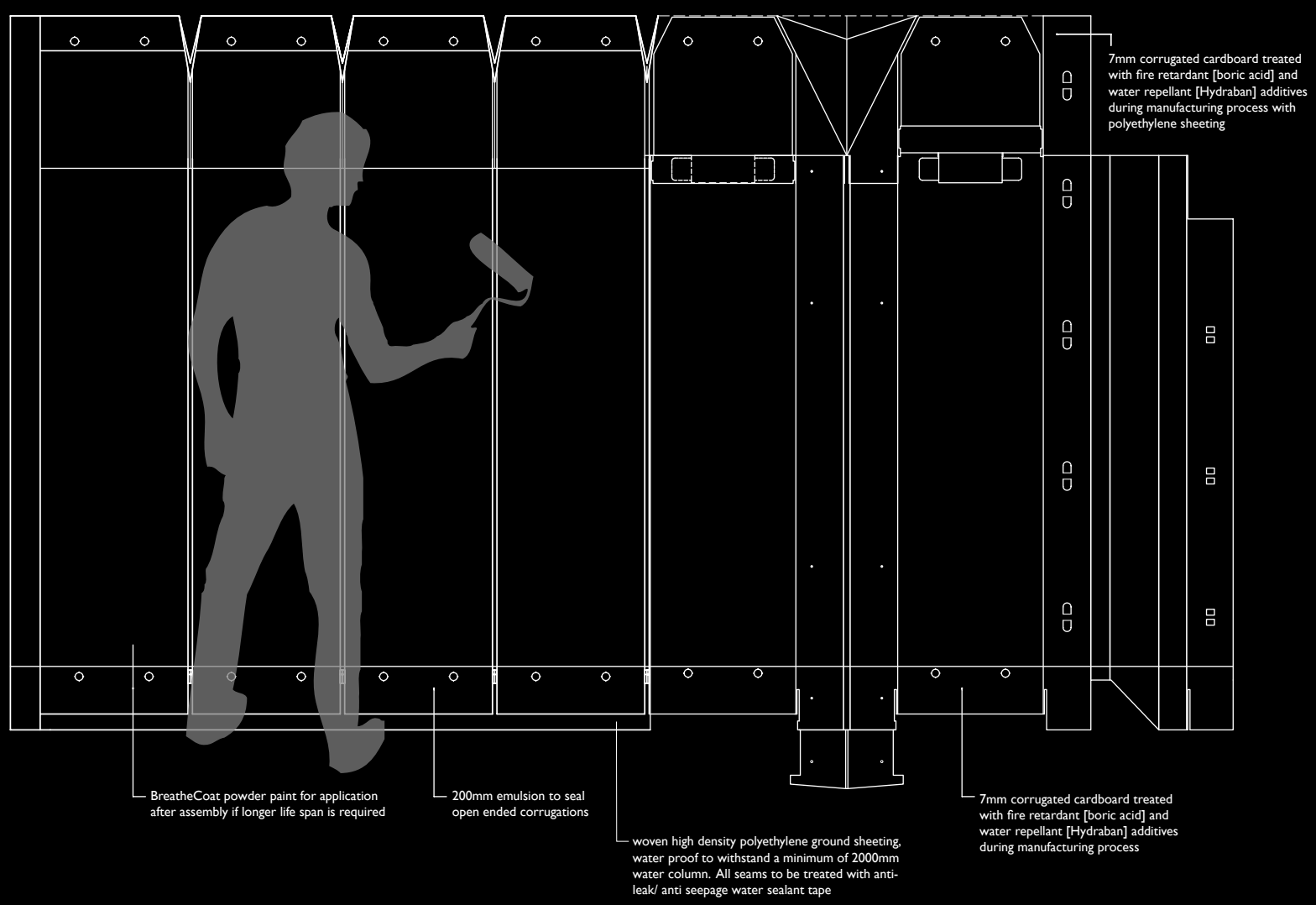


RAIN WATER RUN OFF
[not to scale]



WATERPROOFING

elevation / section through shelter explaining waterproof coatings and treatments
[scale: 1:20]



10.1 SCENARIOS IN SECTION

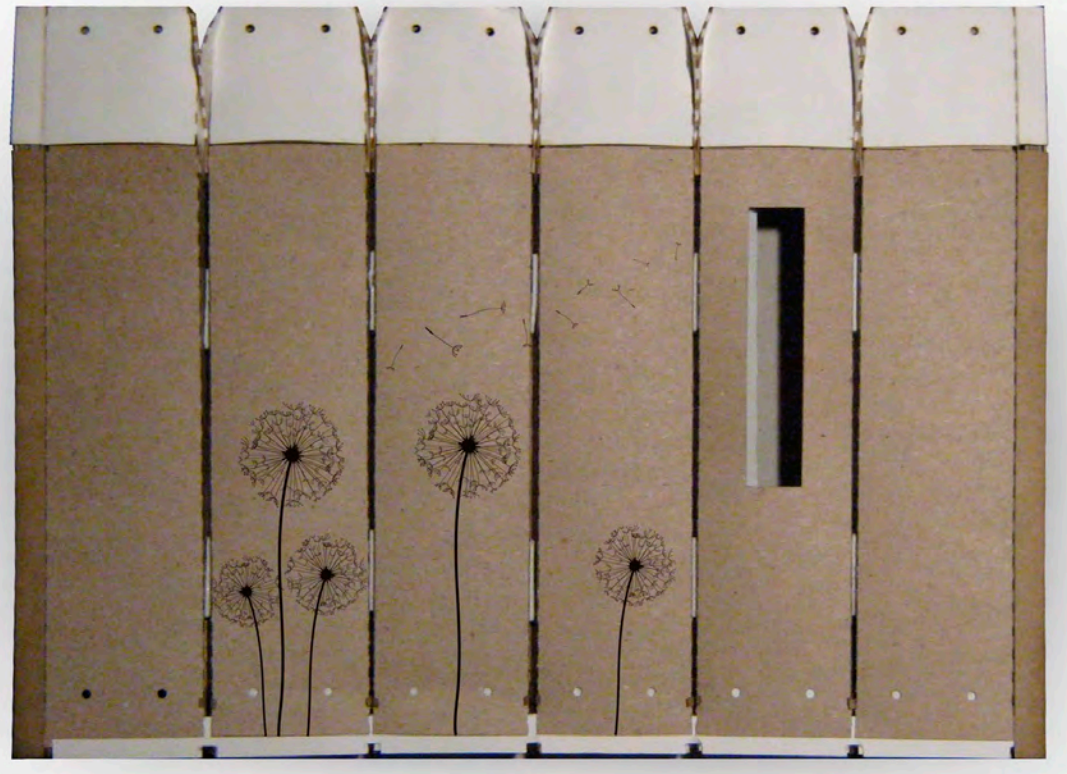
Section through shelter unit in various scenarios showing the diverse range of modular interior components

SUBURBAN PERSPECTIVE

conceptual visualization
[not to scale]

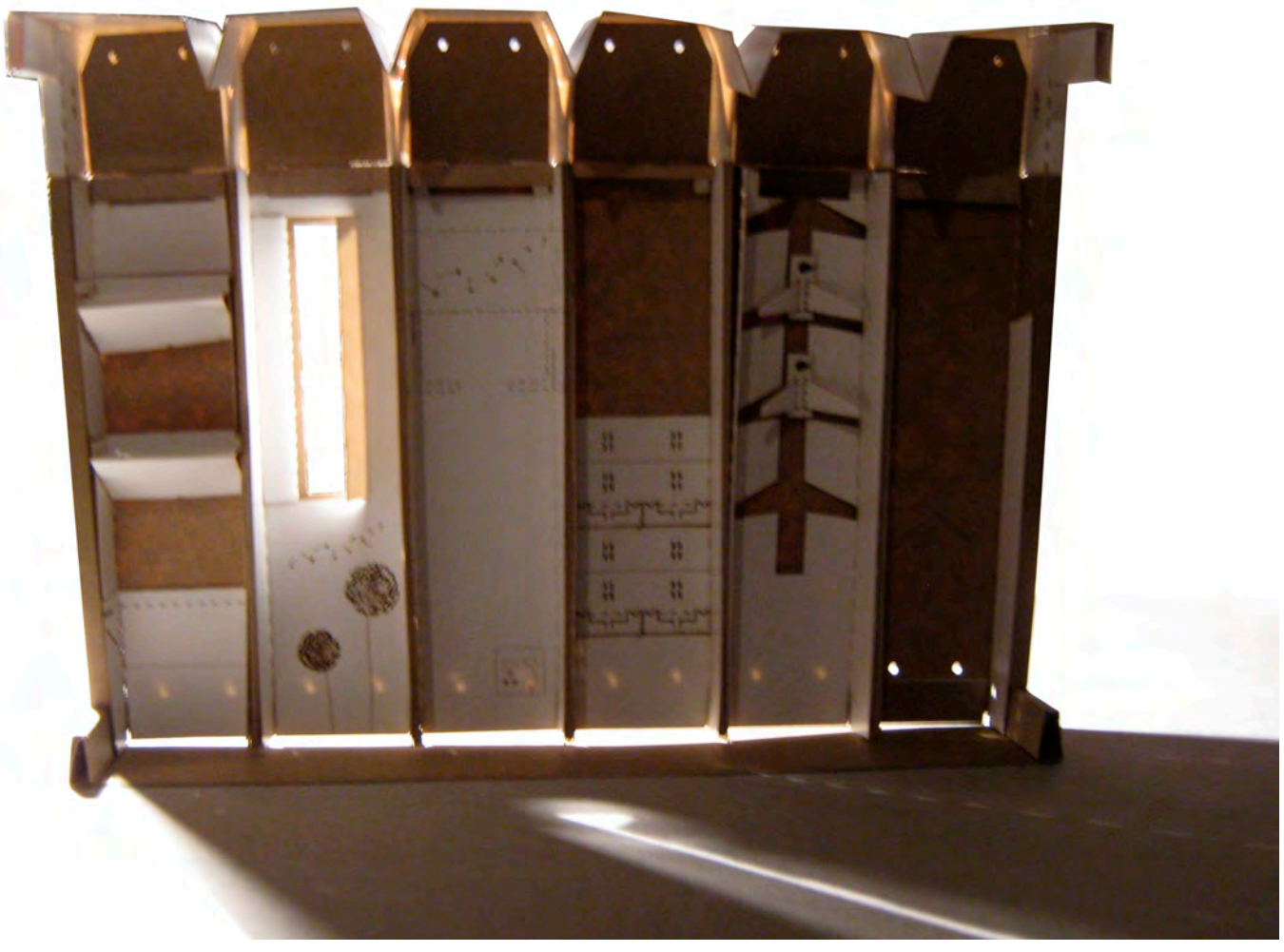
MODELS

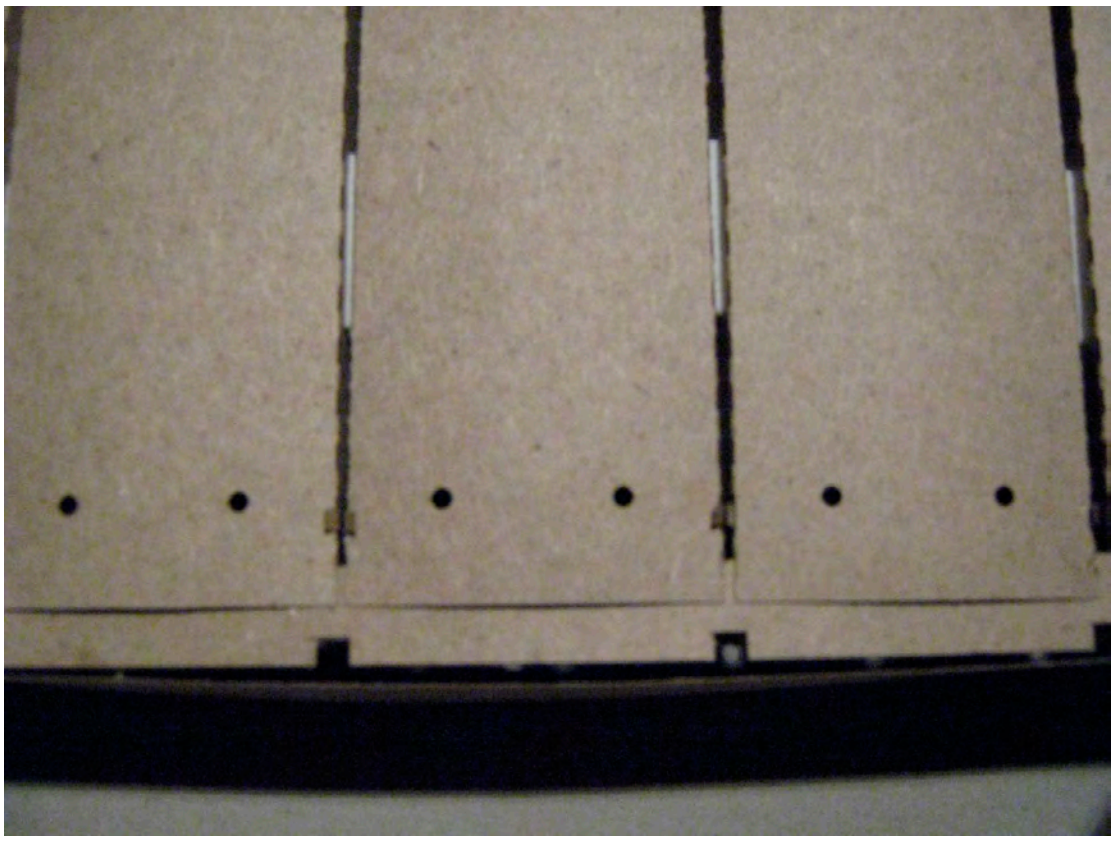
side elevation
[scale 1:10]



MODELS

Interior section showing assembled interior components
[scale 1:10]

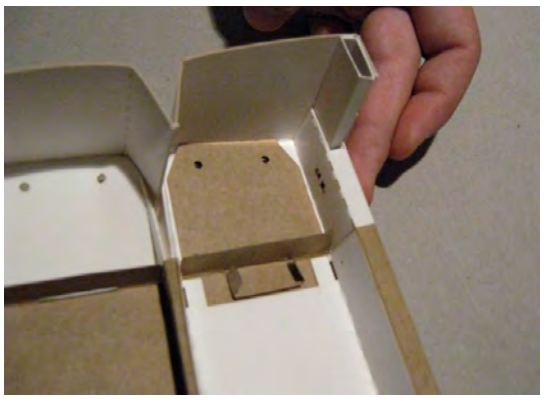


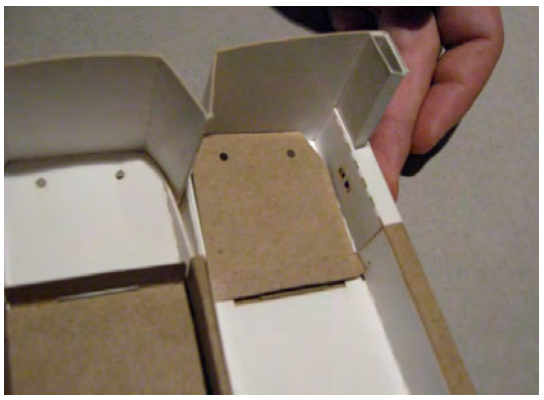


DETAIL 01

Connection between wall component and wall brace

[scale: 1:10]

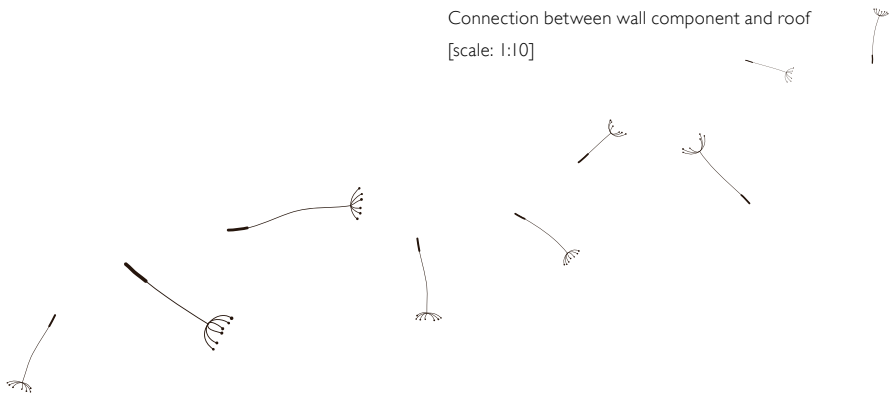




DETAIL 02

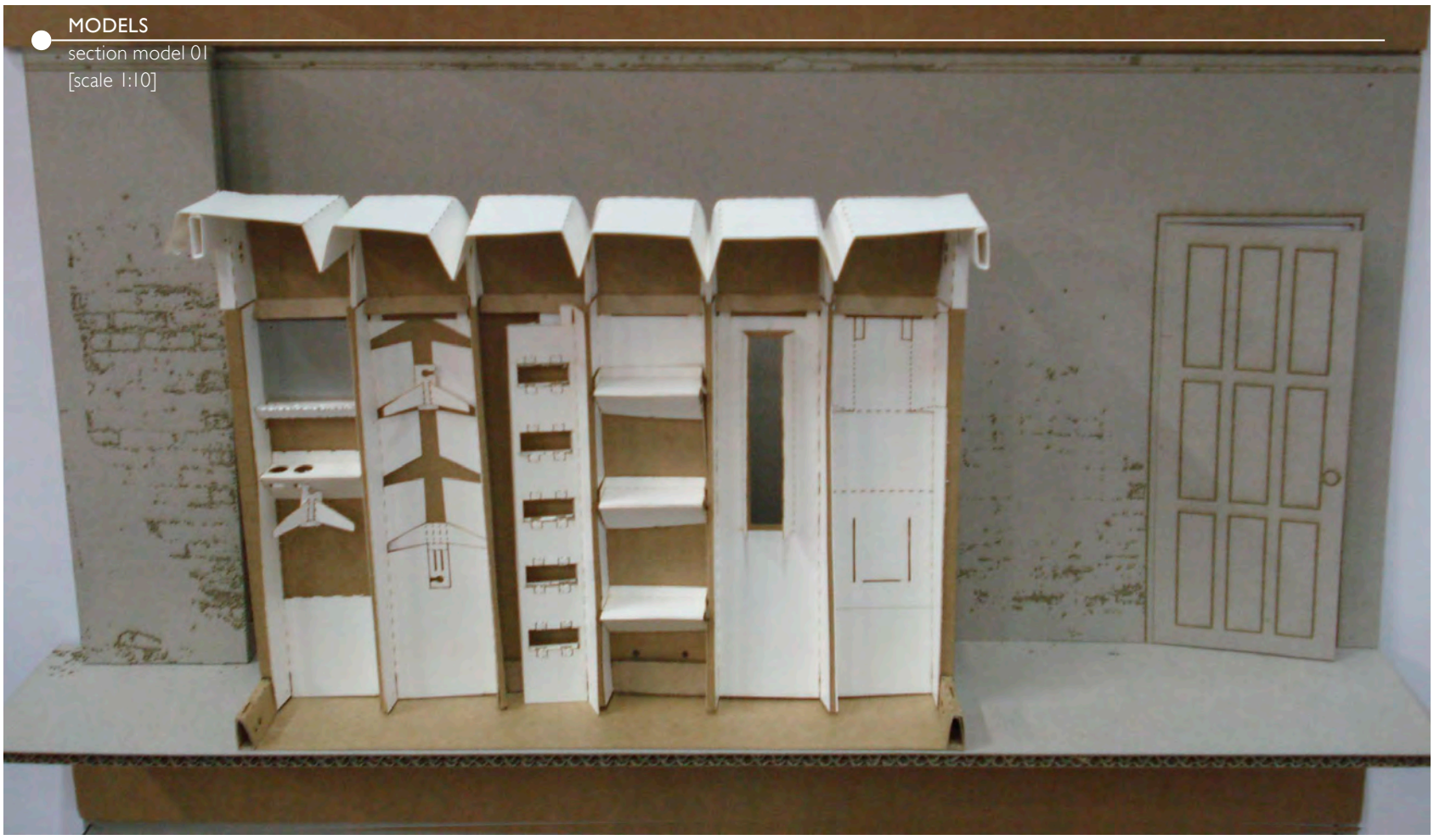
Connection between wall component and roof

[scale: 1:10]



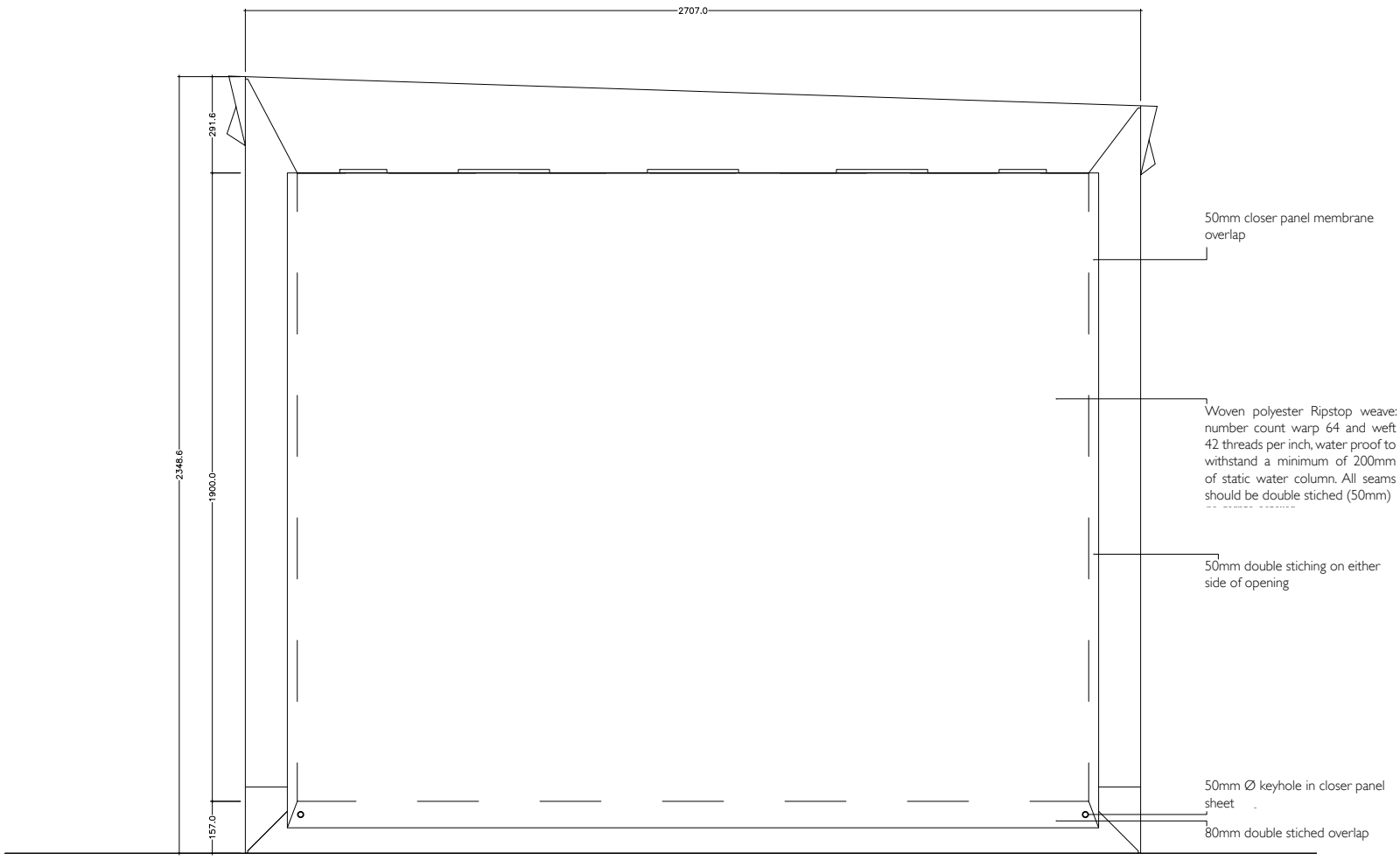
MODELS

section model 01
[scale 1:10]

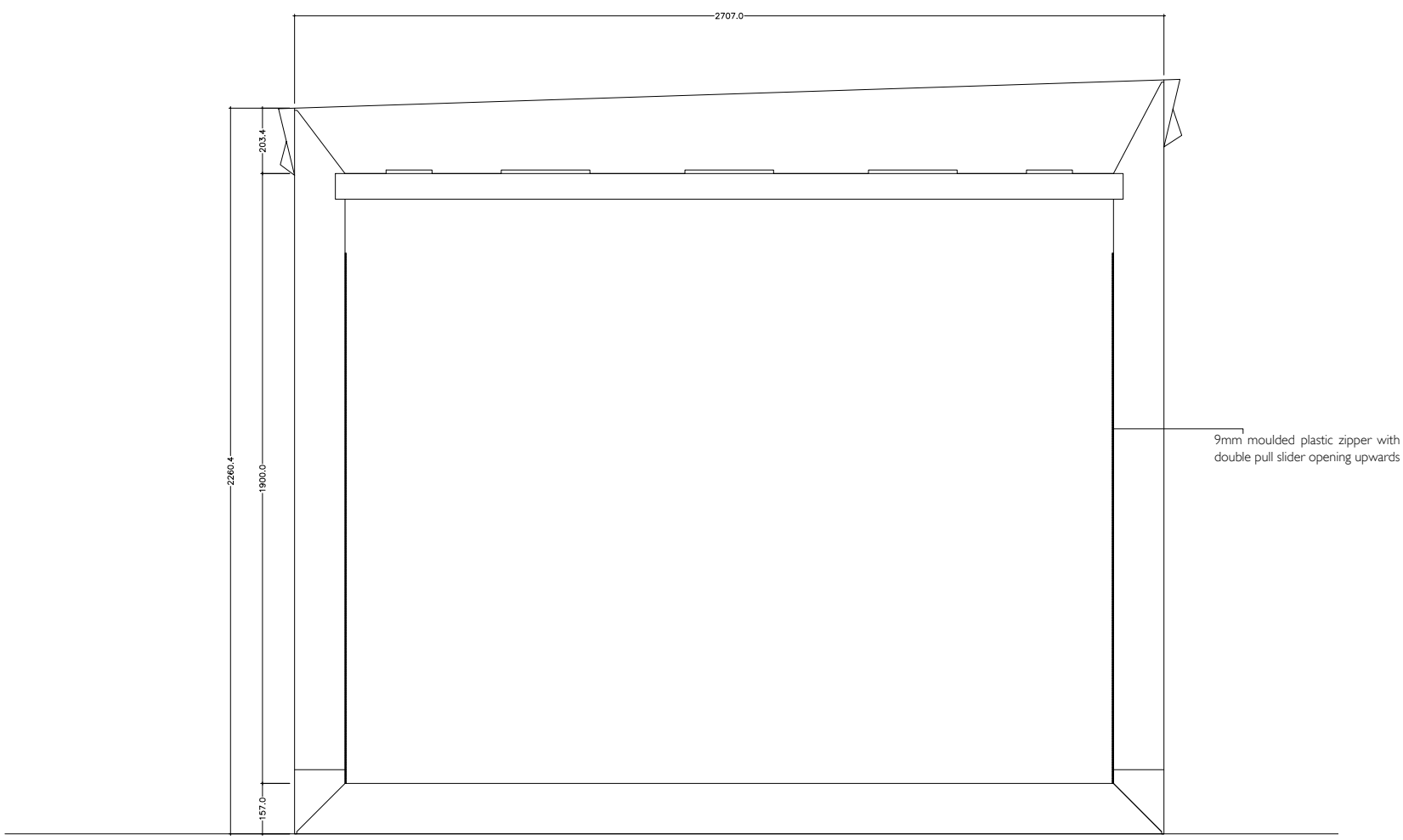


MODELS

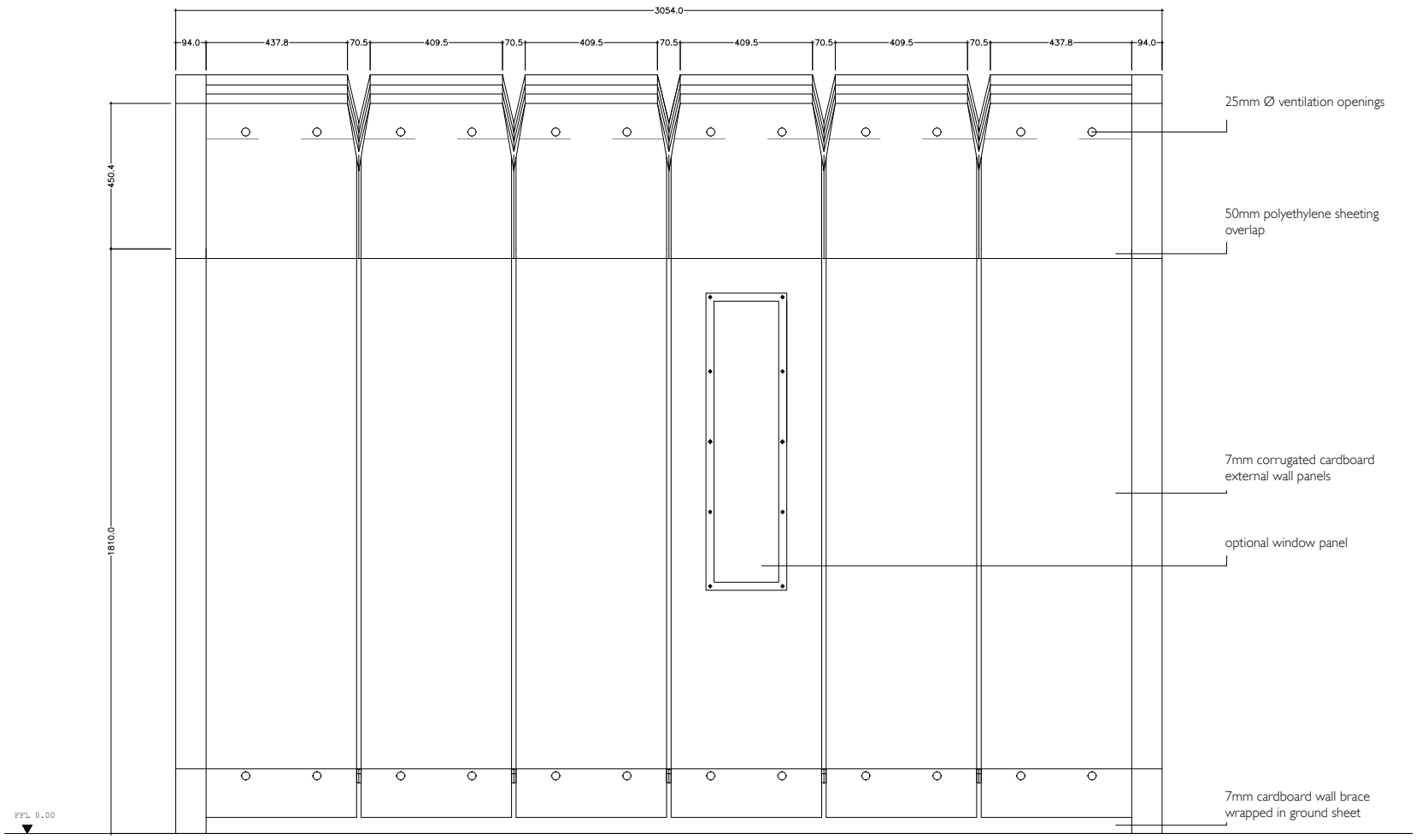
Section model 02
[scale 1:10]



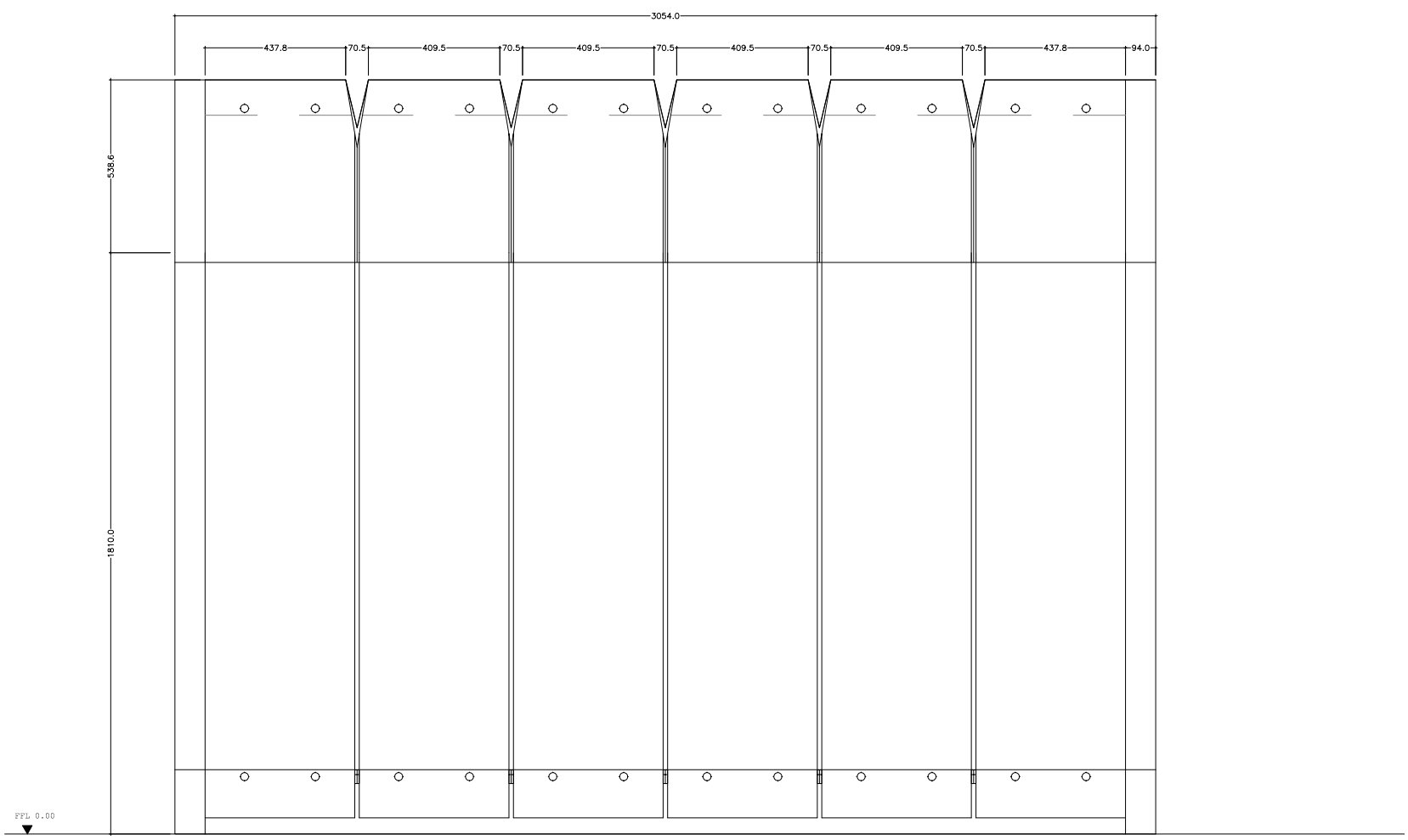
SIDE ELEVATION
[scale 1:20]



SIDE ELEVATION
[scale 1:20]



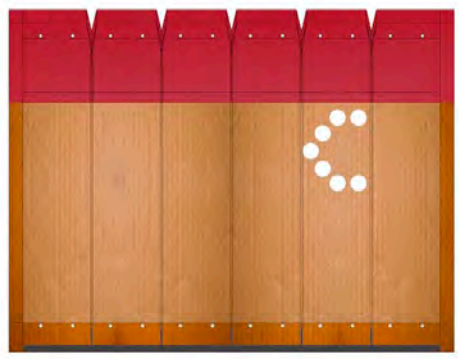
FRONT ELEVATION
[scale 1:20]



BACK ELEVATION
[scale 1:20]

10.1 BRANDING OPPORTUNITIES

elevation variations
[not to scale]



11 | FABRICATION DRAWINGS

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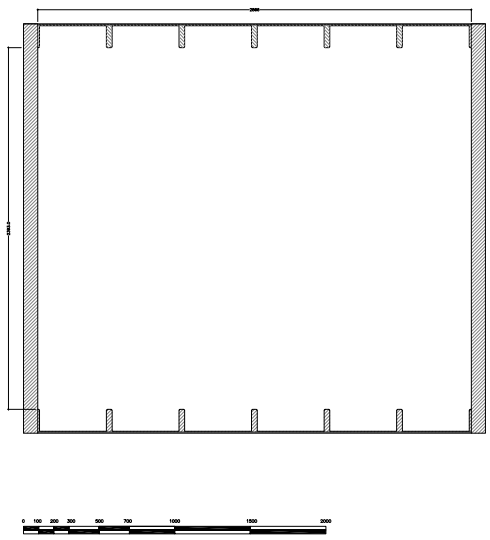
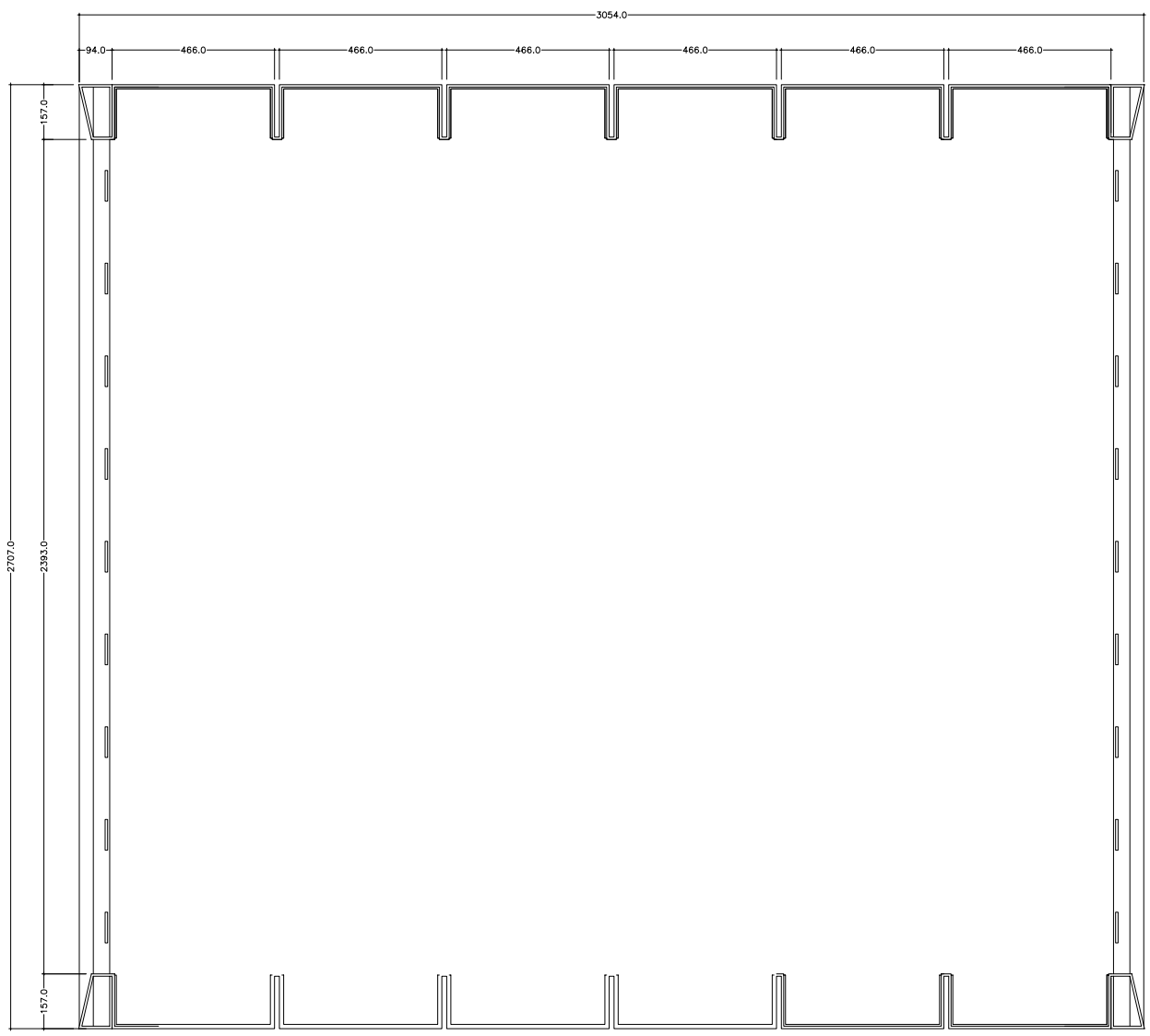
11.1 FLOOR PLAN



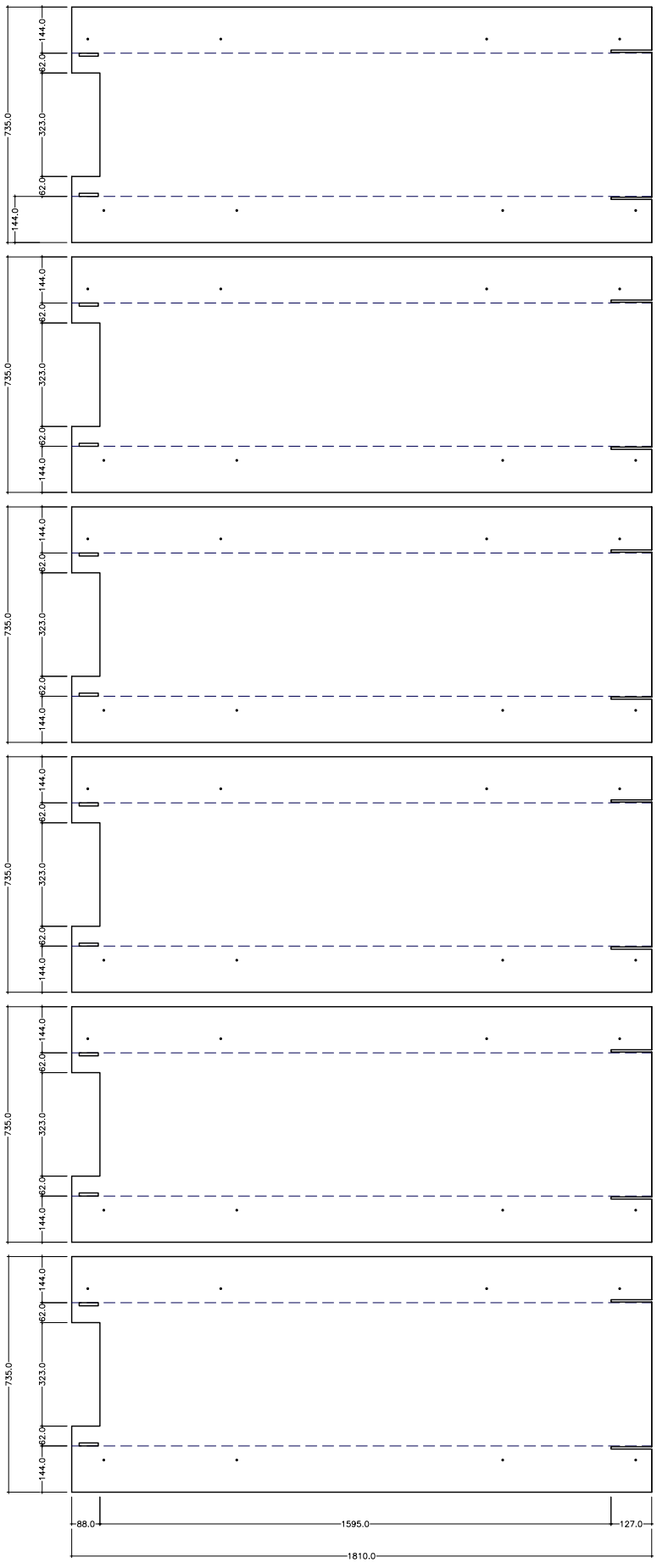
AREA

INTERNAL: 6.9 sqm

GROSS FLOOR AREA: 8.2 sqm



FLOOR PLAN
[scale 1:20]

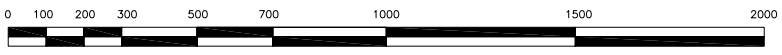


LEGEND

- CUT LINE
- CREASE LINE
- REVERSE CREASE
- PERF LINE
- GLUE

11.2 INTERIOR WALL COMPONENTS FABRICATION DRAWINGS

SPECIFICATION SHEET	
DWG NAME: **INTERIOR WALL COMPONENTS**	# REQUIRED: 12
DESCRIPTION: component blanks	L x B x D: 1810 x 735 x 5mm
SIDE SHOWN: PRINT SIDE	**GRAIN/CORR:** VERTICAL
BOARD: #200 BE FLUTE VL **CALIPER:** 5mm	**OUTSIDE GAIN:** 2.5mm **INSIDE LOSS:** 2.5mm
AREA:	WASTE ON BLANK:
BLANK WIDTH: 2400mm	LEN. CUTTING RULE:
BLANK HEIGHT: 3000mm	LEN. OTHER RULE:



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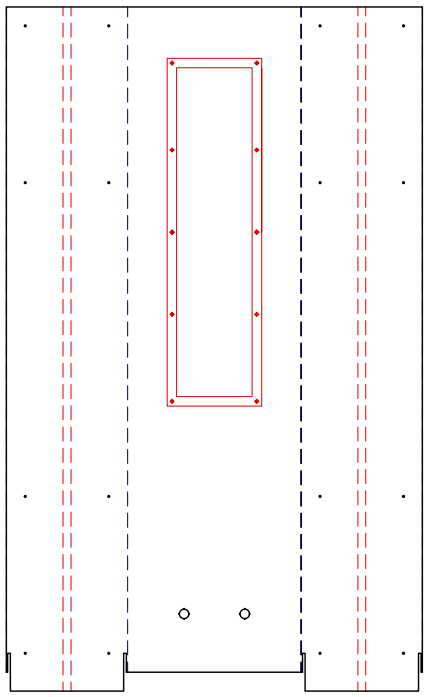
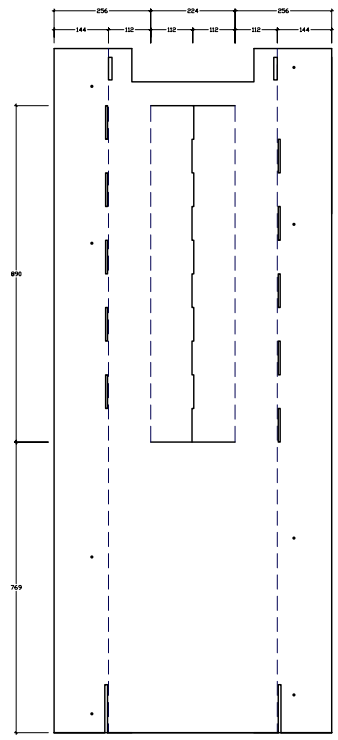
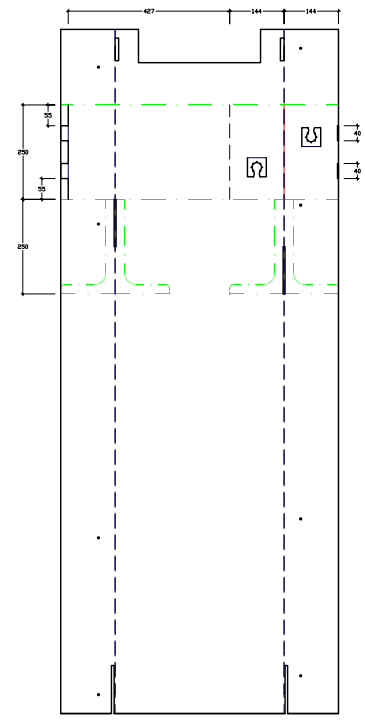
window option
[scale 1:20]

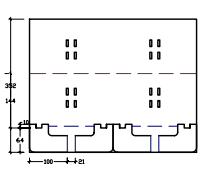


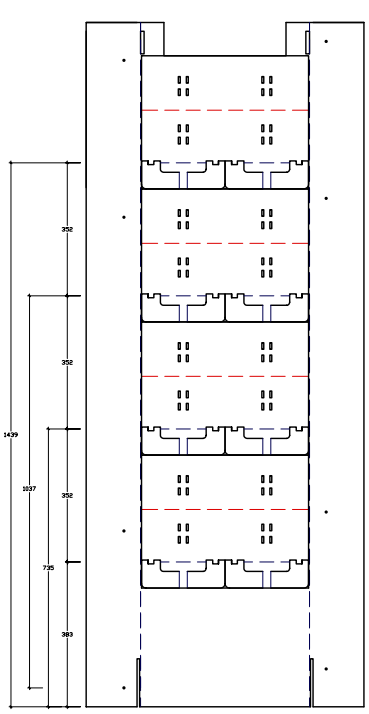


lamp option
[scale 1:20]

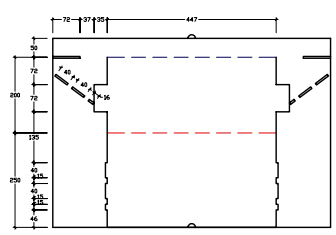


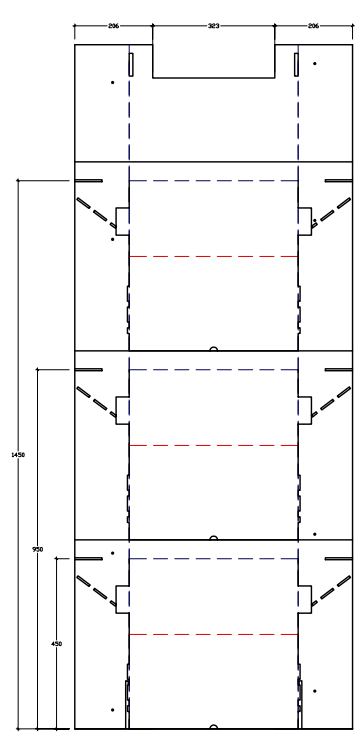
144mm shelf
[scale 1:20]



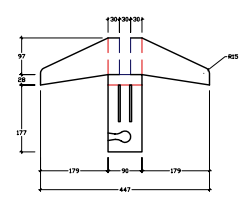


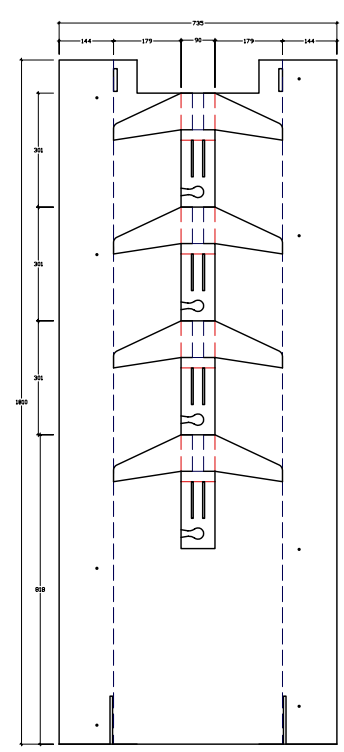
200mm shelf
[scale 1:20]





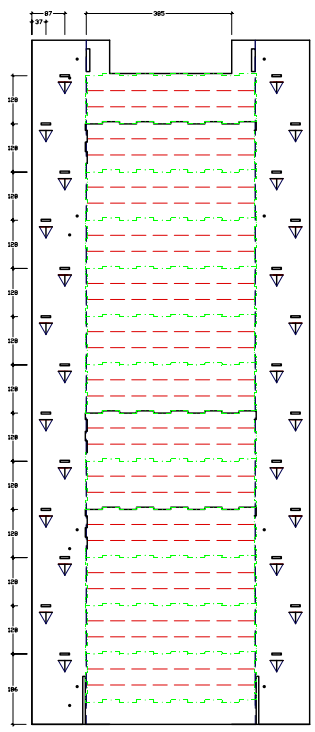
wardrobe and hangers
[scale 1:20]





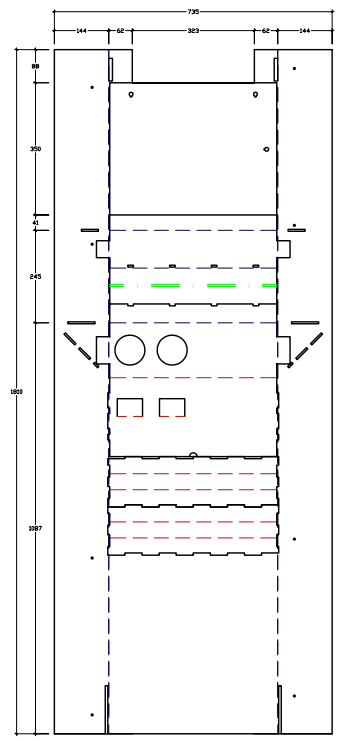
hanging rail

[scale 1:20]



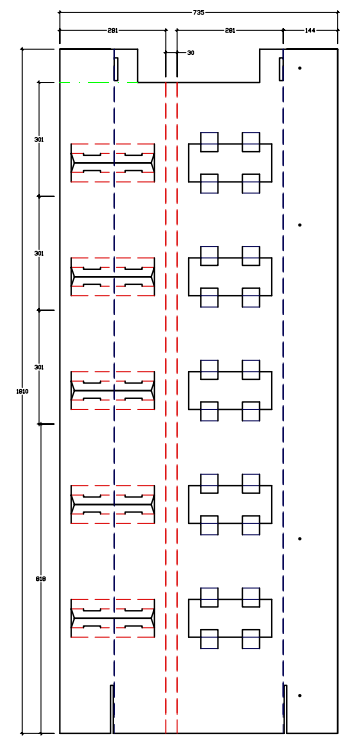
mirror option

[scale 1:20]



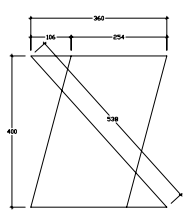
step ladder/ hanging space option

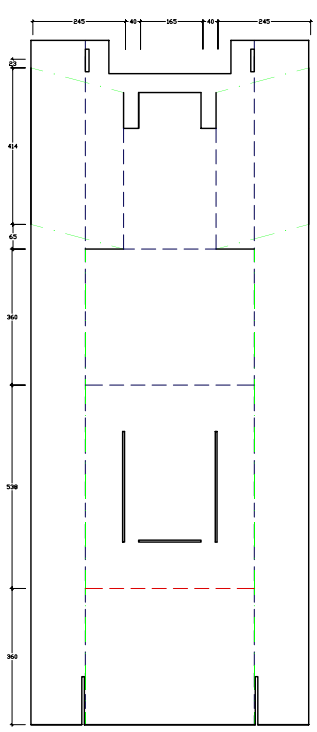
[scale 1:20]



stool * by Erdem Selek

[scale 1:20]



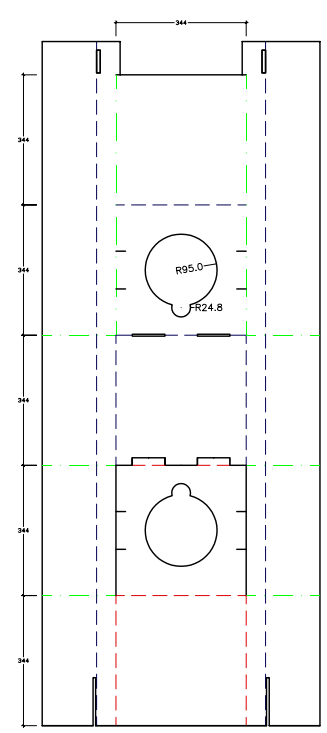


◂ Adaptation of the cardboard stool by Erdem Selek to fit the interior module

Adaptation of the ploo box by Richard Wharton to fit the interior module ▸

ablution * by Richard Wharton

[scale 1:20]



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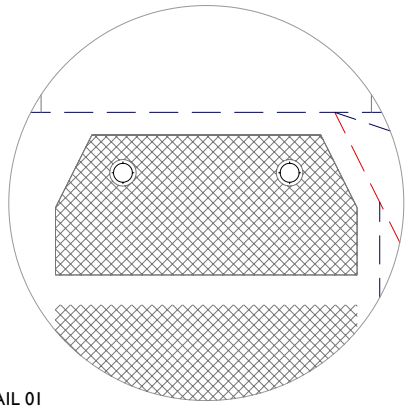
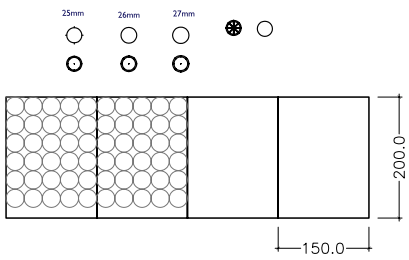


DETAIL 01

VENTILATION DETAIL

[scale: 1:10]

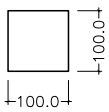


The united nations recommend a ventilation gap of 1200sqm per tent of 4-6 people.

[0.2 and 0.3 sqm per person]

200.0

600.0



International Shelter Standards recommend 0.1 sqm per person.

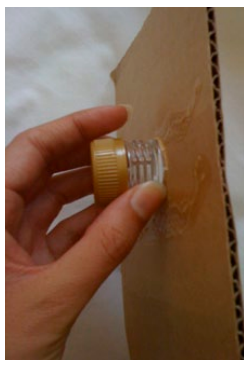
▼

0.07 sqm per bottle cap

Proposed shelter: 64 x 0.07 sqm = 0.45 sqm

UN tent: 85 bottle caps for two people

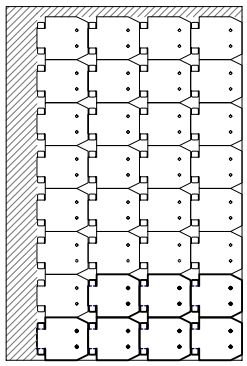
Shelter Standards: 28 bottle caps for two people

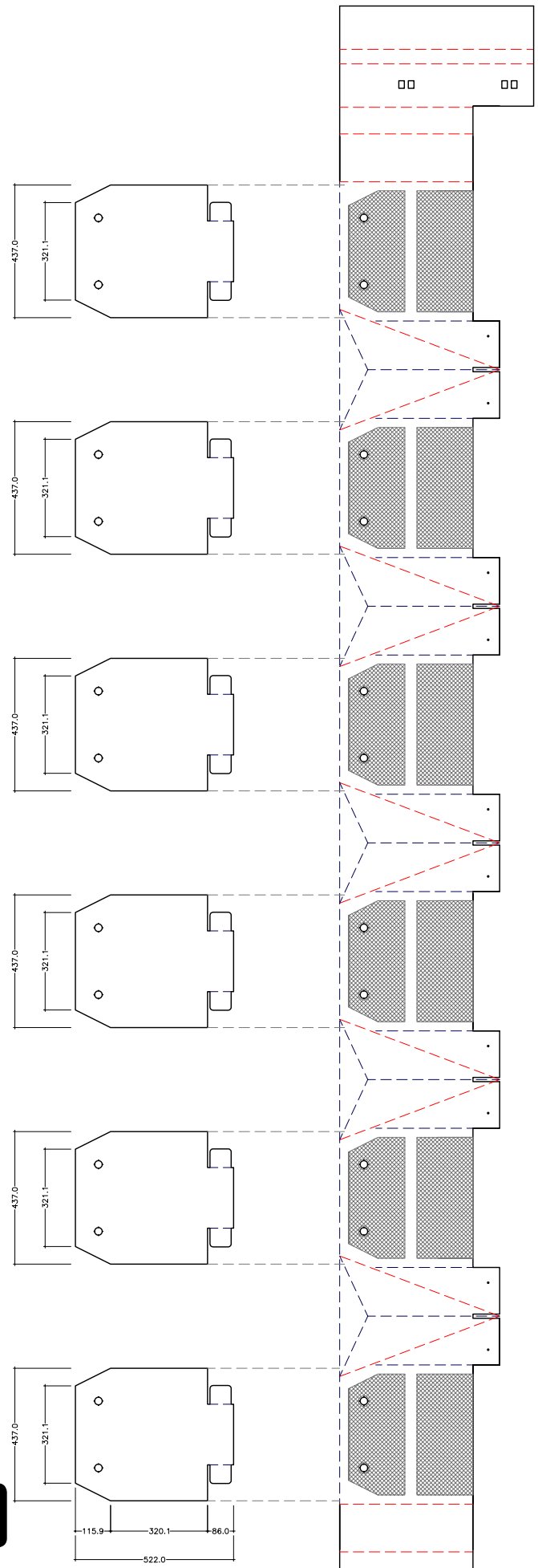


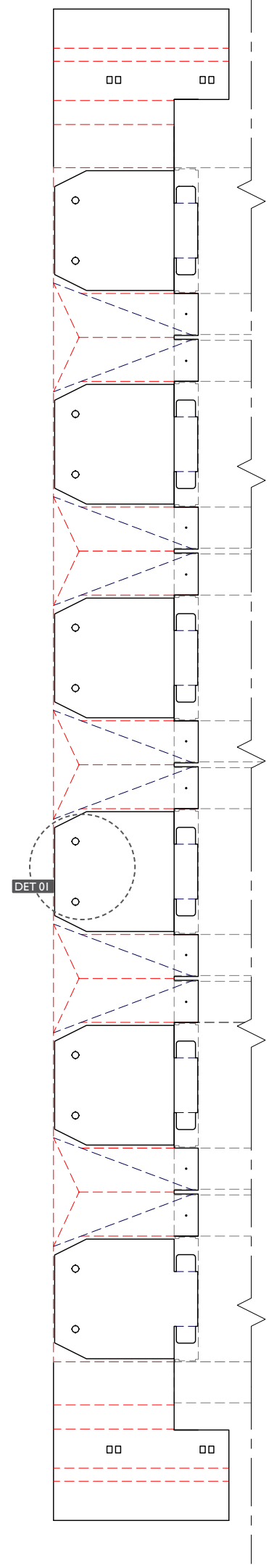
FABRICATION DIAGRAM

fitting on standard 3,6 x 2,4m sheet

[not to scale]

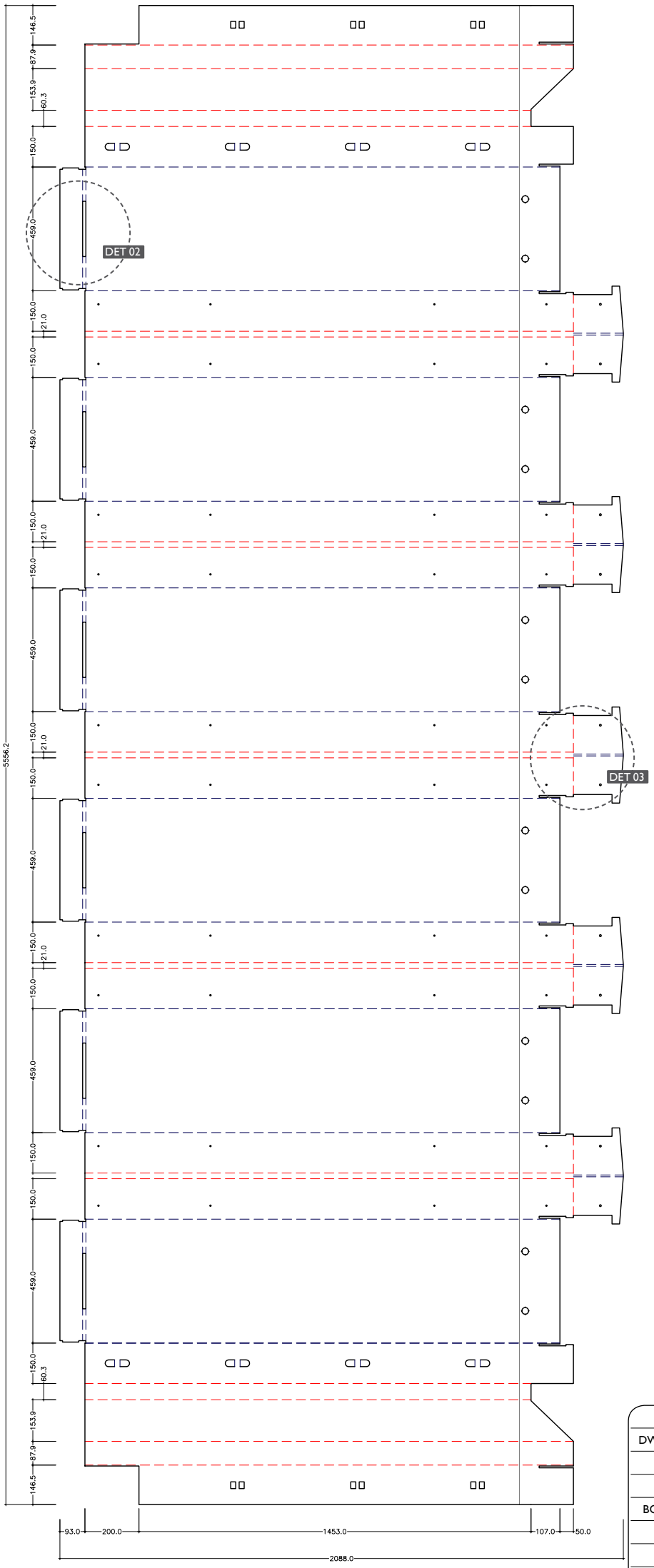




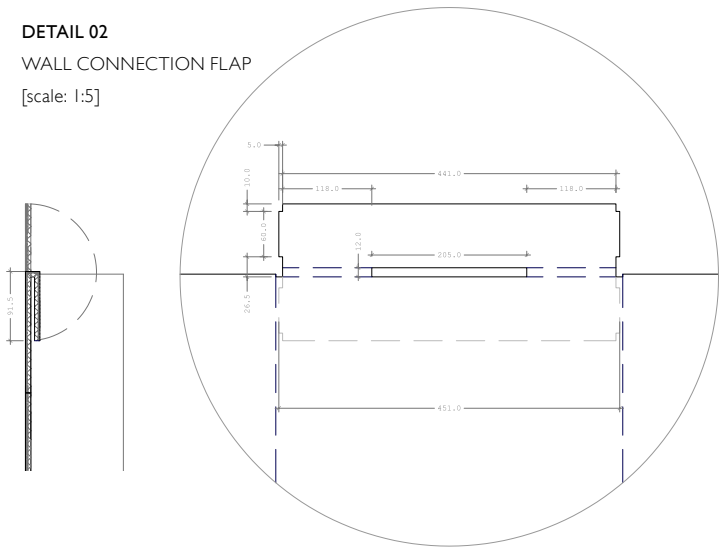


11.3 ROOF/WALL FABRICATION DRAWING

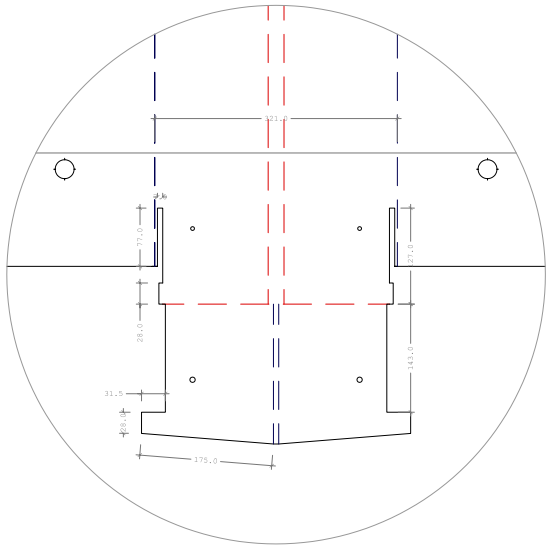
SPECIFICATION SHEET	
DWG NAME: **ROOF/WALL CONNECTION**	# REQUIRED: 01
DESCRIPTION: 2 part plan view with connection detail	L x B x D:
SIDE SHOWN: NON- PRINT SIDE	**GRAIN/CORR:** VERTICAL
BOARD: #200 BE FLUTE VL **CALIPER:** 5mm	**OUTSIDE GAIN:** 2.5mm **INSIDE LOSS:** 2.5mm
AREA:	WASTE ON BLANK:
BLANK WIDTH: 2400mm	LEN. CUTTING RULE:
BLANK HEIGHT: 3600mm	LEN. OTHER RULE:

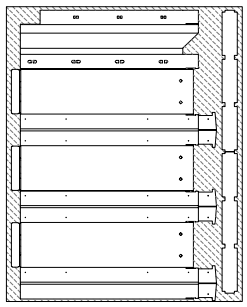


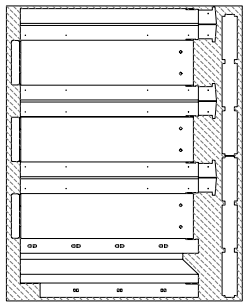
DETAIL 02
WALL CONNECTION FLAP
[scale: 1:5]



DETAIL 03
FLOOR SUPPORT
[scale: 1:10]







FABRICATION DIAGRAM
fitting on standard 3 x 2,4m sheet
[not to scale]

11.4 EXTERIOR WALL FABRICATION DRAWING

SPECIFICATION SHEET	
DWG NAME: **EXTERIOR WALL CREASE PATTERN**	# REQUIRED: 02
DESCRIPTION: plan view with connection detail	L x B x D:
SIDE SHOWN: PRINT SIDE	**GRAIN/CORR:** VERTICAL
BOARD: #200 BC FLUTE VL **CALIPER:** 7mm	**OUTSIDE GAIN:** 3.5mm **INSIDE LOSS:** 3.5mm
AREA:	WASTE ON BLANK:
BLANK WIDTH: 2400mm	LEN. CUTTING RULE:
BLANK HEIGHT: 3600mm	LEN. OTHER RULE:

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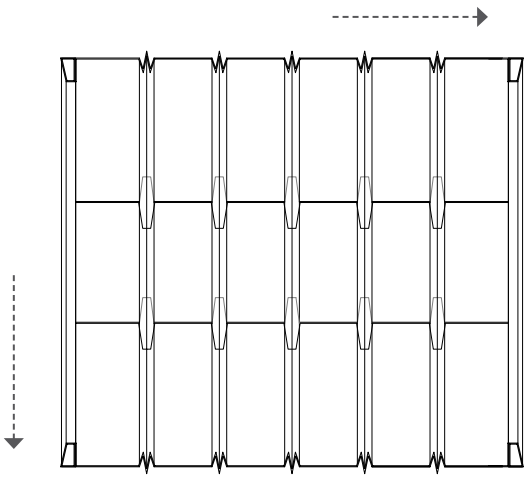
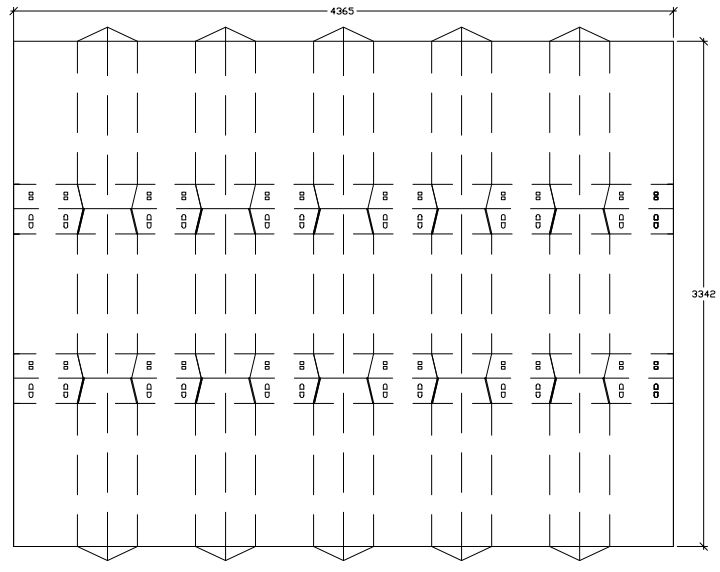
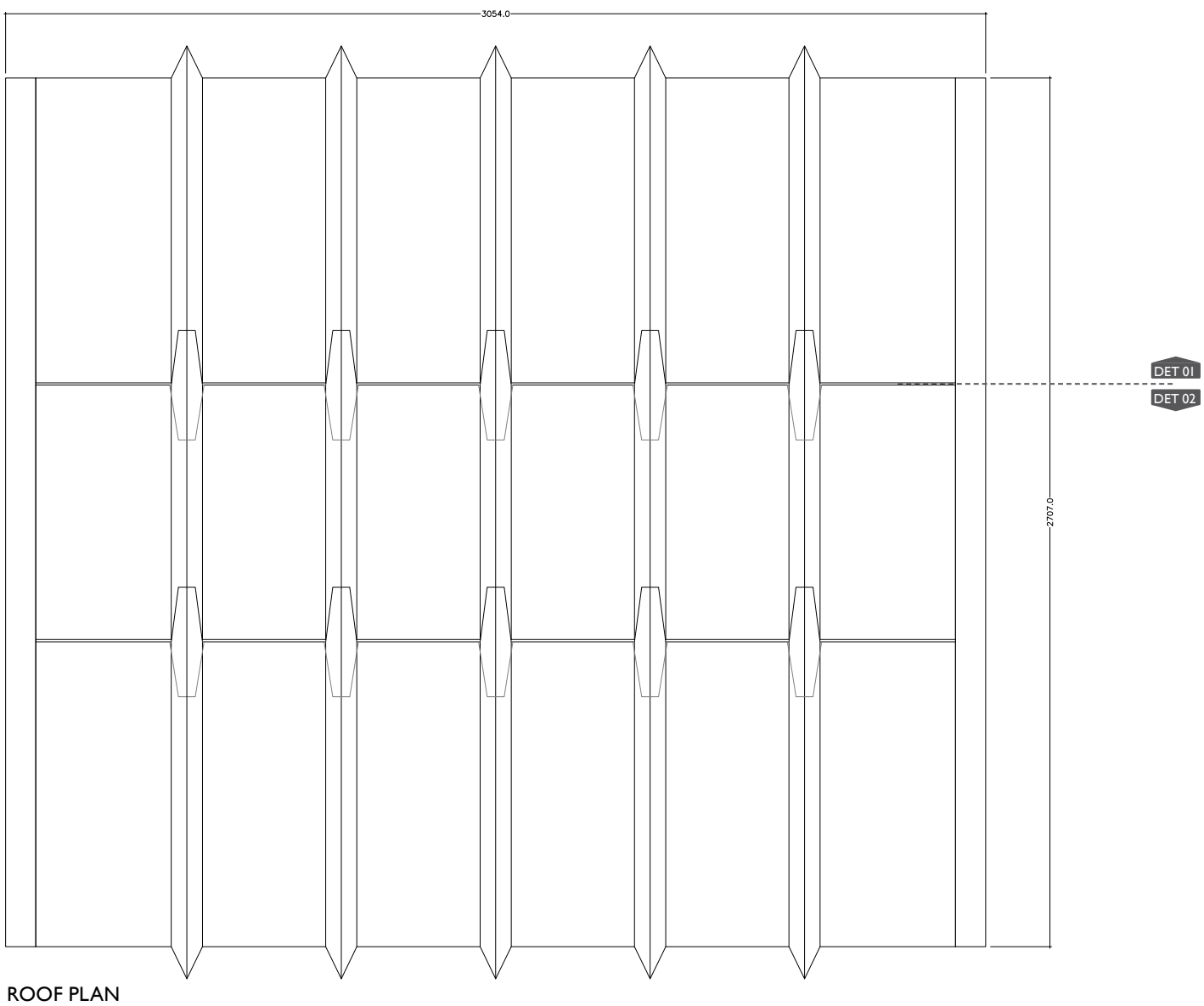
11.5 ROOF PLANS



REFECTED CEILING PLAN
[scale 1:50]

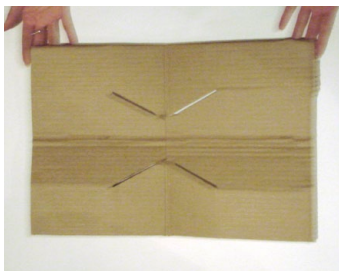


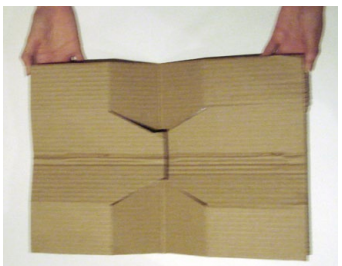
ROOF PLAN EXPANDED
[scale 1:50]

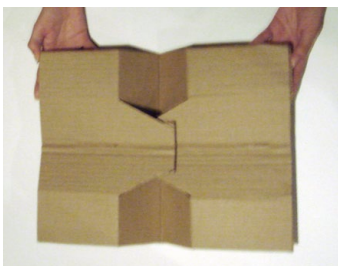


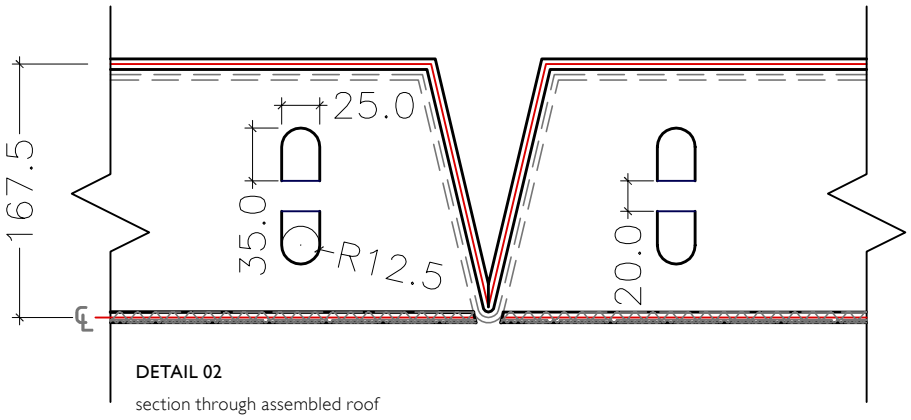
ROOF PLAN
[scale 1:20]

EXPANTION JOINT ASSEMBLY

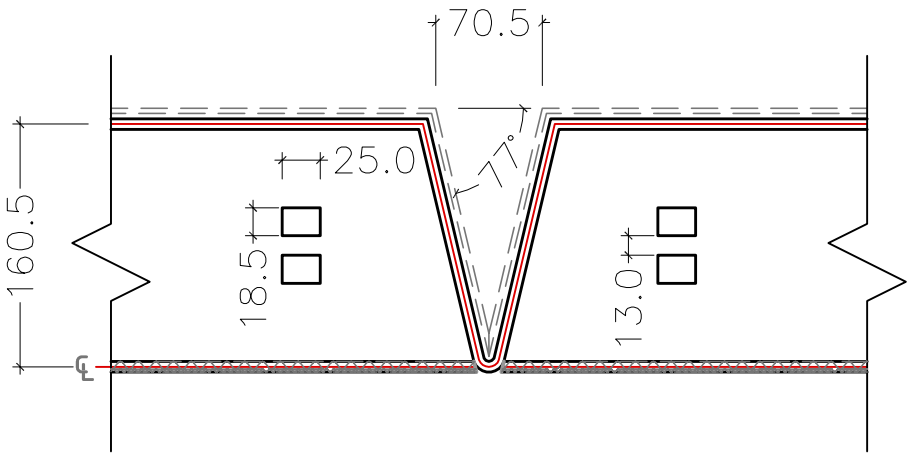






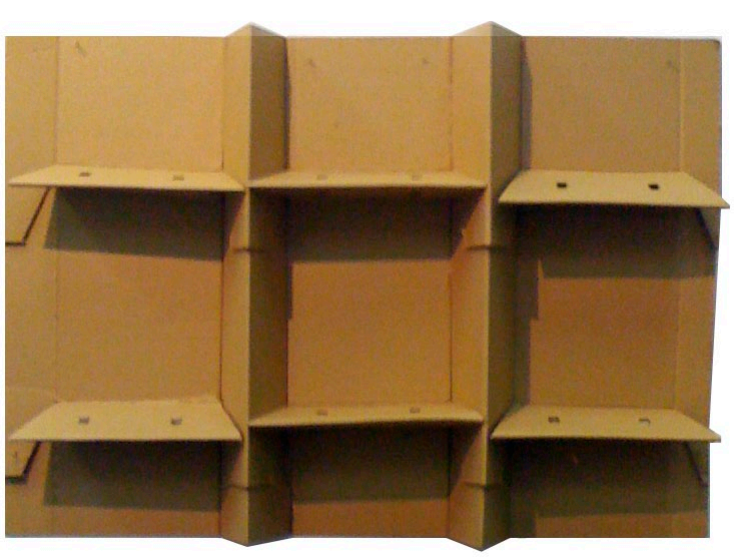


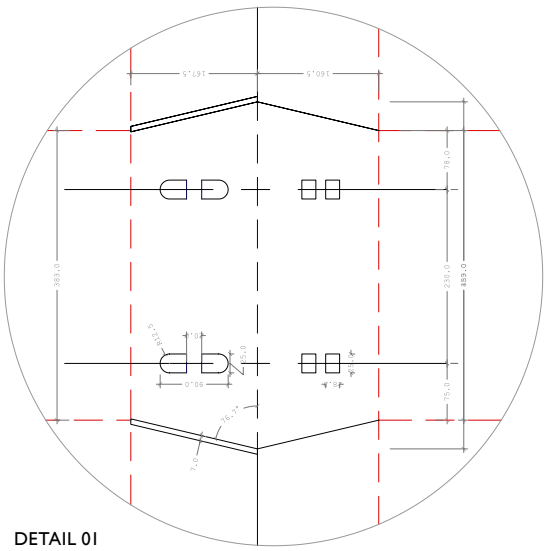
DETAIL 02
section through assembled roof
[scale 1:5]



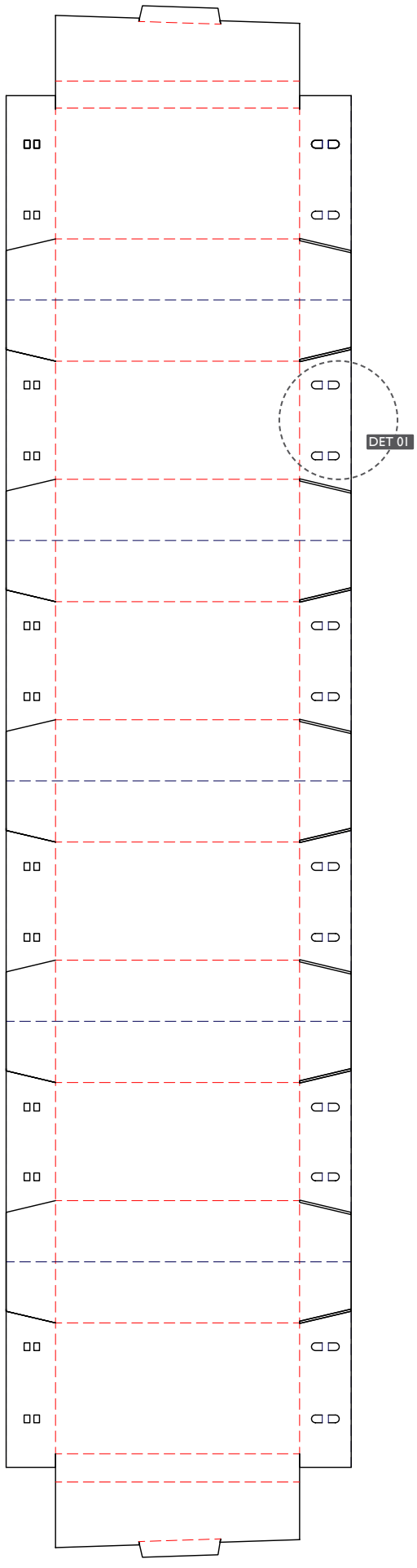
DETAIL 02
reverse section through assembled roof
[scale 1:5]

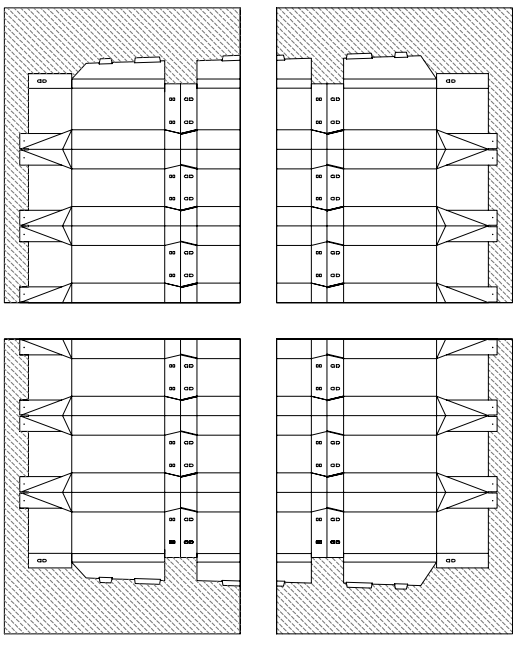
PROTOTYPE of
REFECTED CEILING PLAN
[scale 1:2]





DETAIL 01
expansion joint
[scale: 1:10]

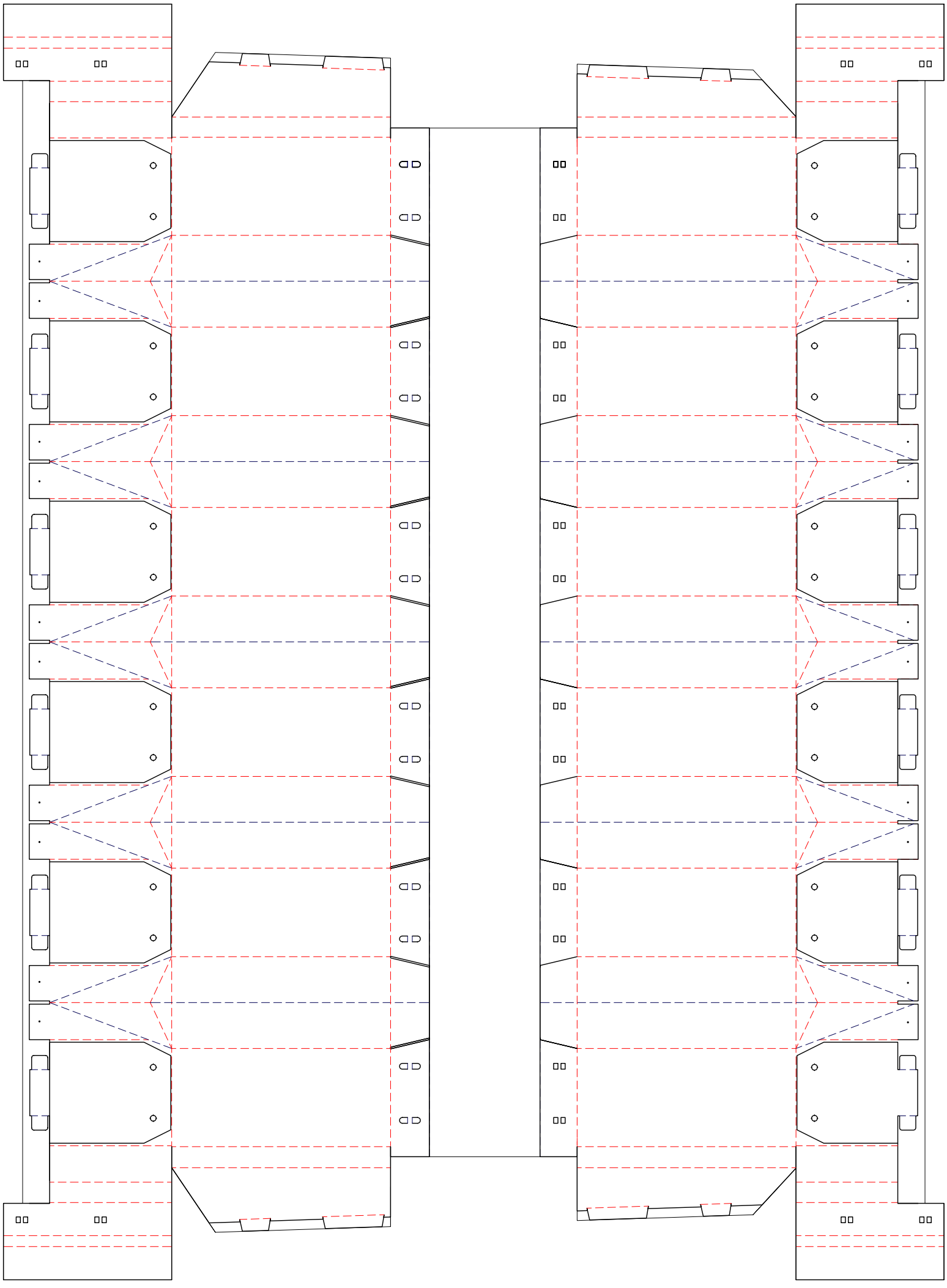




FABRICATION DIAGRAM
fitting on standard 3 x 2,4m sheet
[not to scale]

11.6 ROOF FABRICATION DRAWINGS

SPECIFICATION SHEET	
DWG NAME: **ROOF CREASE PATTERN**	# REQUIRED: 01
DESCRIPTION: 2 part plan view with connection detail	L x B x D:
SIDE SHOWN: NON- PRINT SIDE	**GRAIN/CORR:** VERTICAL
BOARD: #200 BC FLUTE VL **CALIPER:** 7mm	**OUTSIDE GAIN:** 3.5mm **INSIDE LOSS:** 3.5mm
AREA:	WASTE ON BLANK:
BLANK WIDTH: 2400mm	LEN. CUTTING RULE:
BLANK HEIGHT: 3600mm	LEN. OTHER RULE:



In very wet conditions or where no previous foundations exist, an anchoring kit can be supplied to raise the shelter unit another 150mm of the ground.

11.7 ANCHORING KIT [OPTIONAL]

AVAILABLE SYSTEMS:

- **Multi-Cell**
  Kaytech Engineering Fabrics, S.A
  Material: Polyethylene, laminated slit film woven tape strips

  + locally manufactured
  + low cost
  + simplified assembly process
  + light weight
  - strength

Figure 215 Assembly of Multi-Cell

- **Multicell® Cellular Confinement System (geocell)**
  Weismann-Friedman, Israel
  Material: Rubber

  + precedent of intended application
  + strength
  - cost: $12 per sqm
  - ease of assembly?
  - weight

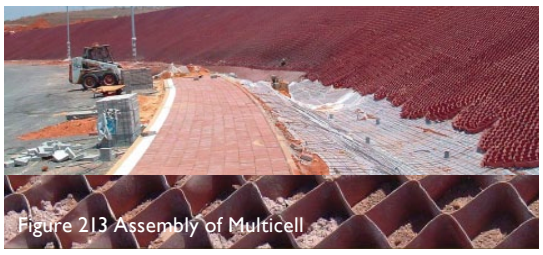


Figure 213 Assembly of Multicell

- **Geoweb® Cellular Confinement System**
  Presto U.S.A
  Material: Polyethylene

  + strength
  + light weight
  - cost
  - ease of assembly?

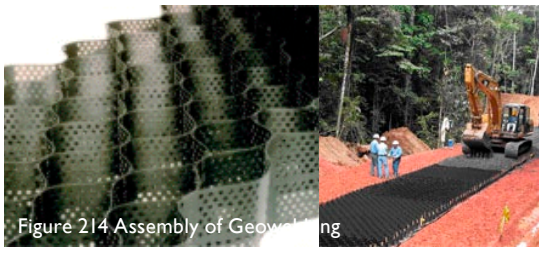
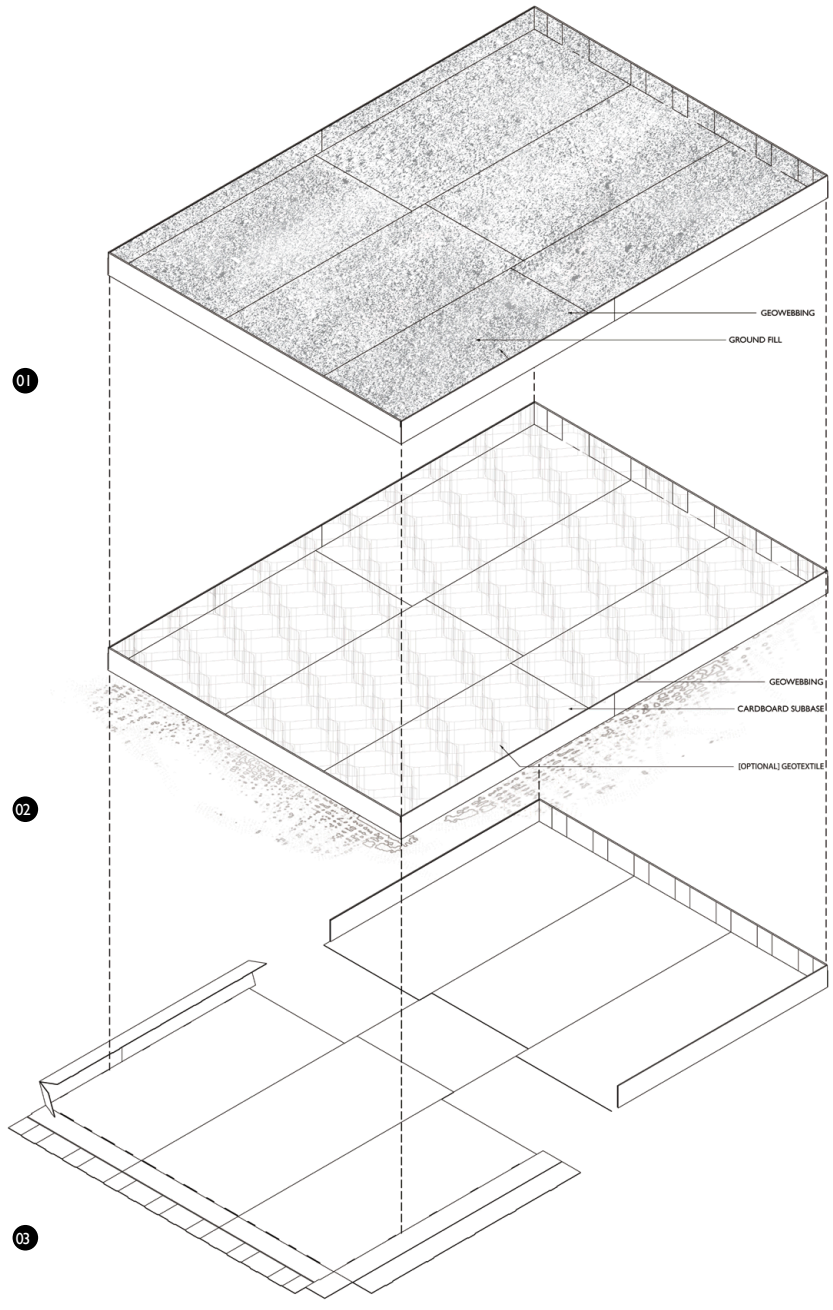


Figure 214 Assembly of Geoweb

ASSEMBLY PROCESS:



Estimated assembly time: **25 min**

Tools required: **shovel**

Package Volume:

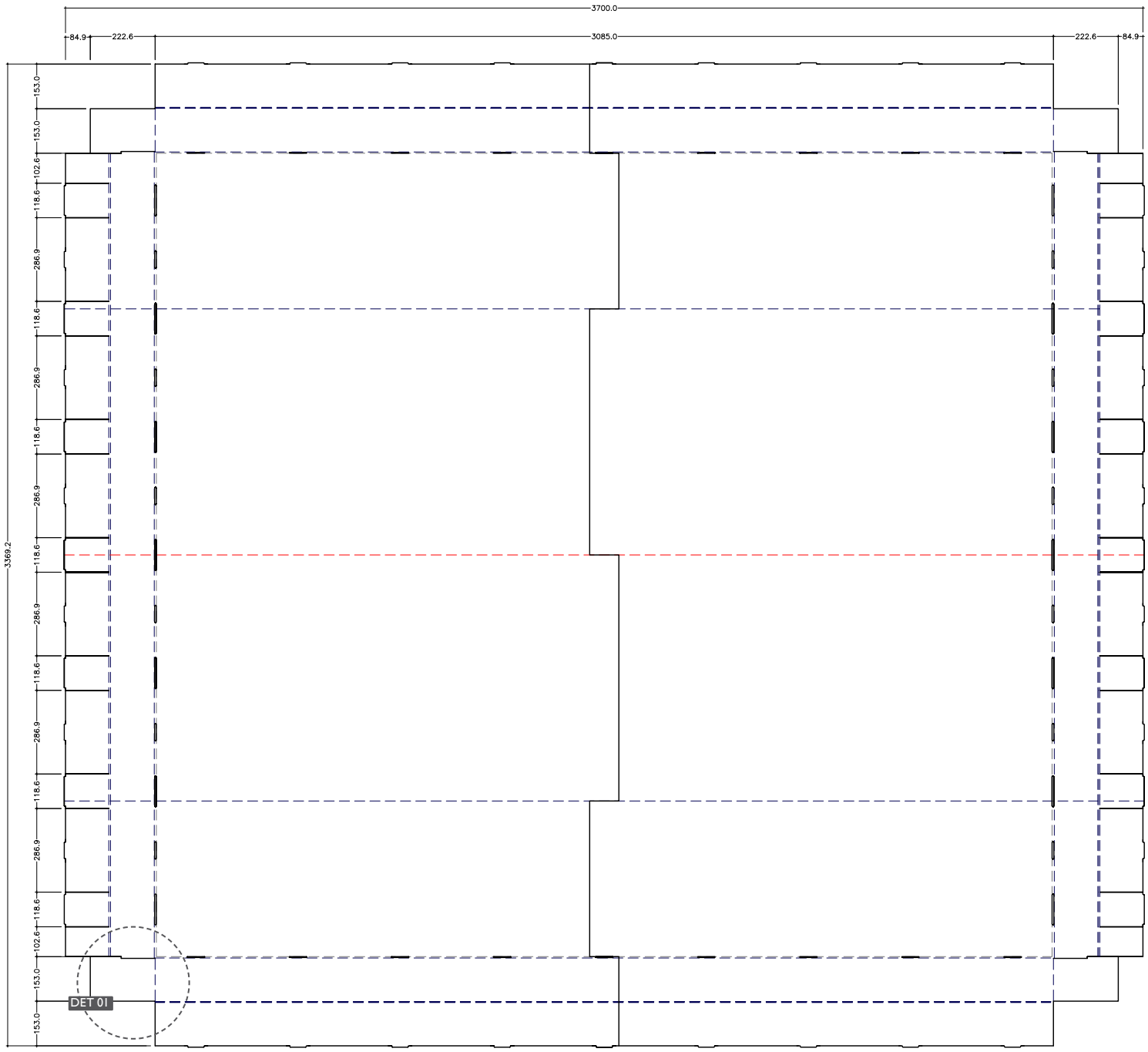
Weight

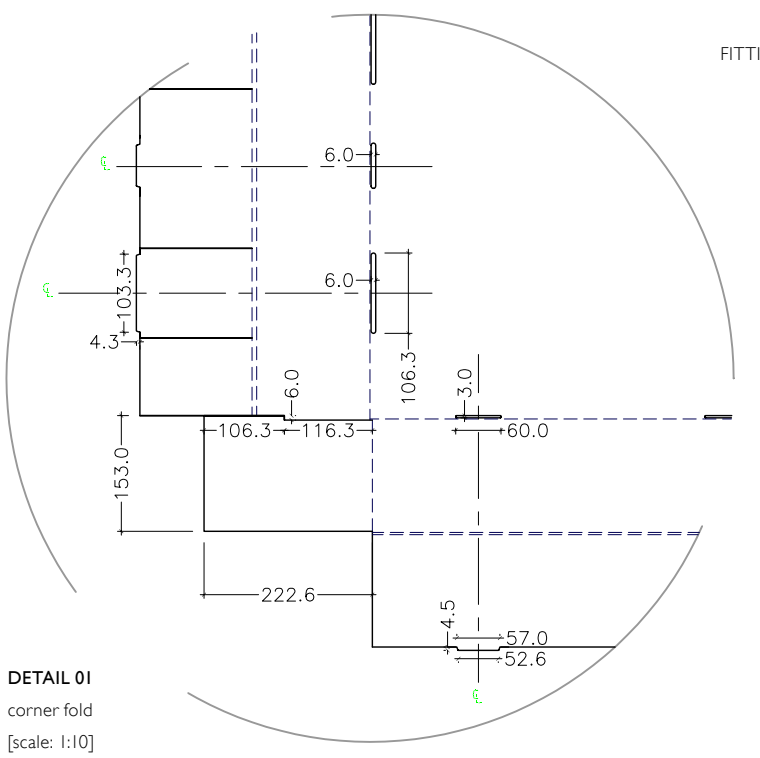
Dimentions

SAND TYPE*	AVE. WEIGHT: kg/m3 kg/m3	INFILL WEIGHT: kgs Infill Volume: 1.154 m	SHOVEL LOAD* MIN: 5-7 kgs	MAX: 8-11 kgs	ESTIMATED TIME: min. 18-21 loads/min [optimal]
Sand [wet]	1922	2218	370	233	19
Sand [wet packed]	2082	2403	400	253	21
Sand [dry]	1602	1849	308	195	16
Sand [loose]	1442	1664	277	175	15
Sand [rammed]	1682	1941	324	204	17
Sand [water filled]	1922	2218	370	233	19
Sand with gravel [dry]	1650	1904	317	200	17
Sand with gravel [wet]	2020	2331	389	245	20

* Material Densities from Simetric.co.uk

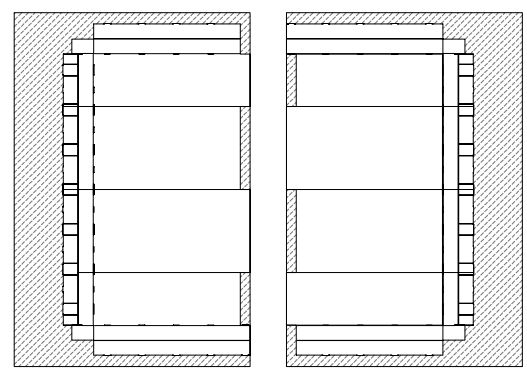
* MARRAS & KARWOWSKI (2006)





DETAIL 01
corner fold
[scale: 1:10]

FABRICATION DIAGRAM
FITTING ON STANDARD 3,6 x 2,4m SHEET
[not to scale]



11.8 ANCHORING FABRICATION DRAWING

SPECIFICATION SHEET	
DWG NAME: **ANCHORING CREASE PATTERN**	# REQUIRED: 01
DESCRIPTION: optional anchoring kit	L x B x D:
SIDE SHOWN: NON- PRINT SIDE	**GRAIN/CORR:** HORISONTAL
BOARD: #140 B FLUTE RL **CALIPER:** 3mm	**OUTSIDE GAIN:** 1.5mm **INSIDE LOSS:** 1.5mm
AREA:	WASTE ON BLANK:
BLANK WIDTH: 2400mm	LEN. CUTTING RULE:
BLANK HEIGHT: 3000mm	LEN. OTHER RULE:

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11.1 COSTING REPORT

COMPONENTS	QUANTITY	UNIT	COST/ UNIT	WASTAGE	SUBTOTAL
CORRUGATED CARDBOARD		sqm			
BC flute	40.7	sqm	R 5.00		R 203.50
BE flute	19	sqm	R 5.00		R 95.00
					R 298.50
Additives		sqm	R 5.00		
WATER RESISTANT					
Hydraban	40.7	sqm	R 5.00		R 203.50
Fire Retardant + Insecticide		gram			
Boric Acid 8% solution					
FILMS					
Aluminium Foil	20.54	sqm	R 4.00		R 82.16
Self adhesive PVC film					
Self adhesive metallic film					
PRINTING					
Litho Printing					
Flexo Printing					
Aquas Coating					
Ground Sheet		sqm	R 5.00		
Geowebbing	15	sqm	R 12.00		R 180.00
OTHER					
Moquito Net					
Zips					
Canvas	6	linear meter	R 25.00		R 150.00
FASTENERS					
plastic studs					
zips					
glue - non water soluable					
REPAIR KIT					
plastic studs					
duct tape					
MANUFACTURING					
Die cutting					
Labour [10%]					
					R 914.16

CONCLUSION

After a year critically evaluating the topic of shelter it remains clear that understanding the complexities of shelter provision is by no means a quick fix solution. It is evident that the potential of space to aid emotional well-being is severely limited by time and resources in the case of emergency.

It has become clear that the role of design in the event of disaster is to synthesize basic human needs with the insight of how space influences human behaviour.

There is a demand for flexible solutions that can evolve as the nature of the disaster changes. The thesis has tried to lay a foundation for the understanding of the most prevalent pressures exerted on the task of designing for disaster relief.

These pressures presented themselves in terms of quantitative and qualitative constraints and needs.

It was first necessary to meet the functional demands at the hand of Maslow's hierarchy of basic human needs. This order of needs where interpreted as design criteria to arrive at a solution that is functional, reliable, usable, proficient and creative.

Analysis of international shelter standards, local building regulations and current commercial cardboard shelters has provided a framework of knowledge that could inform South African standards of shelter.

Although there were limited opportunities to evaluate appropriate disaster response, context studies identified factors that cannot be solved by universal solutions.

As disasters often occur in rural areas, informal settlements and low cost housing developments, striking the urban poor, with dedicated research and response most of these devastating effects can be mitigated and even improved.

It was found feasible to formulate a shelter and response strategy within the limitations of existing local resources. Cardboard presented promising opportunities as an alternative building material within the determined parameters of flat pack deployable typologies.

Given enough time packaging technologies will translate into building technologies as the need and use is identified.

In conclusion, it is recommended that the design proposal be exposed to a broader range of opinion and demographic, in particular, those who have experienced ***grace under pressure***.

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