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THE CONCEPT OF COLLAPSIBILITY | NEW INTERIOR DESIGN APPROACH

A DESIGN FRAMEWORK FOR UNDERSTANDING AND DESIGNING CHANGE AND IMPERMANENCE

DESIGN RESEARCH THROUGH PRACTICE

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DECLARATION

I hereby declare that the work contained within has been composed by me. The contents of this thesis are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This thesis is entirely my own work and contains nothing that is the outcome of work done in collaboration with others, except as specified in the acknowledgements.

Lore Said

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To My Family...To Syria

To My True Friend Thomas Hügin

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ABSTRACT

In this thesis, I argue that in a world characterised by change, contemporary interior designers lack competent guidance on how to interpret and design notions of impermanence, and how to experiment through practice with ways of doing so. The thesis presents a considered investigation into how the concept of 'collapsibility' might contribute to interior design processes while challenging what it describes as the 'current principles of permanence and stability'. Its central argument is: collapsibility should not be understood merely as a mechanistic or functional response to modern life, but rather as a folding, and unfolding and then refolding event, constantly changing and merging in fields of forces.

Collapsibility is a commonly used concept for designing objects with predefined functions such as space saving, as described in *Collapsibles: A Design Album of Space-Saving Objects* by designer Per Mollerup (2001). This research extends beyond such teleological approaches to the concept of collapsibility as a mere mechanism, to suggest that the concept of collapsibility can be understood in a wider prospect as a design approach for both understanding and designing notions of change and impermanence in the 21st century.

While my primary definition of the concept of collapsibility in this thesis is informed by designer Per Mollerup's approach in his album *'Collapsibles'*, my extended approach of the concept of collapsibility in relation to impermanence and change is informed by a wider conceptual framework that is constructed through use of literature: *The Fold* by Deleuze, *Form-Finding* by Frei Otto and *Soft Logic* by Michel Serres. This conceptual framework developed in tandem with my hands-on approach of observing and making collapsible events using semiotic analysis and design practices as prime methods. I analyse collapsible events that happen throughout an everyday life and collapsible events of Bedouin tents. I then make collapsible structures to experiment with how collapsible events operate in a tangible way. These various explorations resulted in a new framework of the concept of collapsibility, in which I explore its practical application in guiding a

design process, of collapsible floor prototype, that challenges common design approaches of permanence and stability.

Finally, I discuss practical and theoretical remarks of the thesis and conclude that the concept of collapsibility should be seen as a new way of thinking that assists designers in interpreting and designing notions of change and impermanence as they continue to emerge within interior design and architectural fields.

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(Mollerup, 2001, pp.6, 7)

Chapter 1 **Research Introduction**

1.1 **Key Words**

Interiors, Change, Collapsible, Semiotic, Permanence, Impermanence, Folds, Force, Event, Floor

1.2 **Hypothesis and Question**

In this thesis, I argue that in a world characterised by notions of impermanence and change, interior designers lack constructive design frameworks that address notions of impermanence and change. **The hypothesis of this research** is that an in-depth study of the concept of collapsibility can provide a constructive design framework – a formula – that can assist interior designers' understanding of notions of impermanence and change in the twenty-first century.

The main question of this research is:

How can an in-depth understanding of the concept of collapsibility contribute to interior design processes so that it challenges currently assumed principles of permanence and stability?

1.3 **Background**

The area of study of this thesis is linked to my academic background within two main fields: interior design and product design. For over three years, I was involved in both teaching and professional practices of interior design before I decided to undertake an MSc degree in product design. Studying the two fields allowed me to identify potential research in one area that could feed into the other.

To elaborate, teaching interior design while continuing to practice designing interiors as a profession made me aware that interior design frameworks are outdated and limited. Shifting

between teaching mode and designing mode, I noticed the submissive nature of interiors to other disciplines such as architecture and a lack of up-to-date specialised guidance that can lead new processes of meaning in the making of interiors in this century.

On the other side, my MSc in product design draws my attention to the tacit potential of the concept of collapsibility. I came across this concept initially in an exciting album titled *'Collapsibles*: *A Design Album of Space-Saving Objects* by designer and engineer Per Mollerup. *Collapsibles* is a neologism coined by Mollerup, which refers to a new category of objects with an ingenious capacity to change and adjust volume and structure repeatedly for storage, space saving or transport (Mollerup, 2001). Collapsibility as a mechanical principle is applied to a vast number of everyday objects, from a newspaper, or an umbrella, to a tent (Mollerup, 2001).

During my MSc project, I only explored the potential use of this concept in designing adjustable origami [1] packaging, *Human Hand Interaction Within Everyday Consumer Product Design* (images of the project are included in Appendix 1, p.1). I also explored designing a *Collapsible Cladding Structure* that folds and unfolds to allow more or less light in a building (images of the project are included in Appendix 2, p.3). I focused on the use of the concept of collapsibility as a functional mechanism for storage convenience. In this thesis I explore the potential of the concept of collapsibility as a new dynamic approach to designing and understanding interiors in the twenty-first century.

1.4 Area of Research

1.4.1 Interiors

The discipline of interior design is also known as interior architecture or interior decoration; all three explore the transformation of interior spaces (Brooker & Stone, 2010, p.6). In this research the word *interior* refers to a given enclosed three-dimensional entity and the practices that address this entity as described by Attiwill (2013). This word, she argues, is interchangeable with the word to *space*; however, the word *interior* brings to

[1] *Origami: The Art of Paper Folding* by Robert Harbin (1979).

focus the design practices that address interiors (Attiwill, 2013, pp.108, 109). Generally speaking, the discipline of interior design suffers from a lack of substantial theoretical research regarding issues surrounding its diverse subjects (Brooker & Stone, 2010, p.6), its theoretical, historical and contextual framework is patchy and fragmented (Hollis et al., 2007, p. xi). In reference to interior designer Justin Wilwerding, interior design theories and terminologies suffer weaknesses that are rooted in a lack of strong philosophical foundations (Wilwerding, 2013 a, p.39). The last decade has witnessed an increasing interest in interior design research that attempts to reposition and redefine the evolving and slippery discipline of interiors (Attiwill, 2013; Brooker & Stone, 2010). For example, in 2011 the International Federation of Interior Architects/Designers (IFI) initiated a series of global symposiums and workshops titled *Design Frontiers: The Interiors Entity* to address 'interiors' issues (Attiwill, 2013). In line with this, Attiwill notes: "*it is apparent that in the twenty-first century, the concept of interior is in crisis*" (2011, p.168).

Since its establishment as an academic discipline in the early 20th century, interior design has relied on borrowing design frameworks from other established disciplines – mainly architecture (Winton, 2013; Caan, 2011; Attiwill, 2017; Weinthal & Brooker, 2013; Brooker & Stone, 2010). Since then, theories and practices of interior design have hardly been challenged (Spark, 2004, p.77). In her paper *Interiorize* (2013), interior designer Suzie Attiwill calls to question approaches interior designers have adhered to from the previous century, and she queries whether interior designers are equipped with a competent way of thinking as they face the dynamic and complex challenges of the twenty-first century. She says:

> "What if space and structure and products of twentieth-century thinking are not useful to a twenty-first century practice and context where contingency and change are dominant forces?" (2013, p.116)

In this thesis, I argue that by relying on architectural frameworks, interior designers have limited their understanding of the impermanent nature of interiors. While architectural frameworks give primacy to pragmatic matters and often seek principles of longevity and permanency, interior design is more concerned with transitory, temporal and impermanent situations (Poldma & Wesolkowska, 2005; Attiwill, 2013; Winton, 2013; Brand, 1994; Brooker & Stone, 2010, p.26). Along these lines, Shashi Caan, in her book *Rethinking Design and Interiors: Human Beings in the Built Environment,* questions the relationship between the architecture and interior design disciplines. The latter is more concerned with psychological matters and behavioural sciences, whereas the former focuses on structural and physical matters (2007, p 54). Designing interiors in this 21st century, she continues, could stretch to include social, ecological and cognitive knowledge (Caan, 2011 pp.158-159).

In this thesis, I argue that interior designers lack constructive design frameworks that address notions of impermanence and change. I unpack this argument in the next chapter, *Designing Interiors in the 21st Century|Reviewing Current Models* while reviewing the building framework *Shearing Layers of Change* (1994) by Stewart Brand. Brand's framework here serves to uncover several rigid approaches such as classification, functionality and order within the architecture framework. Such approaches, I argue, gives primacy to principles of longevity, permanency and stability, hence limited interior designers' understanding of the impermanent nature of interiors. I position my argument in relation to several interior design scholars, mainly Attiwill, Poldma, Wilwerding, Caan, whose views point out to lacking and related limitations of current approaches in interior design. To position my argument in relation to wider debates, I also consider views of the theorist Henri Lefebvre, particularly his book *The Production of Space* (1991) and anthropologist Tim Ingold's insights in his book *Being Alive: Essays on Movement, Knowledge and Description* (2011), and also sociologist Zygmunt Bauman, in his book *Modernity and Ambivalence* (1991), whose opinions challenge prevailed ways of thinking.

This thesis aims to develop a dynamic way of thinking for designing interiors based on the concept of collapsibility. This concept is built around notions of impermanence and change, hence, I argue, it can assist interior designers in understanding and designing such notions.

On the one hand, my extended approach of the concept of collapsibility in relation to impermanence and change is informed by wider conceptual framework that involves the theory of *The Fold* by philosopher Gilles Deleuze, the concept of *Form-Finding* through force by architect Frei Otto, in addition to the philosophy of *Soft Logic* in reference to philosopher Michel Serres, as described by Barnet (1999). These approaches are built around dynamic notions such as soft, force and folds that together inform my extended approach of the concept of collapsibility and challenge current rigid approaches. For example, Otto's concept of *Form-Finding* is built around understanding the dynamic notion of forces in order to generate new forms in architecture. Otto's approach has teased out several new models in architecture, such as textile thinking (Kane, Philpott 2013). Similarly, Deleuze's way of thinking inspires many dynamic forms in creative fields of architecture and design (Vyzovit, 2010) (Attiwill et al, 2017). Since the 1990s Deleuze's philosophies are considered the most influential in creative practices (Flaxman, 2017) (Schumacher, 2012).

On the other hand, my primary definition of the concept of collapsibility in this thesis is informed by designer Per Mollerup's approach in his album *'Collapsibles';* in particular, his reference to 'unofficial' collapsibility.

1.4.2 Per Mollerup's 'Collapsibles'

The concept of collapsibility within design fields is seen as a concept for designing objects with a pre-defined purpose: namely, space saving and storage convenience, as described in *Collapsibles* by designer Per Mollerup (2001). 'Collapsibles' Mollerup defines "*are functional doubles with two opposite states, one folded and passive, one (or more) unfolded and active. They grow and shrink, expand and contract, according to functional*

need." (2001, p.11) Mollerup emphasises the repetitive feature of the collapsibility concept; he asserts that "true collapsible is repeatedly collapsible; it can collapse, and expand, and collapse again and again" (Mollerup, 2011) (emails are included in Appendix B). Collapsible in Mollerup's approach is a mechanism to save space when needed: "*Collapsibles – objects that, in one way or another, fold out for action and fold up for storage*." (2002, p.7)

1.4.2.1 **Mechanisms**

There are twelve principles of collapsing. They are stressing, folding, creasing, bellowing, rolling, sliding, nesting, fanning, hinging, inflating, assembling and concertinaing (Mollerup, 2001, p.30). Most of these mechanisms, according to Mollerup, are not the main functions of an object; rather they mostly support the main function of it, such as the collapsible ladder of the fire truck. Some of these principles describe the structure of a collapsible action, such as concertina and bellow, whereas others track the direction of an action by which an artefact compacts and expands, such as nesting, sliding and inflating. These collapsible mechanisms resist strict classifications (Mollerup, 2001), as sometimes the differences between them are vague. For example, nesting and sliding both refer to containments of parts in other. A telescope, for example, Mollerup classifies as collapsible because of the sliding parts; it could also be argued that it is collapsible because of its nesting parts. Folding and creasing are also similar mechanisms; the latter, however, involves a more predefined structure of creases or pleats (Mollerup, 2001). On the whole, far from any rigid classification, all mechanisms imply processes of folding, unfolding and refolding. These processes are central ideas for the reflection and analysis of 'collapsible events' in this thesis.

1.4.2.2 **'Unofficial' collapsibility**

Mollerup differentiates several types of '*collapsibles*'. Firstly, the true collapsibles include objects with one or more active states and one passive, such as a Swiss Army knife, stretch leggings or a foldable chair. Secondly, the quasi-collapsibles (i.e. semi-

collapsibles): not all adjustable objects fall within the realm of being true collapsibles; some of them are partially collapsible. Objects that have many active states and do not have a passive one can be considered as quasi-collapsibles, such as scissors, which have many active states and folded states that can be considered as both active and passive. A lid of a jar can also be considered as being quasi-collapsible, since it does not have a passive state – both states are active; one for preserving, the other for using the content. There is another type of 'unofficial' collapsibility, he argues, that is not intended by designers. This is when someone, for example, squeezes contents into an overloaded suitcase; the suitcase stretches then gradually shrinks back into its actual form when emptied. Such a collapsible event of the suitcase is not envisaged by designers. "Unofficial" collapsibility in this sense is an inherent quality of something. Mollerup explains:

> "Three actions were happening he said: "Both compression and stretching entail against more or less defenseless fabric. Although they are mechanical opposites, compression and stretching are sometimes practiced together. Picture the stressed traveler sitting on his suitcase, struggling to squeeze its contents down to a manageable volume, while simultaneously stretching the suitcase lid to meet the base. The content is compressed. The suitcase is stretched. Man and machine are stressed. This example illustrates the fact that stress – whether compression or stretching – is often an unofficial collapsibility principle, applied to tools rather more often than their designers might have envisaged." (Mollerup, 2001, p.32)

The non-collapsibles include rigid objects that cannot redistribute their volume or objects that are designed to be folded or unfolded once. For example, self-assembly IKEA furniture is not considered collapsible, it is considered as a part-manufactured product. Assembly toys, however, such as Lego and Meccano are truly collapsible, as following construction they will be dismantled again and again.

There are countless collapsible designs of tools, objects, furniture, adaptive architecture, temporal pavilions and theatre staging etc. The focus of this research, however, is those

'unofficial collapsible' events that are not envisaged by designers. These capacities are taken for granted. Several examples will be discussed throughout the thesis. My intention is to uncover a tacit meaning and row understanding of the concept of collapsibility away from predesigned examples. I want to focus on their formal traits and their processes in real time.

In his album, Mollerup focuses on exploring the common approach of the concept of collapsibility as a mechanism for space saving, transport and storage convenience. His album is primarily a collection of images of collapsible objects and furniture. In this thesis I focus on exploring the concept of collapsibility not merely as a mechanistic or functional response to modern life, but rather as a folding and unfolding and then refolding spectrum of events, constantly changing and merging in fields of forces.

Mollerup has already scratched the surface of the significance of the concept beyond functional matters. He states that collapsibility is a strategy. It is nature's own method to accommodate changes. He also exposes a tacit understanding of collapsibility as immaterial events when referencing psychological collapsibility. He says:

> "The world is in a state of flux. Change is happening all the time, all around us. We try to hang on by continually adapting ourselves and our belongings to our shifting circumstances. (…) The ability to adapt is necessary to continued survival. So it is in nature." (Mollerup, 2001, pp: 17, 19)

> "Man, himself, is a collapsible being, physically and psychologically, needs and wants collapsible tools. (...)The principle is simple: no adjustment, no future. Adapt and survive." (Mollerup, 2001, pp.6, 7)

Mollerup (in personal communication) explains that psychological collapsibility can be experienced when someone wins: they show off (inflate) then hide when they get defeated (deflate). (Mollerup, Personal Communication, 2012) (Email Re: 2 is included in Appendix 7, p.41). The concept of collapsibility can be seen through this lens as a process of strategic adjustment, be it material or immaterial.

These saturated statements expose several important characteristics and meanings of the concept of collapsibility in relation to change, which have triggered this research proposition. Research undertaken for this thesis suggests a wider approach to collapsibility as a concept within design theory for interpreting and designing notions of change and impermanence in the 21st century. This approach expands beyond the common teleological approaches of collapsibility as a mechanism for space saving.

Reflecting on these quotations above, several elementary questions were raised: 1) What kind of collapsible tools do humans need and want? 2) How does this 'simple principle' of adjustment for survival work? 3) Do humans have collapsible tools? If yes, what new ones do humans need? These questions have developed and matured throughout the course of this research, leading to the objectives for this PhD research.

1.5 **Aims and Objectives**

My overall aim is to develop a new way of thinking about designing interiors based on the concept of collapsibility. I believe that this concept, as a framework, will assist interior designers to come to a clearer understanding for interpreting notions of impermanence and will, in turn, open new possibilities for designing dynamic interiors.

Given the shortage of design research around the concept of collapsibility, my first objective is to expand my understanding of this concept by analysing collapsible events in everyday life and then to move to a particular example of Bedouin tents, which are central to a life of change and impermanence, in order to explore and discover the framework-formula of how collapsible events operate.

Finally, I aim to explore the practical application and potential of the framework-formula of the concept of collapsibility in raising new design possibilities that challenge currently assumed principles of permanence and stability within interior design practices.

1.6 **Methodology**

This thesis aims to provide a framework, based on the concept of collapsibility that assists interior designers in understanding notions of impermanence and change. Studying collapsible events, in this thesis, is to be seen as a conceptual lens to analyse and understand notions of impermanence and change within the context of interiors. Given the limited research and literature on the concept of collapsibility, I had to build my own conceptual framework in order to study 'collapsible events' in relation to notions of folds, forces and collapsible capacities. This conceptual framework was developed through observations and tangible experiences investigations, in tandem with the use of literature related to these notions. This literature included *The Fold* (1993) by philosopher Gilles Deleuze, the concept of *Form-Finding/Textile Thinking* by architect Frei Otto in the 1990s, and the philosophy of *Soft Logic* (1991) by philosopher Michel Serres, as described by Barnet (1999). I unpack the conceptual associations and the differences between these approaches and my approach to the concept of collapsibility in the next chapter.

My prime methods throughout this thesis are semiotic analysis and design practices. I use the semiotic analysis method to observe and analyse signs of collapsible events, and I use design practice methods for tangible study of collapsible events. I also use other qualitative methods such as desk-based research, interviews and design workshops to develop a richer understanding of the concept of collapsibility and to examine the validity of my research findings at various stages.

These various investigations of collapsible events in relation to notions of folds, forces and collapsible capacities are developed throughout Chapter Two, Three and Four to become a set of principles underpinning a generic framework of the concept of collapsibility for understanding impermanence. In Chapter Five, I examine this framework's practical applicability in assisting interior designers in understanding notions of impermanence and change through various design processes.

1.6.1 Observation and Semiotic Analysis

In general, the decision to implement the main approaches of semiotic analysis and design practices arises mainly from the dynamic nature of the subject of 'collapsible events' that can benefit from hands-on observation and experimental approaches. The choice of semiology in particular, however, arises from the importance of semiotic perspective to this research position. This thesis aims to provide a framework that will assist interior designers in understanding and designing notions of impermanence and change. This framework, therefore, involves processes of meaning-making. Semiology as a method for interpreting signs and making meaning can be considered as of great relevance to this research position. In other words, semiology is not only a method for analysing and studying collapsible events, but also a subject of interest for this research's particular aim of providing a framework to assist in the meaning-making processes of impermanence and change.

Semiotics is a huge field, and its strengths can be highlighted in its ability to provide both detailed analysis and a unifying conceptual framework for understanding signs (Rose, 2002; Chandler, 2002). However, it also has some limitations, as no treatment of it can claim to be comprehensive. It is based on a subjective interpretation and is highly unsystematic, with little evident practical application (Rose, 2002; Chandler, 2002). Scholars, including interior designer Tiiu Vaikla Poldma (2013), interior designer Justin Wilwerding (2013) and architect Patrik Schumacher (2012), have asserted the importance and relevance of semiology in design fields. However, in interior design, this tool is frequently neglected. According to Tiiu Vaikla Poldma in *Meanings of Designed Spaces* (2013): "*the semiotic power of interior space is one of the least critically analysed components of human culture*" (Poldma, 2013, p.64).

Wilwerding also argues that there is a need for interior design research for "*studies that examine the design of space from a semiotic and phenomenological perspective and that provide a range of typological structures offering a framework of environmental meaning to practitioners*" (Wilwerding, 2013b, p.84). This thesis responds to this need by exploring the semiotic perspective of collapsible events in the context of interiors and aims to

provide a framework that assists interior designers in understanding notions of impermanence and change.

Semiotic analysis, in this research, involves documenting collapsible events using photography and then analysing the images using a semiotic analysis table. This semiotic analysis table divides each collapsible event into three elements: sign, signifier and signified. The table is based on the views of linguist Ferdinand de Saussure, who distinguishes between the signifier, the signified and the sign, the latter being made up of the relationship between the former two (see Table 1) (Saussure, 1983, 1974, quoted in Chandler, 1994). The 'signifier' is the *form* that the sign takes, while the 'signified' is the *concept* a sign represents (Saussure, 1983, 1974, quoted in Chandler, 1994). For example, the word 'open' on a shop door is a sign for someone who reads it. This sign consists of a *signifier*: the actual word 'open', and the signified *concept*: that the shop is open for business (Chandler, 1994). According to Saussure, the sign can be anything depending on the interpreter's intention.

Signification (event)	
Signifier	**Signified**
A physical form of a sign	A concept a sign represents
Sign	
A quality or event that stands for a meaning	

Table 1: *Elements of a Sign* (Saussure, 1983, 1974, quoted in Chandler, 1994)

In Chapter Three, I study signs of collapsible events in everyday life provided by personal observation. I focus on 'unofficial' collapsible events encountered throughout different daily activities where a definition is yet to be given, or of events often taken for granted, for example squeezing a washing-up liquid bottle. A series of photographs is used to document processes of collapsible events (i.e. before, during and after collapsible events).

In Chapter Four, I then analyse collapsible events in a case study on Bedouin tents in order to understand them in the context of interior systems. In other words, I analyse how collapsible events operate on a larger scale as a system of interconnected sub-events.

As this thesis will demonstrate, this analysis plays an important role in uncovering the key principles of the concept of collapsibility, and more importantly in explaining how they connect. These notions will be unpacked throughout the thesis.

1.6.2 Experiential Learning and Design Practices

Frayling's (1993) classification of art and design research identifies three main types of research projects: (a) research into practice; (b) research through practice; and (c) research for the purpose of practice. In her paper, *Methodological Innovation in Practice-Based Design Doctorates*, designer Joyce Yee explains the difference between these types:

> "Research into practice refers to research where art or design practice is the object of the study. Research through practice refers to research where art or design practice is the vehicle of the research, and a means to communicate the result. And finally, research for the purpose of practice aims to communicate the research embodied in a piece of design." (2010, p.3)

This research falls into the category of research through practice. This is where design practices are both the vehicle of the research and a means to communicate the result.

The practical experiments in this thesis mainly aim to gain experiential insights into the way collapsible events operate tangibly. For example, in Chapter Four (*Bedouin Tents Case Study: Semiotic Analyses and Practical Experiments*) I make collapsible models serve to translate abstract and conceptual findings (resulting largely from semiotic analysis) into tangible forms in order to understand how collapsible events operate in action. In Chapter Five, I make collapsible structures of various materials in order to gain experiential insights into their collapsible capacities in action. I then implement this experiential knowledge of collapsible capacities through the design process of the

collapsible floor. The collapsible floor prototype serves to examine a practical application of the conceptual framework of the concept of collapsibility. Philosopher Donald Schön, in his book *The Reflective Practitioner: How Professionals Think in Action* (1983), considers such an approach to be an ordinarily implicit method of learning and gaining knowledge through active reflections of actions. He says:

> "Our knowing is ordinarily tacit, implicit in our patterns of action and in our feel for the stuff with which we are dealing. It seems right to say that our knowing is in our action." (Schön, 1983/1991, p.49) (quoted in Niedderer and Reilly, 2010, p.4)

The experiential insights gained from these practical experiments are sometimes hard to explain. However, the knowledge and the insights presented can be considered explicit. Such approaches are common in Design and Art fields. In line with this, designers Niedderer and Reilly, in their paper *Research Practice in Art and Design: Experiential Knowledge and Organised Inquiry*, state that:

> "Many researchers in art and design and related fields perceive experiential knowledge or tacit knowledge as an integral part of their practice" (2010, p1).

> "Experiential knowledge is perceived to be important for art and design, because it can provide data, and verify theoretical conjectures or observations. While experiential knowledge can be described, some part of it evades communication and remains tacit. It is therefore also termed tacit knowledge. Because of its (partly) tacit nature, experiential knowledge does not easily yield to practices of justification and evidence conventionally used in research." (Niedderer, 2007b, p. 7; Williams, 2001, p.98, quoted in Niedderer and Reilly, 2010, p.5)

The insights and new knowledge acquired through these practical experiments are impacted by both the previous tacit known knowledge of a collapsible material or a structure, i.e. *informed* practices (conducted from an awareness of previous related research) (Cross, 1999, p.9), and the new experiential learning that emerged throughout

the process of the experiments and the interactions with collapsible structures and materials, i.e. *inquisitive* practices (defined as seeking to acquire new knowledge) (Cross, 1999, p.9). In *Bedouin Tent Case Study* (Chapter Four), for example, I rely on my experiential knowledge of the Bedouin tents and the way their structures respond to force. This knowledge was gained through past experience in living and interacting with the Bedouin tents collapsible system. While some assumptions presented in the semiotic analysis may seem subjective, they are explicit and generalisable.

These experiments are by no means a straightforward process. Experiential insights have shaped the planned action for the next practical experiments. Photographs and videos have been used to document the exploration of the various collapsible structures, prototypes and models.

The making of different collapsible structures and materials integrates serval design practice methods such as modelling, material explorations and prototyping.

Modelling: in Chapter Four, I make two representational models of a collapsible system of folds, similar to the one exhibited in the Bedouin tent. I use plastic strips and rubber to create systems of collapsible folds that respond to force. I manipulate the system by applying force (through pulling and pushing by hand) to study their behaviours. This hands-on approach aims to gain experiential knowledge of how a collapsible system operates in a tangible way.

Material experiments: in Chapter Five I make collapsible structures of various materials in order to examine the practical application of the new framework of collapsibility in extending their capacities to change. Making collapsible structures with wood, rubber and metal, my aim is to shift from conceptual understanding to practical. While these experiments are not radically innovative, reflecting on collapsible capacities is the central focus.

I use the framework of collapsibility (underpinned by notions of forces and folds collapsible capacities) as a conceptual scaffold for reflecting on the collapsible capacities of various structures of both soft and hard materials, including silicone, foam, metal and wood. I apply force by hand or foot on various structures and study their collapsible capacities to fold/unfold/refold accordingly. The aim of this experiment is to understand the collapsible capacities of various structures through actively engaging with collapsible events in action.

Prototyping: The second series of experiment design involved modelling and prototyping various collapsible floors. The collapsible floor prototypes were made of different materials that would respond to force when people walked on them, in order to challenge the common passive design approaches to floors. Here, again, I reflect on the notions of folds, forces and collapsible capacities. I used various digital modelling and prototyping tools such as floor 3D printing, (2D/3D) AutoCAD digital software, CNC and laser cutting and CAD Solid Works software to design a collapsible floor. Four prototype models were produced to explore various designs and fabrication methods of collapsible flooring. The collapsible floor was designed to be responsive to force when people walked on it. I used digital (2D) AutoCAD to produce the floor elements using CNC and laser cutting. I also explored other CAD software such as Solid Works to test and compare the actual collapsible behaviour with computer-generated models. I then used 3D AutoCAD digital modelling to produce a collapsible structure with 3D printing in order to experiment with the way fabrication methods affect behaviours of collapsible structure in response to force. The final floor prototype was produced using CNC and laser cutting.

The floor prototypes aimed to explore the practical implications of the framework and provide feedback on the way these frameworks challenge approaches in design that involve the principle of permanence. In other words, the main aim of producing a prototype of a floor was to examine the practical application of collapsibility in challenging current approaches that assume permanence and stability. The floor design itself was not a main focus. This process of making a prototype involves a different type

of reflection when the floor is required for commercial purposes. In designing this prototype, both the process and experiments reflected on the impermanent state and resulting behaviour of the floor. In other words, using the concept of collapsibility and its key principles as a guide, these design practices aimed to challenge the common design approaches to floors as permanent and stable surfaces. Such an experiment can be seen as a method to generate more questions, rather than to provide a new floor design.

1.6.3 Other Supporting Methods

Throughout the course of this research, I also used several other supporting methods to obtain richer data and validate my main research findings. These included:

1.6.3.1 Desk-based research

This involves consulting various sources such as textbooks, design journals, albums, conference papers and articles. I use desk-based research at various stages:

I first use desk-based research to construct a primary understanding of this research's main areas of study: interiors and the concept of collapsibility. This is done in order to strengthen my research position on the lack of constructive interior design frameworks that address notions of impermanence and change. For example, I review dictionaries to explore the etymologies of the word 'collapsible', using desk-based research to understand the origins and connotations of this word. I also review literature around the concept of collapsibility, such as the views of Mollerup in his book *Collapsibles*, to construct a primary understanding of this concept. Furthermore, I review various literature in architecture and interior design using desk-based research to set out a clear context for the research hypothesis questions. For example, in Chapter Two (*Designing Interiors in the 21st Century/Reviewing Current Models*), I review various literature relating to the discipline of interior design and architecture in order to define this research proposition (i.e. lack of interior design frameworks for understanding and designing notions of impermanence and change).

I then use desk-based research to explore literature on established philosophies and concepts that are built around change and dynamic notions, in order to expand my understanding of the concept of collapsibility in relation to such notions. This literature includes *The Fold* (1993) by philosopher Gilles Deleuze, the concept of *Form-Finding/Textile Thinking* by architect Frei Otto in the 1990s, and the philosophy of *Soft Logic* (1991) in reference to philosopher Michel Serres, as described by Barnet (1999). Reviewing this literature played an important role in developing the conceptual foundation of this thesis approach. For example, Deleuze's notion of *fold* and Otto's notion of force as a *form-finding* method together helped to develop my understanding of collapsible events. This is because these notions became part of the core reflections on collapsibility's capacity for form/fold-making and of force for form-giving.

In Chapter Five, I use desk-based research to develop contextual knowledge for my design of collapsible floors, explore contemporary themes and avoid repeating information found in other studies.

1.6.3.2 **Semi-structured interviews**

I conducted semi-structured interviews with scholars from different fields, such as anthropologist Tim Ingold and architect Patrik Schumacher, to expand my understanding of the concept of collapsibility.

Choosing to interview scholars from disciplines other than interior design was based on promoting an interdisciplinary approach. On the one hand, these interviews helped to enrich the terminology and the scope of this research at the start. However, my lack of interviewing skills in terms of controlling the track of the conversation proved to be an issue, particularly during Schumacher's interview. Most of these interviews were not reliant on fixed questions. The interviews took the form of open discussion, with some prearranged bullet points to be covered (transcripts of the interviews are included in Appendices 3 and 4).

I interviewed Tim Ingold after reading his insights in his book *Being Alive: Essays on Movement, Knowledge and Description* (2011). In his book, Ingold challenges current design approaches to built environments. Using Deleuze, he suggests that the built environment does not consist of objects, but rather of currents of countless material flow (these views are discussed in more detail later in this thesis). This idea of understanding objects as dynamic matters is connected with my research subject. I therefore embarked on an investigation of his views on the subject of collapsibility. The interview was insightful; in particular, Ingold made reference to the principle of *tensegrity*, which will be discussed in Chapter Four.

I also interviewed architect Patrick Schumacher after coming across his book *The Autopoieses of Architecture (Volume II): A New Agenda for Architecture* (2012). In his book, Schumacher proposes a manifesto for parametricism as an epochal style for the 21st century. Parametricism is rooted in digital techniques (2009). Parametric design is a computer-based design approach that treats the geometric properties of the design as variables (Schumacher, 2016). In his book, Schumacher emphasised the importance of semiology in architecture. I interviewed Schumacher in order to explore his views on the subject of collapsibility and to understand my subject's relevance to his approach.

The interview started without a defined question. Schumacher started by challenging the main topic of my research (i.e. collapsibility); he questioned whether the concept of collapsibility was used in this research as a metaphor for interpretation rather than a constructive concept. Schumacher continued to challenge my approach on collapsibility, which encouraged further research on architectural methodologies for interpreting forms, i.e. meaning-making. This led me to explore Frei Otto's form-finding concept. Schumacher states that "Frei Otto might be considered the sole true precursor of parametricism" (Schumacher, 2009, p.23). This later became one of the cornerstones of this thesis's methodology.

Schumacher's parametric approach also proved useful during the prototyping and the digital modelling of a collapsible floor. Experimenting with different collapsible floor designs by changing their parameters (i.e. geometric properties) expanded the range of form possibilities produced.

1.6.3.3 **Structured interviews**

I also conducted structured interviews with Bedouins in Syria, indirectly,[2] in order to form a deeper understanding of the way structures of Bedouin tents behave on a daily basis (see Arabic transcript and translation of two interviews with Bedouins in Appendix 9, pp.45-54). The questions were structured and focused on exploring how Bedouins deal with changes in the configurations of the Bedouin tents in the course of a day, month or season. The questions were somewhat similar, but phrased in different way to allow elaborations, such as asking:

- Do Bedouin tents change their configurations through time? How…?
- What kind of changes occur in the interiors of the tents after use (floor, carpets, furnishings, walls, etc.)?

1.6.3.4 **Photographic and video records**

Supporting video and photographic materials were used throughout this thesis as a means of recording collapsible events. In most cases, photographs were used in groups to show different stages of a collapsible event. For example, photographs of the collapsible system models in Chapter Four show the different state of the models before folding and unfolding collapsible events. These groups of photographs were also valuable in my semiotic analysis.

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[2] Because of the war situation in Syria, I sent the questions by email to interior design lecturer Osama Risheh at Damascus University, who interviewed two Bedouins on my behalf then sent the answers back via email (see Appendix 9 transcripts of two interviews with Bedouins, pp.45-54).

Video recording is also used in Chapter Five in order to provide me with a clearer perspective than offered by still images. The dynamic nature of collapsible events requires consideration of the process in action. This tool proved useful later on, as it uncovered different timescales of collapsible events. For example, studying collapsible events by experimenting with different types of material (foam, wood and resin) helped me to notice the different timescales of the process of collapsibility.

1.6.3.5 **Design Workshop/Focus Group: *Everyday Collapsible Acts***

Focus groups as a qualitative research method originated in the field of sociology (Freitas et al., 1998). This method is utilised when researching how people perceive an experience, idea, or event (Freitas et al., 1998). The approach is advisable when producing new ideas or action in new fields (Freitas et al., 1998). I use this method in Chapter Three to collect new insight into 'unofficial' collapsible events based on the perception of other designers and beyond my personal insights. This is mainly to generate additional information for a study on a wider scope.

In this research, the focus group was carried out in a workshop with Master design students. In 2012, a workshop titled *The Everyday Collapsible Acts* with MA and MFA product design students at Edinburgh College of Art explored a wider range of unofficial collapsible events. The students documented their findings by taking sequential photographs and videos or making drawings of the stages of collapsible acts. The participants presented their ideas then discussed and reflected on them with the group while focusing on the topic of collapsible events.

The workshop helped to uncover a wide spectrum of collapsible events. However, finding terminologies to describe and analyse the complex nature of some of the collapsible events that were presented proved to be a challenging task. For example, some of the materials presented by the students described collapsible events involving; expansion, contraction and re expansion of something with an invisible nature, such as auditory collapsible events of sound, thermal collapsible events of heat mass, etc. While this form of invisible

collapsible events can be seen as an interesting subject for further research, they are outside this research's main focus and require knowledge and analytical skill outside of interior design fields.

1.6.3.6 **Field study**

A field study refers to research of a subject undertaken in its natural setting as opposed to a lab setting (Reyes-Garcıa & Sunderlin, 2011). This can be done through various means such as direct observations, interviews and surveys (Reyes-Garcıa & Sunderlin, 2011). In this research, I used field study to explore approaches to floor design within industries' setting. I visited Harrogate Flooring Conference and Show to observe and examine existing design trends and approaches. I also set up a site visit and a collaborative project with Forbo Group Flooring System (one of the international players in flooring manufacturing). This was mainly to survey the willingness of designers and decision-makers in Forbo to engage with my research approach through the design project of *Collapsible Floor*.

1.7 Research Structure and Outline

This thesis is written in six chapters. At the beginning of each chapter, I place thought-provoking quotes, or a poem I wrote, to help set up the scenes for each chapter.

This first chapter, *Research Introduction*, provides a brief look at the research's background, questions, objectives methodology and outline. *Designing Interiors in the 21st Century|Reviewing Current Models* unpacks my literature review and then lays down the theoretical foundations for my proposal for the concept of collapsibility. The chapter focuses on how interior designers have been limited by other disciplines; in particular, architecture and its related assumptions of the primacy of stability and permanence. It points out several design misconceptions around the subject of change by reflecting on established architectural frameworks; in particular, the *Shearing Layers of Change* framework of a building by theorist and architect Stewart Brand (1994). I then discuss

alternative approaches, associated with notions of impermanence, of established theories and philosophies; namely, the philosophy of *The Fold* by Deleuze (1993), and the concept of 'soft logic' by the French philosopher Michel Serres (1991), and Frei Otto's concepts in 1990 of *Form-Finding* (Schanz, 1995). This discussion serves to position my research proposal on the concept of collapsibility as a framework for understanding and designing notions of impermanence in reference to these wider and established concepts.

The third chapter, *Explorations of Collapsible Events*, focuses on studying the concept of collapsibility. I explore a wide range of data collection methods, including investigating the etymology of the word 'collapsible', also exploring scholars' views of the concept through interviews. These are in addition to semiotic analysis and a workshop with Master students to investigate how collapsible events manifest in everyday life as fold events. These various explorations generate new data that expands my understanding of the concept of collapsibility by drawing insights into the vast spectrum of tacit manifestations of collapsible events. The breadth of the methods I used enhances the subject vocabulary.

The fourth chapter, *Bedouin Tents Case Study: Semiotic Analyses and Practical Experiments*, explores collapsible events further, but this time on the larger scale of the Bedouin tent system. I focus on investigating how collapsible systems of Bedouin tents operate as systems of forces and folds through the tensegrity principle. I use semiotic analysis to analyse collapsible behaviours of Bedouin tents. To form a better understanding and confirm my analytical deduction, I ask Bedouins general questions about how Bedouin tent structures behave on a daily basis. The semiotic analysis serves to reveal that collapsible events operate through systems of folds and forces. Beyond the limitation of these visual representations of images of collapsible events, I turn to tangible and practical investigations. I create two physical tensegrity models of collapsible systems to study and manipulate fold and force events as they occur in time. These models, together with the semiotic analysis, enable me to construct a conceptual framework-formula. This is built around understanding forces as for fold/form-giving and seeing collapsibility as a capacity; a 'thing' for form-making. This Bedouin tent case study also

uncovers new design opportunities related to floors, which I explore further in the following chapter.

In Chapter Five, *Collapsible Floor|Challenging Design Principles of Stability and Permanence,* I use the framework-formula of the concept of collapsibility to design a collapsible floor. Firstly, I review current design approaches of floors within industries to uncover its limitations. This is through a field visit to Harrogate Flooring Conference and Show, and a collaborative project with a flooring company, Forbo Flooring System Limited. I then review alternative floor projects within fields of Design and Art in order to prove my proposition, of collapsible floors' relevance to design scenes in the 21st century. Thirdly, I conduct a series of material experiments to explore collapsible capacities. These practical experiments provide me with insights into how to further proceed within designing a collapsible floor using various materials. The impermanent design structure of the collapsible prototype challenges assumptions of stability and permanence of common approaches. It also raises new design possibilities of interactions with flooring surfaces that do not exist when interacting with passive and static floors.

In the final chapter, *Research Conclusion,* I conclude that it is impermanence rather than permanence that characterises our human condition and argue that this should also characterise the design of our built environment. I then restate how this research approach on collapsibility contributes to remedying a gap in interior design literature concerning the notions of impermanency and change. I provide a summary of what I have newly learned as an interior designer, limitations I faced, and also highlight recommendations for future research.

"It is not the strongest of the species that survives, nor the most intelligent; it is the one that is most adaptable to change."

(Charles Darwin, quoted in Mollerup 2001, p.11)

Chapter 2 **Designing Interiors in the 21st Century| Reviewing Current Models**

2.1 **Introduction**

In this chapter, I argue that in a world characterised by change and impermanence, the frameworks and theories that interior designers rely on can be rigid and limiting. Since its establishment as an academic discipline in the early 20th century, interior design has relied on frameworks of architecture (Winton, 2013; Caan, 2011; Attiwill, 2017; Weinthal & Brooker, 2013; Brooker & Stone, 2010). This chapter discuss this issue in two parts:

In the first section, *Rigid Misconception Within Established Architectural Frameworks,* I review an example of an architectural conceptual framework by Stewart Brand, *Shearing Layers of Change* (1994), to uncover several rigid approaches that promote principles of permanence and stability. These, I argue, limit interior designers' understanding and their engagement with the impermanent and dynamic nature of interiors. I support my position with the views of interior design scholars such as Suzie Attiwill, Tiiu Vaikla Poldma, Justin Wilwerding, Shashi Caan and Fred Scott. Also of established thinkers such as theorist Henri Lefebvre, particularly his book *The Production of Space* (1991) and anthropologist Tim Ingold's insights in his book *Being Alive: Essays on Movement, Knowledge and Description* (2011), as well as sociologist Zygmunt Bauman, in his book *Modernity and Ambivalence* (1991).

In the second section, *Impermanence|Alternative Approaches,* I discuss approaches that acknowledge change and impermanence of built environments. These approaches include established theories such as 'soft logic' by philosopher Michel Serres (1991), the theory of *The Fold by* philosopher Gilles Deleuze (1993) and architect Frei Otto's concepts in 1990 of *Form-Finding* (Schanz, 1995).

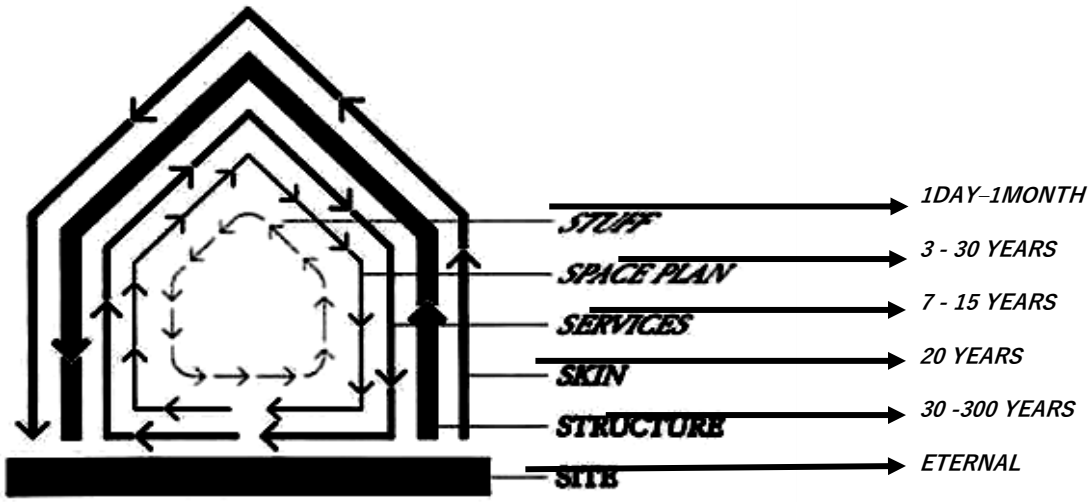
2.2 Rigid Misconceptions Within Established Architectural Frameworks

In this section, I discuss how architectural frameworks that interior designers still rely on foster principles of permanency of both the meanings and the forms of built environments. This, I argue, has negatively impacted the interior design processes for over a century, and is limiting interior design outcomes until the present time. This century, smart technological innovation, such as nano-technologies found in smartphones, engenders a new dynamic, where dynamic and impermanency are becoming the new norm. According to interior designer Suzie Attiwill, in the 21st century, contingency and change are becoming overriding forces (Attiwill, 2013, p.116).

In this section, I expose three theoretical misconceptions highlighted in a building framework by architect Stewart Brand, *Shearing Layers of Change* (1994). Of course, there are other architectural models that could be considered here, such as the original model of *Shearing Layers* suggested by Frank Duffy(1989),or other models that followed Brand, such as *Building Layers* by the Adaptable Future at Loughborough University (AF) Industry and Academic Collaborators (2012). However, the content of Brand's framework is better known in the general field of architecture. The themes I address from Brand's framework provide, in my opinion, a rich source of ideas, particularly in association with the notion of change within a building. His framework touches on several rigid strategies, such as functionality, classifications, in various forms. These strategies imply control, longevity and permanence. While such principles can be valued, they limit the understanding of the nature of interiors. I believe that these problems and gaps in design theories need to be dealt with if interior design is to develop in tandem with architecture.

In his book *How Buildings Learn* (1994), Brand introduces a framework to enable an understanding of building and change through time. He interprets a building in six *Shearing Layers of Change*: site, structure, skin, services, space plan and stuff (1994) (see Figure 1). The concept of building as shearing layers was originally coined by

leading architecture theorist Frank Duffy. Duffy first suggested four layers only: shell, services, scenery and set (Brand, 1994).



SHEARING LAYERS OF CHANGE. Because of the different rates of change of its components, a building is always tearing itself apart.

Figure 1: ***Building Framework Shearing Layers of Change*** **(Brand, 1994)**

Brand's theoretical proposition on building systems, made only of layers of a physical nature and of change as replacement cycles, I believe, implicates several misconceptions; three are highlighted below.

2.2.1 Building systems: not only physical structures but also conceptual

Brand's framework focuses primarily on physical matters. This is evident in the predominantly technical use of terminologies such as site, plan, structure and service. Generally speaking, focusing of physical matters is a common misconception in the Western world. According to anthropologist Tim Ingold:

> "To create anything, Aristotle reasoned, you have to bring together form (morphe) and matter (hyle). In the subsequent

> history of Western thought, this hylomorphic model of creation became ever more deeply embedded. But it also became increasingly unbalanced. Form came to be seen as imposed by an agent with a particular design in mind, while matter, thus rendered passive and inert, became that which was imposed upon." (Ingold, 2010, p.92)

On the one hand, a building can be seen as mere physical matter. However, a building is also the outcome of hybrid matter, both physical and conceptual in nature. According to interior design theorists Graeme Brooker and Lois Weinthal, built environments can be perceived as:

> "Complex weaves of values, issues and spatial formations; this can be both physical and mental structures." (Weinthal & Brooker, 2013, p.2)

Interior designers' reliance on such pragmatic approaches since its establishment, it could be argued, contributes to the production of interiors as physical matter – as objects. These objects are also metaphysical objects. In line with this notion, Michael Benedikt (Professor in American Architecture and Design, University of Texas) highlights concerns related to interior design language. He says:

> "Interior design teachers will have to develop their own body of theory and their own vocabulary, one that does not shrink from incorporating technical knowledge." (Benedikt, 2002, p.4)

Such limitation in language has limited interior design possibilities and has hindered designers' understandings of the system of a building as dynamic networks. Language, used throughout the designing processes, can be seen as either thought-provoking or restrictive. In line with this, Ingold, in his book *Being Alive: Essays on Movement, Knowledge and Description* (2011), also suggests that a technical word like 'building' can impact the way we understand a building as a human production. Instead, he suggests using the word 'dwelling' instead of 'building'. This, he argues, implies a natural manifestation of a living entity, and us 'humans' as inhabitants, rather than a production entity and us as producers (Ingold, 2011, p.10). Similarly, Lefebvre argues that what has yet to be discovered are the hidden associations between space and

language (Lefebvre 1991, p.17). Interior designer Caan asserts the importance of interior design language. She states that this can be seen as a methodology to extend designers' understanding of the meanings of interiors.

"Our existing verbal and visual vocabularies demonstrate a limited ability to address the qualitative aspects of interior spaces. Design terminology is specifically pragmatic (it consists of expressions such as function and circulation, and codifies physical safety), but such terms cannot describe the intentional emotive interplay between humans, objects, and environments. This interplay is necessary to stimulate elevated awareness and behaviour, and so create environments that may, for example, be able to offer the occupant a sense of dignity, and foster greater trust as an outcome of the design process. Most architectural theory has reduced the philosophical concepts of space, harmony, and balance to formal artistic criteria, and rendered the very people for whom buildings are created as lifeless abstractions, almost non-essential participants in the design process. If we are to achieve a better design methodology, there is an urgent need to develop more accurate means of addressing the emotive power of design." (Caan, 2011, pp.37, 38) This is to say that interior designers and theorists should acknowledge and promote new language for interior design that cultivates and feeds into their theories and, subsequently, their design practices.

Architect and interior designer Stanley Abercrombie criticises approaches in interior design that focus on technical matters. He argues that "practices can't exist without something that is of undeniable importance: 'the practice of thinking philosophically'. That is thinking in ways not overtly technical or pragmatic – about an area of endeavour... The most critical design work is totally abstract: the designer's role is not to build the design, to assemble it, to select it or to purchase it, but, first and primarily to think it." (1990, p.28)

Interior designers ought to promote new dynamic terminologies that can narrate the diverse meanings of interiors. In line with this notion, interior designer Poldma, in her book *Meaning of Design Spaces*, highlights the limitations of interior design

frameworks that focus on physical matters that limit the design outcome to static matters.

> "Students learn about interior space as an architectural entity grounded in physical attributes that are static and exist as independent features. Consequently, interior spaces are often reduced to their physical attributes, material and surface decoration, producing static spaces where an office is an office, a restaurant is a restaurant… The spaces they design are by their very nature dynamic in that they integrate people within changing circumstances…Accordingly, in the proposed theoretical framework, spaces are not characterized entirely through static attributes. Spaces are seen as dynamic contexts and products of social interactions." (Poldma, 2010, pp.4, 5)

Recently, few scholars notice the limitation of architectural pragmatic approaches that are highlighted in Brand's framework. The 'Adaptable Future' at Loughborough University (AF) Industry and Academic Collaborators (2012), for example, suggest adding two new layers that are not restricted to physical matters: a central layer called 'Social', and another envelope layer called 'Surroundings' (see Figure 2). Similarly, Lelieveld et al, at Delft University of Technology, introduced a new layer that refers to the sounds, smells, and lighting experiences within a building, called the 'Ambient' (2007, p.247). On a positive note, these new suggestions by AF and Lelieveld et al acknowledge other metaphysical systems within a building that cannot be reduced to physical matter. However, reinterpreting these metaphysical systems through the concept of adjacent layers is still, as I shall argue in the next section, rather misleading.

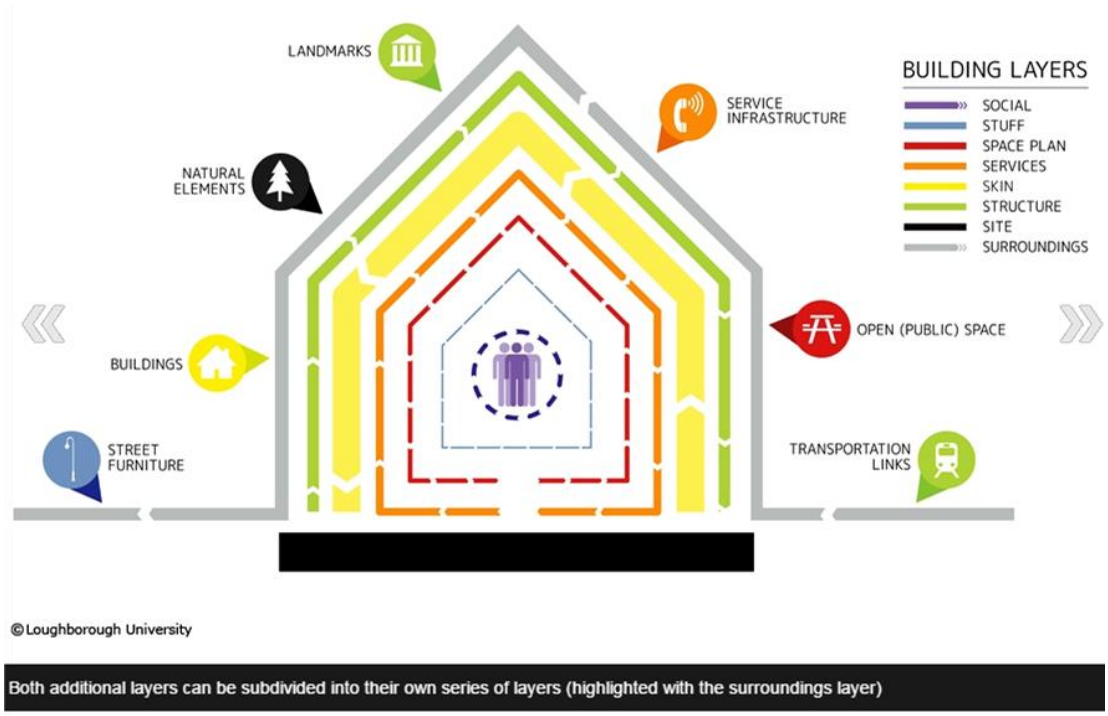


Figure 2: *Building Layers Diagram, Adaptable Future Toolkit* **(AF, 2012)**

2.2.2 Building systems: not simply adjacent layers but entangled networks

Brand interprets building systems and changes within into six adjacent layers. I believe this concept of adjacent layers is misleading. Firstly, such a concept runs counter to the inherent entangled relationship of systems that constitutes a building. Secondly, Brand's proposition implies fixed and distinct boundaries between these layered systems of a building. In reality, however, these boundaries do not exist. Building systems, including us humans, are entangled material/immaterial currents of vague boundaries in-between.

Lefebvre (1991), in his work *The Production of Space*, elaborates on this notion of entanglements and vague boundaries of built environments. He argues that a fixed physical structure such as a wall, seen normally as a boundary, is an illusion:

> "Visible boundaries, such as walls or enclosures in general, give rise for their part to an appearance of separation between spaces, where in fact what exists is an ambiguous continuity." (Lefebvre, 1991, p.87)

Ingold, in *Being Alive: Essays on Movement, Knowledge and Description* (2011) argues that perceiving surfaces as physical boundaries that separate us humans from non-human matters is a misconception. Built environments and humans that live within are continuums of countless matter:

> "The surface of materiality, in short, is an illusion. We cannot touch it because it is not there. Like all other creatures, human beings do not exist on the 'other side' of materiality, but swim in an ocean of materials." (Ingold, 2011, p: 24)

> "To perceive the environment is not to look back on the things to be found in it, or to discern their congealed shapes and layouts, but to join with them in the material flows and movements contributing to their – and our – ongoing formation." (Ingold, 2011, p.88)

Lefebvre also acknowledges this vague nature of built environments in *The Production of Space (*1991), particularly in his reference to social space as a *'thing/not-thing'*. He says:

> "…space qualifies as a 'thing/not-thing', for it is neither a substantial reality nor a mental reality" (Lefebvre, 1991, p.402)

Besides, advanced technological innovations such as the internet transform the understanding of what is normally perceived as fixed and permanent structures. The internet also challenges fixed physical and theoretical structures of interiors seen as walls, rooms, zones or functions, when allowing an interior, through the medium of computers, to engage with a range of spatial entities beyond these fixed structures. In the same way, technological innovations such as virtual realities blur boundaries between fixed binaries such as material/immaterial, physical/metaphysical, actual/virtual and tangible/intangible. Caan explains that boundaries within interiors are becoming increasingly blurred with the development of virtual technologies and the internet. She explains:

> "The way we interact with the world has never before undergone such rapid change. The revolution of the Internet

> and digital communication has upended many long-standing conditions of human relations, and the world we inhabit is no longer only a physical environment, but also a landscape that we occupy virtually. What was already false – the perception that the physical limits of our body define our personal space – has been clearly exposed as a fiction, since we now live in a global village that extends beyond the tangible boundaries of our neighborhoods and cities." (Caan, 2011, p.170)

According to architect Mark Blaschitz, in the future, walls will not be designed as solid forms, but as temporal colours and structures of some sort (Blaschitz in Leydecker, 2013, p.262). In some extreme cases, technological innovations within fields of genetics and material science stretch further to blur fixed boundaries between human and non-human (Dunne & Raby, 2013: p.48). As architectural historian Iain Borden puts it, in this century "boundaries are becoming zones of negotiations" (2000, p.221).What these arguments and examples demonstrate is that, in the 21st century, fixed boundaries, theoretical or physical, are increasingly challenged by impermanency.

In the near future, as change becomes an inherent quality of building systems and elements within, permanent and passive structures of built environments will inevitably transform to something more impermanent and active. In other words, built environments are not static or passive objects. In line with this, Lefebvre explains that space is a social being. It is more than a passive entity; rather, it is an active and interactive being that influences and is influenced by lives within it:

> "The outcome is a vast movement in terms of which space can no longer be looked upon as an 'essence', as an object distinct from the point of view of (or as compared with) 'subjects', as answering to a logic of its own. … Is space indeed a medium? A milieu? An intermediary? It is doubtless all of these, but its role is less and less neutral, more and more active, both as instrument and as goal, as means and as end. Confining it to so narrow a category as that of 'medium' is consequently woefully inadequate." (Lefebvre, 1991, p.411)

This idea of an active and interactive built environment suggests the need for a broader and deeper mode of understanding of notions of change and impermanency than the limited propositions of change as replacements cycles, suggested by Brand.

2.2.3 Change within building systems is not only about replacements

In his building framework, Brand focuses on the type of change that involves replacements. This is when an old element within a space is replaced with a new one if it is broken or cannot be adapted to a new function (Brand, 1994). Brand's framework shows how some systems within a building are fast changing, such as in the *Stuff* layer, where the replacement cycle is rapid and can occur on a daily basis. Other systems are slow, such as the *Structural* layer. Such systems are built in a permanent form; replacement cycles, therefore, can take centuries (Brand, 1994) (see Figure 1). This difference in the speed of replacement cycles, Brand argues, tears a building apart.

Brand argues that the longevity of a system is determined by its capability to absorb new changes in services and technology. This notion implies that the more adaptable a system is, the less likely it needs to be replaced. To stop a building system tearing itself apart and to lessen the difference in speed between these cycles, therefore, means to focus on change that involves adaptability instead of focusing on change that involves replacements. At the moment, building systems are designed either to defy change by endorsing permanence, like in a *Structural* system, or to accommodate the change via fostering replacements, such as in the *Stuff* system. Increasing capacities of building systems to adapt to new changes of situations, needs and technologies can slow down fast replacement cycles in some systems, whilst also activating the ability to change in a slow system that normally defies it. Architects and interior designers ought to rethink short-lived strategies that foster replacements and rethink rigid structures that negate change. Brand's proposition on change is limited because he assumes a quantifiable nature of change. Brand understands time and change through the concept of replacement cycle can be seen as a linear approach. Change is happening everywhere and in various forms (Scott, 2008, p.17). Changes within building systems,

however, are, as Caan argues, increasingly complex and unpredictable (Caan, 2007 page). In line with this, biologist and philosopher Conrad Hal Waddington explains how the more complex a system is, the harder it is to locate the weak links of elements of change (i.e. 'soft spots') (1977, p.91). For example, smart technologies impact and change human needs; accordingly, the ways in which humans interact with built environments is also being modified (Poldma, 2013). This complex change is referred to by theorist Stuart Kauffman as the "butterfly effect" (1993). To understand change through a linear cycle of replacements is to understand it in isolation from forces that caused it and the ramifications. Such approach to change is both limiting and limited.

2.2.4 Discussion: primacy of permanency

The three theoretical misconceptions mentioned above reflect a rigid way of thinking that prevailed in the 20th century. Such a mindset mistakenly assumes that everything can be calculated, defined and interpreted within fixed structures, including notions of change. Such a rigid mindset proves to be limited because it appoints primacy for permanence and the fixations of structures over impermanency and ambiguity of reality. It seems that the concerns of these two disciplines are different – while architectural frameworks give primacy to pragmatic matters and often seek principles of longevity and permanency, interior design is more concerned with transitory, temporal and impermanent matters of shifting situations and needs (Poldma & Wesolkowska, 2005; Attiwill, 2013; Winton, 2013; Brand, 1994; Brooker & Stone, 2010, p.26). While interior design often changes with the alteration of existing buildings, architecture is often typified by new builds and by starting from scratch (Brooker & Stone, 2010, p.26). Interior architect Fred Scott, in his book *On Altering Architecture* (2008), elaborates on this notion. He says:

> "All buildings, once handed over by the builders to the client, have three possible fates, namely to remain unchanged, to be altered or to be demolished. The price for remaining unchanged is eventual loss of occupation, the threat of alteration is the entropic skid, the promise of demolition is of a new building. For the architect, the last course would seem the most fruitful." (2008, p.2)

Brand's framework suggests a linear approach to change in time as cycles. His perspective could be argued as being related to the way we think of time in relation to linear progression. The sense of time progressing onwards keeps people feeling secure (Harvey, 1989, p.202). On the other hand, time is not to be seen as a linear arrow, theorist David Harvey notes. He explains that spaces are used to regulate social life; any change in the latter creates an inevitable new sense of space and regulation of time. The perception of time as being linear has changed mainly because of technology. Time, Harvey argues, is not an objective matter nor a subjective one, as both perceptions dissolve in the multiplicity of time. Harvey argues that both time and space cannot be understood objectively without material consideration, and it is through thinking about the latter that we can ground our knowledge to the former (space and time) (Harvey, 1989, p.204). The objectivity of time and space is given by the material practice of social reproduction that varies according to geographical, cultural, and historical aspects (Harvey, 1989, p.204). This is to say that social time and space are constructed differently. And since change continues to be the dominant factor, social reproduction both of social space and time will be in constant shifts.

This perspective of time as multiple fluxes challenges the way Brand understands time and change as linear cycles. This new meaning of time implies a new meaning of interior matters.

At the present time, built environments are perceived as commodities. This can be seen as a result of the shift in meaning of the built environment that designers witnessed when mass production began in the mid-nineteenth century. The development of rationality and efficiency formulated by Henry Ford (Fordism) impacted the meaning of the word 'design' as it began to describe a technical and functional process (Harvey, 1989, p.137). Interior architect Fred Scott says, "*Function assumes qualities of precision and absence of ambiguity."* (Scott, 2008, p.3) He roots this issue in the attitude of iconic architects such as Le Corbusier, who claimed that the house is to be "a machine to live in". He explains:

> "The functionalists were the early saints of Modernism, even though sometimes their beliefs seem to float between the moral

> and the aesthetic, deserting one for the other in the face of argument. Their intention was to keep the purposes of Modernism free from doubt… The Machine Aesthetic presumes a clarity of purpose, as that which the machine itself has. The Machine is the vehicle that will carry society towards Utopia." (Scott, 2008, pp.2, 3)

In the last 50 years, designers have been more or less controlled by the demands of business and industry, rather than designers' concerns or societies' requirements (Wood, 2008). The notion of business dominance over the roles and values of interior design professions has been a concern for many designers and thinkers. John Wood for example, explains how, since the Industrial Revolution, the modern practice of designing for consumer society, marketing purposes to the mainstream has expanded far more than that of designing for people's wellbeing (Wood, 2008, p.4). He states that, in the last five decades, property developers have embraced designs with a point-of-sale profit goal and short-term efficiency (Wood, 2008, p.4).

In line with this, architect Cliff Moser, in his book *The Disruptive Design Practice Handbook of Architecture*, highlights this in the notion of business dominance as he explains how stakeholders of architectural commodities and services have recently become a trap as they grow to become key players directing market forces (2014, p.74). It could be argued that this notion of business value dominance minimises the interior designers' roles within businesses to that of mere mercenaries and precludes interior designers' values from having a greater impact on peoples' wellbeing.

For example, in his book *The Articulate Surface: Ornament and Technology in Contemporary Architecture*, architect and critic Ben Pell provides an example of a quick-fix design practice method, i.e. 'panelisation'. Technologies such as CNC (computer numeric controlled) fabrications have facilitated the production of large panels/sheets of materials of various sizes and thickness (Pell, 2010, p.11, 12). This method, he argues, offers architects greater control over the technical processes (Pell, 2010, p.11, 12). Such a design method is frequently used in interior design to quickly replace old surfaces with new prefabricated ones. Whilst also embracing the stereotypes about the interior design profession being an attainable and easy task, and

simply a matter of arranging trendy products, materials and colours. This is evident in makeover shows on television, where designing interiors is swiftly performed. In most cases, the processes of designing interiors in these shows are reduced to functions and style. Such stylistic practices have produced misconceptions about interior design that, according to Caan, are rooted in the emerging role of the interior decorator. At the end of the nineteenth century the upholsterer role has evolved from furniture-making to a coordinator of interior furniture (Caan, 2011, p.85).

Wilwerding condemns current interior designers' lack of a self-understanding of their important role in the process of social construction (Wilwerding, 2013 b, p.76). Similarly, in his white paper *21st Century Design,* Rob Girling (who has worked for several well-established businesses such as Apple, Microsoft, Sony and IDEO) highlights this matter and condemns such superficial design approaches to interior spaces. He explains:

> "In the late 20th century, design became obsessed with the creation of the ephemeral, luxurious, cool, and the beautiful. These attributes narrowly focus success criteria on creating desirability rather than what we truly need to make us happier and improve our lives. This has also created a short-term focus for design to appeal to the cycles of fashion rather than on providing lasting value and focusing on long-term benefits and outcomes." (Girling, 2012, p.2)

Interior designers are rather ignorant of their influential role, as the interior design profession can be considered a powerful ideological tool for change: it can reinvent, transform and enhance people's ways of living. According to Attiwill, "*The international association for the interior design profession has defined the identity of interior designers as professionals who 'determine the relationship of people to spaces based on psychological and physical parameters, to improve the quality of life*'." (Attiwill, 2017, p.93)

Currently, interior designers trying to reveal the legitimacy of their profession promote awareness of several core matters. However, these efforts are inchoate. According to Poldma, "*Until recently, and in an effort to legitimise the profession, interior designers*

have generally tended to be more concerned with building professional practices, ethical conduct, and solving problems of a pragmatic nature." (2010, p.5) I believe it is important to correct this perception because interior design, in its core, is a tool to improve people's quality of life. While function and aesthetic are important, they remain secondary. In line with this, Wilwerding calls for interior designers to pay greater attention to how aesthetic judgments are constructed (Wilwerding, 2013 b, p.81).

Modern architectural theories that prevailed in the previous century focused primarily on functional approaches that could be regulated by fixed strategies such as classifications, distinct boundaries and repetition (Schumacher, 2012, p.637). Spaces were mostly defined according to a set of highly structured rules. Rationality in the form of idealisation of functionality and order underpin design theory and the industrial logic of modern interior spaces (Spark, 2004) (Wilwerding, 2013 b). At the present time, the design of contemporary interior spaces is still highly dependent on such rational ways of thinking of the 20th century (Wilwerding, 2013 b). These rigid qualities meant control. Theorist and sociologist Zygmunt Bauman, in his book *Modernity and Ambivalence* (1991), criticises limited strategies that attempt to precisely define structures in order to manipulate and control the uncertain:

> "To classify, means to set apart, to segregate… To classify, in other words, is to give the world a *structure*: to manipulate its probabilities; to make some events more likely than some others; to behave as if events were not random, or to limit or eliminate randomness of events." (Baumann, 1991, p.1)

> "The typically modern practice, the substance of modern politics, of modern intellect, of modern life, is the effort to exterminate ambivalence: an effort to define precisely – and to suppress or eliminate everything that could not or would not be precisely defined." (Baumann, 1991, pp.7, 8)

Functionality, classifications, and boundaries seen as rational strategies are often used to control the form and meanings of built environments. Such approaches have transformed interiors until they have become mostly solid abstraction, devoid of social expressions (Melles & Huppatz, 2013, p.90). This dominance of architecture over

interior design not only impacts theoretical aspects and practice, but also determines its language. Interior designers ought to break away from architectural dominance and promote new frameworks that acknowledge the different aspects of interiors. In this technologically and digitally enhanced century, technological innovation engenders a new dynamic, where temporality and impermanency are becoming increasingly the new norm (Poldma & Wesolkowska, 2005, p.56). Poldma & Wesolkowska explain how this century engenders a new dynamic, where things are transitory and always modified. People's realities, she argues, are defined by activities and activities are no longer defined by place and time (Poldma & Wesolkowska, 2005, p.56). She says:

> "In the age of mobile communication, we have thus moved from *spatialized time*, where the nature of the activities was predominantly governed by the structuring logic of the place one reads in a library, one studies in a classroom, one eats in a restaurant, etc. to *temporalized space*, where the nature of the activities of its inhabitants define the place (a restaurant becomes a playground, a coffee house becomes an electronic mall, a train becomes a work station, etc." (Poldma 2010, p.7)

In more recent work, Attiwill asserts the need for a new mindset of notions of impermanence while celebrating doubts in design that challenge the rational logic that prevailed in previous century. She says:

> "This is the crux of posing interior and the value of posing each time anew to effect a pause between stimulus and response. To intercede in habits and clichés, open up to the outside, to change, movement and chance. To produce a plan of immanence within a plane of immanence that makes a provisional stability – a composition that is also composed – and engages in the world because 'experimentation on oneself is our only identity, our single chance for all the combinations which inhabit us." (Attiwill, 2017, p.109).

This is to say that, in the last 10 to 20 years, interiors have undergone a remarkable shift, affecting the way people perceive, consume and design interiors (Poldma, 2013, p.5). Spaces now are not only about fabric, smart products, technologies and stuff (Milligan & Ashcroft, 2007, p.22). Physical interiors, it could be argued, exist now within a digital realm, which poses a dilemma as to whether current rigid design

frameworks can respond and accommodate such dynamic challenges. Contemporary interior designers and architects have a responsibility to alter the rigid perceptions that limit their response, and introduce strategies that can encourage change in various forms (Caan, 2011, p.9). Designer Nicole Koltick at Design Futures Lab, in her article *Occupy Object,* calls for dynamic strategies and new ways of thinking that relinquish control; instead, celebrating doubt and uncertainty. She states:

> "Such were our past dreams of complete agency or authorship. In relinquishing the subjective position and the comfort of anthropocentric supremacy, we must come to terms with the realm of objects and devise a new operational approach...By recognizing how little we truly know, and by giving equal focus and philosophical merit to the whole entirety of stuff and situations that exist, we can come to terms with the fact that the fuzzy and the indeterminate are fundamental properties of reality." (Koltick, 2013)

Attiwill also condemns 20th century ways of thinking about built environments as she questions, and, at the same time, calls for new approaches that acknowledge notions of change when she asks:

> "What if space and structure and products of twentieth-century thinking are not useful to a twenty-first-century practice and context where contingency and change are dominant forces?" (2013, p.116)

Interior designers, I believe, need to break away from the rigid and pragmatic approaches of architecture that give supremacy to fixed structures and principles of permanency. They instead ought to introduce alternative approaches that acknowledge dynamic notions of impermanence in built environments without reducing the meaning of change to the linear understanding of replacement. In line with this, architect Patrik Schumacher (2012) points out the holes in both Modernist and Postmodernist theory. He argues that while the first offers order without acknowledging complexity, the second fosters complexity without offering constructive guidance (Schumacher, 2012, p.680).

Quoting Love (2000), Wilwerding explains how current interior designers lack a strong philosophical foundation that underpins design terminologies and theories (Wilwerding, 2013, p.39). Wilwerding accordingly states that in this century, meta-analysis for interiors is critical (Wilwerding, 2013 a, p.37). On a similar note, Lefebvre points out the limitations of theoretical and philosophical approaches of interior design that do not inform interior designers about the impermanent nature of '*Space as Social Being'.*

"To date, work in the interior design philosophy area has produced either mere descriptions which never achieve analytical, much less theoretical, status, or else fragments and cross-sections of space. There are plenty of reasons for thinking that descriptions and cross-sections of this kind, though they may well supply inventories of what exists in space, or even generate a space, cannot ever give rise to knowledge of space." (Lefebvre, 1991, p.7) Interior design ought to break away from architectural pragmatic approaches and promote hybrid frameworks that acknowledge the impermanent nature of interiors. The discipline of interior design, by its very nature, is an interdisciplinary subject. According to Terry Meade, in his paper *Interior Design: A Political Discipline* (2013), it is rather impossible to define the boundaries of interior design as a discipline without the consideration of its wider association with a wider political realm of professions (2013, pp.398- 402).

Generally speaking, current processes of designing interiors lack theoretical and philosophical depth. Wilwerding links the theoretical and language deficiencies within interior design to the lack of a strong philosophical foundation that corresponds to its intricate values and meanings (Wilwerding, 2013 a, p.39). Promisingly, in recent years, scholars in interior design are beginning to address more deeply political, theoretical, philosophical and practical issues. This can be seen as part of the *Interiorist* movement that noticeably increased the level of interest in interior design (Attiwill, 2013; Weinthal & Brooker, 2013). In the last two decades, for example, there has been a noticeable increase in approaches that are of a hybrid nature of design across design and architecture disciplines such as meta-design (Love, 2000) (Wood, 2008),

interdisciplinary design (Repko, 2008), co-design and collaborative and participatory design (Johansson, 2005). Nevertheless, few of these approaches have yet fully matured to offer comprehensive interior design guidance on how to proceed. Designer Elisa Giaccardi argues that segmentation of theory and practice hinders the development of holistic approaches within the discipline:

> "In the last two decades, the idea of meta-design has appeared as both a theoretical issue and an operational methodology; however, it has always been an isolated concept, producing neither an established approach nor a coherent theory." (2005, p.343)

Similarly, Poldma questions the incompetency of interior design frameworks that still approach theoretical and practical design matters independently. She says:

> "Although thinking about complex issues and contexts promotes new emerging frameworks for both theory and practices, we still theorize and conceive of both theoretical and physical spaces as separate, constructed within disciplines and understood within limited frameworks." (Poldma, 2013, p.ix)

In this century, boundaries between processes, whether actual/virtual, tangible/intangible, material/immaterial, physical/metaphysical or theoretical/practical are dissolving. This century has seen a new mindset of designing spaces; a state of mind that produces a negative attitude towards rigid boundaries in its various forms. Instead a positive attitude towards the acknowledgment of doubt celebrates possibilities.

Interiors, at its core, extends beyond theoretical and practical matters. Actual separation between the two often dissolves in real life. Theoretical and practical segmentation hinders the understanding of the nature of interiors as a whole (Wilwerding, 2013 a, p.41). To fuse the two, I believe, cannot be achieved without first promoting a new understanding of the core nature of the concept of interiors as being impermanent and increasingly vague. According to Suzie Attiwill, the concept of interior is in crisis in the twenty-first century (2011, p.168). To define interiors causes a dilemma. Justin Wilwerding (2013 a and b), reflecting on the need of new

meaning for interiors in the 21st century in his essay *Meanings of Design and Space: A Metaphysical Groundwork*, states that designers ought to reflect on the conflation of meaning of space as a mass produced/standardised commodity of objects and/or space as a set of social meanings, values and design associations and aesthetics (Wilwerding, 2013 b, p.75).

I believe that when interior designers understand the true nature and meaning of interiors and design accordingly, they will regain their influential positions in the production processes of interiors and reclaim their legitimate significance in social construct. Contemporary interior designers, architects and theorists are now responsible for altering orderly, linear, functional design strategies that have promoted counter principles of stability and permanence in built environments. Design frameworks and strategies of the 21st century should balance other philosophical concepts, meanings and values that acknowledge that change and impermanence are key traits in this century. Spaces, as Lefebvre puts it, are *"social beings"*, constantly in the realm of change through evolving social patterns: "*never quite becomes absolute, never quite emancipates itself from activity, from use, from need, from 'social being'*" (Lefebvre, 1991, p.83).

At the moment, interior designers struggle with the limitation of their design framework and the lack of constructive design guidance to balance and acknowledge notions of change and impermanence. In this thesis, I shall introduce the concept of collapsibility as a new approach and a new interior design term to help understand and design impermanence. Such an approach, I argue, can contribute to interior design processes and practices so that it challenges currently assumed principles of permanence and stability. Interiors, through this lens, are collapsible events, impermanent, never fixed in meaning nor in form.

While my primary definition of the concept of collapsibility in this thesis is informed by designer Per Mollerup's approach in his album *Collapsibles*, in particular, his reference to 'unofficial' collapsibility. My extended approach of the concept of

collapsibility in relation to impermanence and change is informed by a wider conceptual approaches. The next section outlines these approaches

2.3 **Impermanence|Alternative Approaches**

These sections outline several concepts that helped in shaping an in-depth understanding of the meaning of the concept of collapsibility. Given the lack of in depth research on the concept of collapsibility, I had to build my own conceptual framework to study 'collapsible events' in relation to notions of folds, forces and collapsible capacities. This conceptual framework developed through observations and tangible experiences investigations, in tandem with the use of literature related to these notions. These are the theory of *The Fold* (1993) by philosopher Gilles Deleuze, the concept of *Form-Finding/Textile Thinking* by architect Frei Otto in the 1990s, in addition to the philosophy of *Soft Logic* (1991) in reference to philosopher Michel Serres, as described by Barnet (1999). Both Deleuze's concept of *The Fold* and Otto's method of *Form Finding* through forces helped shape my understanding of collapsible events in relation to two key notions of 'folds' and 'forces'. *Soft Logic* by Serres, on the other hand, serves to communicate my proposed meaning of the concept of collapsibility as a philosophical approach. The next section unpacks more of these concepts' contributions to my research and their difference to my proposed framework on the concept of collapsibility.

2.3.1 ***Soft logic***

Philosopher Michel Serres distinguishes between two ways of thinking; the first he refers to as box-thoughts, which means rigorous or rigid logic, whereas the second is sack-thoughts, meaning soft logic (Serres, 1991, quoted in Barnett, 2003, p.2). Serres argues that our way of thinking lacks *soft logic* or flexibility in a similar way to a system of fabric that can stretch, adjust and fold. He says, "Our philosophy lacks a good organum of fabrics." (1991, quoted in Barnett, 2003, p.2) Serres' comparable analogy between 'box' and 'sack' thinking, I believe, can offer profound implications within architecture design theory and practice. In the academic journal *Textile: The Journal of Cloth and Culture*, editor and curator Pennina Barnett unpacks this theory

and explains, in a poetic way, what flexible thinking implies and how such dynamic approaches can influence the way humans perceive built environments. Her explanation, I argue, implies collapsibility.

> "What if the poetics of cloth were composed of 'soft logics', modes of thought that twist and turn and stretch and fold? And in this movement new encounters were made, beyond the constraints of binaries? The binary offers two possibilities, 'either/or'; 'soft logics' offer multiple possibilities. They are the realm of the 'and/or' where anything can happen. Binaries exclude: 'soft logics' are to think without excluding." (Barnett, 1999, p.26)

In the above quotation her reference to the twists and turns and stretch and fold of material can easily be thought of as collapsibility. In the following quotation the descriptions of composing folds and twists similarly give rise to the notion of collapsibility and begin to address the importance of impermanence:

> "...for this is a space of quiet, but not one of silence, where gestures, though small, stir sense and sensation; and senses confuse and cause a vibration; where visual is tactile and tactile is visual; and what is at stake is – not representation – but the composing of fold that takes place in slow motion, as intimate moments steal into view [...] this is an intimate space, a space of close vision: the curl of a hair, the twist of thread, the crease of a cloth. A place to lose oneself in the intimacy of the fold, as satin reshapes and velvet vibrates [...] The visual tactile is a dimension of the haptic, where 'there is neither horizon nor background nor perspective nor limit nor outline or form nor centre. It is what Deleuze and Guattari call a smooth or nomadic space." (Barnett, 1999, pp.184-185, cited in Hemmings, 2012)

Barnett further argues:

> "…if 'soft' suggests an elastic surface, a tensile quality that yields to pressure, this is not a weakness; for 'an object that gives in is actually stronger than one that resists, because it

> also[3] permits the opportunity to be oneself in a new way. The poetics of cloth are composed of folds, fragments and surfaces of infinite complexity. The fragment bears witness to a broken whole; yet it is also a site of uncertainty from which to start over; it is where the mind extends beyond fragile boundaries, beyond frayed and intermediate edges, expanding in the fluidity of the smooth. The surface is a liminal space, both inside and out, a space of encounter." (Barnett, 1999)

Soft logic as described in the above quotations encapsulates a conceptual collapsible capacity to fold, twist and turn. Such logic, Barnett argues, is not limited to 'binary' or 'either/or' situations. Collapsible capacity in this sense offers multiple possibilities of events. It is not either/or events, but a spectrum of sub-events. As I discuss in the introductory chapter, collapsibility as a function described in by Mollerup is often understood as objects that have double states; folded and unfolded, passive and active. Mollerup focuses on collapsible events that are of a binary nature. This thesis explores further this notion of collapsible capacity as the ability to perform a spectrum of events and the reverse. Such understanding informs the explorations of analysing collapsible events in everyday life in Chapter Three.

2.3.2 *'Form-finding', 'textile thinking'*

Otto's method of form-finding is built around the principle of generating new forms through observing and understanding interactions of forces with material. Otto's method is built around principles of force and structural conditions. Forms in Otto's sense are not pre-thought, shaped or designed, but they are found. According to engineer Wanda Lewis, "*Form-finding can be defined as an iterative process of shaping structures according to prescribed boundary configurations and forces acting on them. It is a process that may, or may not; involve the elastic response of the structure."* (Lewis, 2015, p.121) Building on Otto's approach of form- finding (using

forces to generate forms), this thesis focuses on exploring the elastic response of a structure to process (i.e. collapsible capacities of structures).

In other words, Otto's method of 'form-finding' is built according to the material and structural support and resistance to tension. Loads and strain result in the form of the structure. Otto refers to such processes as form-finding or self-forming processes. For example, Otto used form-finding techniques such as hanging suspended chain models of suspended constructions to generate new architectural forms that are created by gravity. A chain suspended from two points takes its bended shape from its weight (Nerdinger, 2005). Otto's work on form-finding has teased out a new conceptual way of thinking and modelling in architecture referred to as 'system thinking' or 'textile thinking' (Kane, Philpott 2013).

When working at the Institute for Lightweight Structures, Otto's method was experimented with by a group of researchers with the methods of form-finding in self-generated structures to inspire architecture and urban design. Together with the federal research programme, 230 researchers from interdisciplinary backgrounds invented what they refer to as 'self-formation processes'. This was inspired by nature. Otto's experiments with form-finding are "*governed by laws of attraction/repulsion or expansion/contraction, they present emergence and self-organisation behaviour akin to physical processes in natural patterns*" (Lopes, Paio and Sousa, 2014, p.597). This principle, they argued, is closer to the human being. Architect Irene Meissner, who elaborates on Otto's intention of such methods of self-formation and form-finding processes, says:

> "Frei Otto developed models and methods in which forms generate themselves in order to observe and analyse the processes by which material objects originate in all realms of nature, technology and architecture." (Meissner, 2005, in Nerdinger, 2005, p.56)

While architects are concerned with longevity as architects build things to last (Meissner, 2005, in Nerdinger, 2005, p.58), Otto's research programme on lightweight structures seeks new understanding for an adaptable architecture that can

accommodate change (Schanz, 1995). The adaptable architecture was a focal subject for Otto. In his interest was a building that can be put up when needed and dismantled when not in use, and put up again and again (Meissner, 2005, in Nerdinger, 2005, p.57). This idea of adaptable building that can accommodate change and is made of a flexible material inspired many of his tent-like changeability designs. Therefore, many of the designs are produced of light membrane of rubber and textile (Schanz, 1995). In his reference to a building that can be dismantled and put up again, he is referencing the concept of collapsibility (which is the subject of this thesis). Otto, it could be argued, was well aware of the impermanent nature of the built environment.

Generally speaking, Otto's work develops complex design patterns through his approaches to self-formation as they bring a large number of components into a simultaneous force field. This is to say that form and aesthetics are found in structures' response to forces.

According to architect Irene Meissner, Otto refers to himself as an anti-architect because of his radical approaches to mainstream methods in architecture (Meissner, 2005, in Nerdinger 2005, p.57). For example, for Otto the notion of 'form-finding' implies the principle of 'form follows force'. He was never convinced with the motto of '*form* follows function' coined by architect Louis Sullivan in 1896 (Meissner, 2005, in Nerdinger, 2005, p.57). Historically, most shapes and form are developed from geometric shapes, but for Otto they are developed using force (Schanz, 1995). Architect Irene Meissner explains that Otto thought it presumptuous for a building to outlast its serviceability. She states that Otto believed that pursuit of permanence is the pursuit of something dead (Meissner, 2005, in Nerdinger, 2005, p.58).

In other words, Otto rejects today's approaches that predetermine forms and styles in architecture. His ultimate goal, Meissner argues, was to dematerialise architecture so a building can adapt to the changes it is subjected to almost daily; say, changes of temperature, light and winds (Meissner, 2005, in Nerdinger, 2005, p.57). Our time, Otto believes, needs adaptable mobile buildings (Schanz, 1995, p.13). This leads to

more tents, shells and air-supported membrane; i.e. changeability and mobility (Schanz, 1995, p.13) see Figure 3.

Figure 3: ***Music Pavilion Sails at the Federal Garden Exhibition at Kassel*** **(Otto, 1955)**

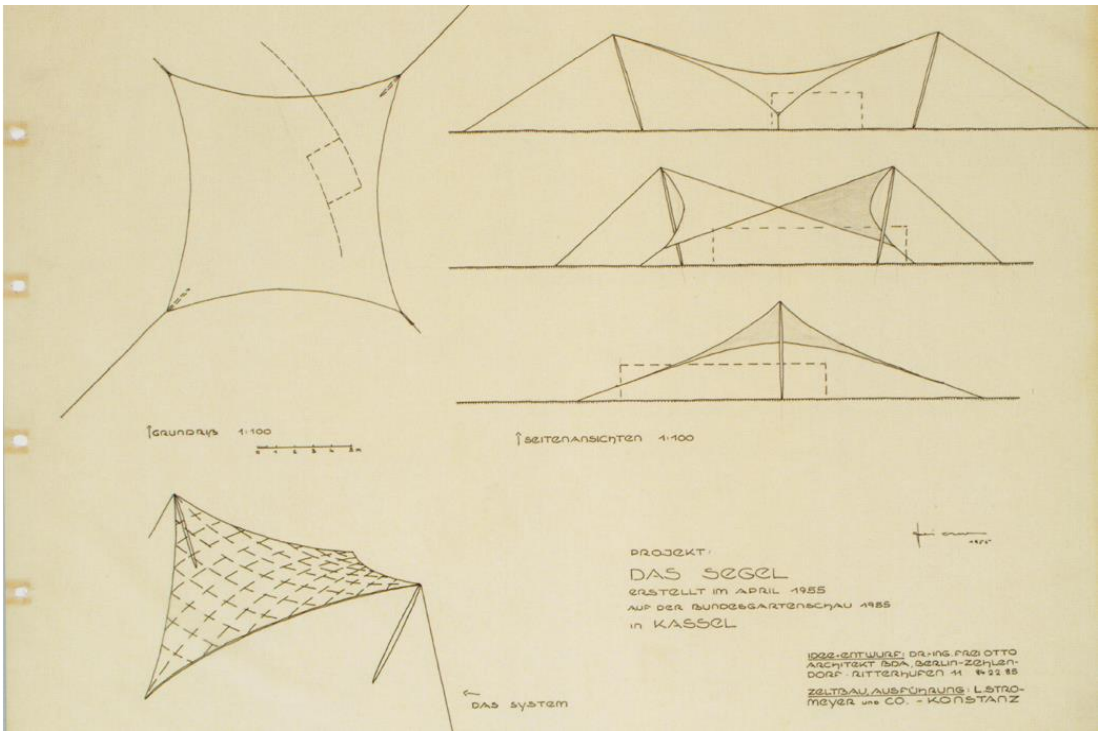


Figure 4: ***Sketches and Drawings for the Federal Garden Exhibition*** **(Otto, 1955)**

Applying both of Otto's 'form-finding' approaches to interior design would mean a more interactive interior, where physical forms are not static hence their meanings also not fixed. In this thesis, I unpack a strong association between collapsible events through semiotic analyses. Force, in this thesis, is considered one of the key principles of the framework of the concept of collapsibility. I then demonstrate using design practice how form-finding approaches experiments are translated in the designing of a collapsible floor that responds to forces as people walk on it.

His form-finding method gives insight on how to think about designing impermanent forms in reference to notions of force. I demonstrate how physical self-forming processes impacted my design practices to design a collapsible floor in Chapter Five.

The method of form-finding gives primacy to form. This is to say that the biggest architectural interest in this method is finding new forms, i.e. form-finding (Kotnik and Weinstock, 2012). The way Otto used the processes was that he captured the force then reproduced it. The motion and the dynamic nature of the forces are illuminated after the production. It is captured, it is still, and hence it is permanent. Otto's approach examines the connection between force and form. My approach in this thesis extends form-finding and self-formation in a constant state. In other words, while Otto's form-finding is a method to discover new forms that explains the processes by which they are being originated, this method when applied to a collapsible structure opens a new realm of form possibilities based on an active capacity of a collapsible structure to interact with forces and find forms again and again. In this thesis, force is an element for a continual discovery of form. Force is continual giver of forms. It is what Ingold, in his reference to Klee's work, describes as a 'form-giving'; a way to give life to matter through force.

> "Form, to recall Klee's words, is death; form-giving is life. I want to argue that what Klee said of art is true of skilled practice in general, namely that it is a question not of imposing preconceived forms on inert matter but of intervening in the fields of force and currents of material wherein forms are generated." (Ingold, 2010, p.92)

This approach to force as for form-giving is a key element of the design practices and semiotic analysis of collapsible events in this thesis. Through the lens of collapsible events, I aim to show how forms are not found, but 'forms occur'. Forms are transitory events that emerge through fields of force.

2.3.3 *The Fold*

Deleuze and psychoanalyst Félix Guattari first introduced the philosophy of the fold in *A Thousand Plateaus: Capitalism and Schizophrenia* (1988). To be anything, Deleuze and Guattari reasoned, is to continually fold (1988). Gilles Deleuze then, in his book *The Fold* (1993), develops the concept of folds to present a new way of thinking. Matters, he suggests, are dynamic folds in a continual process of 'becoming'. In this thesis, engagement with the philosophy of *The Fold* helps shift the course of the research approach from studying collapsibility as a *concept*, to studying collapsibility as an *event*.

Deleuze's philosophy, in particular *The Fold*, provides a methodology to understand the notion of impermanence through folds. Such methodology, it could be argued, enables designers, artists and architects alike to challenge the prevailing rigid logics and structures that are prevailing. Conley gives a clearer explanation for this notion. He says:

> "The geometrical shapes of Deleuze's sentences reproduce the serialities of which he writes. Leibniz manifests a vision of the world with consequences that exceed the correlation of philosophy with the beginnings of industrial technology. At the beginning of the eighteenth century, the idea of a stamp (or an impression promoting the effect of individual style) 'imposed a law of constancy on the production of objects. With the fold a fluctuation or deviation from a norm replaces the permanence of a law, when the object assumes its place in a continuum of variation.' The object acquires a new status when it refers no longer to a spatial conception of molding, but a 'temporal modulation' or a 'continuous variation of matter'." (Conley, 1993, in Deleuze, 1993, p.xx)

Deleuze's theory of *Folds* inspired a great number of researchers and practices in various fields; in particular, creative fields of art and design and architecture. For

example, in Attiwill's *Practising with Deleuze: Design, Dance, Art, Writing, Philosophy* a group of scholars in art, design, dance, and philosophy unpack Gilles Deleuze's and Félix Guattari's written work through various contemporary creative practices (Attiwill et al, 2017).

Architect Sophia Vyzovit, in reference to Deleuze's work, also explores folding as a method of producing new forms that can be applied in architecture, product or textile design. Her publications *Super Surfaces* (2006), *Folding Architecture* (2010) and *Soft Shells, Porous And Deployable Architectural Screens* (2011) show a great number of exploratory design prototypes made by designers and architects using various paper-cutting and paper-folding techniques to generate new forms inspired by Deleuze's philosophy.

There is a strong association between the concept of collapsibility and Deleuze's philosophy of *The Fold.* Folding, unfolding and refolding events are core elements of the definition and reflection on the concept of collapsibility in this thesis. So they are in Deleuze's description of *The Fold*. For example, he says, "*Leibniz had mediated what historians study in terms of social contradiction of the ancient regime with an activity that 'folds, unfolds, and refolds' matter, space and time*." (Deleuze, 1993, p.xvii)

Another example explaining *The Fold* highlights collapsibility in the quotations below. He says:

> "Unfolding is thus not the contrary of folding, but follows the fold up to the following fold. Particles are 'turned into folds', that a 'contrary effort changes over and again.' Folds of winds, of waters, of fire and earth…Folding-unfolding no longer simply means tension-release, contraction dilation, but enveloping-developing, involution-evolution. Every fold originates from a fold, plica ex plica." (Deleuze, 1993, pp.6, 7, 8)

> "But unfolding is no more the contrary of folding than an invariant would be the contrary of variation. It is an invariant of transformation." (Deleuze, 1993, p 22)

These descriptions of Deleuze's philosophy of *The Fold* show folding and unfolding and refolding activities can be read as collapsible events.

This association between Deleuze's philosophy and the concept of collapsibility are also highlighted in philologist Tom Conley's understanding of Deleuze's work. In his translations of Deleuze's book Conley notes that *The Fold* is a philosophical practice of opposites and reverses. He says:

> "Once again, the manner confirms what Deleuze observes about the sufficiency of Leibnizian reason: an 'extraordinary philosophical activity which consists of the creation of principles', where there are two poles, one toward which all principles are folding themselves together, the other toward which they are all unfolding, in the opposite way." (Conley, 1993, in Deleuze, 1993, p.xx)

Perhaps Deleuze's most elaborate yet tacit reference to collapsibility is when he talks about folding, unfolding and refolding in relation to interiors (this brings to the forefront the main area of study of this research – interiors and collapsibility). He says, "*What has changed is the organisation of the house and its nature... it is always a question of folding, unfolding and refolding.*" (Deleuze, 1993, quoted in Rajchman, 1993, p.13)

At the present time, Deleuze's philosophy can be seen as one of the most influential philosophies since the1990s (Schumacher, 2012). According to Gregory Flaxman:

> "I do not know whether artists today are on the whole more interested in philosophy than before, but I think it's fair to say that, where and when this is the case, Deleuze's influence and appeal are undeniable." (Flaxman, 2017, p.14)

On the one hand, Deleuze's influential philosophies are of significance in understanding notions of impermanence. On the other hand, his philosophical concepts and abstract language are often hard to decode. The quotation below can be thought of as an example of such a case:

> "Fold over folds: such is the status of the two modes of perception, or of microscopic and macroscopic processes. That is why the unfolded surface is never the opposite of the fold, but rather the movement that goes from some to the others. Unfolding sometimes means that I am developing – that I am undoing – infinite tiny folds that are forever agitating the background, with the goal of drawing a great fold on the side whence forms appear; it is the operation of a vigil: I project the world 'on the surface of a folding'...I am forever unfolding between two folds, and if to perceive means to unfold, then I am forever perceiving within the folds." (Deleuze, 1993, pp.106, 107)

While the philosophy of *The Fold* gives rise to the notion of impermanence, the ontology of the term *The Fold* still assigns primacy to form and therefore continues to reproduce folds as forms, not as continuous folding events. In this thesis, I argue that the ontology of collapsible events assigns primacy to events and their processes through providing a structure on how the multiplicity of an event can be understood as a spectrum of folding, unfolding and refolding. I therefore propose that the concept of collapsibility can operate as what Lefebvre refers to as '*super-code'*.

The concept of collapsibility as a super-code decodes philosophies such as *The Fold* and *Soft Logic* into physical forms. This is through the instant coupling between an object and its subject during a 'collapsible event'. Lefebvre argues that theories operate at the limited conceptual level of language; for a theory to be translated in physical form, it has to be in the form of super-code (i.e. a practical philosophy) (1991, p.17). He explains super-code as:

> "A code of this kind must be correlated with a system of knowledge. *It* brings an alphabet, a lexicon and a grammar together within an overall framework; and it situates itself… between the *lived* and the *perceived.*" (Lefebvre, 1991, p.65)

Deleuze's, Otto's and Serres' approaches together are at the core reflections of my research's understanding of collapsibility as a capacity for form/fold-making and of forces for form-giving.

Such theories are closely related to the concept of collapsibility, but they are hard to render into practice without a framework that helps link and translate theoretical and abstract forms of language into physical and practical forms. In other words, this framework can be seen as a design strategy to embrace impermanence of both the form and the meaning of interiors (i.e. physical and theoretical). Such strategies have not fully developed yet in the discipline of interior design.

In other words, these approaches that are built around understanding notions of folds, forces and collapsible capacity, when overlapped can offer a constructive framework a clearer understanding of notions of impermanence. The framework of the concept of collapsibility, this thesis aims to provide, connect these notions to reflect a constructive framework of impermanence and change.

The next chapter, *Explorations of Collapsible Events*, starts to unpack the connections between these notions mainly through the semiotic analysis.

2.4 **Summary**

To sum up, it is apparent that there is a need for constructive interior design theory that can guide meaning and form-making processes of impermanence in response to the challenges this century presents. There are already some theories that have started to acknowledge impermanence, including soft logic and folds. Both established theories describe impermanence in a theoretical way. However, I suggest that these theories are hard to decode into practice because they do not have a constructive framework. In this thesis, I introduce the concept of collapsibility as a framework to understand impermanence. I provide a design framework-formula which, I believe, can enable designers to render theories such as folds and soft logic into practice. This formula will provide access to a new way of thinking about the design of impermanence in relation to notions of force and fold. I will, in the next chapter, explain what a collapsible event is.

A Poem

Collapsible Story...[4]

A Collapsible story is stories of events in-between…prior and beyond

It is the story of a lung quivering

Of a... heart twitching

A story of endless negotiating of control and surrender

Of a... weave, of a current travelling through, back and forth repeatedly

Of a... curtain waving in and out of a window

Of a... grass bowing down to a breeze passing

Of a wooden floor emotionally trembling under a child's excitement

A Collapsible story is the story of timeless alterations

It is the story of a word becoming thoughts… of thoughts becoming a thing, of a thing becoming lives...and the reverse of all these 'becomings'

Not being a Collapsible story is to stop living... to stop becoming

###

Lore Said (2016)

[4] After writing this poem, I was inspired to translate theses poetic meanings into visual forms. I therefore created images of fictional collapsible spaces (images are included in Appendix 25, p.77). These images were only an expression of an imaginative thought.

Chapter 3 **Explorations of Collapsible Events**

3.1 **Introduction**

In this thesis I argue that understanding notions of impermanence are inseparable from, and arise through, understanding the broader context of collapsible events. This chapter addresses the methodological approach of this thesis that is built around studying collapsible events in relation to notions of folds and forces.

The common approach of the concept of collapsibility is teleological; with predefined function in mind, such as space saving, as described in Mollerup's album *Collapsibles.* This concept refers to the ability to shift and reverse repeatedly between dual states: one active and the other passive, for example, when folding a chair away for storage then unfolding again for use. There are twelve mechanisms to collapsing/folding something physically: stressing, folding, creasing, bellowing, rolling, sliding, nesting, fanning, hinging, inflating, assembling and concertinaing (Mollerup, 2001, p.30). In this chapter I focus on exploring what is described by Mollerup as 'unofficial' collapsible events. These are often not envisaged by designers. I aim to uncover a new meaning of the concept of collapsibility beyond being understood as a mechanism. A collapsible event, I argue, is to be understood as an expression of impermanence.

In this chapter, I go beyond this understanding of the concept of collapsibility to show that a collapsible event is not only about duality or predefined function as a means to an end. Objects as collapsible events are active folds continually changing and emerging in fields of forces. Collapsible events when understood as continua of folding/unfolding and refolding events are fundamental manifestations of impermanence. The term 'collapsibility' offers a particular framework to understand a dynamic event through

reversible, repeatable processes such as, say, folding/unfolding/refolding, endlessly. This, in my opinion, provides the term 'collapsibility' with an advantage over themes that are more general terms, such as flexible, responsive, transformable, reconfigurable, adaptable or interactive.

Due to the scarcity of in-depth design research that studies the concept of collapsibility, I devised my own framework for analysing collapsible events in association with fold events and forces, using various qualitative research methods.

These include:

- Exploring the etymologies of the word 'collapsible' using desk-based research and semi-structured interviews with scholars including anthropologist Tim Ingold and architect Patrik Schumacher (transcripts of both meetings are included in Appendices 2 and 3 pp.3-31) (two audio recordings of these meetings are also included in the CD enclosed with this thesis).[5]
- Study of the associations between folds events and collapsible events in everyday life using semiotic analysis and a workshop titled *The Everyday Collapsible Acts* with MA, MFA design students in ECA/University of Edinburgh.

3.2 **Etymology of the Word 'Collapsibility'**

The nouns 'collapse' or 'collapsibility' are derived from the verb 'collapse'. The origin of *collapsed* dates to the 17th century, and it is derived from the Latin *collabi*,

[5] The audio recordings are in CD folders: *Patrik Schumacher* – *Interview* and *Tim Ingold* – *Lecture and Interview.*

from *col-* 'together' + *labi* 'to slip or fall', and it means ‘fall together’ (Oxford Advanced Learner's Dictionary, 2016). In the American Heritage Stedman's Medical Dictionary (2016) ‘collapse’ as a noun represents “a condition of extreme prostration”, “a failure of a physical system”, or “falling together of the walls of a structure”. The Visual Thesaurus (2016) connects the verb *collapse* with verbs such as: turn up, fold up, crumble, break down or up, fall in and cave in. The first part of the word is a form of the Latin prefix con- (cum), which becomes *col-* and *cor-* meaning with, together, jointly, combine, compile (Collins English Dictionary, 2016).

The Oxford Dictionary (2012) defines the verb ‘collapse’ as follows:

- (of a structure) means to fall down or into
- (of a lung or blood vessel) fall inwards and become flat and empty
- (of a person) fall down and become unconscious, sit or lie down as a result of tiredness
- (of an institution or undertaking) fail suddenly and completely
- (of a price or currency) drop suddenly in value
- (of an object) fold or be folded to fit into a small space or to “compress a displayed part of a spreadsheet or other electronic document”

In the Macmillan Dictionary Thesaurus (2016) the verb ‘collapse’ is also related to the changing dimensions of an object or separation of it into parts so that it takes less space, such as: widen, stretch, open out, fold up, and roll. Such meaning of the verb includes actions in opposing conditions, for example, roll and roll out, furl or unfurl and fold and unfold (Macmillan Dictionary Thesaurus, 2016).

The adjectives ‘collapsible’ or ‘collapsed’ are derived from ‘collapse’ + -able. The suffix *–able* is a word-forming element of an English adjective that adds a notion of ‘capable of’, or sometimes ‘full of, causing’ (Online Entomology Dictionary, 2018). The word refers to the ability to be folded compactly (The Collins English Dictionary, 2016) and thus be foldable. Synonyms of ‘collapsible’ include *foldable*: means capable of being folded up and stored, *telescopic*: implies having parts that slide and nest inside each other,

and *tip-up*, as when something is designed to tip up, out of the way (English Thesaurus, 2012).

3.2.1 Insights

Two key insights can be extracted from these definitions:

Firstly, the meanings of the verb *collapse* often imply negative connotations. In the Oxford Dictionary (2012), for example, the verb 'collapse' is often associated with loss of verticality of a person or a building when falling, sudden events, or the reduction of value and energy. However, the adjective 'collapsible' does not imply negative connotations. When adding the suffix *–able*, the meaning transforms to imply constant ability to adjust. 'Collapsible' as an adjective does not mean a loss of energy; in fact, in some cases collapsible objects can produce energy, such as when stretching an elastic band. The collapsible capacity of the elastic produces force as stretching that enables the elastic to contract back. Tim Ingold, during an interview in 2012,[6] elaborates with a similar example of how collapsing a spring does not mean loss of energy:

> "We might tend to think that when something collapses, it's that all the force, all the energy goes out of it; but it could be the other way around... for example a spring…you have a spiral spring, and you pushed it down, but actually, all that energy… it means that there is a tremendous amount of potential energy in the spring that will shoot up if you take the pressure off…" However, "When people talk about collapsing, not always, but often, I think they'd think in terms of vertical dimension, which is…the thing standing up, so that they have some notion of uprightness and then collapsing would be the loss of that uprightness. You might argue that is a sort of very culturally loaded perception; you know that

[6] Audio recordings of this meeting is included in the CD enclosed; folder: *Tim Ingold – Lecture and Interview.*

> in the West there is long tradition of giving a moral evaluation to uprightness… When people talk about that something collapses, it means falling apart, it has lost direction, is not going anywhere." (Ingold, Personal Communication, 10th of August, 2012) (transcript is included in Appendix 3, pp.20, 24 and 25)

Secondly, the etymologies above permit the recognition of a collapsible system of some sort. The etymologies of the Latin origins in the Oxford Advanced Learner's Dictionary (2016) (slip/fall with/together) signify an existence systematic act. Similarly, the synonym *telescopic* connotes an existence of collapsible relationships between various elements that nest and slide within each other and function as a one system. The concept of collapsibility, however, is often known and used or designing objects. In his album *Collapsibles*, Mollerup mentions a great number of well-known collapsible designed products including Swiss Army knives, maps, lantern lights, sunglasses, books, newspapers, umbrellas, blinds, shutters.

Thirdly, the definitions of the word *collapse* imply repeated coupling of dynamic events. For example, in the Macmillan Dictionary Thesaurus (2016) to 'collapse' something can mean to fold/unfold, to roll in/roll out or furl/unfurl. However, a collapsible event is not only two actions but a continuum of adjustments. For example, folding the Trice chair shown in Figure 5 consists of many sub-folding/unfolding events. The figure shows a chair folding and unfolding in five intermediary adjustment events. The extent of each intermediary sub-event within a collapsible process is a relative issue because it is often a matter of choice of how many elements the interpreter wants to distinguish and define as a sub-collapsible event.

Figure 5: *Trice Chair Design* (Kähönen, 1986)

The term ‘collapsible’ is commonly understood as a mechanism for a specific function. For the Adaptable Future (AF) Industry & Academic Collaborators, in their toolkit *Frame-Cycle* diagram (2012) (image of the diagram is shown in Figure 6), collapsibles are linked with movable structures that perhaps can be folded for easier transport. Similarly, Mollerup, in his book *Collapsibles*, associates collapsibility with space-saving objects that can shift between two states; one active state and the other passive, such as an umbrella. In line with this, Schumacher also says that the word ‘collapsible’ means things are folded up then disappear (for storage for example).‘Reconfigurable’ or ‘transformable’, Schumacher recommends, are better, more understandable terms: “collapsible is a kind of sub-set of reconfigurable” (Schumacher, Personal Communication, Feb. 2012) (transcripts are included in Appendix 2, p.16). While such terms can also describe

dynamic events of impermanence, the multiplicity of the meaning of the term ‘collapsible’ (which involves the folding, unfolding, refolding of an event). I believe, provides a constructive model to understand impermanent as a system of opposite and reversible events. This claim unfolds through the course of this research.

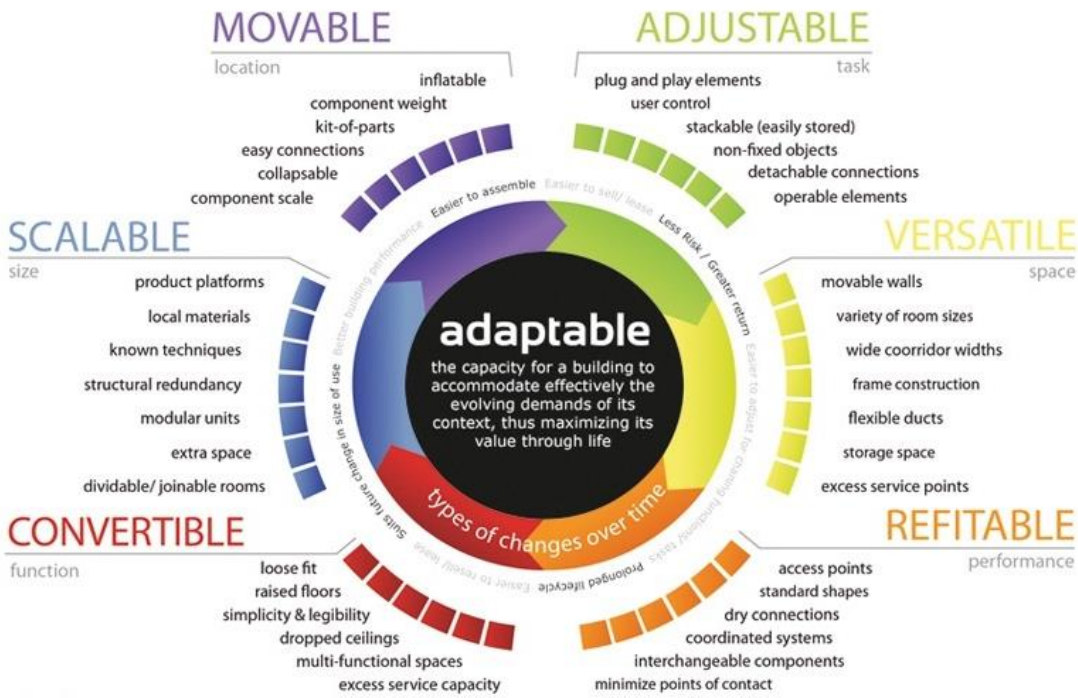


Figure 6: ***Frame-Cycle, Adaptable Future Toolkit*** **(AF, 2012)**

Such approaches to collapsibility (for space saving, for storage convenience or for transportation) focus on limited dual understanding of collapsible events. These approaches do not acknowledge the strategic processes of a collapsible adjustment. A collapsible event, I believe, is neither about a folding nor unfolding but the process in-between. This in-between continuum of adjustments can be understood as one of the principal expressions of impermanence. In the next sections, I explain this notion further while analysing collapsible events that are unintended by designers for a specific function.

To sum up, this etymological analysis proved to be a useful tool for provoking new thought. It assists in expanding my vocabulary and provides insights about related themes that widen the scope of the research. I mind-map these initial insights to help organise my thoughts (images of the visual maps are included in Appendix 4, p.32). I believe such a tool is of great importance for designers. In line with this, architect Gottfried Semper commented on the importance of etymology and linguistics in relation to art forms. He states: "it will not be long before research into linguistics will start to interact with research into art forms; such a link is bound to lead to the most remarkable revelations in both fields" (2004, quoted in Schumacher, 2012, p.178).

3.3 **Semiotic Analysis of Collapsible Events**

In this section I analyse tacit collapsible events that happen in everyday life. I focus on the type of collapsible events Mollerup refers to as 'unofficial' collapsibility (2001, p.32). These are not envisaged by designers. I use a semiotic analysis table based on views of linguist Ferdinand de Saussure. This table divides each collapsible event into three elements: sign, signifier and signified.

3.3.1 Case one: fold events of a sofa when squashed under force loads

Figure 7: ***Collapsible Behaviours of a Sofa*** **(Said, 2012)**

event signification: fold events of a sofa when squashed under force loads	
Signifier	**Signified**
• Temporary new systems of folds emerge instantly on the surface of the sofa every time it is squashed under loads. These folds disappear gradually when loads are shifted away. • Reductions and expansion of the volumes of sofa cushions as weights are loaded and removed.	Temporary force event generated by weights of the body.
Sign	
Collapsible capacity of the sofa.	

3.3.2 Case two: fold events of a washing liquid container when squeezed

Figure 8: ***Collapsible Behaviours of a Washing Liquid Container*** **(Said, 2012)**

event signification: fold events of a washing liquid container when squeezed	
Signifier	**Signified**
• Temporary new systems of folds emerge instantly on the container every time it is squeezed by hand. These folds disappear quickly when the pressure is off. • Reductions and expansion of the volumes of container as pressures are applied and removed.	Temporary force event generated by the hand.
Sign	
Collapsible capacity of the washing liquid container.	

3.3.3 Case three: fold events of skin of a hand when pressed against a solid lid

Figure 9: ***Collapsible Behaviours of Human Skin*** **(Said, 2012)**

event signification: fold events of skin of a hand when pressed against a solid lid	
Signifier	**Signified**
• Impermanent new systems of wrinkles similar in shape to the grooves of the lid emerge on the skin every time it is pressed hard against the lid. These wrinkles disappear fairly slowly when pressure is off. • Minor compression and expansion of the skin as pressure is applied and removed.	A temporary and relatively strong force event generated by the hand pressing against solid object (the lid).
Sign	
Collapsible capacity of human skin.	

3.3.4 Case four: fold events of piles when applying loads over a period of time

Figure 10: ***Limited Collapsible Behaviours of a Fitted Carpet*** **(Said, 2012)**

event signification: fold events of piles of a fitted carpet when applying load over a period of time	
Signifier	**Signified**
• Small marks emerge on the surface of a fitted carpet as its fibres (pile of carpet) furl under gravitational loads of objects (mat, chair) over a period of time. These fibres (pile of carpet) unfurl slowly when loads of objects are shifted away. • Micro compression and expansion of the carpet thickness as weights are loaded and removed.	Force events over an extended period of time generated by gravitational weight of objects; mat, chair.
Sign	
Limited collapsible capacity of a fitted carpet.	

3.3.1 Insights

The analysis shows that collapsible events bring together both causes (forces) and effects (folds) to signify a change event and communicate impermanent states. While the collapsible capacity allows an object to fold, the forces determine the shape of these folds. In other words, these collapsible events, as signs, are produced by the relationship between the 'signifier' system of folds (signifiers) and forces (signified). These insights can be summarised in this table below:

Signification: A Change Event	
Signifier (a physical form of a sign)	Signified (a concept a sign represents)
System of Folds	**Force**
Sign (a quality or event that stands for a meaning)	
Collapsible Capacity	

Table 2: *Elements of a Change Event* (Said, 2019)

Everyday examples show that these collapsible objects have integral forces that allow them to reverse an action and bounce back when the external force that caused it is removed. These collapsible behaviours differ according to the object's material and structure. For example, collapsible behaviours of the sofa differ from that of the washing liquid container. The integral forces of the plastic material of the washing liquid container allow it to bounce back and return to its shape quickly. The integral force of the sofa, on the other hand, takes more time and recovers gradually. The fitted carpet, as a whole, shows no collapsible capacity because of its coupling with a hard floor. The analysis of the carpet example only indicates a minor integral force of the pile to fold in response to a force.

When objects interact with an external force, the most dominant force determines the form of the event. For example, in *Case Three* the integral force of the lid is greater than the integral force of the flesh. Therefore, the lid leaves marks on the flesh and not vice versa. On the contrary, in *Case Two* the force applied by hand is greater than that of the integral force of the bottle; therefore, it determines the form of the folding events of the bottle. The configurations of these folding events depend on the hand size, pressure, position, the material and the content.

On the whole, events of folding, wrinkling and creasing appear as expressions of a change in state (signifiers). Folding, creasing and wrinkling are capacities that collapsible objects have that allow them to communicate a change of state. Some objects show higher collapsible capacity than others; for example, the washing liquid container, the sofa and the flesh exhibit collapsible capacities to fold more than the fitted carpet.

3.4 **Exploration of the Everyday Collapsible Acts|Design Workshop**

In 2012, I conducted a workshop titled *The Everyday Collapsible Acts* with MA and MFA product design students at Edinburgh College of Art, with the help of their tutors, Arno Verhoeven and Douglas Bryden. In this workshop, students were asked to search for and record 'unofficial collapsible' events using photography or videos (the brief of the workshop is included in Appendix 5, p.34). The students documented their findings by taking sequential photographs, videos or making drawings of the stages of collapsible acts. I use the term 'collapsible act' instead of 'collapsible event'. This term is inspired by the American philosopher George Herbert Mead and his understanding of the philosophy of the act in his Essay 21 in *The Philosophy of the Act: The Process of Mind in Nature* (1938). The word 'act' emphasises the performative trait of the concept of collapsibility. By using this word therefore, I aimed to encourage the participants to focus less on observing collapsible objects and more on observing the process of a collapsible event as an act/performance that involves multiple events.

The students presented many examples of common collapsible objects, such as a curtain, a laundry basket, a stapler and a mint box (a video recording of this workshop is included in the CD enclosed with this thesis).[7] New insights, however, are provided by participants A and B (see consent forms of participants A and B in Appendix 6, pp.36- 39. The participants presented unofficial collapsible events of invisible nature. The examples are highlight below

Figure 11 addresses the collapsible act of a frame aperture when zooming in and out. It shows a collapsible manifestation of a visual event through a series of images while zooming in on a poster. The frame aperture expands consecutively and repeatedly when

[7] The video is in CD folder: *MA workshop – Everyday Collapsible Objects.*

zooming out to include a wider perspective of the poster and then shrinks back when zooming in to minimise perspective.

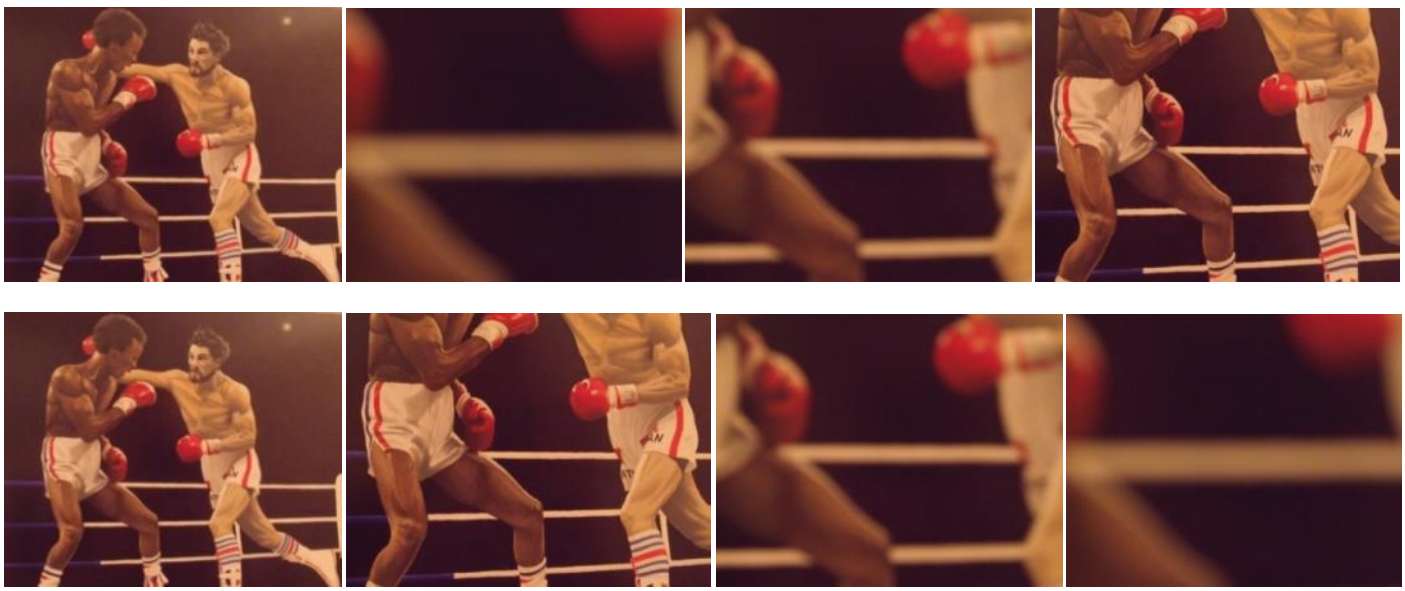


Figure 11: *Visual Collapsible Manifestation* (Participant A, 2012)

Figure 12 addresses the collapsible act of sound volume when amplifying and attenuating. It shows an example of a collapsible manifestation of auditory events through two images. The images do not show the sound, of course, but only a representation of two states; one image represents a high sound volume, whereas the other represents the state when volume sound is low. The sound waves expand consecutively and repeatedly when amplifying, and then shrink down during attenuation.

Figure 12: ***Auditory Collapsible Manifestation*** **(Participant A, 2012)**

Figure 13 addresses the collapsible act of heat mass when increasing and decreasing. It shows an example of a collapsible manifestation of thermal events through two images. The images do not show the heat mass but only a representation of two states. The image on the right represents the presence of heat mass indicated by the red light while the dial is on. The left image shows the absence of heat mass where both the light indicator and the dial are off. The heat mass enlarges and contracts corresponding to the dial intensity levels.

Figure 13: ***Thermal Collapsible Manifestation*** **(Participant B, 2012)**

Figure 14 addresses the collapsible act of energy levels when increasing and decreasing. It shows an example of a collapsible manifestation of energy-related events through two

images of car batteries. The image to the right represents a charged battery; the other image to the left shows an empty battery. The energy level expands when charging, and decreases while being used.

Figure 14: ***Energy Collapsible Manifestation*** **(Participant B, 2012)**

Figure 15 addresses the collapsible act of pressure levels of air in balloons when inflating and deflating. It shows examples of a collapsible manifestation of air pressure events through two images. The image on the left shows several fully inflated balloons. The image on the right shows a slightly deflated balloon indicated by the wrinkles on the surface. The balloon volume expands when air pressure intensity increases, and the balloon volume shrinks accordingly when air pressure decreases.

Figure 15: ***Air Pressure Collapsible Manifestation*** **(Participant B, 2012)**

3.4.1 Insights

It could be argued that these invisible events are collapsible as they involve repeated actions of expansions, contractions. In other words, these events are collapsible because they are repeatable and revisable adjustments. The key insights this workshop highlights is that 'unofficial' collapsible events can manifest in conceptual form, for example, visual, auditory and thermal. A similar example of invisible collapsibility is psychological, as mentioned by Mollerup: "*Man, himself, is a collapsible being, physically and psychologically"* (Mollerup, 2001, pp. 6). He explains that psychological collapsibility can be experienced when someone wins; they show off (inflate) then hide when they get defeated (deflate) (Mollerup, Personal Communication, 2012) (Email Re: 2 is included in Appendix 7, p.41). Mollerup also provides an example of an invisible collapsible event when mentioning the French Michelin Guide. He says the graphics in the guide are collapsible. They compress information into a code, which unfolds their meaning when interpreted. It is a semantic collapsible (2001, p.61).

Similarly, Schumacher mentions an example of visual collapsible events. These are when the notion of movement of the observer-parameter such as lighting, perspective and place

shift some shapes or figures expand, emerge and then disappear. He says you can make things looks as if they are animated only by changing the lighting. This can make it look as if the whole thing changes its configuration. Yet these changes only, Schumacher argues, are a matter of perception (Schumacher, Personal Communication, Feb, 2012) (transcripts are included in Appendix 2, p.18).

Describing some of the conceptual collapsible events presented (namely auditory, thermal collapsible events) proves to be a challenging task. These events required basic background knowledge and terminologies in physics, which I lacked. However, whether or not all these events in the workshop are collapsible is beside the point. Even when it is the case, I find it is more important to consider how the designation of 'collapsible event/act' informs new understanding of collapsible events as change events. This is to say that, the term 'collapsible' seem to play a strategic role by enabling students to define, interpret and connect a series of reversible events under one expression i.e. collapsible act. This perspective shifts beyond the common understanding of the concept of collapsibility as a mechanism for namely space saving, and storage convenience. The workshop shows the students' openness towards understanding the concept of collapsibility in a broader context as physical/conceptual events, and beyond its limited common understanding in design as a mechanism for a means to an end.

3.5 **Discussion: Impermanence and Collapsible Events**

These explorations show that collapsibility can be understood to be part of a process of strategic adjustment, physical or conceptual. The workshop, for example, shows that collapsible events can manifest in both immaterial and material forms such as sound and heat. Perhaps studying intangible collapsible events through images are hard to pinpoint. On the other hand, it can be somewhat useful to acknowledge and be aware that these conceptual collapsible processes are taking place.

Overall, the explorations show that understanding impermanence in relation to folds is inseparable from, and arises through, understanding of collapsible events in relation to

two notions of fold and forces. Both the workshop and the semiotic analysis uncover substantial existences of a wide spectrum of everyday collapsible acts. These manifest as folding events; albeit tangible or intangible.

This chapter uncovers a hidden dimension of the concept of collapsibility and how collapsible events operate in relation to forces. These explorations show that collapsible events are not only a mechanical act, but a field of a continuum of folding events as expressions of impermanence. Waddington (1977, p.18) argues that there are two ways of viewing the world: one view is that the world essentially consists of things that interact with one another; the alternative view is that the world consists of processes. Objects as collapsible events are to be understood as processes of folding, unfolding and refolding by force. Such a dynamic understanding can empower the design of passive and inert elements of interiors.

Collapsible events, therefore, are not to be seen as mechanisms for a means to an end, but as temporal expressions of temporal forces. These collapsible events manifest through a system of folding events. This notion, I believe, can help grasp the meaning of impermanence.

The semiotic analysis reveals passivity and limitation in the way carpet is designed. A collapsible capacity is second nature to the material of a carpet, yet it is limited when the carpet is attached to a permanent floor. The floor design is not receptive to forces, thus passive and static. Ingold (2011) critiques the contemporary approach to materiality and considers it as a useless abstraction. He said: “It is a concept we impute to things because we do not bother to hold them in sufficient regard for what they are and what they do. The actual ‘materials’, it seems, have gone missing.” (Ingold, 2011, p.20) In the next chapter I discuss how the active collapsible capacity of the rugs/floor of Bedouin tents empowers their design.

These unofficial collapsible systems of events are produced through balancing two counter forces: tension and compression. This mechanical balance is referred to as tensegrity (Ingber, 1998, p.49). Tensegrity is a mechanical principle widely applied in natural systems on many scales, including the human body (Ingber, 1998). This structural principle was originally coined by Buckminster Fuller and its literal meaning is "tensional integrity" (Fuller, 1975).

These unofficial collapsible events, of forces and folds, are forgotten and fall outside the view of interior design theory. I believe, however, that they can open up a new paradigm of how to understand and design impermanence. In other words, to understand notions of impermanence of built environments is, I believe, to be aware of the countless tacit collapsible events, processes, negotiations and experiences within everyday life. Some impermanent events in nature might take decades and centuries to fold, unfold, and refold again; for example, mountains are results of collapsible events.

How much can we, as architect and designer, learn from these interventions of tacit spatial collapsible events? How much do these un-envisaged events redefine the ways we think about designing impermanence? In line with this, Abercrombie argues, in *A Philosophy of Interior Design*, that:

> "Philosophy does not have to do, as is often thought, with the general, abstract, otherworldly…it is, rather, the interpretation of the closest, the concrete, the everyday. For in the proximate, the daily, the apparently small, there is hidden… the metaphysical; the here-and-now is the place where meaning is disclosed, where our existence must find interpretation, if it can find am interpretation at all. That is what dwelling, or the space of dwelling, is: something proximate, daily, and apparently small over against great things." (Tillich, 1933, quoted in Abercrombie, 1990, p.166)

Most of these events discussed are related to objects. In the next chapter I will investigate further how such unofficial collapsible events operate on a larger scale in the collapsible system of Bedouin tents.

3.6 **Summary**

To sum up, *Folds* and *Soft Logic* theories offer a way of thinking about the encounter between impermanence and design. The explorations of collapsible events show that the concept of collapsibility brings such theories closer to their practices through the engagement with concrete registers and formulas of folding events. Folds, through the lens of the concept of collapsibility, are not to be understood as geometrical static forms, but as dynamic events.

Understanding interiors through this coupling of subject and object of folds/folding, I believe, offers interiors an escape from common permanent approaches, thereby establishing the possibility for more adaptable built environments. In other words, such extended understanding of interiors as system of interconnected collapsible events of various natures can be seen as a useful tool to engage with a wider spectrum of collapsible experiences, including light and sounds of elements within interiors. In other words, understanding the built environments as collapsible events, I believe, can overthrow the models of permanency and significantly transform the way the built environment is built and designed as static and passive structures. Built environments' structures, through the lens of the concept of collapsibility, are never fixed but temporal; in constant transitional states.

The explorations of collapsible events above draw round the relationship between collapsible events and impermanence; however, these explorations do not offer a comprehensive framework on how collapsible events operate in the larger scale of a building system. In the next chapter, I explore the practical assembly and framework of the concept of collapsibility within the context of building systems of Bedouin tents. While I investigate the relationship between notions of collapsible events, folds, forces.

"The principle is simple: no adjustment, no future. Adapt and survive"

(Per Mollerup, 2001, p.7)

Chapter 4 **Bedouin Tents Case Study: Semiotic Analyses and Practical Experiments**

4.1 **Introduction**

The previous chapter shows that 'unofficial' collapsible events manifest as temporal fold and force events. In this chapter, I study collapsible events in the larger scale of systems within a particular case study. My aim is to build a framework for understanding and designing impermanence based on in-depth understanding of how collapsible events operate as system in a key architectural case.

For this case study I have chosen images of Bedouin tents from the Levant region (i.e. Syria, Jordan, Lebanon Palestine etc.) (the original source of the images used before editing can be found in Appendix 8, pp.42-44). This is mainly because I had the chance to personally study and experience these tents in the Palmyra Desert, Syria, during an interior design workshop. The design of the Bedouin tents can be influenced by many local, economic, historical or political factors. However, the design principles of the systems of these Bedouin tents are similar throughout (Jabbour, 1988).

I use semiotic analysis to analyse signs of collapsible event structures in Bedouin tents. I also interview Bedouins, indirectly,[8] to form a deeper understanding of how structures of Bedouin tents behave on a daily basis (see Arabic transcript and translation of two

[8] Because of the war situation in Syria, I sent the questions by email to interior designer lecturer Osama Risheh at Damascus University who helped with interviewing two Bedouins on my behalf then passing the answers back via emails (see Appendix 9 transcripts of two interviews with Bedouins, pp.45-54).

interviews with Bedouins in Appendix 9, pp.45-54). I also create two physical models to manipulate and study how collapsible events operate as a system in a tangible way.

In this case study, I also rely on my past experiential knowledge of the Bedouin tents and how their structures respond to forces. While some assumptions presented may seem subjective, they are explicit and generalisable. This case study on tents focuses on ‘unofficial’ collapsible events that are not intended or designed to accommodate a particular function. The collapsible event of folding, unfolding and refolding a Bedouin tent when nomad, is not, therefore, the main focus.

4.2 **System of Bedouin Tents**

The design of Bedouin tents has changed little over centuries (Langmead and Garnaut, 2001, p.36). Four main elements are used to construct the system of Bedouin tents: fabric, poles, ropes and wedges. Some of these elements are planted and fixed into the ground like the wedges; some are semi-fixed, like poles and ropes; some terminals are fixed, and others are floating.

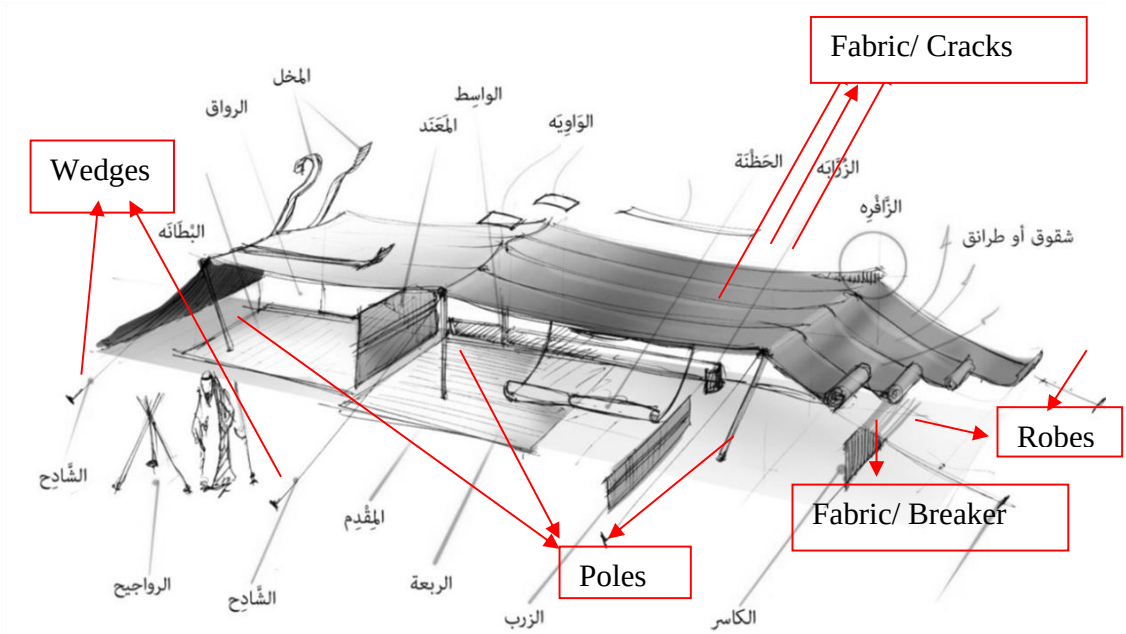


Figure 16: *Bedouin Tent Diagram* (Risheh, 2015)

Fabrics make up most of the tent's interior and exterior and are often made of wool. That is why the tents are often referred to as 'Wool Houses 'or 'House of Hairs' (Jabbour, 1988). The name is related to the goat's hair used to weave the fabrics (Langmead and Garnaut, 2001, p.36). Occasionally, however, fabrics are made of flax and plants, depending on the dwellers' social and financial status within a tribe (Jabbour, 1988). Most Bedouin tents have three walls that are named differently. The logic behind choosing different names depends on its position, location, or function within the system. For example, the walls used as partitions are called '*Kaser*" كاسر', which means a *breaker*, whereas the main and longest fabric wall on the back is called '*Rouak' رواق* '.This term means an outdoor *corridor*, referring to its long shape. The roof is called a '*Shak' شق* and is also made of the same wool fabrics. The term means *crack* or *fracture*, referring to cracks of light in-between several stitched pieces of fabrics (see Figure 16).

- **Poles**

Poles are often made of wood and vary in length. Each pole is planted with one end in the ground while the other end floats. Bedouins sprinkle some water over the top of the sand to make it denser before planting these poles (Risheh, 2015). These poles lift and bear most of the weight of the fabric. The height of the poles is approximately 200 cm on average (Katsap and Silverman, 2015, p.307). The length of pole can be adjusted, tilted or pushed deeper in the sand, depending on its function. For example, the ceiling is usually higher near the cooking area (to reduce the effect of heat on the ceiling fabric). The central poles are often longer than the side ones (see translation of two interviews with Bedouins in Appendix 9, pp.50-54).

- **Ropes**

Ropes are often made of flax. They connect the fabrics traditionally via holes or metal hook rings with the wedges fixed in the ground through holes around the poles. Dwellers need to adjust and tighten these ropes regularly, as the weight of the fabrics, heat, wind and people's interactions with the system could loosen the structure (see translation of two interviews with Bedouins in Appendix 9, pp.50-54).

- **Wedges**

The wedges are either made of wood or heavy stones and are strongly planted in the ground. Their purpose is to create heavy forces that resist against the pulling forces of the ropes. All together, these interacting forces lift and balance the structure of a Bedouin tent.

The size or direction of the Bedouin tent is never permanent or fixed. The size of a tent is often determined by the family and often adjusted and readjusted through the years to accommodate more or fewer members (Na'amneh, Shunnaq and Tasbasi, 2008, p.155). If more rooms are needed, more fabrics are stitched to lengthen or widen the tent and poles are added accordingly. Figure 17 shows examples of various Bedouin tent sizes,

expansions and adjustments. The direction of a Bedouin tent changes and rotates during seasons, depending on wind and sun direction. The entrance is normally facing away from the wind currents (Langmead and Garnaut, 2001, p.36) and it often changes location according to sun direction (Figure 18). For example, in summer, to avoid direct sun, the tent will be slightly rotated east-west (Na'amneh, Shunnaq and Tasbasi, 2008, p.154).

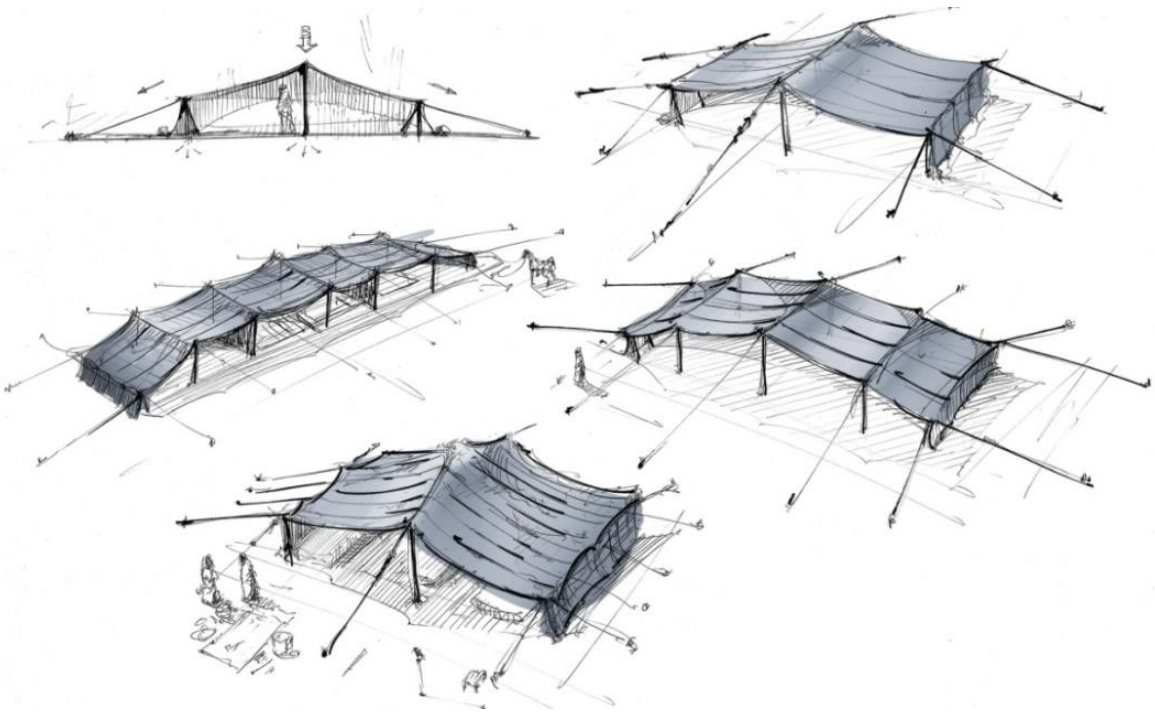


Figure 17: *Bedouin Tent Expansion* (Risheh, 2015)

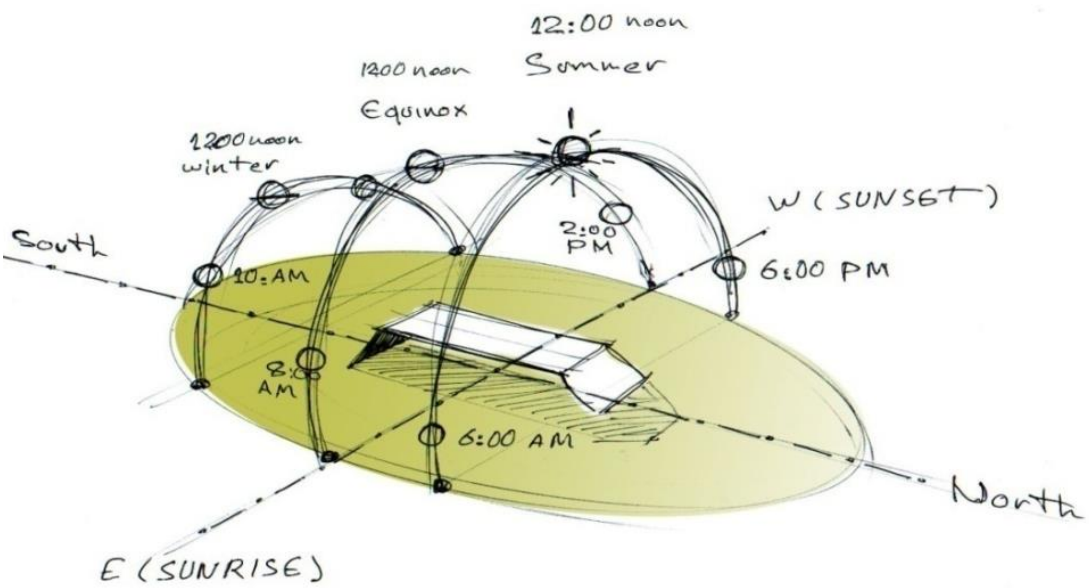


Figure 18: ***Bedouin Tent Sun Direction Diagram*** **(Risheh, 2015)**

This Bedouin tent system represents more than a roof/shelter for its dwellers. Such building systems embody socio-cultural values that are constantly produced and reproduced throughout generations (Na'amneh, Shunnaq and Tasbasi, 2008, p.150). For example, a tent made of wool has social and political importance, as it can signify the class of the Bedouin tent's dwellers. In his interview, Gasem Muhammad Olabi, a Bedouin dweller from Daraa, showed some reservations when answering questions. He insisted on asking him not about a 'Bedouin tent', but about the 'Bedouin wool house'. He said that a tent can be made of any cloth but a wool house is made of animal wool (goat or camels). He said, in an irritated tone, "we have never lived in a tent; we have only lived in a wool house" (see translation of the interview with Bedouins in Appendix 9, p.50). The significance of wool fabric indicates a quality of life. In a paper titled *Assessing the Thermal Performance of Bedouin Tents in Hot Climates*, architect Shady Attia (2014) explains how the membranes of the Bedouin tents made of wool work as heating/cooling systems. The fibres of the wool swell when it is wet, preventing water coming through. Oppositely, they contract in size when it is dry and hot, allowing the pores of the wool

membranes to open, expand and breathe (Langmead and Garnaut, 2001, p.36). The system therefore constantly needs to be readjusted or tightened to maintain the same shape, as it will be stretched by the end of summer (see translation of two interviews with Bedouins in Appendix 9, p.51).

4.3 **Semiotic Analysis of Collapsible Events in Bedouin Tents**

In this analysis I use a similar tool to the one used in the previous chapter. However, in this analysis I divide the sign into two levels of meanings, denotation and connotation, to unpack further the relationship between the concept of collapsibility and notions of impermanence. This approach is based on semiotic views of theorist Roland Barthes (1957, quoted in Chandler, 1994). The denotation of a sign refers to the the most basic or literal meaning of a sign, while the connotations are the implicit meanings of a sign (see Table 2). For example, the word 'home', as a sign, denotes a building or an interior structure of some sort. The connotation of the word 'home', however, involves another level of meaning that can refer to comfort, safety or an identity. This semiotic analysis consists of three cases of collapsible events within the Bedouin tent system.

Signification (event)	
Signifier A physical form of a sign.	**Signified** A concept a sign represents.
Sign Denotation:	
The most basic or literal meaning of a sign.	
Sign Connotation:	
The implicit meanings of a sign.	

Table 2: *Levels of Meanings of Sign* (Barthes, 1957, quoted in Chandler, 1994)

4.3.1 Case one: system of collapsible events when a boy leans on a side wall

Figure 19 shows various changes of the Bedouin tent as the boy leans on and subsequently pulls the side wall. This pulling force causes a series of changes to the tent's structure that cannot be easily identified in a still image, but signs of these changes can still be detected. The red arrow represents the direction of the external pulling force applied by the hand. Marks in yellow (arrows and circles) represent change events whereas blue marks represent a speculation of previous positions of the structure of the tent (poles, ropes, fabrics) before forces are applied by the boy.

The system of folds emerging on the side wall, marked by yellow arrows, signifies the direction of this pull force. The dotted blue L-shaped line (near the left) is a speculation of the configuration of the side wall before it was changed. The force stretches the fabric of the side wall, pulling the rope down closer to the hand. The rope, in turn, drags the poles and the fabric of the ceiling, moving the whole structure of the tent slightly towards the hand. The solid blue lines are speculations of the previous angles of the poles. The yellow circles indicate the position of various connective points. The blue circles are speculations of the positions of these connective points before the pulling force was applied. These change events are dependent on the value/intensity of the pull force in relation to the integral forces of the system of the tent. This whole series of change events will most likely be reversed to its previous state as soon as the external force applied by the boy is terminated.

Figure 19: ***Collapsible Events When a Boy Leans on a Wall*** **(Eviljohnius, 2005)**

Signification of a collapsible event: A boy leaning on side wall results in a series of reversible change events in the system of the Bedouin tent.	
Signifier	**Signified**
• Temporary systems of folds emerge on the side walls while other folds disappear. • Temporary changes to the ropes' configurations: some are loosened while others are stretched. • Poles change directions at various angles.	A new force generated by the boy leaning.
Sign Denotation:	
Capacity of the system of the Bedouin tent to change repeatedly in response to external forces.	
Sign Connotation:	
Collapsible capacity of the system of the Bedouin tent.	

4.3.2 Case two: system of collapsible events when kids rest against the walls

A similar event can be detected in Figure 20. The image shows two children resting against the side walls of the tent. Their weights generate external forces that cause a series of changes in the system. The horizontal red arrow indicates the direction of the forces generated by the weights of the kids while leaning. Marks in yellow represent change events on the walls, whereas the blue dotted line represents a speculation of the positions where the two walls previously met before the forces were applied by the kids. Various counter-integral forces of the tent keep the balance of the structure.

The figure does not show details of how the system of the Bedouin tent changes to accommodate the external new forces; namely, the ropes stretching/loosening or poles changing angles. However, the apparent signs of change events can be detected through the emerging of new systems of folds on the side walls (these are marked in yellow lines). The shape of these systems of folds corresponds to positions, heights and values of forces applied by the children. The whole series of change events can be reversed to its previous state as soon as the external forces applied by the children are terminated.

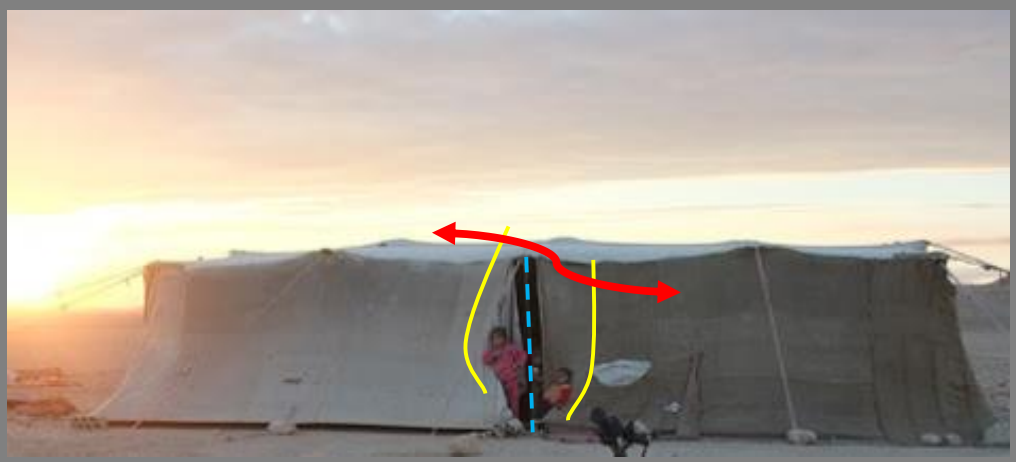


Figure 20: ***Collapsible Events When Children Rest Against the Walls*** **(Travel Designery, 2011)**

Signification of a collapsible event: children resting against the walls result in series of reversible changes in the system of the Bedouin tent.	
Signifier	**Signified**
• Temporary systems of folds emerge on the side walls while others disappear. • The gap between the two fabric walls slightly widens then contracts when forces are removed.	New change events of forces generated by the children's weights.
Sign Denotation:	
Capacity of the system of a Bedouin tent to change repeatedly in response to external forces.	
Sign Connotation:	
Collapsible capacity of the system of the Bedouin tent.	

4.3.3 Case three: system of collapsible events caused by wind, people or animal activities

Figure 21 shows a number of rugs scattered outside the Bedouin tent. While no humans or animals are shown in the image, several forces can still be detected. The red arrows indicate wind force activities. The marks in yellow represent change events in the system whereas blue marks represent a speculation of the previous positions of various elements (walls, rugs) before change events occur.

For example: the arrangements of the rugs can be traced to various social activities. The rugs' arrangements begin near the entrance of the tent, then extends across the site. This arrangement is used both to navigate people across the site and as a social platform for various gatherings. For example, the rugs in the left corner are used as a platform to sit near the fire (circled in green). The wind forces are evident by the ways various rugs across the scene have creased, twisted and folded (arrows in red indicate the likely course of action of the wind forces being blown towards the left of the image). These rugs were likely to have been placed flat on the sand before the wind forces changed their configurations (blue dotted lines highlight the previous positions of the rugs). Other, less dramatic, folds on the rugs may indicate the walking activities of humans or animals (these are marked in dotted yellow lines). Another change event can be noted on both sides of the entrance to the Bedouin tent. Both fabric walls have been partly detached from the ceiling to widen the entrance of the tent (the blue dotted lines highlight the previous position of the walls when they were attached) .This series of change events can be manually reversed to its previous state.

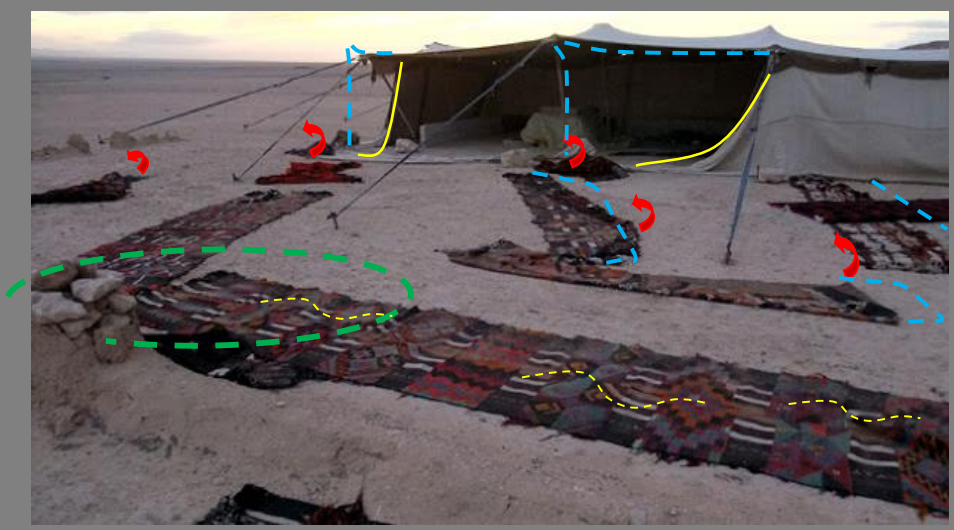


Figure 21: ***Collapsible Events Caused By Forces Of Wind, People/Animals***

(Travel Designery, 2011)

Signification of a collapsible event: winds, people and animal activities result in series of reversible changes in the system of the Bedouin tent.	
Signifier	**Signified**
• Temporary systems of folds emerge on the rugs as they crease twist and fold. • The entrance widens when the fabric walls detach from ceiling. • Temporary systems of folds emerge on the walls when relaxed.	New forces generated by wind activities. New forces generated by people or animals.
Sign Denotation:	
Capacity of the system of the Bedouin tent to change repeatedly in response to external forces and new situations (social, functions, weather).	
Sign Connotation:	
Collapsible capacity of the system of the Bedouin tent.	

4.3.4 **Insights**

The semiotic analysis shows that in Bedouin tents, folding events connote collapsible capacities and folding events denote change/impermanence capacities.

The analysis shows that the Bedouin tent system changes its configuration in response to various external forces through its collapsible capacity. This system of counteracting forces (i.e. tensegrity) holds and balances the structure of the tent, while still allowing the structure to change its configuration in response to external forces. And, more importantly, it allows it to reverse/recover to its original form. For example, in case one, a new system of folds has emerged on the side wall, poles have shifted, and ropes have adjusted forms. When the external force is removed, the tent's structure reverses the change and returns to its original configuration. These systems of change are collapsible because they are all reversible. Ingold explains how this system of forces operates:

> "You put up a tent and you've got rigid poles and you've also got strings; the strings are flexible; you can roll them up, the poles are rigid, but the structure of the tent is held in place by the fact that the strings and the poles, the flexible and the rigid elements, are pulling against one another, so as to create a coherent structure, which technically you could lift off the ground and it would still hold. (...) There is a balance between the forces of tension and compression, so that the rigid element, which is compression, and the flexible element, tension, and they balance each other." (Ingold, Personal Communication, 10th of August, 2012) (transcript is included in Appendix 3, p.22)

Figure 22 illustrates how these systems of forces interact. While gravitational forces pull the system of a Bedouin tent downward, rigid poles standing vertically create a counter force that lifts the structure of the tent upwards (see dotted arrows in red). Ropes connecting to the fabric walls and the wedges planted in the ground pull the structure horizontally (see solid arrows in red). Balancing the distribution of these push and pull

forces through the system helps to stabilise the structure of the tent. Figure 23 is a close-up example of this tensegrity system of the Bedouin tents.

Figure 22: *Tensegrity Principle* (Eviljohnius, 2005)

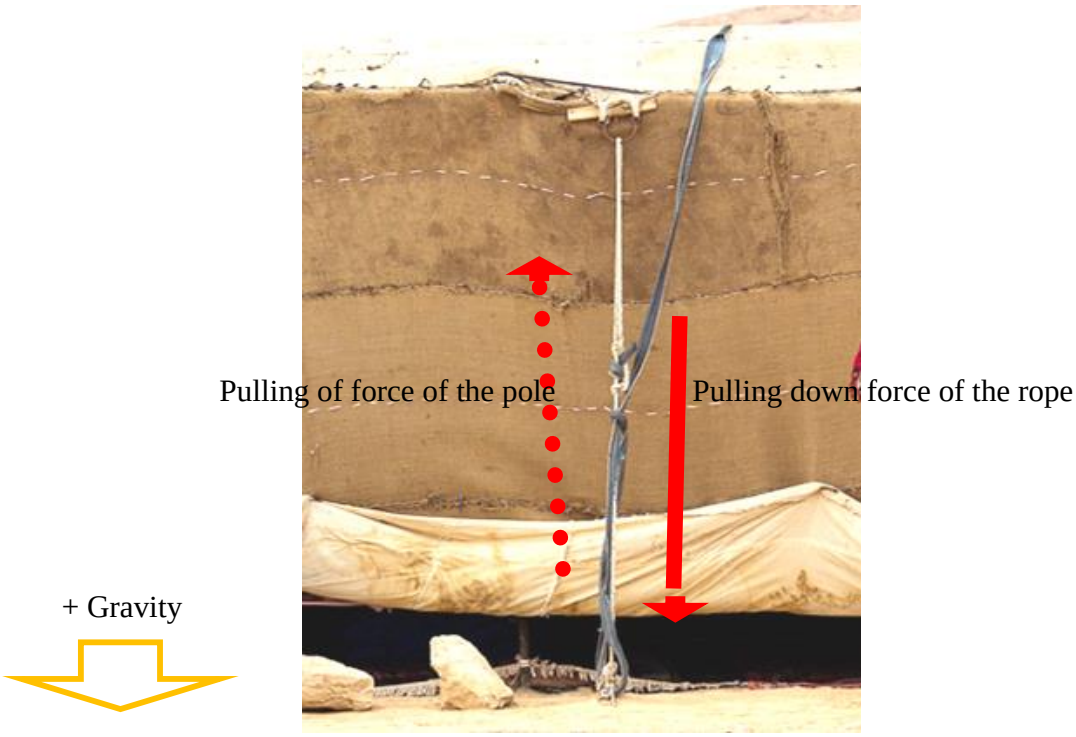


Figure 23: ***Close-Up Example of Tensegrity Principle*** **(Myphotopic, 2012)**

Unlike the structure of contemporary buildings that derive their stability from its continuous compression (Ingber, 1998, p.50), the structures of Bedouin tents derive their stability from the continuously counteracting forces of compression and tension.

The pattern of system of folds in cases one and two can all be read and interpreted in relation to the external force applied by the kids and the boy. These systems of folds can be seen as a temporal expression of temporal external forces. The expressions fade away when the force is terminated. When a new external force is applied, then the Bedouin tent system produces new expressions (new system of folds). The collapsible capacity of the Bedouin tent system enables it to become a communicative/expressive system. Such a notion, I believe, is of great importance.

This understanding of impermanent events through collapsible systems of folds can provide insight into how to design impermanence and change. In the next section, I will

translate this idea into a physical model of collapsible system of folds to experience and understand how such collapsible system operate in a tangible way.

4.4 Collapsible Systems: Tensegrity Models Experiments

Moving on from theoretical considerations, I now move into the practical part of the research. In the next section, I explore further this notion of collapsible systems as a communicative system in a tangible way. As a physical, practice-based experiment, I build two physical collapsible systems based on the principle of tensegrity in order to manipulate and study how these systems communicate various forces.

In this section, I discuss my observations of how two models of collapsible systems behave in response to forces. Similar to the system of Bedouin tents, both models are built according to tensegrity principles and consist of fixed and semi-fixed elements. In the first one, I investigate how a collapsible system responds to forces that I apply. In the second model, I explore how I can channel these forces to manipulate the expression of a system.

These models can be seen as representational units of two different collapsible systems. Collapsible events in Bedouin tents can happen in a more complex and extended scale of networks[9]. The scale of these models therefore is relative. My aim is to simplify a collapsible system to help understand how it operates.

4.4.1 Model 1: travelling forces in a collapsible system

This collapsible system model consists of nine collapsible fold units within a fixed frame placed on a foam-board support. These units are connected with mediators (pieces of plastic) to create the system of folds (see Figure 24).

[9] Appendix 24 is a hypothetical image of a more extended network of collapsible events. The image integrates multiple replications of Model 1 to communicate the scalability of a collapsible system.

Each collapsible fold unit is made from two strips connected to shape a three-dimensional fold. The plastic strips are held in an arch shape with elastic bands (see Figure 25). Each unit is built using the tensegrity principle. The plastic strips, when bent, produce forces that stretch the elastic bands in turn, when elastic bands stretch, they produce counter forces that hold the plastic strips in the form of an arch and, therefore, the nine arches together as a system.

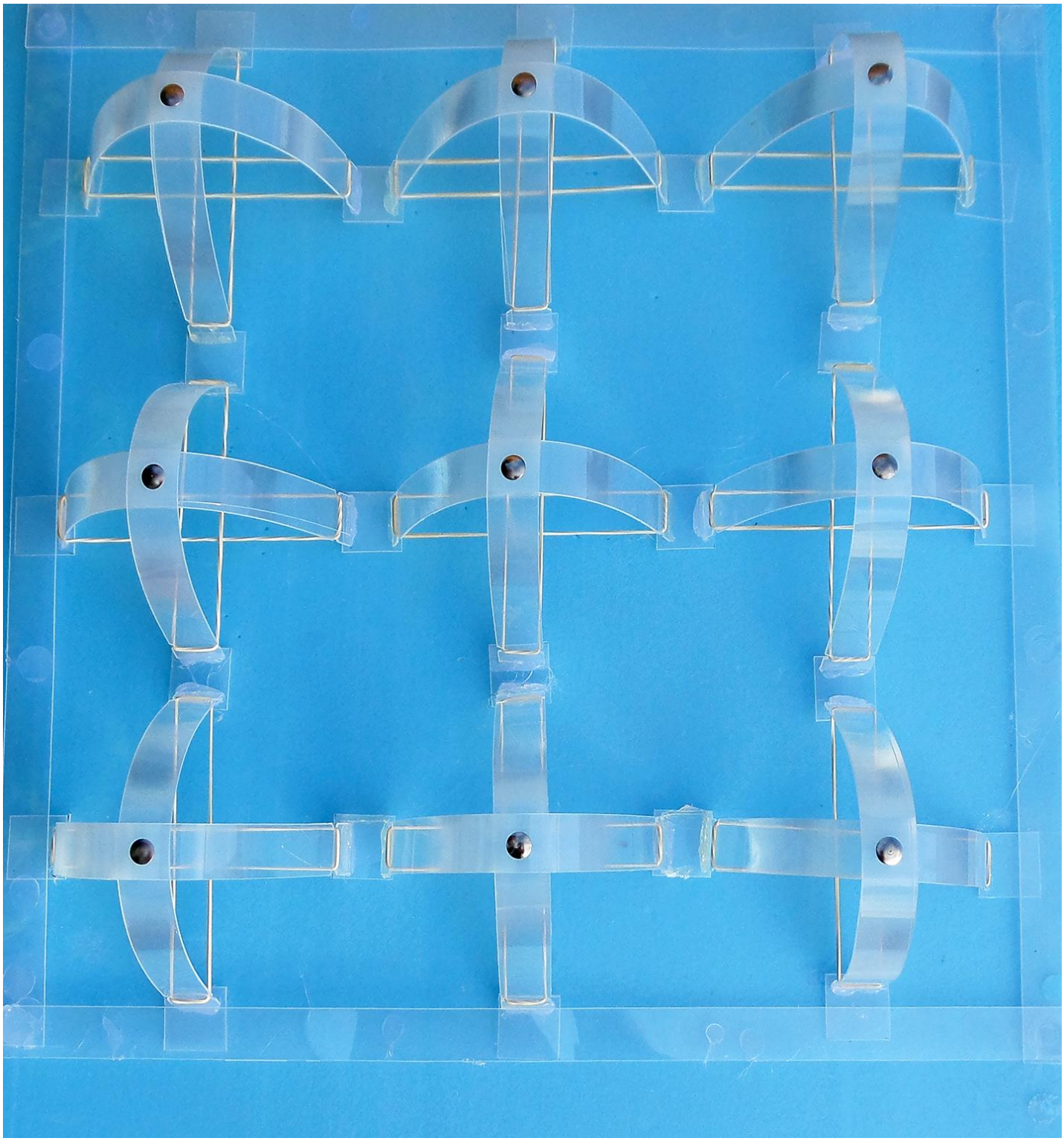


Figure 24: ***Model 1: Collapsible System of Folds*** **(Said, 2013)**

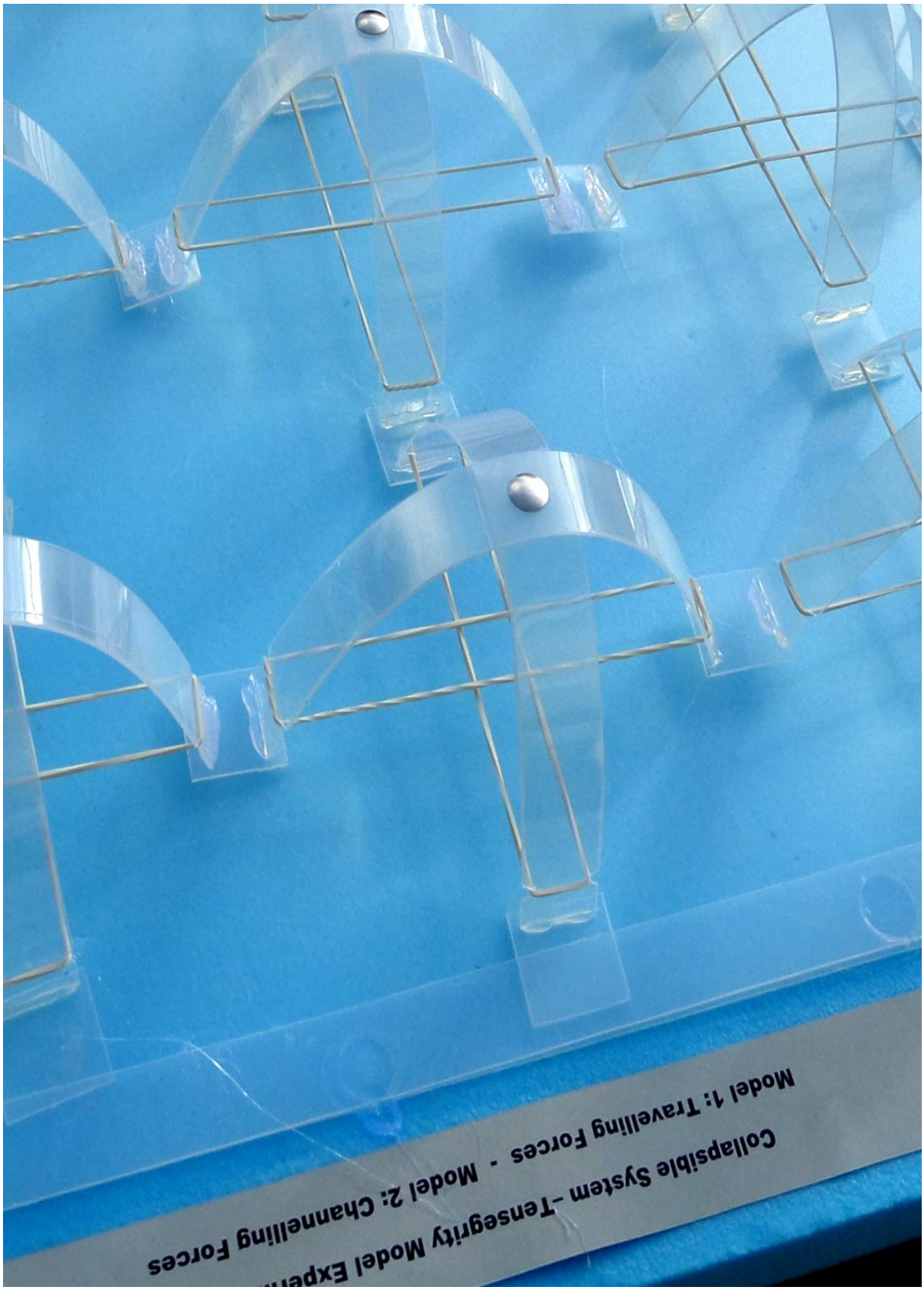


Figure 25: Model 1: A Three-Dimensional Collapsible Fold Unit (Said, 2013)

When applying a push force by hand on the fold unit in, the whole system slightly changes its configuration. The blue dots, on the top of each fold unit in Figure 26, represent the position before applying the force. The red dots in Figure 27 indicate new positions of fold units after they have shifted. The fold unit under direct force stretches; this produces multiple horizontal forces that push the mediators, causing further changes to neighbouring folds. The directions of these shifts are indicated with yellow arrows in Figure 27. When the push forces are removed, the fold unit contracts back; therefore, the whole system reverses and returns to its previous configuration. Figure 28 shows a side view of these multiple collapsible events. In figure 28, the yellow arrows indicate the stretches of the fold units, while the red arrows indicate the trajectory of the force.

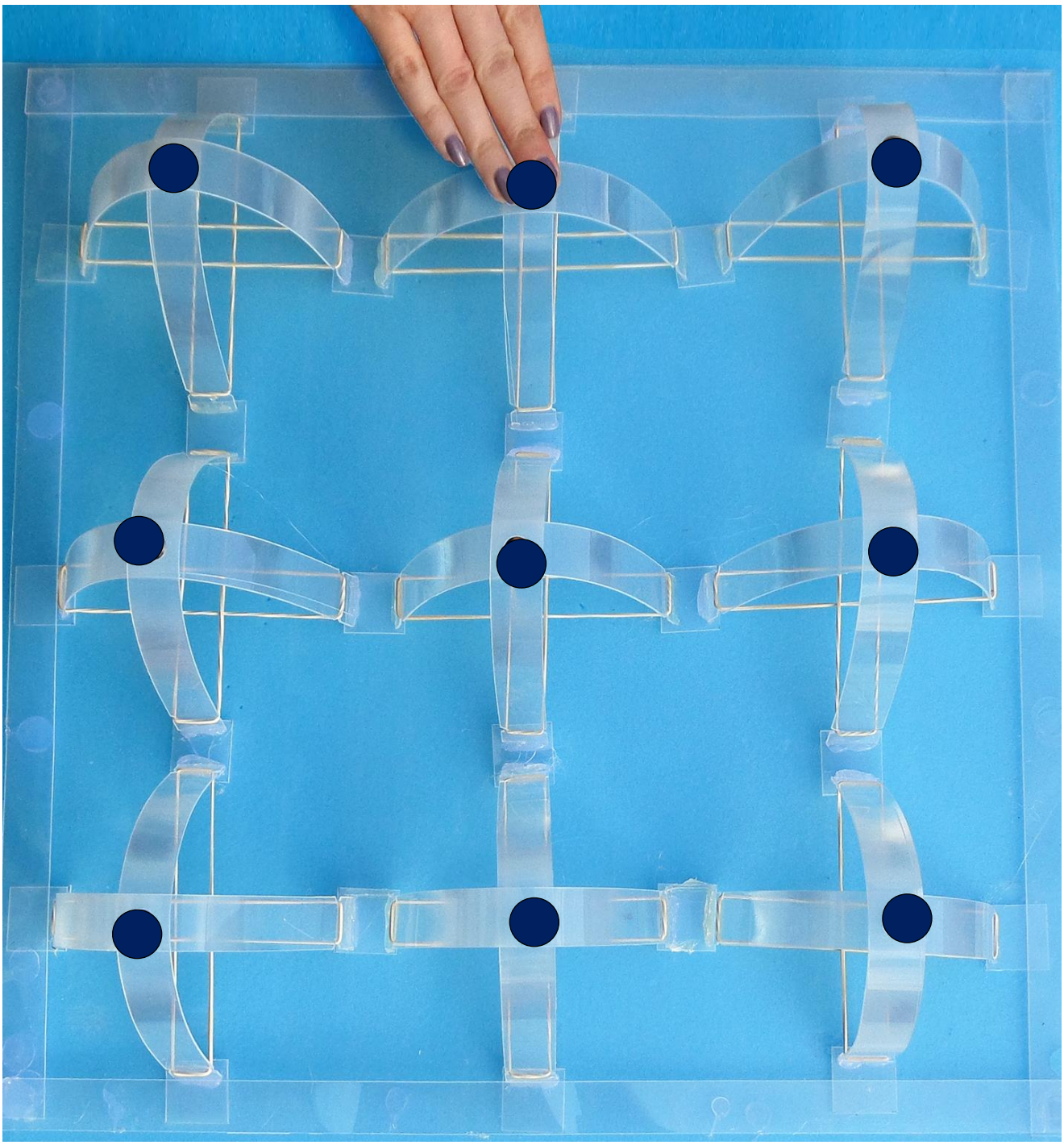


Figure 26: ***Model 1: Before Applying Push Force*** **(Said, 2013)**

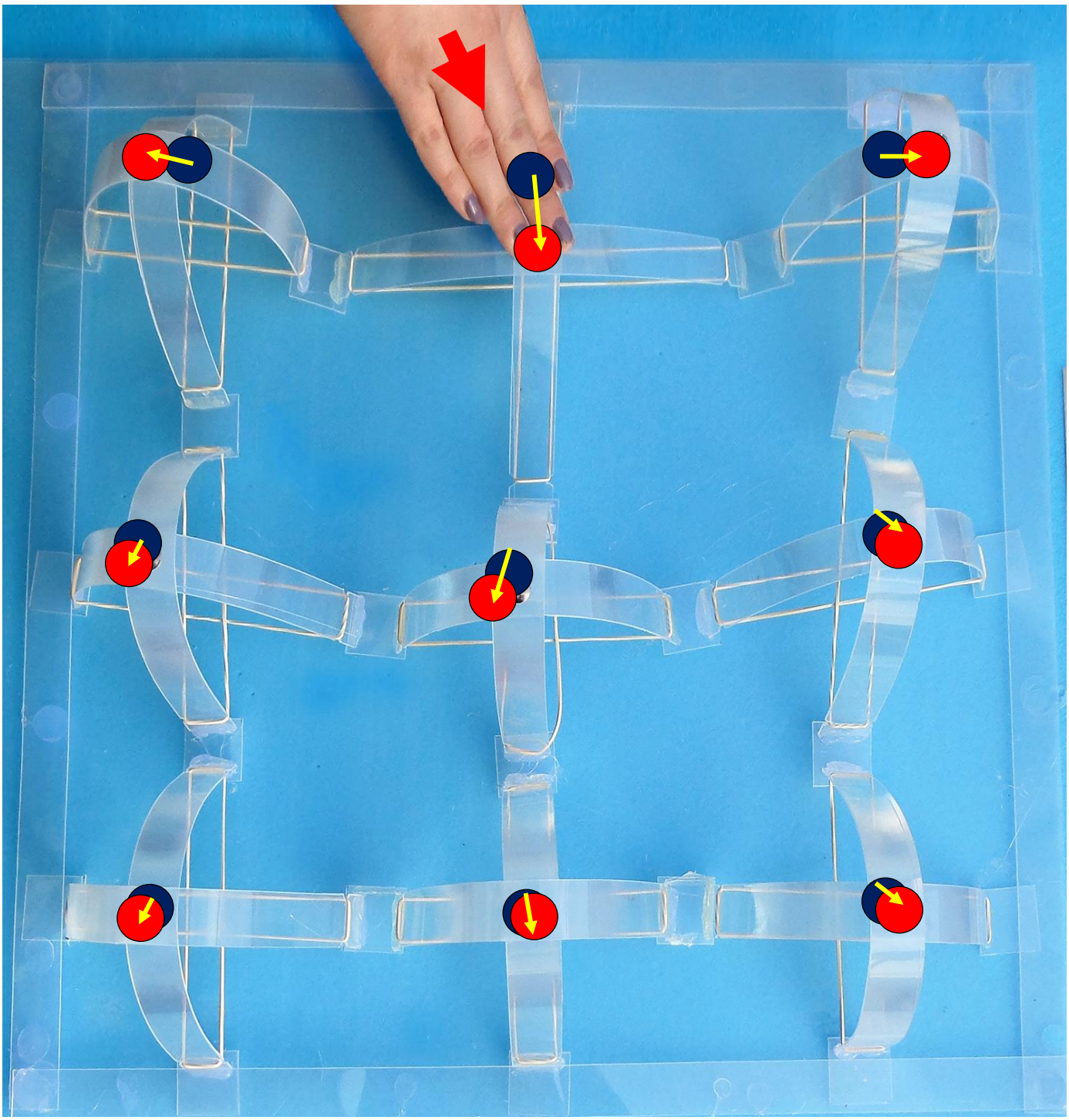


Figure 27: ***Model 1: While Applying Push Force*** **(Said, 2013)**

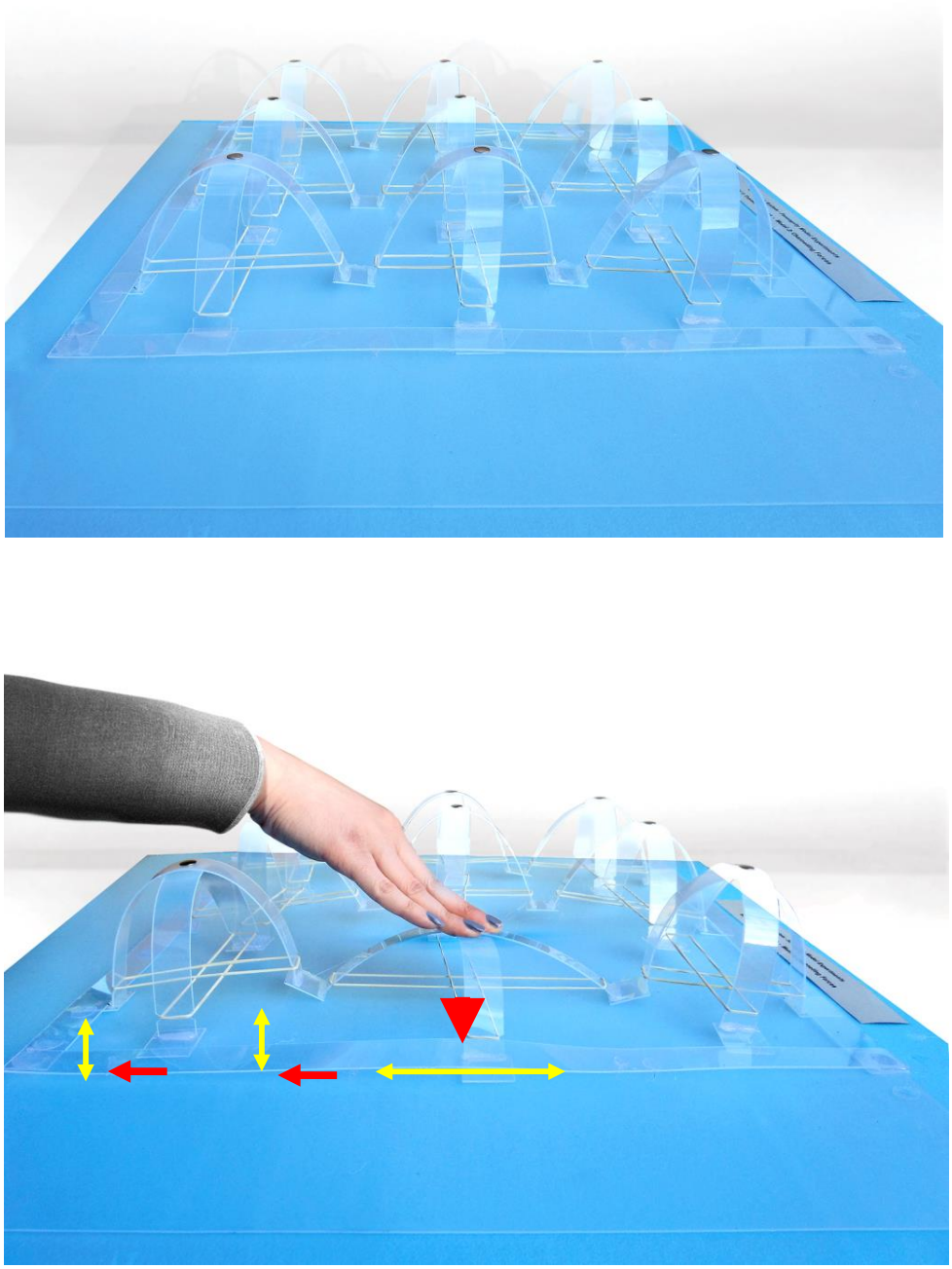


Figure 28: ***Model 1: Travelling Force*** **(Said, 2013)**

The units under direct force stretch, causing other units of folds to contract. The value of the force determines the changes in the collapsible system. In Figure 29 force is applied by hand on the central fold unit. The value of this force is less than the value of the force shown in 30 (these forces are indicated by red arrows). The degree of the changes is proportional with the value of the applied forces. (The yellow arrows in Figure 29 and 30 indicate the trajectory and different degrees of changes in the configuration of the collapsible system).

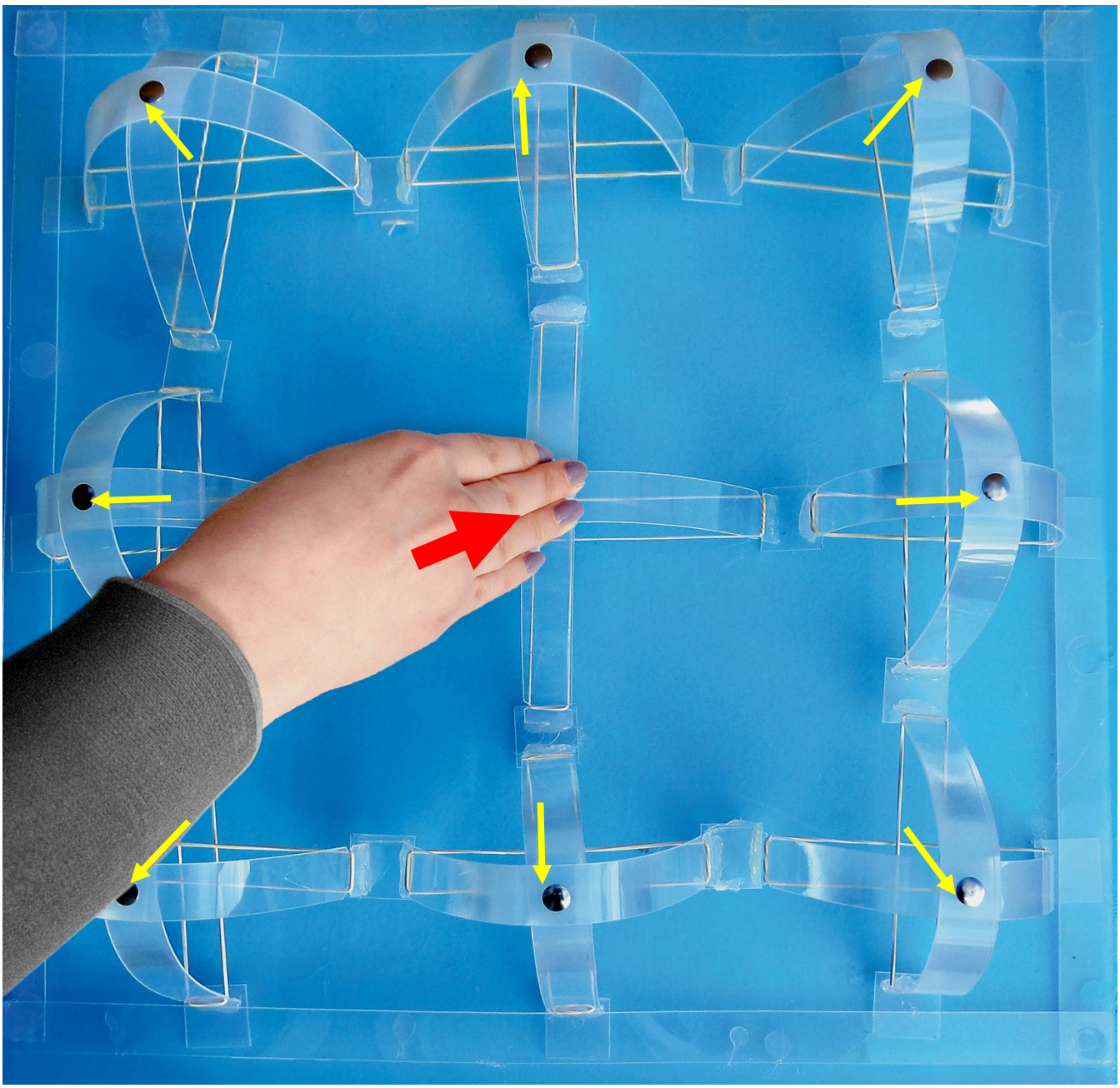


Figure 29: ***Model 1: Collapsible System Behaviours When Applying Force by Hand 1*** **(Said, 2013)**

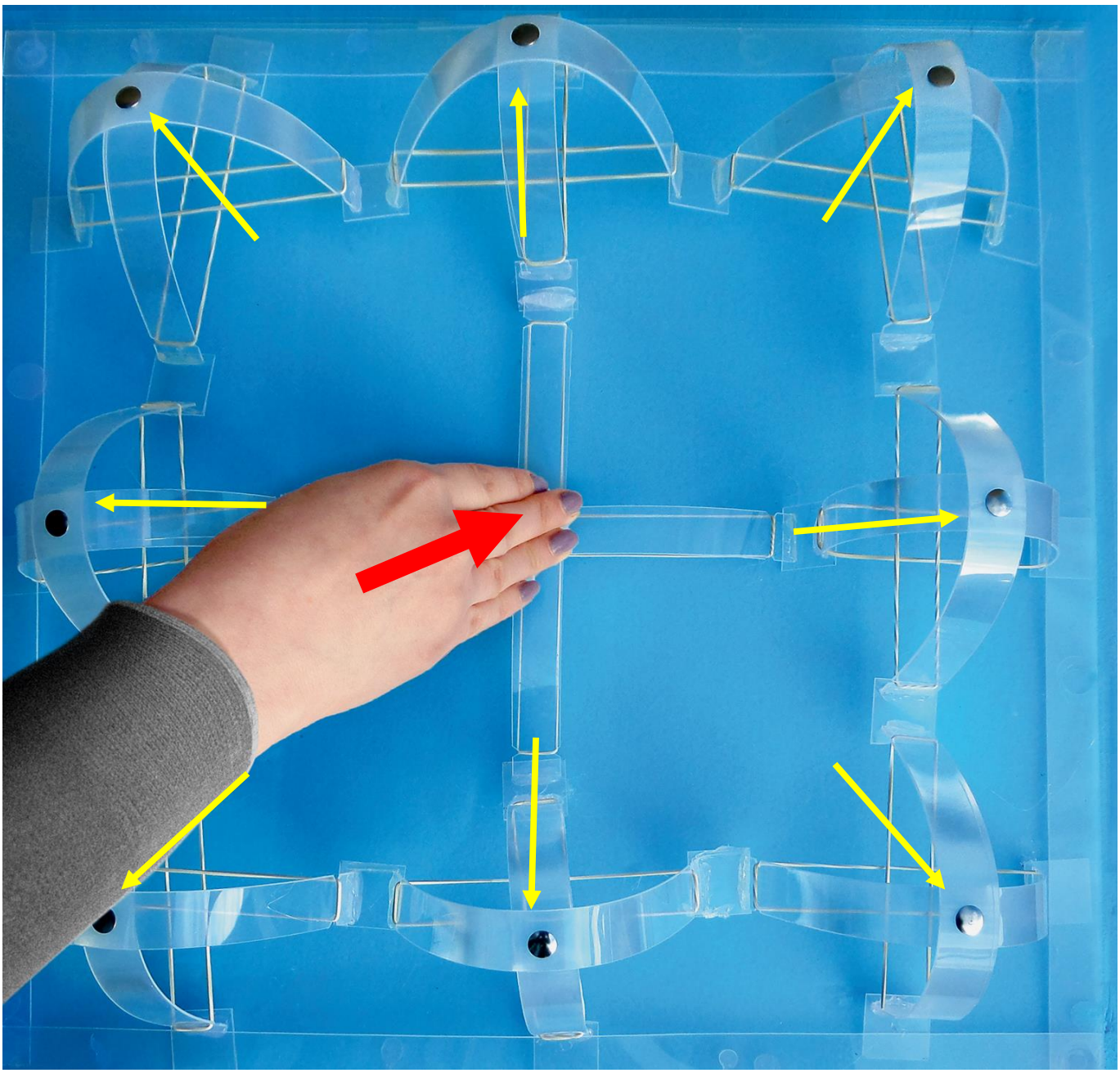


Figure 30: ***Model 1: Collapsible System Behaviours When Applying Force by Hand 2*** **(Said, 2013)**

4.4.2 Model 2: channelling forces in a collapsible system

In this experiment, I attempt to control the direction of the force as it travels through the collapsible system. The second model is similar to the first one in principle, but different in its configuration. It is composed of a folded surface in the shape of a fan and a fold unit that is similar in construction to the one in the previous experiment. The fan has two fixed terminals and one floating, and a fold unit with four terminals: one terminal is fixed and three are floating. One floating terminal of each element (the fan and fold) is connected by a thread. The fixed terminals are fixed to the cardboard support underneath with push-pins (see Figure 31).

When push force is applied by hand on the fold unit, several change events occur in the system. The fold unit stretches from the three floating terminals, pulling the thread that connects it with the fan, causing the fan to open/unfold (see Figure 32 and 33). When the force is terminated, the collapsible fold unit retreats to its previous shape and the fan folds and contracts. Figure 31represent the state of the collapsible system before applying force, Figure 32 shows the changes in the collapsible system after the push force is applied. Figure 33 shows a higher degree of force applied by hand. This vertical force appears to travels horizontally through the fold unit, then via the thread channelled by the fixed push-pins to pull the fan open. (Red arrows indicate force while yellow arrows indicate trajectory of change).

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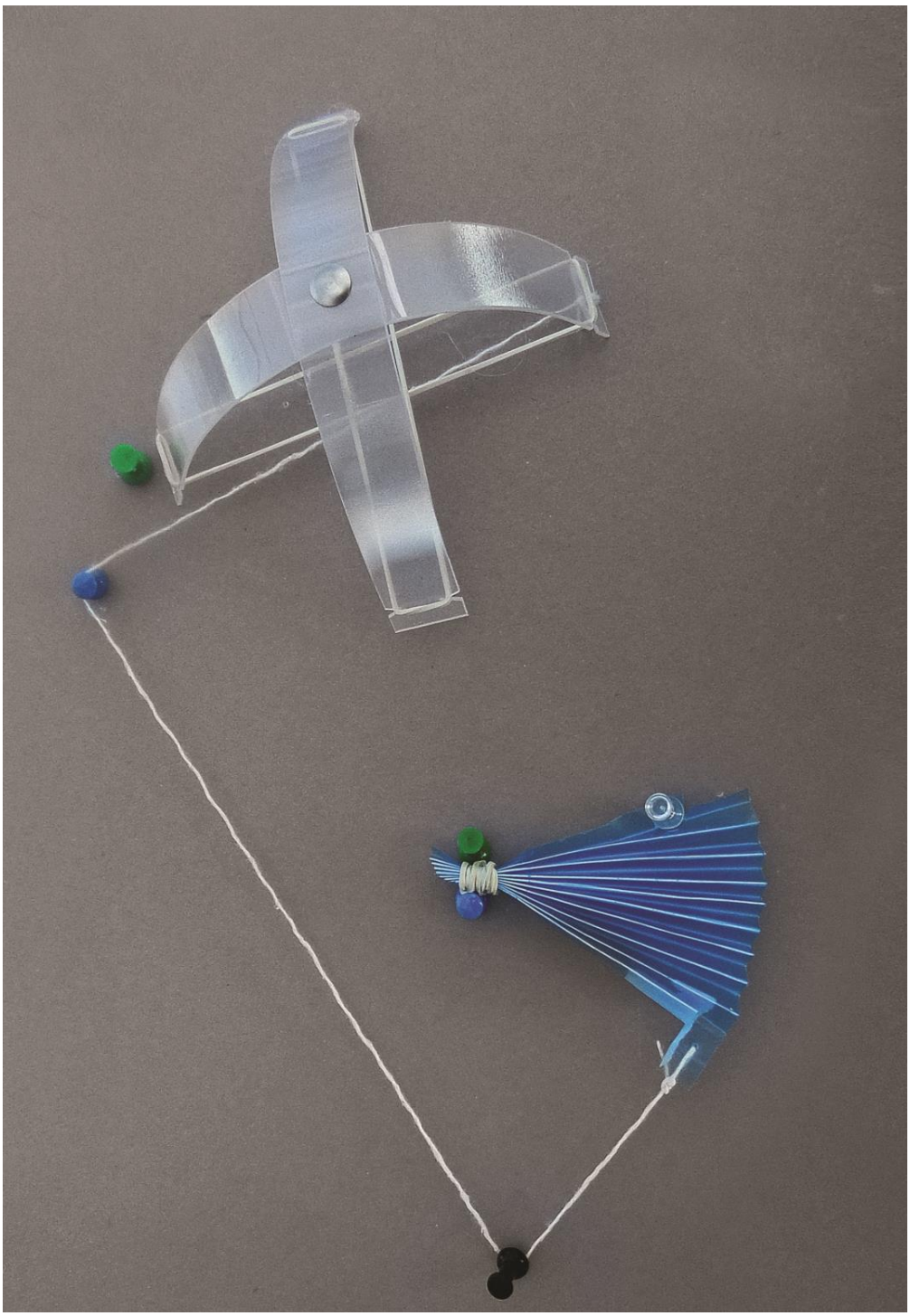

Figure 31: ***Model 2: Channelling Forces Top View*** **1 (Said, 2013)**

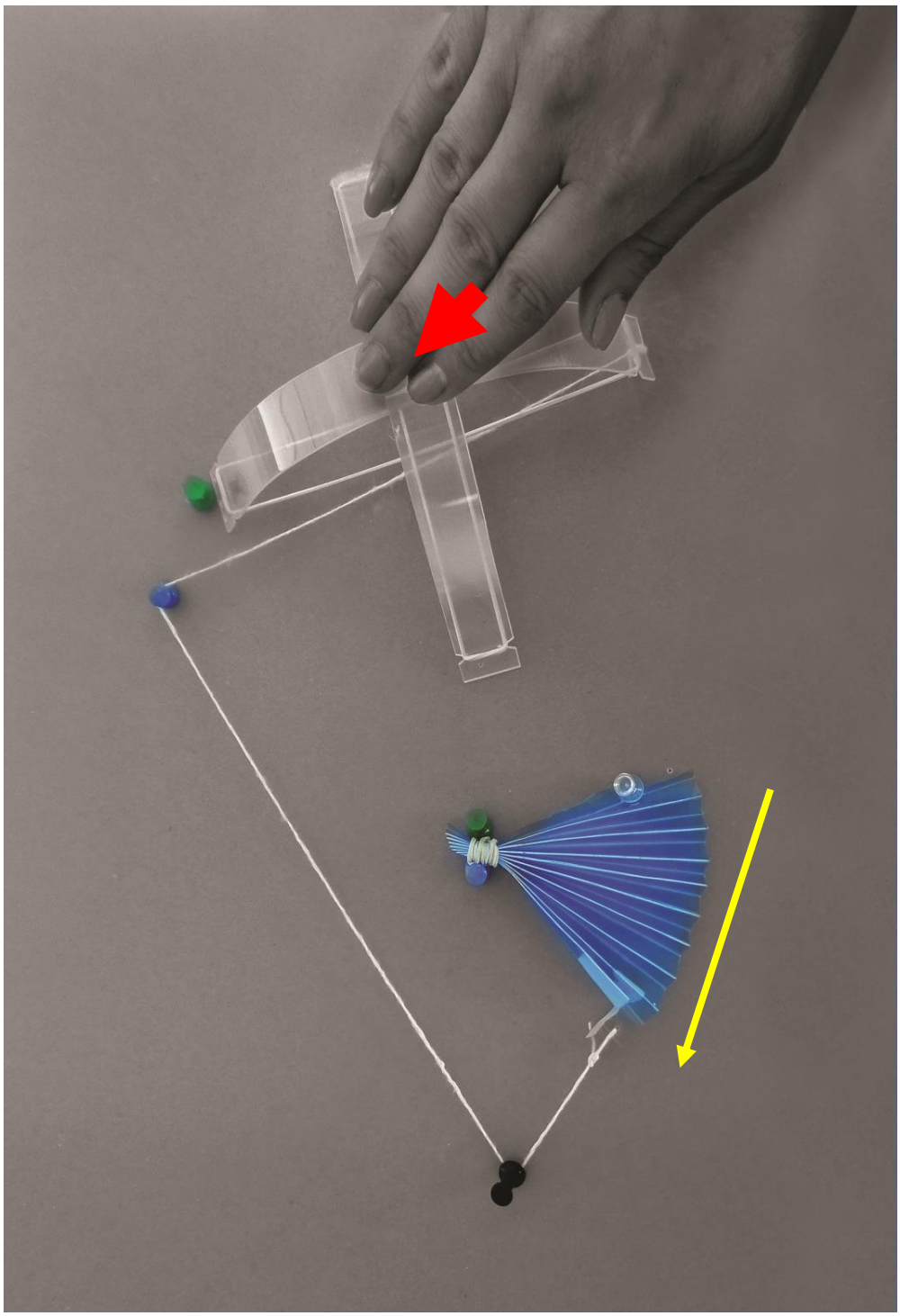

Figure 32: ***Model 2: Channelling Forces Top View*** **2 (Said, 2013)**

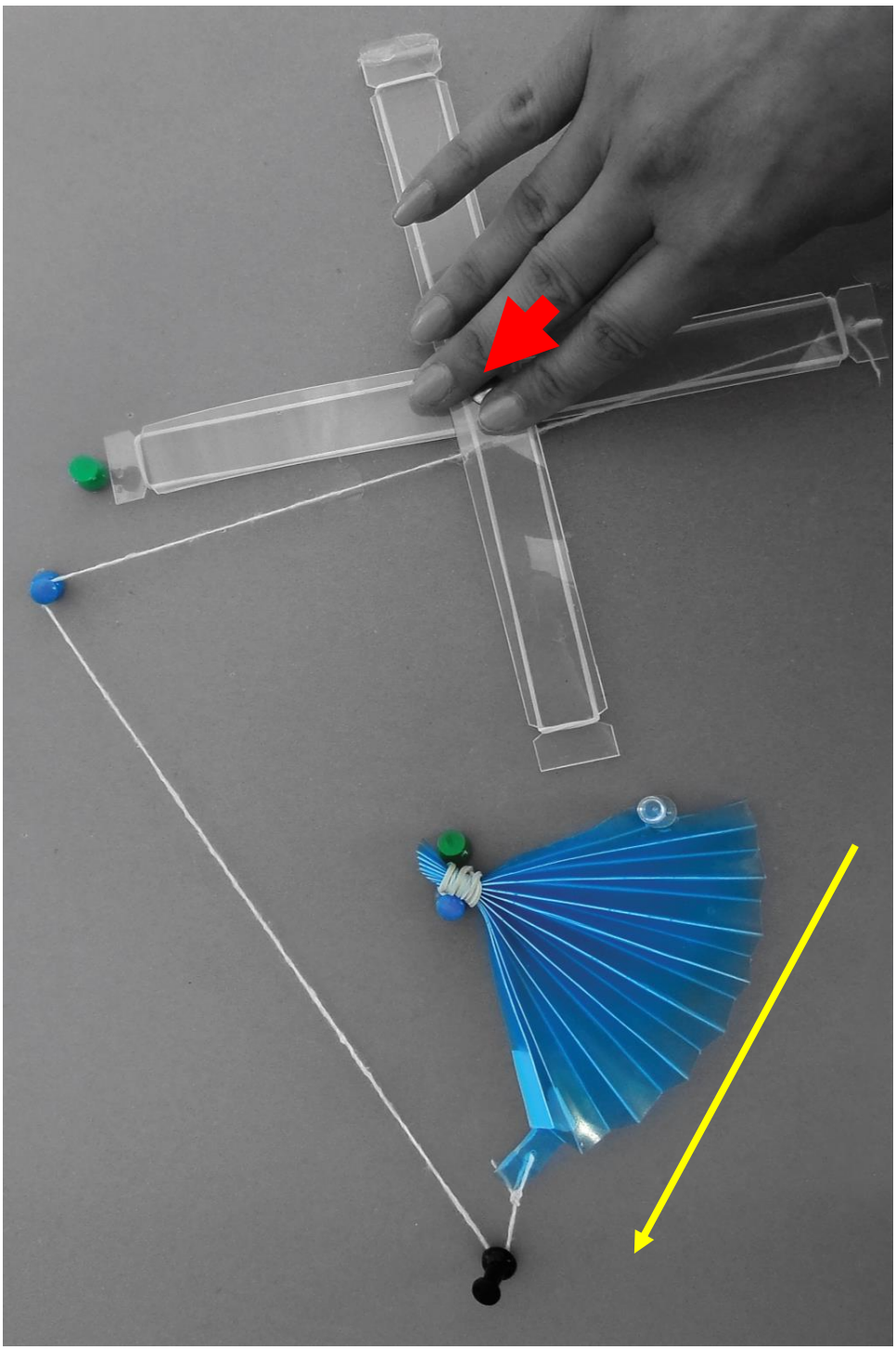

Figure 33: ***Model 2: Channelling Forces Top View*** **3 (Said, 2013)**

4.4.3 Insights

Both models appear to communicate forces through a system of sub-collapsible events; namely, the elastic bands stretching/contracting, plastic strips folding/unfolding and the fan expanding/contracting. These collapsible systems exhibit similar behaviours as forces appear to travel through semi-fixed elements causing changes along the way. When the forces meet the fixed elements (the frame, push-pins, cardboard support), the forces change their directions.

The sketch in Figure 34 is an illustrative example of such a system of events. The arrow with the plus mark represents the applied vertical force. The solid line represents the fold units before the force is applied. The force meets the fixed platform beneath, so it changes direction to travel horizontally. It firstly hits the fixed frame closest (to the right). Then the force travels via the fold to the left. The dotted line represents the travelling fold/force. The horizontal force then changes to a vertical force when hitting the fixed frame.

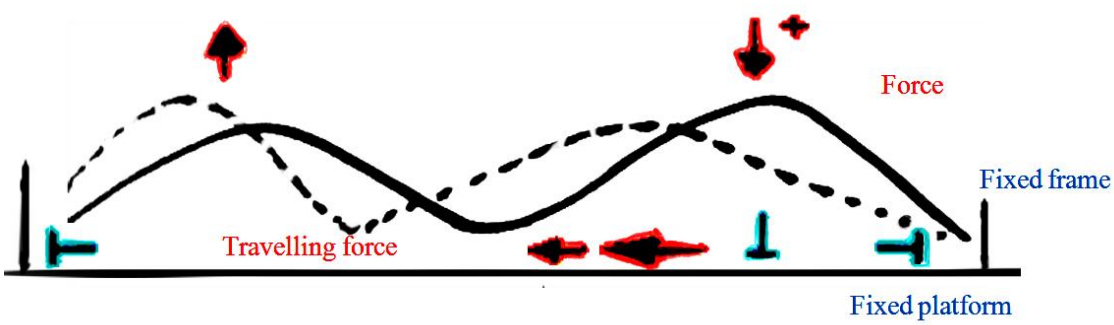

Figure 34: *Illustrative Sketch of Travelling Forces* (Said, 2013)

Forces within a collapsible system can be channelled and contained by altering places of semi-fixed and fixed elements. For example, if the same unit of folds is placed between

two fixed elements, the force will change the configuration of the fold unit itself. The sketch in Figure 35 is an illustrative example of such an event. The arrow with the plus mark represents the applied vertical force. The solid line represents the fold unit before the force is applied. The dotted line represents the changes to the fold unit when the force meets fixed elements on the sides. In other words, behaviours of a collapsible system can be manipulated to communicate a variety of expressions through fold events.

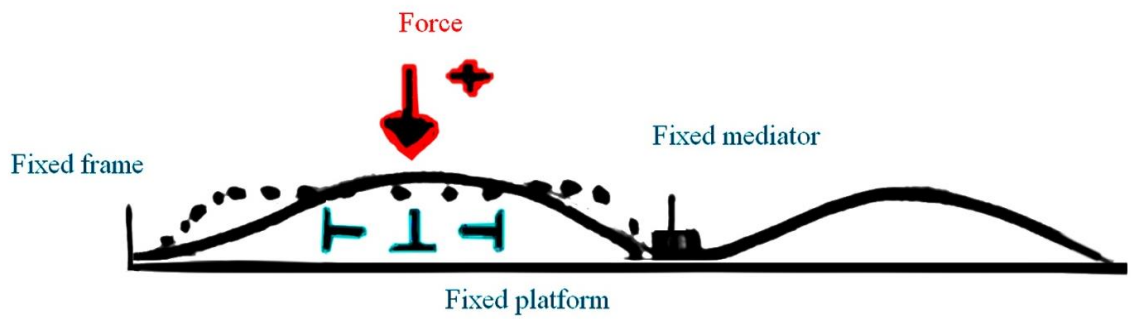

Figure 35: *Illustrative Sketch of Channelling Forces* (Said, 2013)

The tensegrity models' experiments show that the collapsible capacity of a system enables it to actively communicate force events through fold events. The tensegrity collapsible models allow me to manipulate collapsible events as they occur time in a tangible way. By changing position of fixed and semi-fixed elements, I channel/direct forces, therefore changing how forces impact a collapsible system of folds.

4.5 Discussion: The Framework-Formula of the Concept of Collapsibility

The semiotic analysis and the related practical experiments of the tensegrity collapsible models demonstrate that the understanding of impermanence through the understanding

of collapsible events comes with the understanding of folds and forces, as both cause and effect of change events interchangeably.

In Bedouin tents collapsible events appear to manifest as a system of folds and forces, whereby the former channels the latter and the latter gives form to the former. While **fold events** are expressions of **force events**, **collapsible capacity** of the structure of a Bedouin tent enables the respond to force. The force does not produce collapsible events, but is rather produced and actualised in time through the collapsible capacity of folding, unfolding and refolding events. The formula of the concept of collapsibility can be summarised as: the understanding collapsibility as the capacity for form/fold-making and forces as form/fold-giving.

4.5.1 Key principles:

A set of principles underpinning the framework of the concept of collapsibility can be extracted from this formula. These are:

- **Fold event**
- **Force event**
- **Collapsible capacity**

These three elements together resemble impermanence and change events. These principles, collectively as a framework, help interpret impermanence and change events (see semiotic Table 4). This interpretation happens through three representatives: fold event, force events and collapsible capacity. The relationship between these elements is governed by the logic of sign (i.e. semiology). This system of *signs*, *signifiers* and *signifieds* has the inherent ability to change forms repeatedly; thus, to guide new meaning of constantly emerging impermanent events.

Signification: Impermanence change event	
Signifier Fold event	**Signified** Force event
Sign Collapsible capacities	

Table 4 ***The Framework of the Concept of Collapsibility*** **(Said, 2020)**

These principles are interchangeable depending on the event under question. In this research the focus is on finding new ways to interpret and design impermanence and change events. It is therefore the *signification* under question as shown in Table 4.

Within this framework, I believe, lies the significance of the philosophy of collapsibility as expressed in Bedouin tents. This is to say that the collapsible capacity of the Bedouin tents turned its system into a site of representations of impermanence and change events; a communicative site, where the input/output forces are represented and read. This capacity of a system can be therefore appreciated in terms of two qualities: expressive and readable.

4.5.2 Expressive/readable

Expressive space can mean readable space (Lefebvre, 1991, p.144). The analysis shows a collapsible system of Bedouin tents is both readable and expressive.

A collapsible capacity allows a system and its elements to communicate impermanent force events through an impermanent system of folds. For example, the rug in the Bedouin tent, discussed in Semiotic Analysis section 4.3.3 Case Three: exhibits capacity to communicate forces, from people, animals or wind, through its collapsible capacity to fold. Collapsible events can be read as the meaning of impermanent events; albeit natural, social and physical force events have caused them. Collapsible events, in this sense, can be seen as expressions of impermanence and change.

Such capacity, it could be argued, empowers the system of Bedouin tents and elements like the rug/floor. The rug's folding-unfolding events no longer simply mean reduction/expansion of size, but an expression. A similar collapsible system principle is used in the human body to produce facial expressions. For example, Claus Mattheck (2009) explains how muscles, tendons and bones' tensegrity systems enable fold-making. These fold expressions, in the context of humans, often have a familiar meaning. For example, when humans contract the folds/wrinkles between the eyebrows and stretch the folds around the mouth down, it can mean: angry (see image on the left in Figure 36). When the folds around mouth stretch up, it can be read as smiling (see image on the right in Figure 36). When af ace is relaxed, these folds/wrinkles expressions can fade away depending on age.

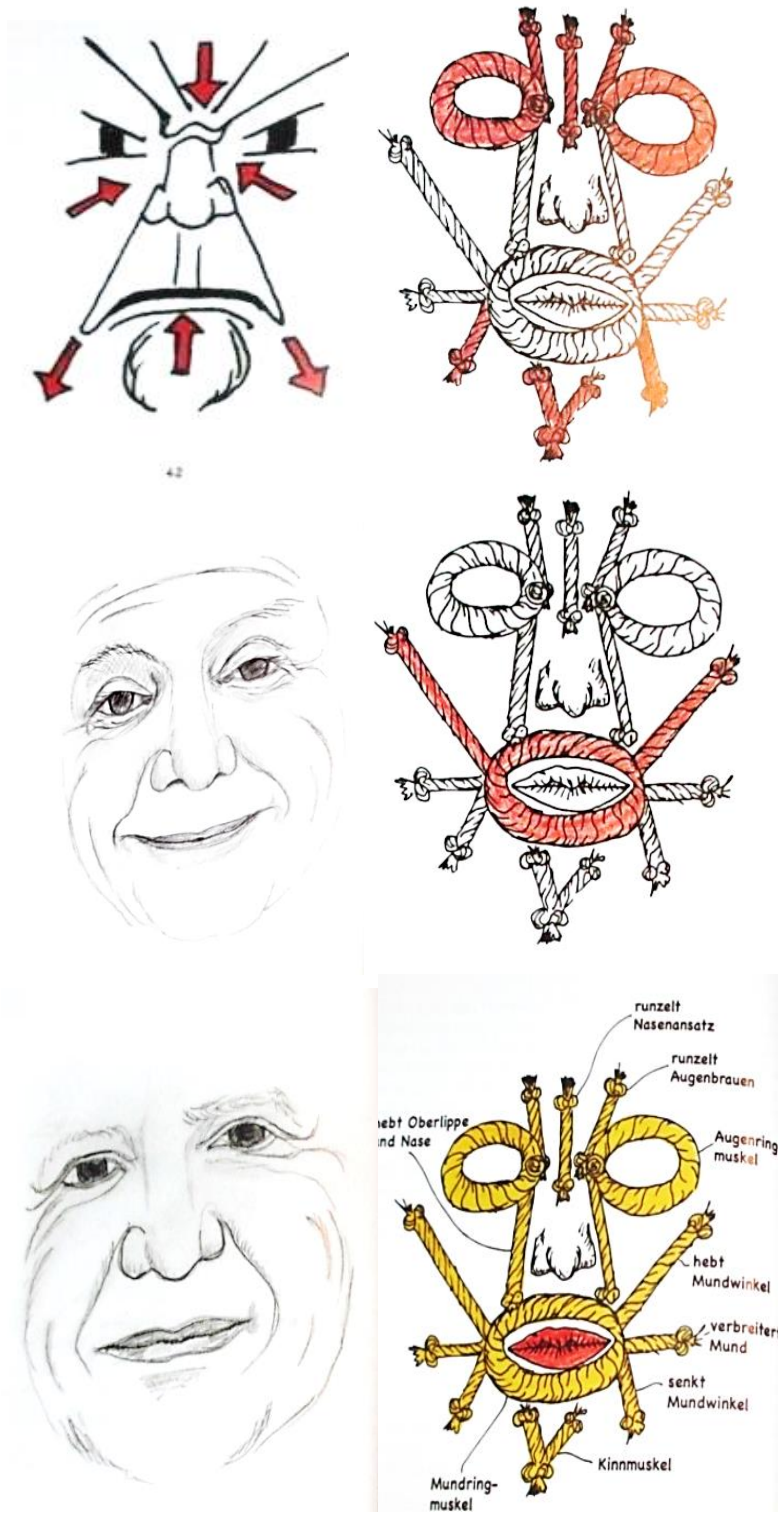

Figure 36: ***Facial Expressions*** **(Mattheck, 2009)**

The Textile Mirror by architect Felecia Davis (2012) is a great example of how a collapsible system of folds is used to design expressive system. The wall reflects feeling of people in the room. It wrinkles to reflect pain sadness or happiness. Davis explains:

> "The Textile Mirror is a prototype wall panel that changes shape in response to people's emotions. In particular, I envision that this prototype could be used to help a user modify their emotional state from stressed or angry to happy and calm, simply by attempting to transform the shape of the fabric. My intent was for the user to observe the fabric changing in reaction to her stressful state, and then reflect on their emotional state in order to try to relax. The Textile Mirror as shown here uses a mobile phone as the user interface, and is actuated by nitinol wires sewn into the back of the fabric." (Davis, 2012)

The collpsible capacity of the system o a Bedouin tent enables its elements to interact and express different meanings and forms, therefore, resisting fixed meaning. The rug, for Bedouins, is not a fixed meaning or fixed object i.e. a 'thing'. The rug in the Bedouin tent is perceived as a collapsible capacity. Like other elements of the tent, all are chosen based on their physical qualities, i.e. weight, structure, density, resistance and material. The rug is constantly shifting from being a flooring platform for socialising or navigation, to a folded and rolled container as luggage when travelling, then perhaps unfolded again and hung vertically as a divider wall when Bedouins resettle. This collapsible capacity of an element like a rug as an expressive system shifts the focus away from its postulated definition as an object/a floor cover to more of a fluid existence. In other words, Bedouins seem to understand materials and structures as capacities, rather than a commodity. Lefebvre states that things lie when they are seen as commodities (Lefebvre, 1991, p.81). Bedouins' way of thinking on capacities seems less prone to limitations and misconceptions of current established models. A rug as a collapsible capacity has power. A rug with collapsible capacity is receptive to forces and therefore has the potential to be expressive. Understanding interiors and its elements through their collapsible capacities empowers them to become communicative; both expressive and readable.

4.6 **Summary**

To sum up, the framework of the tent seems to be run by explicit knowledge and intuition about materials and structures. Such knowledge is not covered by the standardised understanding of current established models of buildings. Bedouins are nomadic in lifestyle and also in the core meaning of life; they have nomadic relation to borders and boundaries in all forms, metaphysical and physical. Unlike the boundaries in a building system of site, skin, structure, service, space plan and stuff, described by Brand in Chapter Two, Bedouin tents have a unique framework, where these systems are hard to dismantle into layers. The skin, the structural and space plan layers are all are entangled. Their material logic is built on tacit knowledge that has been accumulated through years of experiential practice. The reproduction of their social life depends on impermanent systems and therefore do not conform to a fixed logic.

Through this case study I benefited from understanding the collapsible capacity of the rug as empowerment and this has helped me notice inadequacies of current floor design. Floors, through this lens of collapsibility as a capacity to repeatedly change and express new meanings, can challenge rigid contemporary design practices that fixate the form and fixate meanings. At the present time, flooring products are designed as covering materials of various textures and materials. This approach commonly assumes fixed forms and meanings of the design of floor surfaces.

In the next chapter, I explore design approaches to floors within industries and Art and Design fields. I also explore how using the framework of the concept of the collapsibility can guide a design process of a floor that challenges current rigid approaches

"It is the nature of the world of form that nothing stays fixed for very long - and so it starts to fall apart again. Forms dissolve; new forms arise. Watch the clouds. They will teach you about the world of form."

(Ekhart Tolle, 2006)

Chapter 5 **Collapsible Floor|Challenging Design Principles of Stability and Permanence**

5.1 **Introduction**

The previous chapter pointed to a limitation in the design approach of floors as a permanent and static surface. In this chapter, I aim to challenge such passive approaches by proposing an alternative approach based on the concept of collapsibility. Such an approach, I argue, activates a new semiological affordance of a floor as it becomes communicative of impermanence. I use the framework of the concept of collapsibility as a conceptual scaffold for my practical experiments of designing a collapsible floor. The formula of this framework uses forces as fold/form-giving and collapsibility as capacities for fold/form-making.

First, I review current design approaches to floors within industries and Art and Design fields to highlight several design limitations and prospects. I then experiment with collapsible materials and structures including wood, foam and resin. Using the insights from these experiments, I demonstrate how collapsible floors communicate impermanence. For this, I use various design practice methods including 3D modelling, 3D printing and CNC prototyping.

5.2**Floor Design Approaches Within Industry**

I investigate the industries' approach through a visit to Harrogate Flooring Conference and Show in September 2013, one of the UK's main events of flooring design and productions. I also set up a collaborative project with Forbo Group Flooring System, one of the international players in flooring manufacturing.

Harrogate Flooring Conference and Show review

The visit to the Harrogate industrial fair underlines several issues:

- Designing flooring is, largely, a functional and practical matter. For example, many presentations by flooring design companies, within the conference, focus of innovation themes related to costs and practical installations and sustainability. A lecture by architect Brian Murphy, for example, introduced new software technologies that can help flooring manufacturers and architects to reduce waste of geometrical shapes of flooring for both economical and sustainable reasons (see some photographs of the presentation on the green-sustainability theme by architect Brian Murphy and Interface Floor Company in Appendix 10, pp.55, 56). Another example of practical themes is related to easy maintenance and hygiene (see Product Brochure: Forbo Focuses on Maintenance Themes in Appendix 11, p.57).
- Floors are also decorative covering materials for designing a new texture, colour, or patterns such as, linoleum, wood, ceramic, fabric. For example, a series of presentations by interior designers in *Scarlet Opus Limited* focus only on decorative aspects of designing a floor; namely, seasonal trends of patterns and colours (see some photographs of the presentation by Scarlet Opus Limited in Appendix 12, p.58).
- The dominant qualities for these covering materials of floors are often flat boards, sheets, tiles, or roles of various sizes and thickness (see samples by Eco Lab in Appendix 13, p.59).
- Minor mentions of alternative design themes emerged in the Harrogate Flooring Conference and Show. For example, a lecture by architect Robert Firth on futuristic and intelligent flooring design titled *Flooring in the Future – Science Fiction or Science Reality?* His examples challenge the norm perceptions of flooring design as passive covering materials. He used various examples of dynamic flooring from animated/fictional movies. He also pointed a finger at nanotechnologies that allow smells, sound and feel of a material to change. Such technologies, he argues, are not far from being implemented in the field of flooring design (see some photographs of Firth's presentation in Appendix 14, p.60).

Overall, the roles of interior designers within industries of commercial flooring businesses appear to be limited. Flooring products are often viewed and designed as covering materials, both decorative and practical. Therefore, innovative ideas are generated around these subjects. Innovative ideas related to modes of interactions with floors were not present.

In order to further explore the limitations of the roles of design within the flooring industry, I got in touch with Forbo, one of the international players in flooring manufacture, with a large variety of products and business models of flooring systems.

5.2.1 Collaborative design project|Forbo Flooring System Limited Design

In 2013, I proposed a collaborative flooring design project to Forbo. The concept of collapsibility is an unfamiliar subject for flooring manufacturers; however, Forbo are familiar with models that include movement flooring systems, such as those used in airports or in treadmills at gyms (Forbo, 2017). A meeting was set up to discuss my project brief with Peter Albertz (head of design) and Marijke Griffioen (concepts and trends designer) in Forbo at their production facilities in Assendelft/Netherlands (see first invitation letters from Forbo Flooring System Company in Appendix 17, p.64). In the meeting, I introduced my concept of a collapsible floor under the theme of fiction design (see Forbo project brief *Collapsible Surface: New Vista for Flooring Design* in Appendix 15, pp.61-62). This theme, I observed in the conference, is more of a familiar terminology and an appealing subject to industries. Such a theme also seemed appealing to Forbo, as it reflects an innovative spirit and way of thinking. Griffioen suggested that fiction can be one of the themes that underpin the exploration of collapsible floor structure design (see email correspondence with designer Marijke Griffioen at Forbo Flooring System Company in Appendix 16, p.63).

After this meeting, a collaborative project with Forbo's innovation department was planned for a period of three months in the form of an internship (see second invitation

letters from Forbo Flooring System Company in Appendix 17, pp.65, 66). The outcomes of the project would be part of an exhibition under the theme of *Future Design* that communicates the innovative and pioneering spirit of Forbo's innovation department team and company. Unfortunately, the Dutch government declined my request for a visa permit.

On reflection, to work closely with experts within the flooring industry would have provided me with a clearer picture of the role of interior designers and the type of challenges they face within such industry. However, several positive remarks can be extracted from this experience. Firstly, the willingness of designers and decision-makers in Forbo Group Limited to engage in the design project of *Collapsible Floor* reveals openness towards the potential of such a design idea. It could be should be noted, however, that such a design idea appears to be more appealing when framed within futuristic themes namely, fiction.

Secondly, during the visit to Forbo I had the chance to tour their facilities and gain important insights related to the range of terminologies used in production processes. These, I noticed, are primarily derived from the structural state of a material in each stage. For example, terms used to describe a covering material made of linoleum vary from shreds, granule-heaps, linoleum beds, sheets, roles to tiles. It is not until a material is installed on the floor that it is called a flooring surface. This observation brings to light the variety of structures a material can manifest. Such a notion inspires me to explore collapsible structures of various materials, before I start the process of designing a collapsible floor.

Overall, reviewing the industries' approach shows a limitation in the way floors are viewed simply as covers attached to passive, rigid and flat surfaces. Such an approach has recently become one of the popular and accepted quick-fix solutions within interior design practices.

Iinterior designers' reliance on quick-fix aesthetic and financial profit-focused solutions undermines their profession's responsibilities and potential. Interior design, I believe, is a powerful ideological tool for enhancing people's everyday life. The next section highlights alternative approaches to designing floor within Art and Design fields that push design limitations of conventional floor designs.

5.3 Floor Design Approaches Within Art and Design Fields

In this section, I explore projects that challenge permanent, passive and static approaches of floor design. These projects, I argue, are closely relevant to my concept of a collapsible floor.

5.3.1 *Floor* (2007), *Tunnel* (2007) and *Melt* (2014) projects

- Architect Leonardo Crescenti and semiotician Rejane Cantoni explore people's interactions with unstable floors in various projects. In the project *Floor* (2007), Cantoni and Crescenti designed a kinetic surface that generates movements in the shape of a travelling wave when someone steps on it (see Figure 37). In their own words, they say: "The mode of agencying the *Floor* interface is very simple: you step on one of the two ends of the machine and this action produces a displacement of haptic information, that is, a wave is displaced in the direction equivalent to the action." (Cantoni and Crescenti, 2007)

Figure 37: *Floor* (Cantoni and Crescenti, 2007)

In another two floor installation projects, *Tunnel* (2007) and *Melt* (2014), Cantoni and Crescenti designed floors that respond to the weight of people. In the *Tunnel* project, the floor is made out of thin aluminium plates suspended by pulled springs (see Figure 38). Each plate is attached to a frame and each frame is mounted on springs. These frames are then stacked and linked to each other, creating a tunnel shape. The plates tilt in response to people's weight and cause the whole structure to move correspondingly.

Figure 38: *Tunnel* (Cantoni and Crescenti, 2010)

In the *Melt* project, the floor surface is made of large aluminium sheets that are supported by compression springs underneath (see Figure 39). As people walk on the floor, the aluminium sheets bend in response to the weight forces; the compression springs counteract these forces, pushing both the aluminium surface and the person above upwards. This structure produces a trampoline effect, as the man appears to be air-bound in Figure 39.

Figure 39: *Melt (*Cantoni and Crescenti, 2014)

5.3.2 *The Future at Your Feet* project and exhibition 2011

In this project, teams from various fields, including design, art, architecture and film, developed various flooring models that challenge principles of stability and permanency. In one of the projects, the *Change/Sternform*, product designers Olaf Kiessling and Andrea Grossfuss designed a soft, spongy floor that provokes questions such as what it would it feel like if our home's floors could soon feel like natural surfaces: a sandy beach, forest or snow (see Figure 40). They argue that our body's bone structure, musculature, orientation and reflexes are not made for wearing shoes and walking over hard, flat floors.

Figure 40: *The Chang /Sternform* (Kiessling and Grossfuss, 2011)

5.3.3 ***Onskebronn* (2008) *Multitoe* (2010) *Microbial Flooring Surface* (2013) projects**

This group of projects pushes the limits of floor design to suggest alternative functionality. For example, the project *Onskebronn* is an interactive floor at a central station in Berlin, Germany that senses pressure. This installation was created in 2008 by Sven Beyer, a performing artist and founder of *Phase 7*, an interdisciplinary artist network. Pedestrians' movements trigger sounds and project movements of light on the floor (see Figure 41).

The floor in this project is not passive, but an interactive device with a playful interface. Similarly, the research project *Multitoe* by the Human Computer Interaction (HCI) Lab at Hasso Plattner Institute tracks users based on their weight distribution and shoe characteristics. This floor design enables high-precision interactions and invokes different interface menu options (see Figure 42).

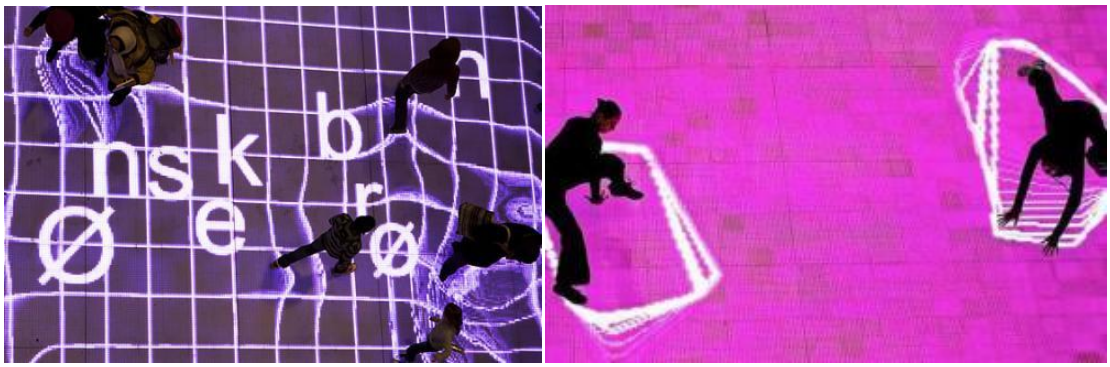

Figure 41: ***Onskebronn Interactive LED Installation*** **(Phase 7, 2008)**

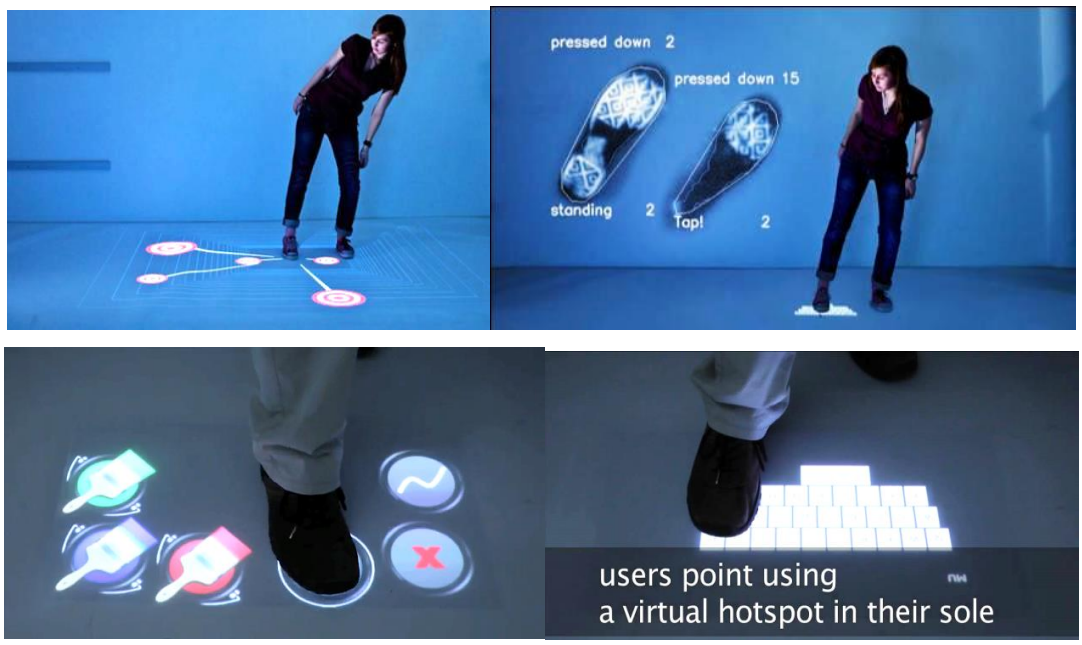

Figure 42: ***Multitoe: High-Precision Multi-Touch Floor*** **(HCI Lab UIST, 2010)**

Another project by Design Futures Lab at Drexel University is directed by interior designer Nicole Koltick. The project focuses on trans-disciplinary design research that produces full-scale design prototypes. A project titled *Microbial Flooring Surface* by the researcher Tashia Tucker is part of a series of synthetic biology dynamic surfaces called *The Future of Adaptive Living Environments.* The floor is made of a mat layer from silicone with a sensor map underneath that is programmed to detect bacteria, as well as to react to light and pressure (see Figure 43).

Figure 43: *Microbial Flooring Surface* (Tucker, 2013)

In the projects above, floors are not passive and static covering materials. Instead, floors are interactive structures, with many added new functions and meanings. These floor projects involve different dynamic themes. All, however, imply intrinsic collapsible capacities. Floor surfaces appear to form and reform, fold/unfold and refold their configurations in response to people's forces. Some of these collapsible capacities are exhibited in physical form, such as in the *Melt* and the *Change* projects, where the surface produces collapsible system folds. While other projects, such as *Onskebronn* and *Multitoe*

show implicit collapsible capacities. These are displayed via visual/digital adjustments of shapes and lights.

Such projects challenge passive approaches of floors seen in industry; however, their impact appears to still be limited to individual creative projects. Within interior design professional practice, floors are still understood and designed as static and permanent surfaces. Therefore, human interactions with these surfaces are still limited. This is, I believe, because such projects are still perceived within a fragmented practical framework under various dynamic design themes. For such projects to change how floors are designed and manufactured as permanent, and thus on how humans interact with a floor, a unified design agenda that integrates both theory and practice of impermanence is needed.

5.4 **Material Explorations of Collapsible Behaviours**

In this section, I make collapsible structures of various materials and study their behaviour in response to external forces using forces as fold/form-giving and collapsibility as capacities for fold/form-making.This formula is used as a device to detect and explore collapsible capacities of various materials and structures (both soft/spongy and rigid/stiff qualities) (see the products used for the material experiments with silicone, latex and PU foam in Appendix 21, p.70). The outcome will later feed into the designing processes of my collapsible floor in the following section.

Figure 44 shows a collection of materials used in the experiments. The next sections outline these experiments in more detail.

Figure 44: ***Collections of Material Experiments*** **(Said, 2014)**

5.4.1 Silicone

The first two surfaces are casted of RTV silicone.[10] To create the moulds, I used a soldering iron to melt blue foam boards, creating two patterns of cavities (see Figures 45 and 46).

Figure 45: ***Casting Silicone in Blue Foam Moulds*** **(Said, 2014)**

[10] RTV – stands for Room Temperature Vulcanising silicone (see Appendix 21 for photos of the products used for material experiments p.70).

Figure 46: ***The Mould and Silicone Cast*** **(Said, 2014)**

Figures 47 and 48 show the two casts after the silicone is solidified. The structure of the first consists of pointy bumps in rows of waves, with patches of voids in-between. The second one consists of grooves in waves, with fewer voids in-between.

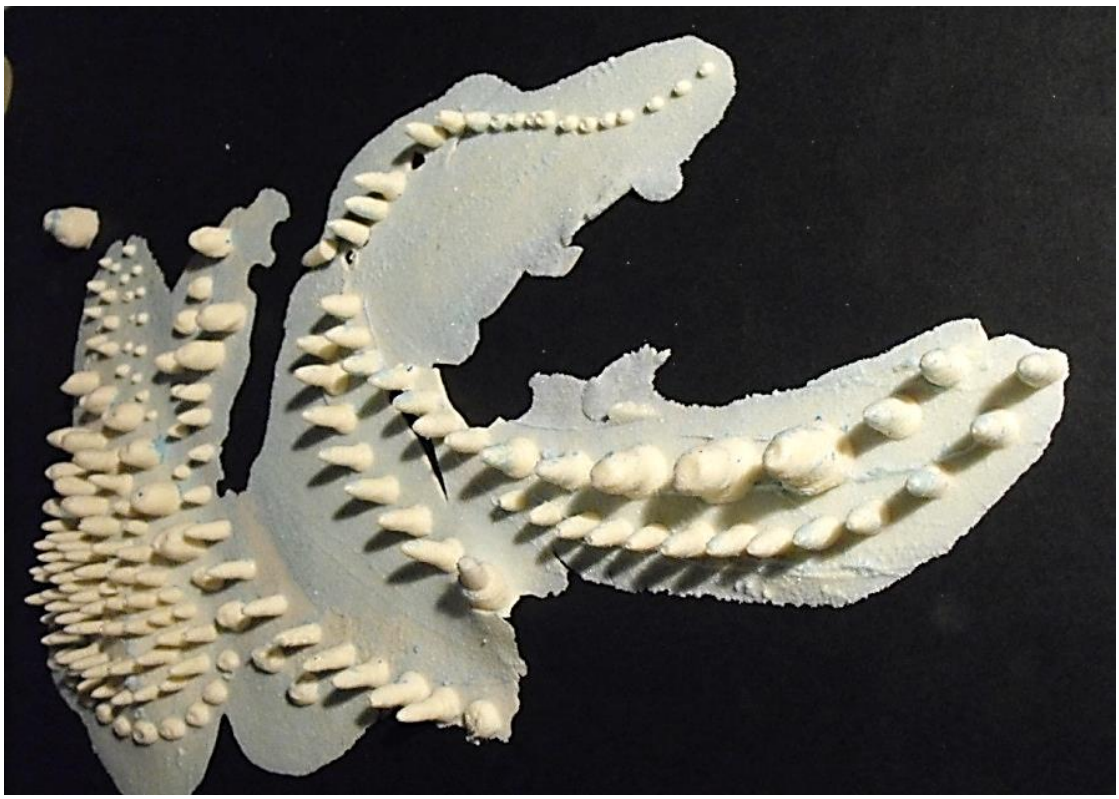

Figure 47: ***Silicone Structure with Bump-Like Rows in Waves*** **(Said, 2014)**

Figure 48: ***Silicone Structure with Groove-Like Waves*** **(Said, 2014)**

When applying various forces on two silicone structures with a foot, they exhibit slightly different collapsible behaviours. For example, the pointy bump-like structure both compresses and deforms its configuration noticeably in response to the forces applied (see Figure 49). Whereas the surface with the groove-like wave structure compresses without drastic changes to its configuration. Such physical property is referred to as elasticity (Houwink, 1971). This is because there is a collectively greater volume of voids within the bump-like structure compared to the groove-like structure. The difference of void-mass ratio within these structures influences their integral forces; hence, they respond

differently (a video recording of similar experiment is included in the CD enclosed with this thesis).[11]

Figure 49: *Collapsible Behaviours of Bump-Like Structure* (Said, 2014)

5.4.2 Latex

I inspect the collapsible capacities of the same structure using two materials. I re-cast the groove-like structure using latex material[12] (see Figure 50). When applying vertical forces on both casts (the latex and the silicone), they exhibit similar collapsible behaviours. Both compress, then decompress when the forces are removed. Minor experiential differences can be detected as the latex structure bounces back more quickly to its former shape than the silicone. Such differences in collapsible behaviours are principally related to the

[11] The video: *Instant Collapsible Response of the Pointy Bump-Like Structure, Lore Said, PhD* is in the CD folder: *Experiments – Material Explorations*.

[12] Water and ammonia-based liquid latex (see Appendix 21 for photos of the products used for material experiments p.70).

distinction between the materials' particular density properties. The density on a molecular level is defined as mass-void ratio within a particular material. The density influences the integral forces of the structures; hence, they respond differently.

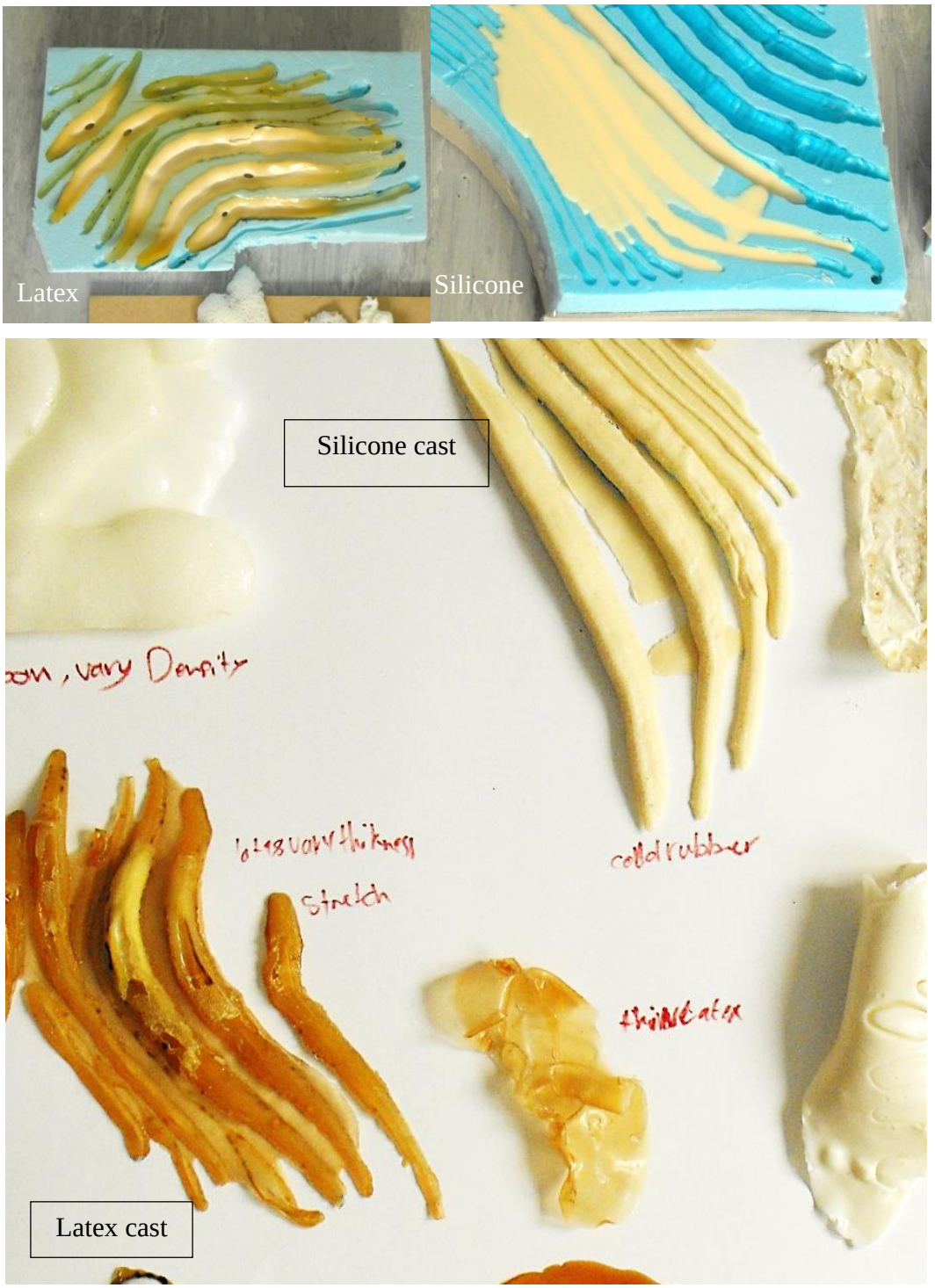

Figure 50: ***Collapsible Structure Using Latex and Silicone*** **(Said, 2014)**

5.4.3 **Foam**

In order to further explore this aforementioned notion of density of a collapsible material, I create a structure with areas of various densities using PU foam.[13] I do this by changing ratios of chemical agents used to produce the foam. I create several foam mixtures of different densities then pour them sequentially into a plastic tray that is used as a mould (see stages one and two of casting in Figure 51). After the mixtures solidify, various parts of the surface exhibit different collapsible behaviours in response to pressure. The observations show that each part recovers in slightly different times; the parts with high density recover more quickly than those with the low density. This notion was detected by observing the indentations disappearing gradually as the pressure forces leave the surface.

[13] Two component polyurethane foam (see Appendix 21 for photos of the products used for material experiments p.70).

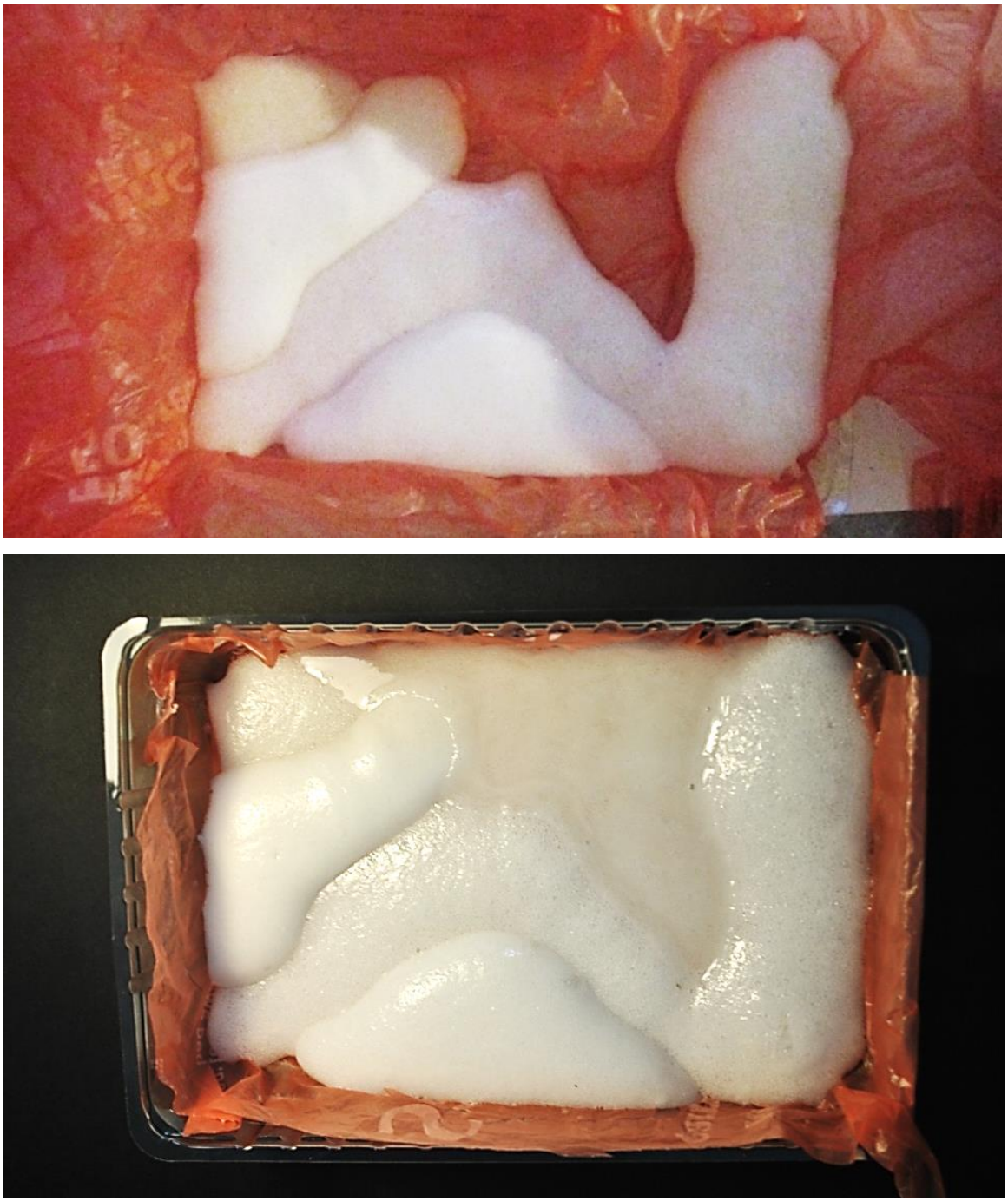

Figure 51: ***Collapsible Structure of Foam with Different Densities*** **(Said, 2014)**

5.4.4 Hybrid material

On the same subject of density, I cast two materials in one mould: foam and silicone. To my surprise, the mixture generates a bubble-like structure. The distribution, size and quantity of bubbles determine the various densities throughout this structure (see Figure 52). When applying pressure forces, the bubbles instantly deflate combined with sound feedback. After the forces are terminated, the surface inflates very slowly and only partly recovers its shape (see Figure 53) (two videos 1, 2 recording of this experiment is included in the CD enclosed with this thesis).[14]

[14] The video: *Hand Interaction with Bubble-Like Structure, Lore Said, PhD, 2014* is in the CD folder: *Experiments – Material Explorations.*

Figure 52: ***Collapsible Structure of Bubble-Like Foam/Silicone*** **(Said, 2014)**

Figure 53: ***Collapsible Behaviours of Bubble-Like Structure*** **(Said, 2014)**

I also experimented with applying forces on commercial products of elastic materials of high-compression latex, and liquid-rubber materials. When stretching both materials, the high-compression latex instantly springs back to its shape, while the liquid-rubber takes a longer time to recover slowly (three video recordings; 1, 2 and 3 of these experiments are included in the CD enclosed with this thesis).[15]

[15] The videos: *Instant Collapsible Response of Latex Material 2014, Lore Said, PhD* and *Slow Collapsible Response of Liquid-Rubber, Lore Said, PhD 1, 2* are in the CD folder: *Experiments – Material Explorations*.

5.4.5 **Metal**

In this experiment, I use a sheet of metal. When applying forces on this structure while it is placed on a flat/rigid surface, it does not exhibit any collapsible capacities (no signs of folding formations/deformation can be detected). However, when suspending the metal plate in the air and applying pressure, it deforms. As soon as the force is removed, it springs back to its original configuration. Such collapsible behaviours are made possible by the existence of voids around the structure that can allow such alterations.

When the force surpasses a certain value, the metal sheet loses its elasticity and deforms permanently. Such physical property is referred to as plasticity (Houwink, 1971). This is when a material exhibits an ability to alter the distribution of mass and deforms permanently. This deformation activates a collapsible capacity. Figure 54 shows that when applying an external pressure force (as shown by the thumb), the structure deforms; some folds stretch and expand, others elevate, while some contract. As soon as the force is removed, the structure recovers to its original configuration.

Figure 54: ***Collapsible Behaviours of a Metal Structure*** **(Said, 2014)**

Figures 55 and 56 shows various metal structures that I made using the same method. These structures exhibit similar collapsible behaviours when applying forces in proportion to their structure configuration. In other words, the higher ratio of mass within a metal structure, the greater force is required to deform.

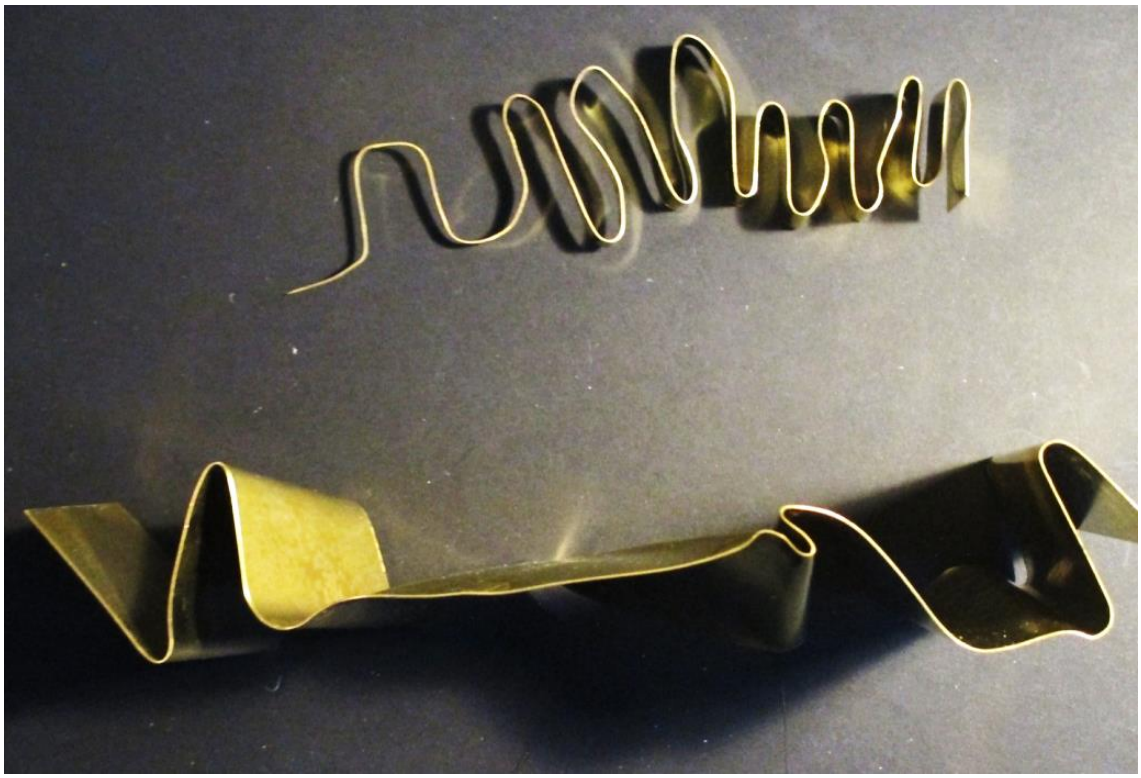

Figure 55: ***Collapsible Structures of Metal*** **(Said, 2014)**

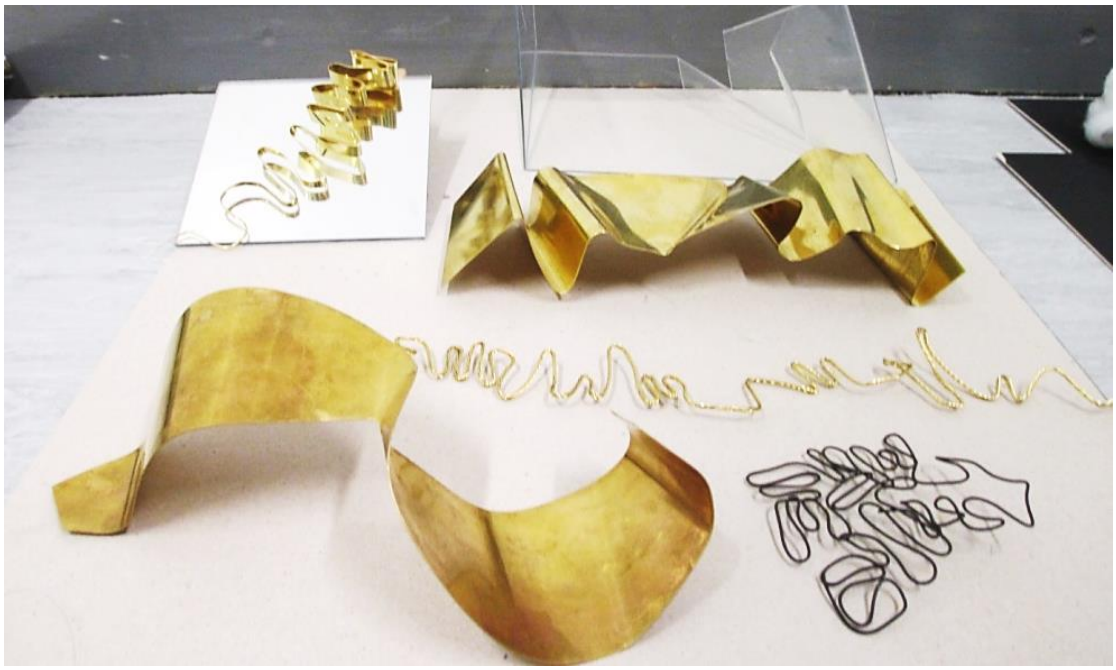

Figure 56: ***Collapsible Structures of Metal*** **(Said, 2014)**

5.4.6 Plastic and paper

Similar to the previous metal experiment, when a plastic sheet is placed on a flat/rigid surface, no signs of folding formations/deformation can be detected. I therefore use forces to deform the plastic sheet in order to activate its collapsible capacity. Figure 57 shows a clear plastic structure and various other metal structures. Such collapsible behaviours can be made possible through alterations and displacements of void and mass within a structure. Similar to the metal structures, when I apply pressure forces, the configuration of the plastic structure changes; some folds stretch and expand, others elevate, while some contract. When forces are terminated, these deformation events reverse. Comparing with metal structures, the plastic structure exhibits less springiness (a video recording of this experiment is included in the CD enclosed with this thesis).

Figure 57: *Collapsible Structures of Metal and Plastic* (Said, 2014)

However, comparing with paper, for example, plastic has more springiness. Figure 58 shows various structures that I made from paper. To create similar structures made from metal or plastic (like those made from paper) would require greater forces proportional to the integral force of the material.

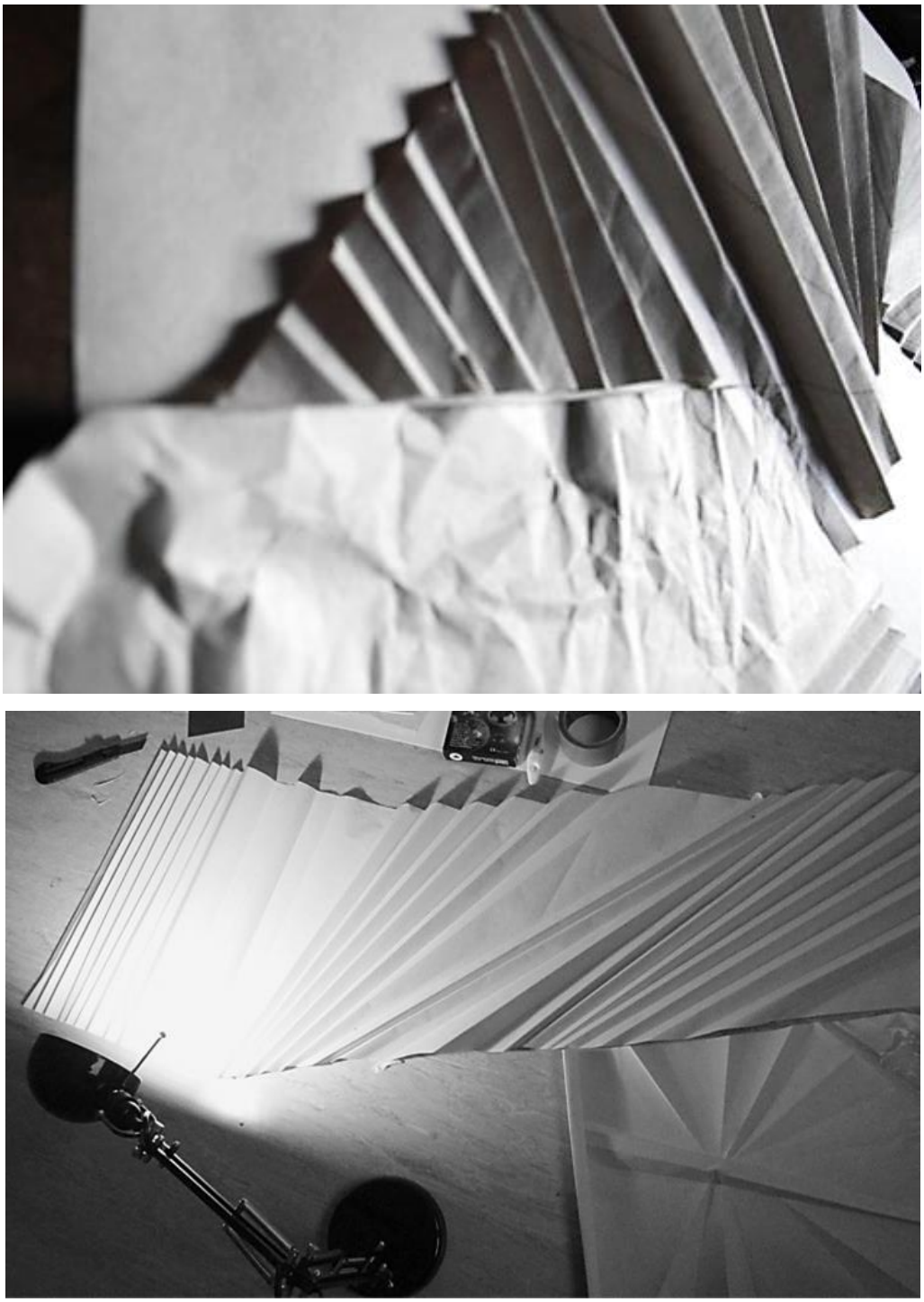

Figure 58: ***Paper Crumbling/Pleating Collapsible Structures*** **(Said, 2014)**

5.4.7 **Wood**

When applying forces by hand/foot on a plank of wood that is placed on a flat/rigid surface, it does not exhibit any collapsible capacities. No signs of indentation, compression or deformation can be detected. However, a plank of wood can exhibit collapsible capacity, but it is proportional with the force applied. In other words, a tree exhibits collapsible behaviours (bends/unbends) when responding to forces generated by wind. Like in the previous experiments, collapsible behaviours can be activated through the alterations and displacements of void and mass within a wooden structure. To deform wood permanently, force is often not enough. Generally, wood requires other conditions, such as heat, to plasticise the wood, humidity to extend the plastic range and force to deform (Wengert, 2015).

I therefore experiment with making slots in a small piece of wood (using a band saw) to activate its collapsible capacity (see Figure 59). The red arrows indicate forces applied by hand. The yellow arrow indicates collapsible deformations as the slots open from one end and contract from the other. When the force is removed, the structure recovers to its original configuration. Such a method is also explored by designer Carolien Laro in the *Spring Wood Collection of Stools* (2010) (images of the stools are included in Appendix 18, p.67). It is also explored by Dukta Gmbh Flexible Wood Company to produce surfaces that have capacities to fold (see examples of Dukta products in Appendices 19 and 20, pp.68, 69).

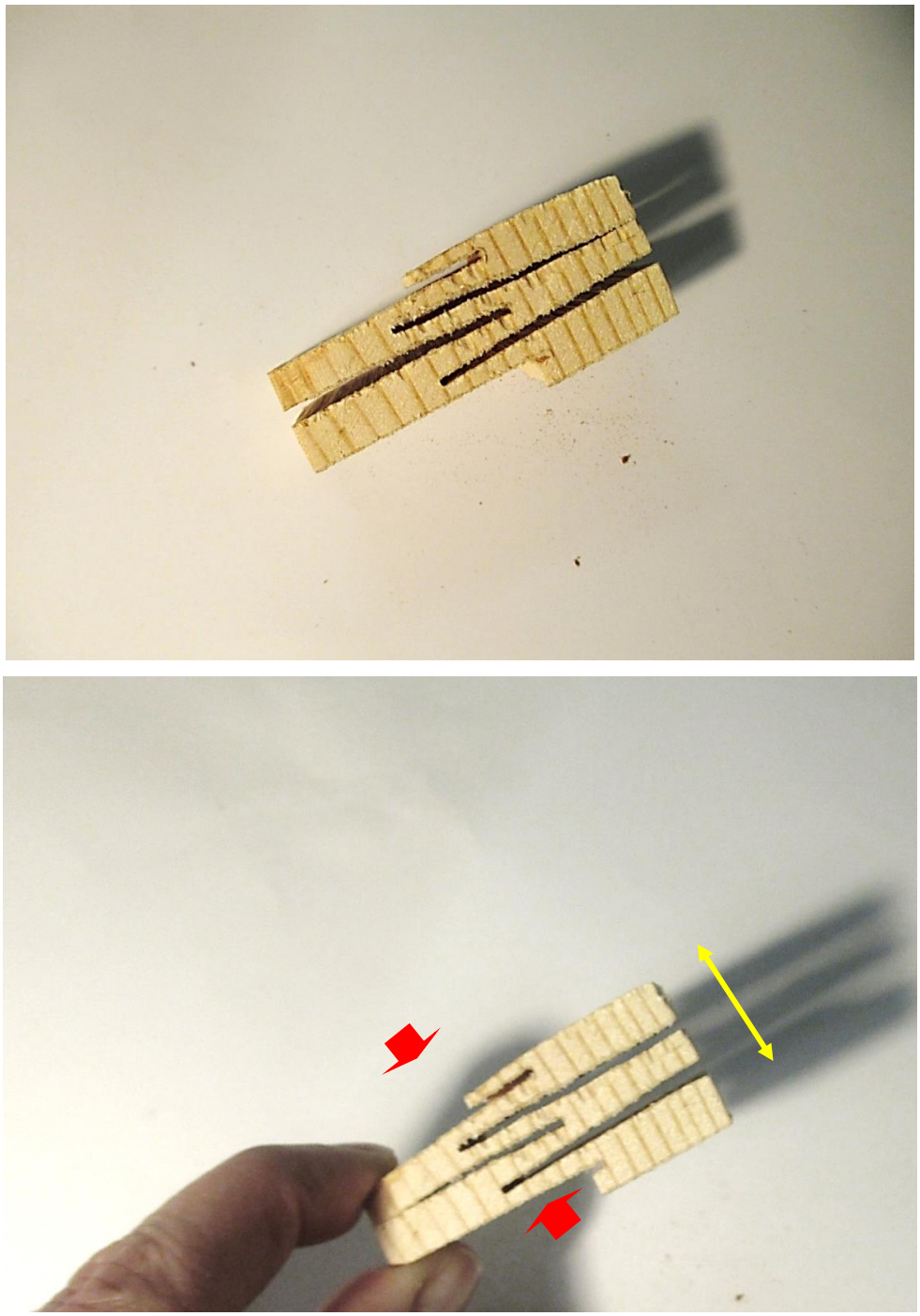

Figure 59: ***Collapsible Behaviours of a Slotted Piece of Wood*** **(Said, 2014)**

To explore the potential of this slot method in activating a range of collapsible behaviours, I conduct a series of experiments. Firstly, I experiment with a different number of slots (voids) within a wooden structure. Figure 60 shows a wooden block with more slots on the left side. The observation shows that when applying pressure forces, the slots on the left side show greater deformation and expansion than the ones on the right. In Figure 61, red arrows indicate force, the yellow arrow indicates the area with greater expansion, while the yellow dotted line indicates the course of deformation. This is to say, the number of slots affects the degree of collapsible deformation.

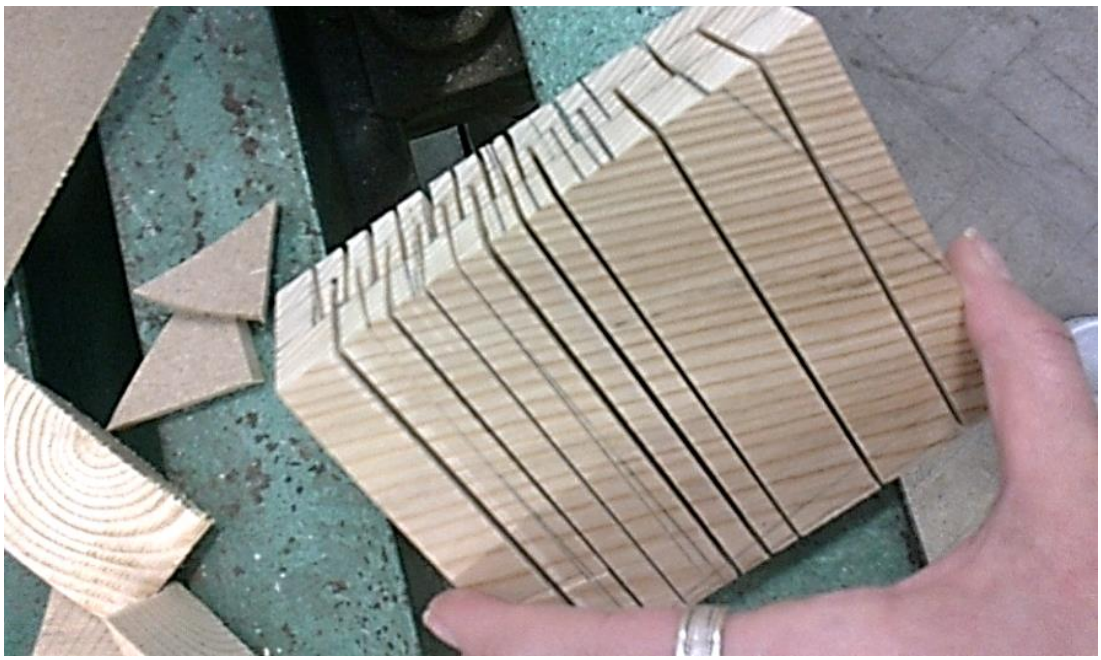

Figure 60: ***Wooden Block with Varied Number of Slots*** **(Said, 2014)**

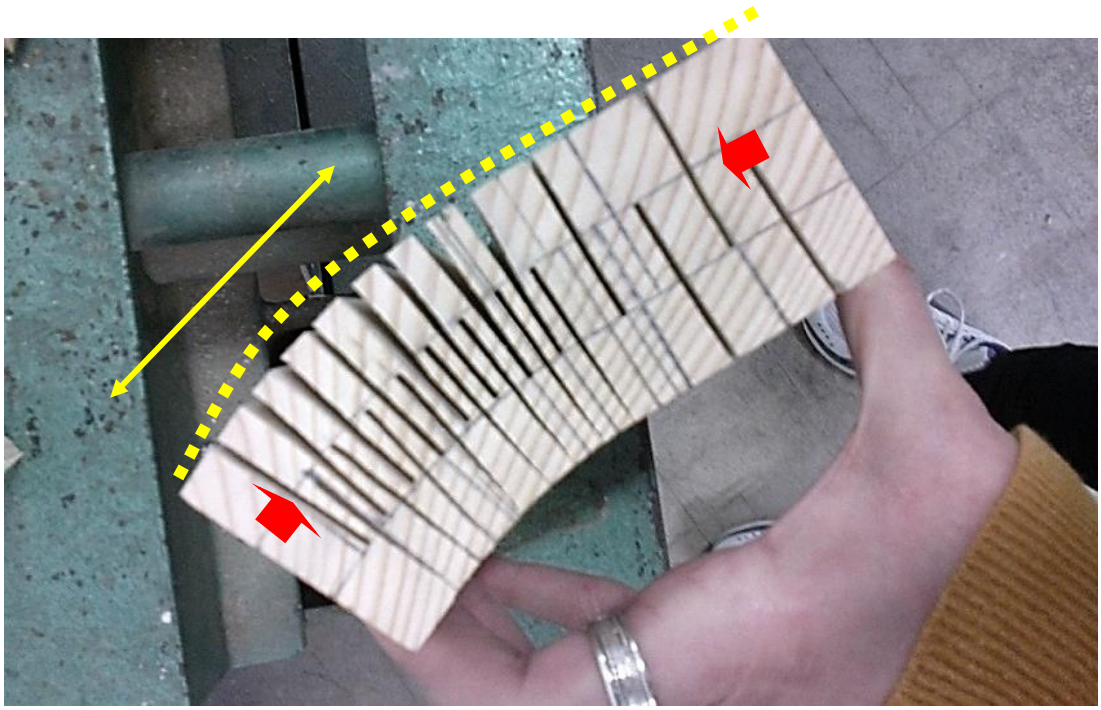

Figure 61: ***Collapsible Behaviours of a Wooden Block*** **(Said, 2014)**

Secondly, I experiment with changing angles of the slots on a longer piece of wood (see Figure 62). Gravitational forces activate the collapsible capacity straightaway without the need to stimulate additional external pressure forces. The angles of the slots appear to determine the course of deformation of the plank. For example, in Figure 62 the yellow marks highlight the angling to the right of the curvature of the wooden plank between the top and bottom. The two yellow pointers would be in line if the slots were ninety degrees.

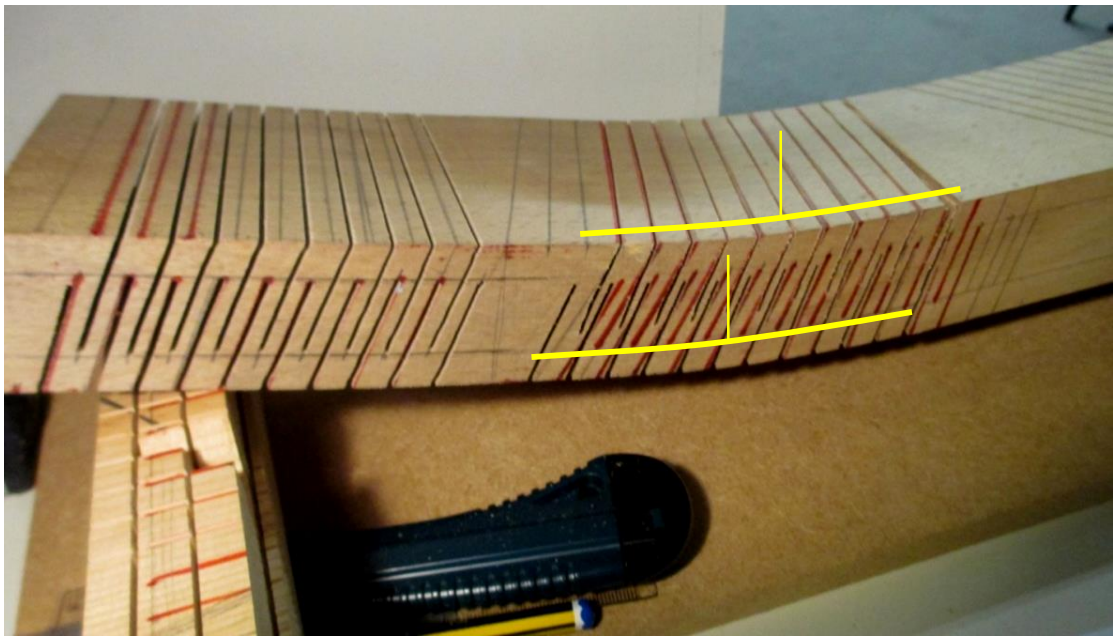

Figure 62: ***Wooden Plank with Slots of Various Angles*** **(Said, 2014)**

Thirdly, I insert various materials inside the slots of a wooden structure to stimulate different collapsible capacities. Figure 63 shows a wooden structure with Dacron polyester fibres inserted in the slots on one side. These fibres, when inserted (compressed), generate a tension force that causes the slots to open on one side and therefore contract on the other.

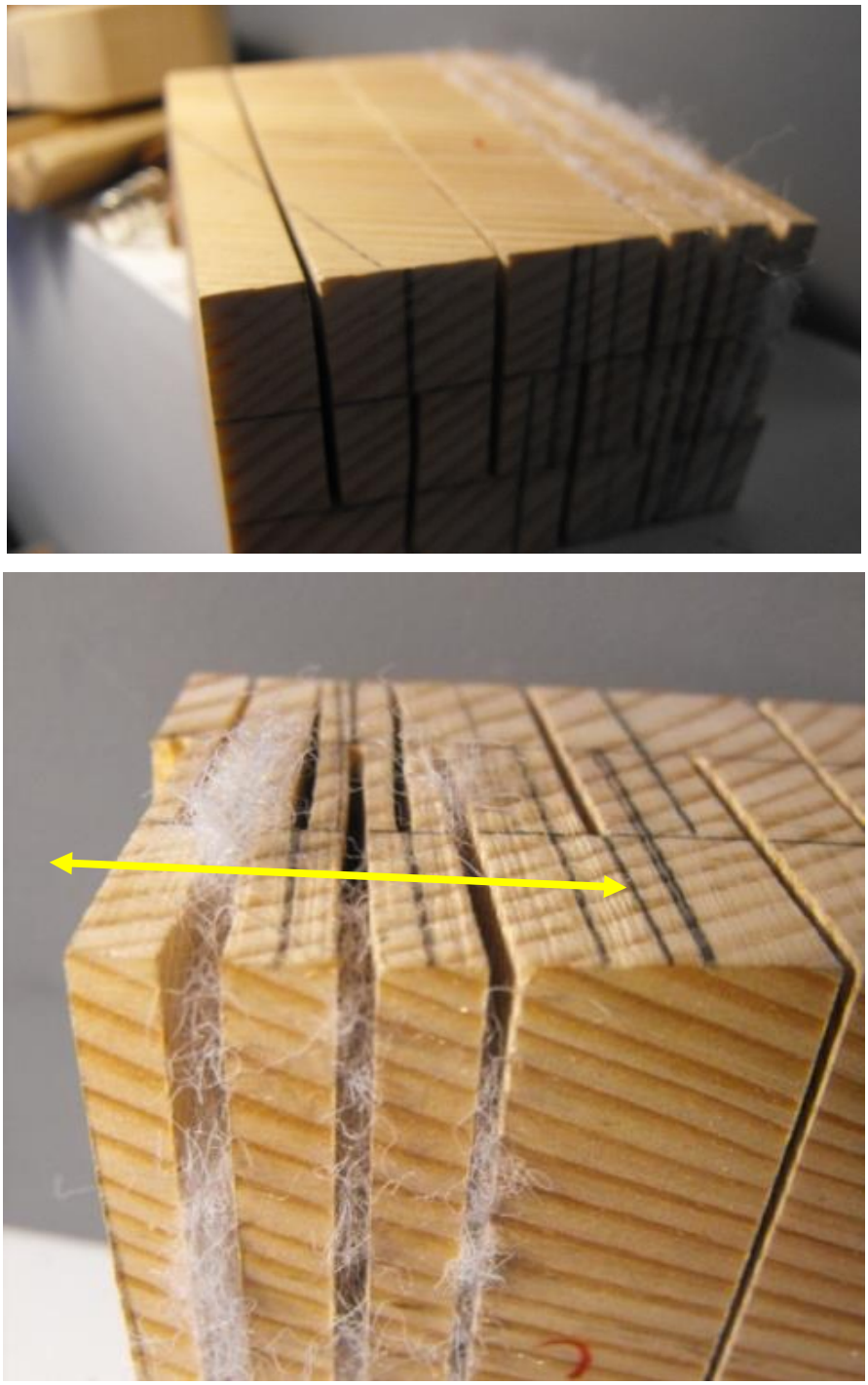

Figure 63: ***Dacron Stuffed in Slots of Wooden Structures Cause Deformations*** **(Said, 2014)**

Figure 64 shows a collapsible event in three stages. The first photo shows the initial stage as the force is applied. The second shows the deformations as the Dacron compresses and the slots contract on one side and therefore open on the other. While the third shows that, when the force is removed, the wooden structure bounces back and the Dacron fibres decompress.

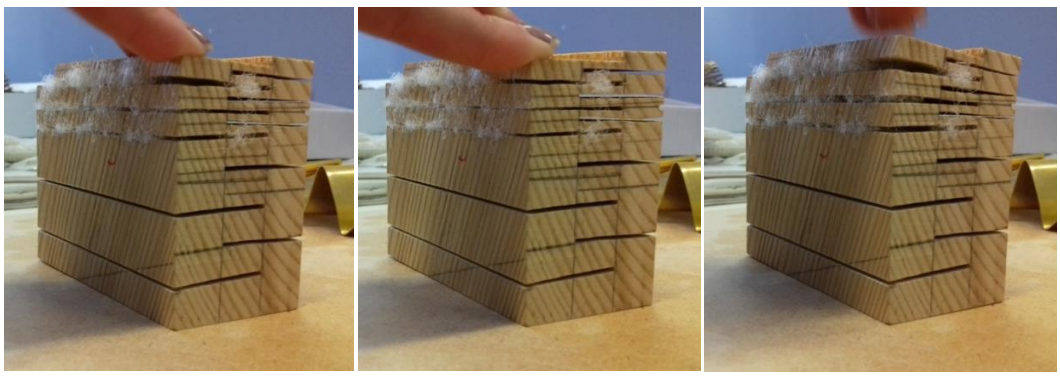

Figure 64: ***Collapsible Behaviours of Wooden Structures Stuffed with Dacron*** **(Said 2014)**

On the contrary, when wedging wood in the slots, the structure deforms but does not exhibit any collapsible behaviour when external forces are applied. This is because the voids have been eliminated (see Figure 65).

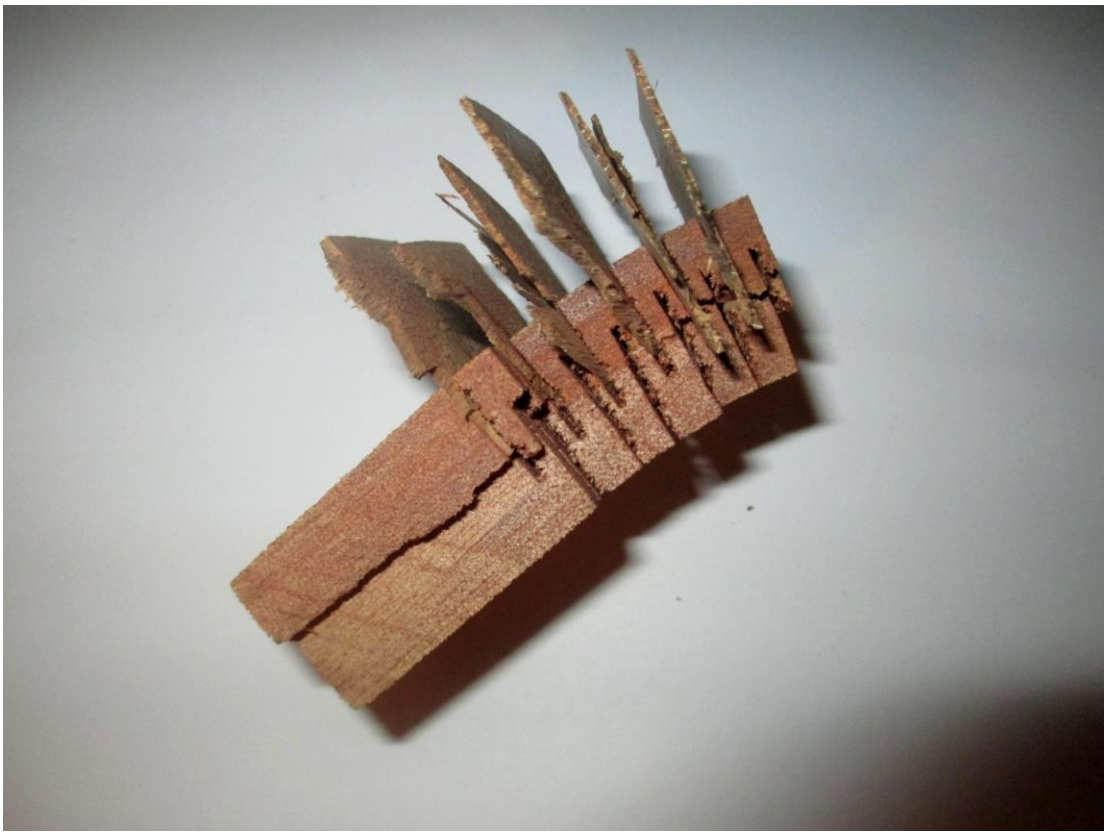

Figure 65: ***Wood Sheets Wedged in an MDF Structure*** **(Said 2014)**

Similarly, Figure 66 shows an MDF[16]wooden structure with a bent metal rod wedged in two slots. The bend of the metal rod (with five slots in between) generates a tension force that causes deformations in the wooden structure. Slots on one side of the wood are prised open, while they contract on the other side.

[16] MDF stands for Medium Density Fibreboard of hardwood or softwood mixed and pressed together to make lighter wood-based boards (Kües, 2007, p.303).

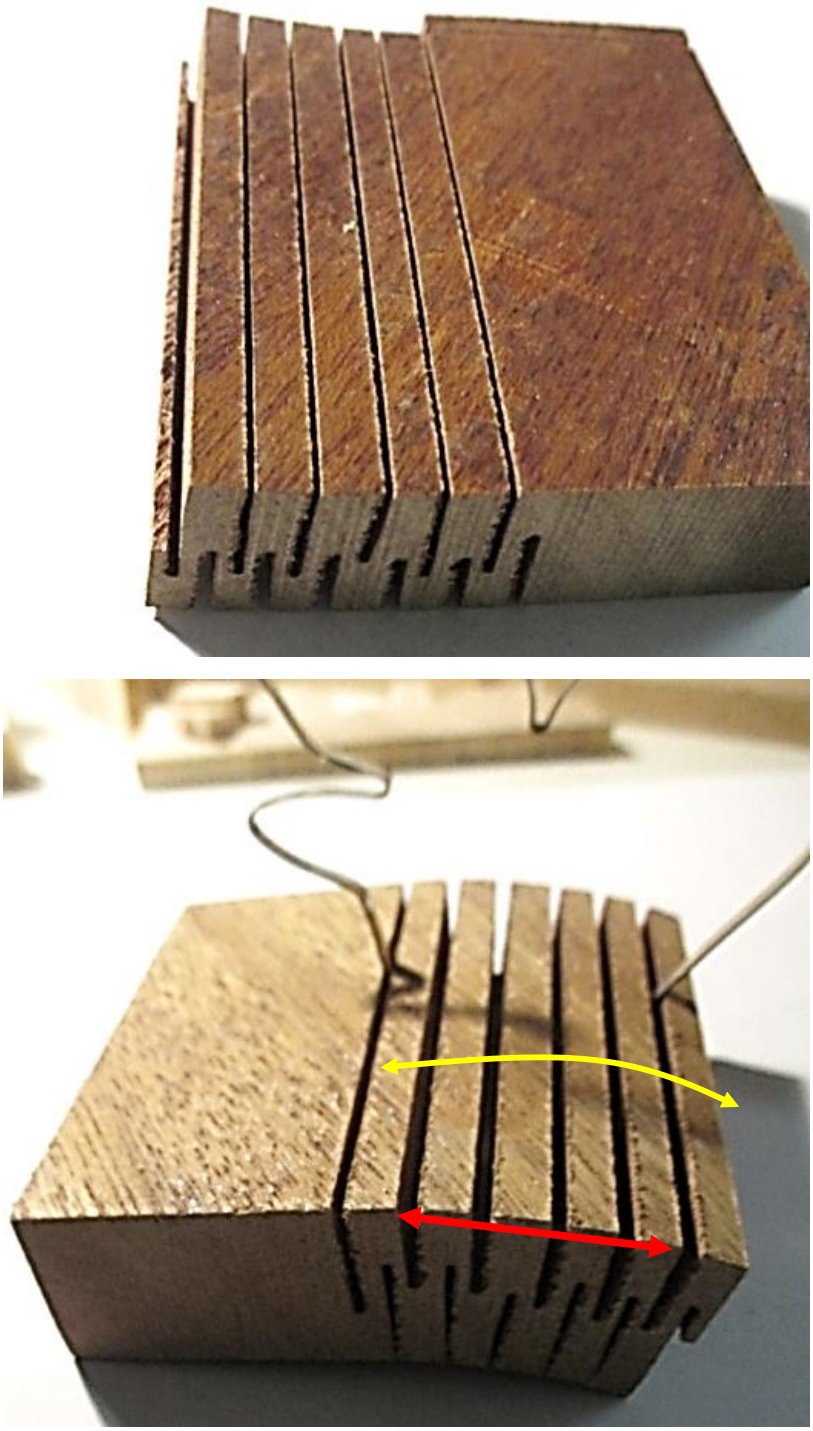

Figure 66: ***Bent Metal Rod Wedged in an MDF Structure*** **(Said, 2014)**

When increasing the bend, and therefore the tension of the metal rod (with four slots in between), it causes greater deformations (see Figure 67).

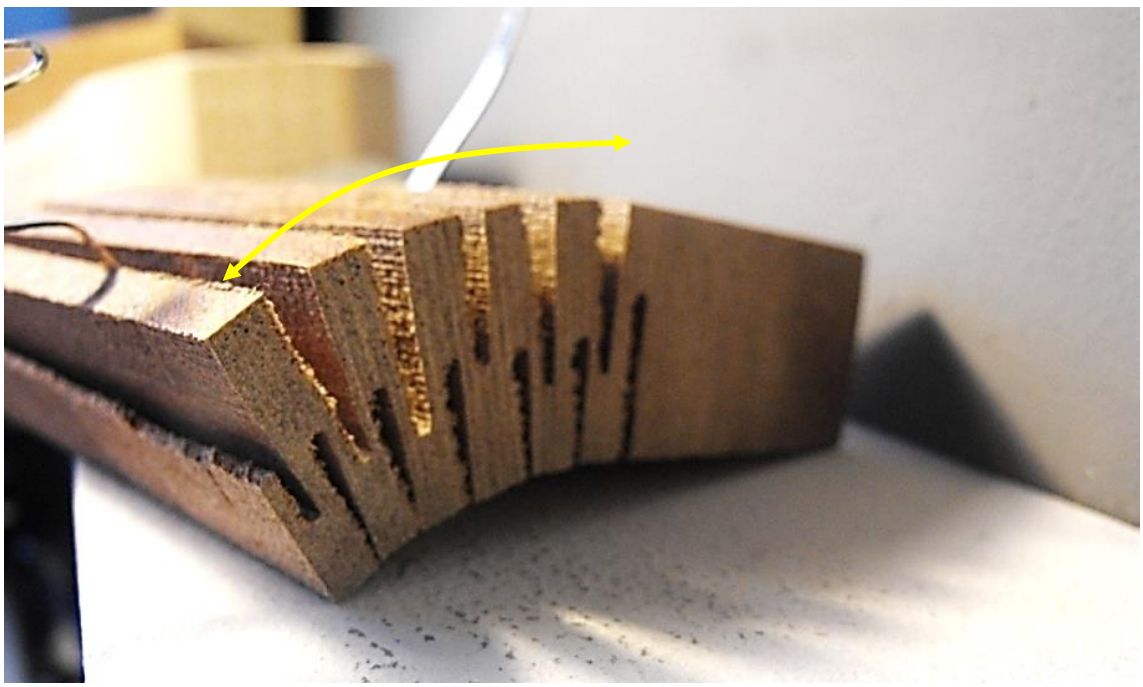

Figure 67: ***Increasing Bend of Metal Rod Causes Greater Deformations*** **(Said, 2014)**

5.4.8 Insights

Some of the materials I explore are inherently collapsible, such as silicone and latex. By 'inherently collapsible', I imply that a material, regardless of its structure, possesses an elastic property that allows it to alter configuration repeatedly in response to forces. Other hard materials like metal and wood require design intervention to rethink their structures in order to activate their collapsible capacities. This is not to say that metal or wood do not have elastic capacities in response to forces, but more to say that elasticity of such material is relative. As engineer James E. Gordon, in his book *The New Science of Strong Materials: Or Why You Don't Fall Through the Floor*, puts it: everything 'gives' to some extent, even rocks compress like a spring, but the extent to which a material or a structure

deflects varies (1991). He further says: "*there is, and there can be, no such thing as a truly rigid material"* (1991, p.25).

Regardless of whether these collapsible capacities are inherent or engineered, collapsible capacities can vary considerably depending on several parameters. These include:

- Density of a material: (the void-mass ratio within a material) affects the way forces travel through a structure, and thus the way a structure behaves in response to forces. The intangible voids prove to be as important elements as tangible masses when considering designing collapsible structures.
- Configuration of a structure: the ratio of voids and mass affects the way forces travel through it, and thus the way it behaves. Rigidity can, to some extent, imply a condition that prevents collapsibility (Mollerup, Personal Communication 2012) (Email Re: 2 is included in Appendix 7, p.41). However, rigid materials have the collapsible capacity to make folds depending on the structure and distribution of mass and voids (e.g. in the form of slots), such as shown in the example of slotted wood in Figure 59. The different ways mass and voids are distributed within a rigid structure determines the degree of its collapsible capacity, for example the varied number of slots in wood (see Figure 62). The existence of voids within a structure provides a physical space for force to move and displace mass, therefore altering the configuration of the whole structure. These voids activate collapsible capacities. Examples of this are shown in Figure 57 by introducing voids and bending the metal and the plastic sheets and introducing a void by adding slots to the wooden plank shown in Figure 59.
- Collapsible capacities of structures can be influenced when combined with other collapsible capacities of other materials, such as seen in the example of the Dacron fibres (Figures 63 and 64) or the metal rod with wooden pieces inserted in a wood structure (Figures 66 and 67). The insertions of other materials create tensegrity structures, where multiple forces of various materials interact together. These, in turn, impact the way a structure behaves.

One the one hand, determining specific parameters of collapsible behaviours of a material or a structure enquires extensive knowledge that extends beyond the scope of design to the engineering science of rheology.[17] On the other hand, exploring various materials through the formula of the concept of collapsibility (forces as fold/form-giving and collapsibility as capacities for fold/form-making) enables me to understand the concealed affordances of rigid materials such as wood and metal. Therefore, enabling me to alter the affordances from structures with passive/static capacities, to collapsible structures with expressive/eventful capacities.

Force and a collapsible capacity of a structure work hand in hand with the material to process collapsible events. These events form through constant distribution and deformation of material mass and void. Incorporating mass and void is a method to design flow of forces within a space, a structure, a material.

On the whole, these practical explorations have allowed me to gain experiential knowledge about the range of collapsible capacities a material or a structure can have. And to realise how important the notion of designing void is in relation to mass. In line with this, Attiwill argues that the sculpting of negative space is what is interior design is about, rather than the production of the negative space (Attiwill, 2013). The following section of designing and prototyping a collapsible floor utilises experiential insights and knowledge gained from this series of experiments.

5.5 **Designing a Collapsible Floor**

This section outlines my processes of designing a collapsible floor. I experiment with incorporating several collapsible materials to create a hybrid collapsible floor structure. I

[17] Engineering rheology is a branch of science that studies deformations and interchange of motions, force and energies of matters (Tanner, 2000).

make several collapsible structures and study how they respond to forces applied by the feet.

5.5.1 Slotted wooden structure

In these experiments I use the slotted wood structure (produced earlier in previous experiments) to test its potential in designing a collapsible floor. I use two different wooden structures: one of the structures has vertical slots; the second has slots that are slightly angled. I place foam of various densities underneath both structures in order to allow space for flexion (to facilitate displacement of the mass of the wood).

Figure 68 shows the results when applying forces on both structures using feet (see red arrows). The foam underneath compresses (see arrows in yellow), the wooden structures flex/deform mimicking the curvature of the feet in two directions. The wooden structure with the angled slots (on the right) exhibits a slightly higher degree of flexion than the structure with the vertical forces; the top slots contract more while the slots on the bottom open (see arrows in blue). The angled slots of the structure divert the vertical force load. Many factors can play a role in this slight difference, such as the various densities of the foam and the direction of forces applied in relation to the angles of slots. In other words, the shape and degree of the flexions of the wood structure are determined by the relationship between the external force (the foot) and the opposing integral force of the structure that resists (both the wood and the foam).

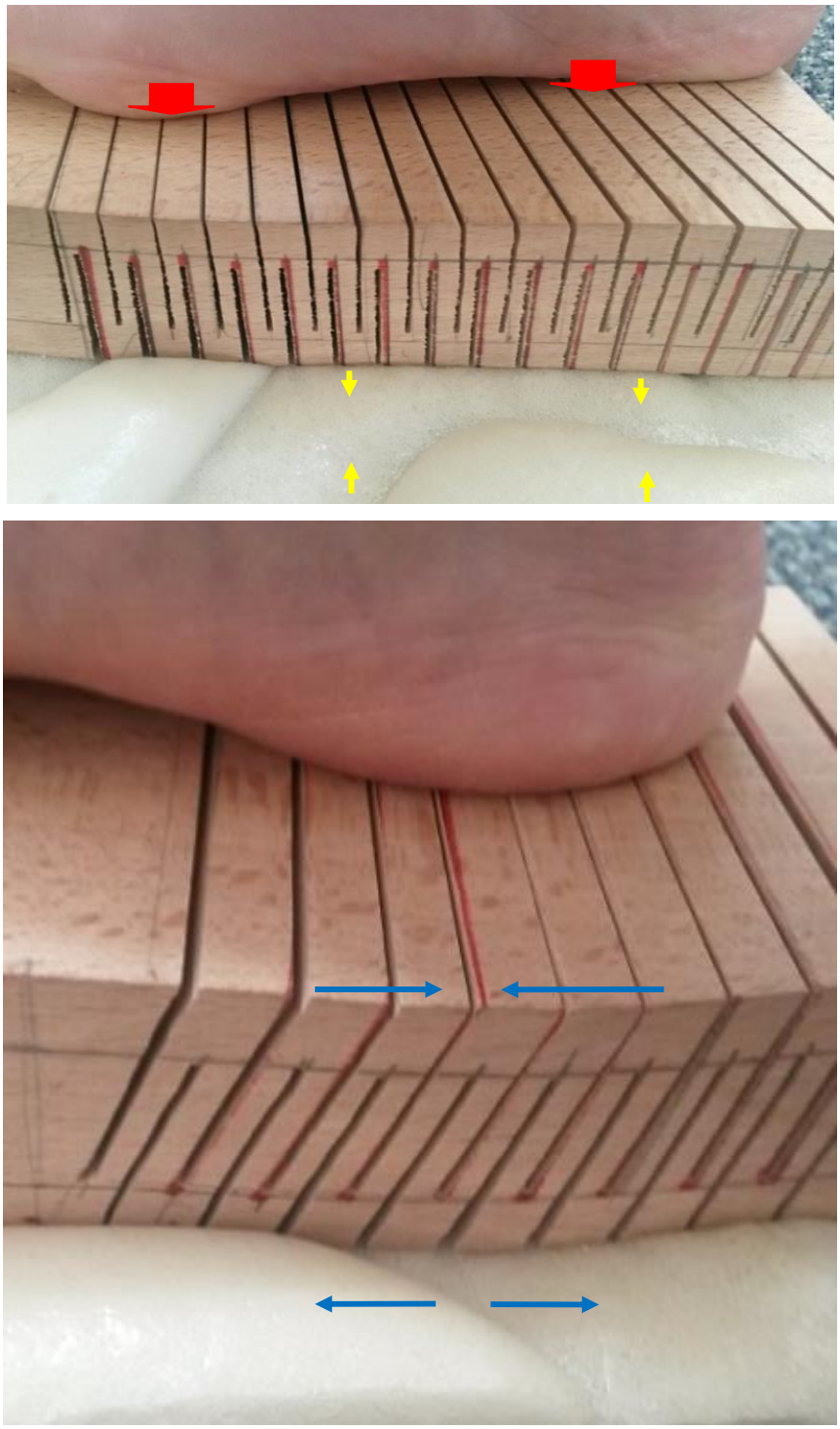

Figure 68: ***Feet Interactions with Small Collapsible Floor Surfaces*** **(Said, 2014)**

Determining and detecting the range of possibilities and exact deformations of such a structure is possible using engineering tools like CAD Solid Works software. In order to compare the actual collapsible behaviour of such a structure with computer-generated models, with the help of mechanical engineer Thomas Hügin, I created a computer-generated model of the slotted wooden structure.

Figure 69 shows a slotted collapsible structure created by CAD Solid Works software, with four points of forces applied (direction of force marked by purple arrows). The green arrows pointing upwards are supporting points. The colour chart on the right corner represents values of displacements in the structure from high in red, to low in blue. This stimulus is more to be seen as an exaggerated value of forces and deformations of such a structure. This is because creating an accurate model would require detailed information about the physical characteristics of the piece of wood that is used. This type of analytical tool works better for materials with consistent characteristics, such as metals. With natural materials like wood, such a calculation proves to be complicated, as each piece can be unique in its characteristics and therefore responds differently.

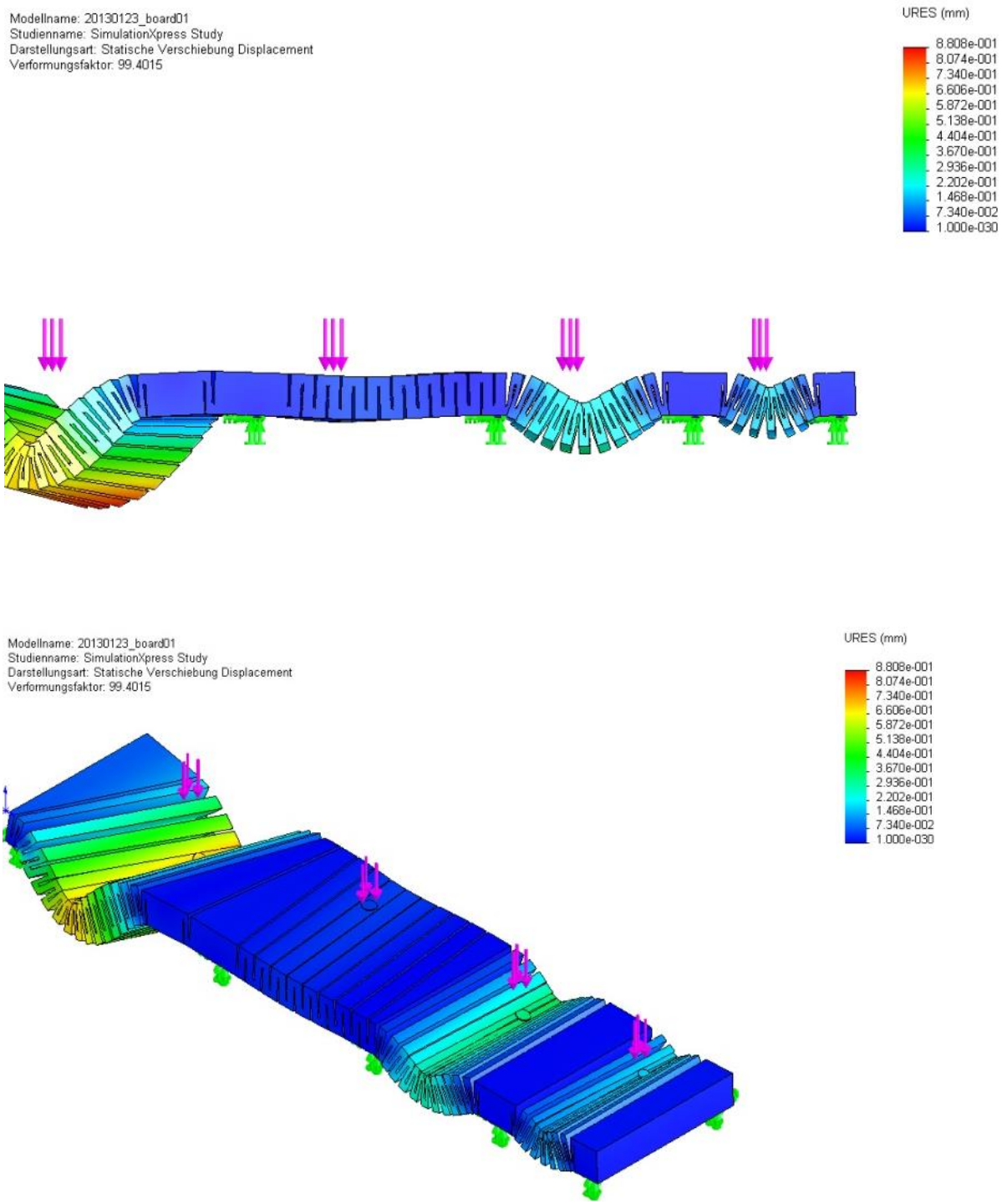

Figure 69: ***Collapsible Model Using CAD Solid Works Simulation*** **(Hügin, 2013)**

The slotted wood structure appears to mimic the curvature of the feet in two directions. This experiment shows that floors can respond to the curvature of feet.

In order to explore this notion, I experiment with a higher degree of collapsible behaviour by creating a structure that can deform three-dimensionally. I add cross slots to enable the structure to flex in two directions (see Figure 70). This cross-slotting method is referred to as Duna by Dukta (2017) (see model specifications of Duna Dukta products in Appendix 19, p.68).

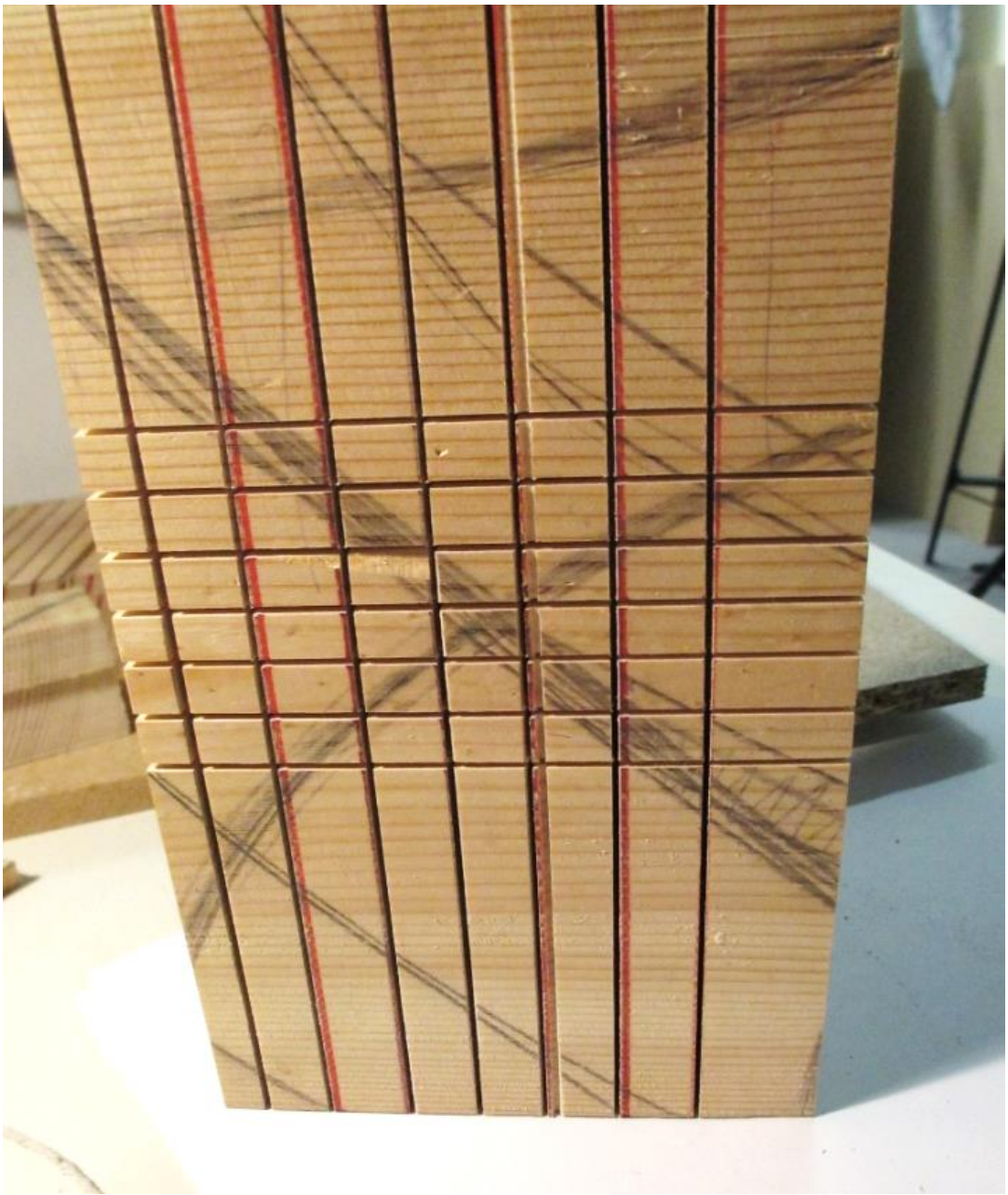

Figure 70: ***Crossing Slots Method to Achieve Three-Dimensional Deformation*** **(Said, 2014)**

The larger number of voids in this structure weaken it, so when I apply load forces it breaks easily (see Figure 71). When applying forces, the delicate wood parts in-between the slots stretch in different directions, and then break. Such a structure proves delicate, and thus risky to be used for my floor.

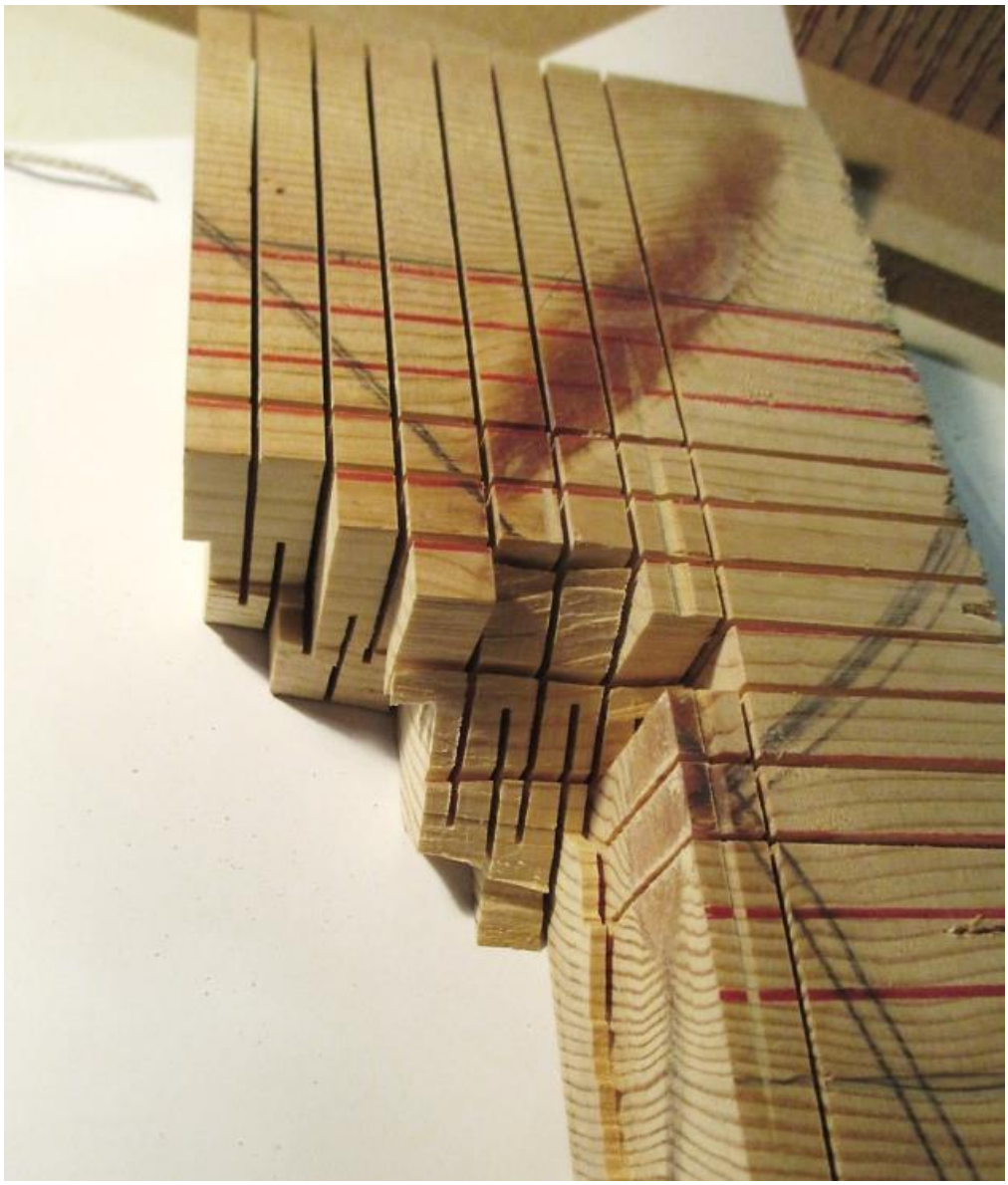

Figure 71: ***Crossing Slots Weaken the Collapsible Structure*** **(Said, 2014)**

Figure 72 shows an example of how I intended the structure to behave. This example is by Dukta and it is made of an elastic plywood. In the next section, I experiment with producing a stronger collapsible structure from plywood. Before this, however, I focus in the next section on expanding my understanding of a foot's interactions with floors/grounds.

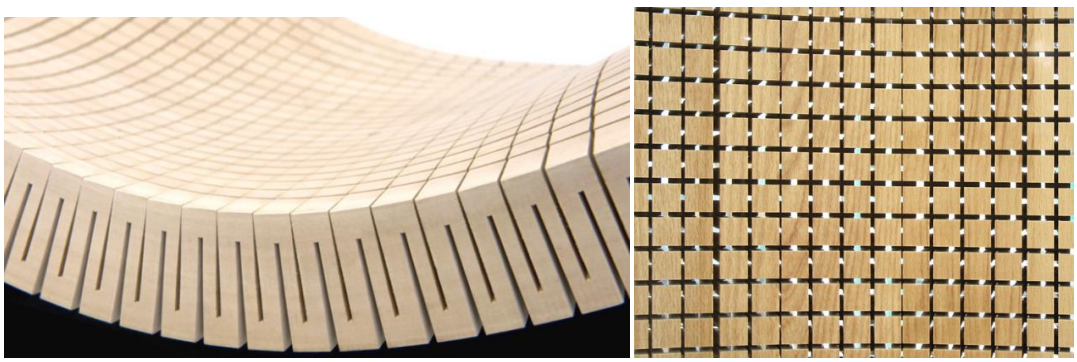

Figure 72: ***Duna Crossing Slots Structure*** **(Dukta, 2017)**

On the other hand, the way the surfaces have responded highlights a design opportunity related to an interactive floor. In the next section I will utilise the rocking effect of the tile, and the fold seen on the wooden floor, and combine them with the remarks of the broken structure of the slots.

5.5.2 Woven collapsible structure of wood segments

I combine insights from observation with remarks of the experiment with the structure with slots to build an improved version of the slotting structure with few modifications. These include extending the voids of the slots to full cuts so the structure is made of segments. I then reconnect these segments with latex cords. These latex cords mean to

replace the delicate wooden parts in-between the slots that originally held the structure together. The structure employs the tensegrity principle to create a structure that can bear more load forces by utilising collapsible capacities of various materials.

5.5.2.1 **Initial prototype**

I use an inexpensive MDF material of 12 mm thick in the initial prototype for the purpose of verifying the structure with little cost. The structure in this experiment consists of three elements: the MDF segments, cords made of latex that go through holes in each segment connecting them together and the foam mat that is placed underneath to allow greater deformation.

I use a CNC cutting machine to cut the MDF segments. This machine requires modelling the segments digitally beforehand. I therefore build different shapes of segments using AutoCAD modelling software. I experiment with different shapes before I choose the one with the minimum curvature (see red mark in Figure 73). Each segment has two folds; on the top and bottom. This is to amplify deformations of the collapsible structure when forces are applied. The folds on the bottom of each segment create a rocking effect, while the folds on the top create an effect of a three-dimensional deformation. Each segment therefore has a slightly different shape depending on its place within the curvature of the fold.

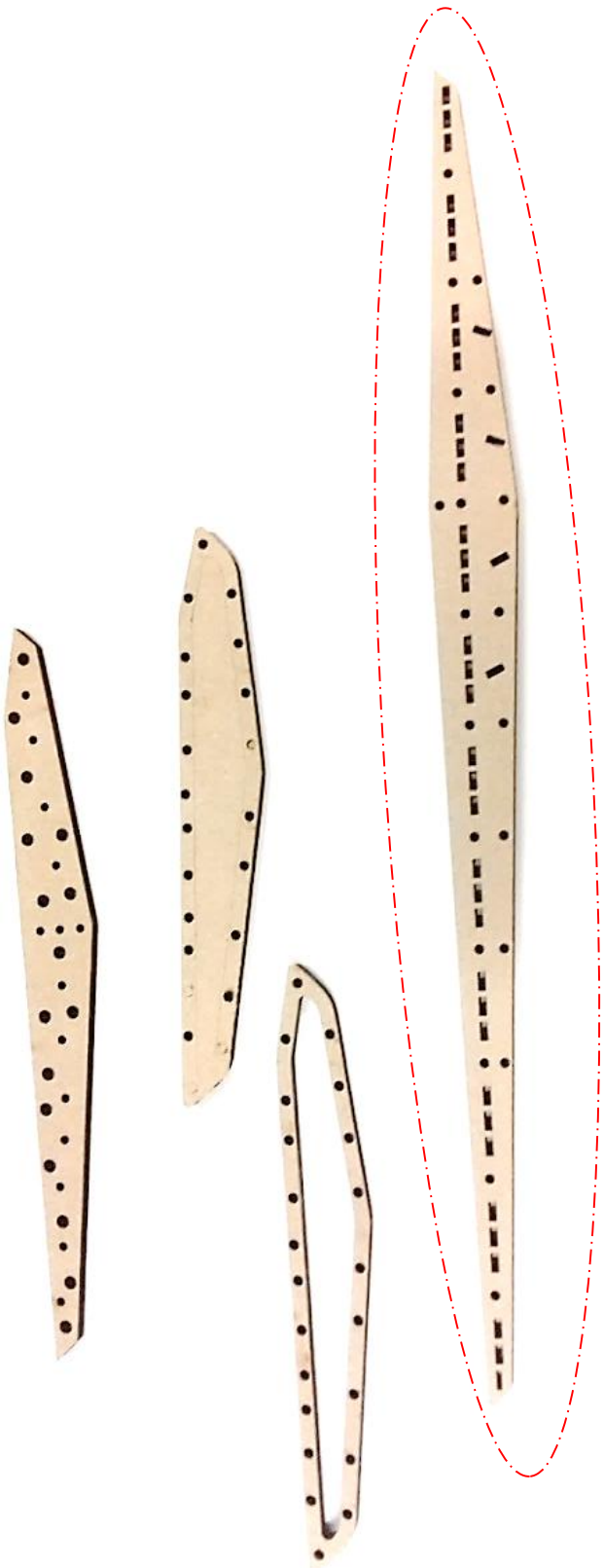

Figure 73: *Different Shapes of Segments* (Said, 2014)

When stepping on the structure, the force causes the foam underneath to compress, and each segment to rock, pulling the latex cords. The connected rocking segments create a parametric effect,[18] as if the whole structure is folding (see Figure 74). When force is removed, the structure recovers. The foam decompresses, pushing the segments up to their original positions, while the stretched latex cords contract back.

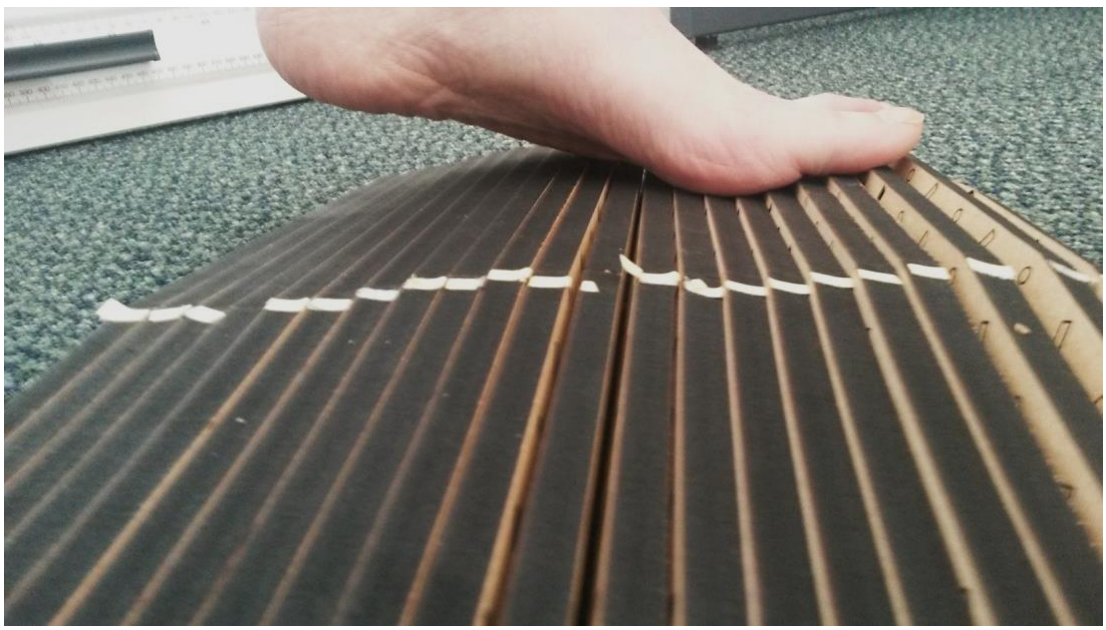

Figure 74: ***Foot's Interaction with Collapsible Structure of Wooden Segments*** **(Said, 2014)**

The size of the prototype does not allow enough room for testing interactions of walking. It is limited to stepping. So, I experimented with both my hands in stimulating actions

[18] "Parametric Design is a computer-based design approach that treats the geometric properties of the design as variables." (Schumacher, 2016) In principle, every property of every element can be seen as a variable that is subject to parametric variation (Schumacher, 2016). Parametricism as a style, coined by Patrik Schumacher (2009), is rooted in digital techniques. Schumacher states that, "Frei Otto might be considered the sole true precursor of parametricism." (Schumacher, 2009, p.23)

similar to walking (see Figure 75). The collapsible structure responds actively to the forces I apply with my hands (four video recordings, 1, 2, 3, 4 of this experiment are included in the CD enclosed with this thesis).[19] I therefore decide to explore making a larger structure using a higher strength type of wood, namely plywood, to explore this collapsible structure's interaction with feet.

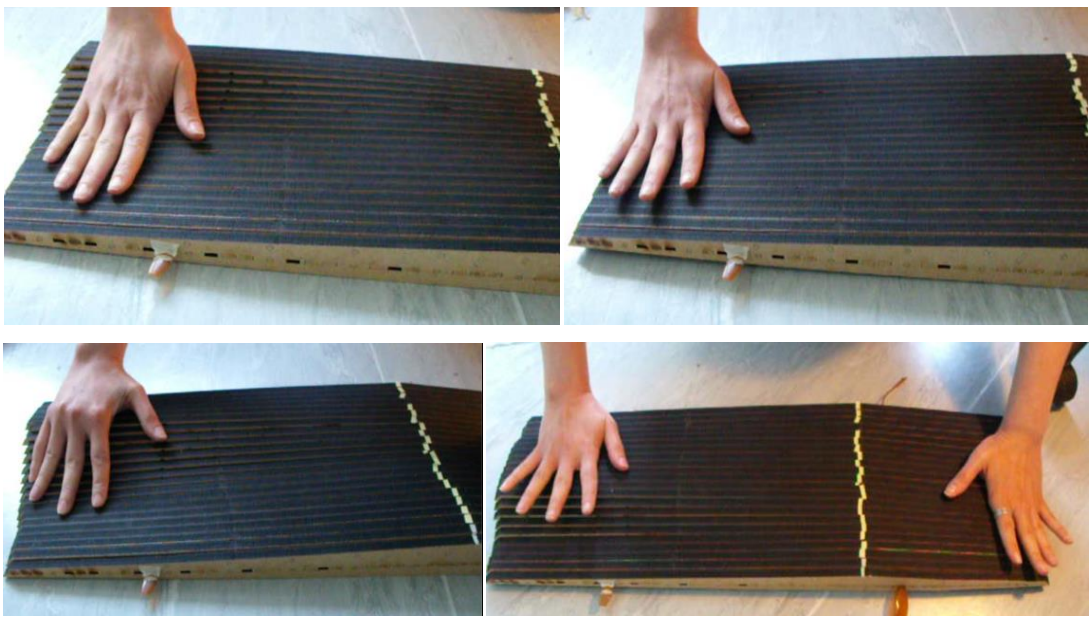

Figure 75: ***Hand Interaction with Collapsible Structure of Wooden Segments*** **(Said, 2014)**

Before I do so, I make a small-scale prototype to explore another digital fabrication method of 3D printing. The experiments with CNC laser cutting speed up the production processes of the segments considerably. It would have otherwise been much more time consuming to use the traditional tools that I used to produce the slotted wooden structure;

[19] The videos are in CD folder: *Experiments – Small-Scale Collapsible Floor – Studio Experiments.*

namely, a band saw. I therefore explore how 3D printing tools can facilitate the fabrication processes of my collapsible structure.

5.5.2.2 **3D printing prototype**

Similar to the CNC cutting method, 3D printing fabrications also require building the model digitally beforehand. With help of Diego Zamora Barroso, a PhD colleague whose research focuses on innovative design tools, namely, 3D printing, I create a small-scale model of the same structure. In this experiment both processes of making the segments and assembling them are compressed in one. The elastic strips, that connect the segments, are placed half-way during the fabrication processes of the segments (see Figure 76) (a video recording of this experiment is included in the CD enclosed with this thesis).[20]

Figure 76: ***During the Making of a Collapsible Structure Using 3D Printing*** **1 (Said, 2014)**

[20] The video is in folder: *Experiments – 3D Printing Prototype.*

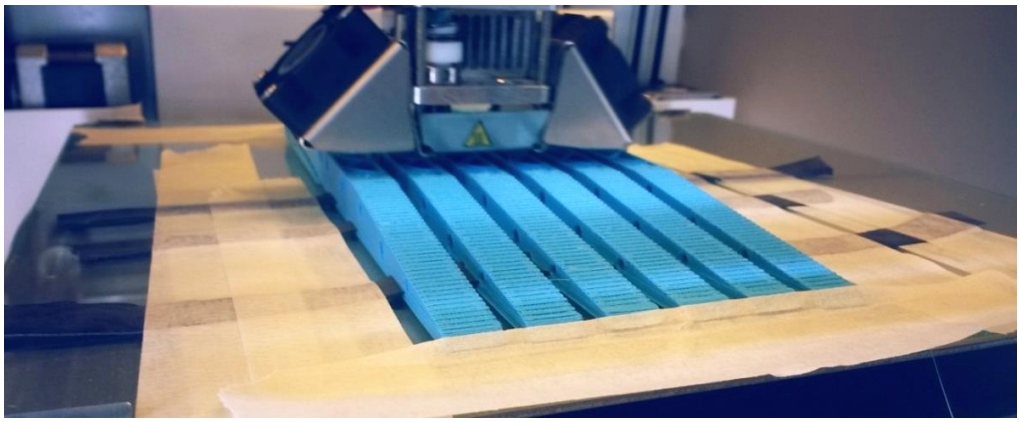

Figure 77: ***During the Making a Collapsible Structure Using 3D Printing*** **2 (Said, 2014)**

The 3D printing innovative fabrication tool facilitates the production of such a collapsible structure. See Figure 77 towards the end of the process of making a collapsible structure. Such a method challenges the limits of conventional production by making the process less time consuming and reducing the time needed for assembly.

Considerable 3D computer geometry is required for 3D prototyping. 3D printing prototyping shows signs of a time-effective contribution to the production of complicated collapsible structures and models; however, the nature of the data is not quantitative to be able to determine such claim. Another notion to extract from this rapid prototype experiment is that the remote nature of building forms through 3D printing removed my ability to engage with form changing and adjustment through the tactile sculpting of a physical material, as seen in the moulding experiments. These issues can be a subject for further studies in future. However, this case study is to validate the implication of using the framework of collapsibility in practice to guide form-making of impermanence.

5.5.2.3 **Large-scale prototype**

In this experiment, I make the same collapsible structure of woven wood segments (wood segments, foam and elastic ropes) but on a larger scale. Figure 78 shows a CAD drawing

of the side view of a segment, and how the segments are stacked and connected with elastic ropes. The structure forms a floor surface with an uneven surface. This floor has a slight curvature in the shape of a three-dimensional fold structure. Each segment therefore has a different shape depending on its location within the fold. Figure 79 shows a digital simulation of the collapsible floor model in its neutral state, while Figure 80 and 81 shows two perspectives of the collapsible floor. Both are digital simulations of the changes in the floor configuration if forces are applied.

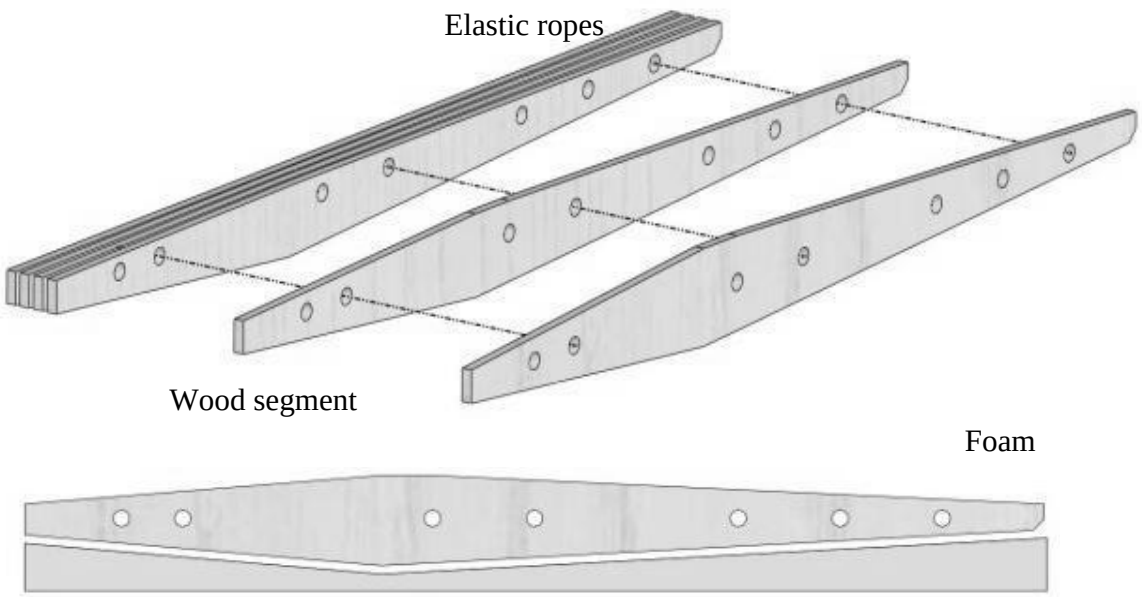

Figure 78: ***CAD Drawing of Wood Segments*** **(Said, 2014)**

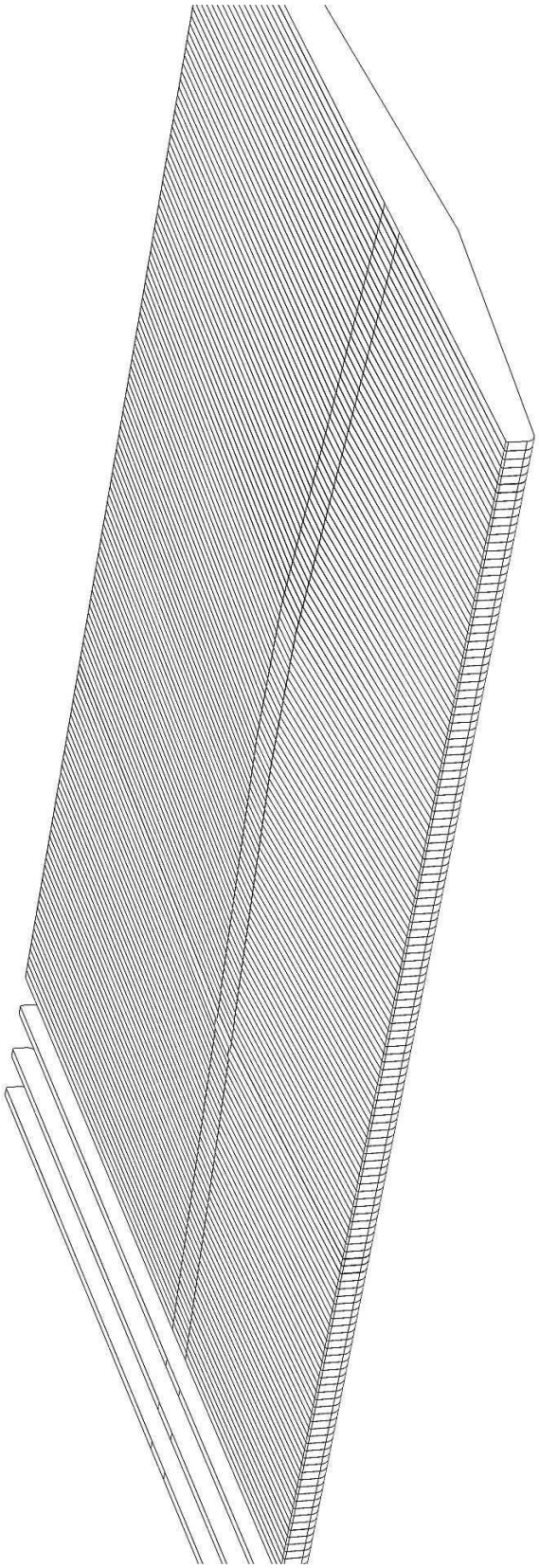

Figure 79: *Digital Simulation of the Collapsible Floor Model in its Neutral State* (Said, 2014)

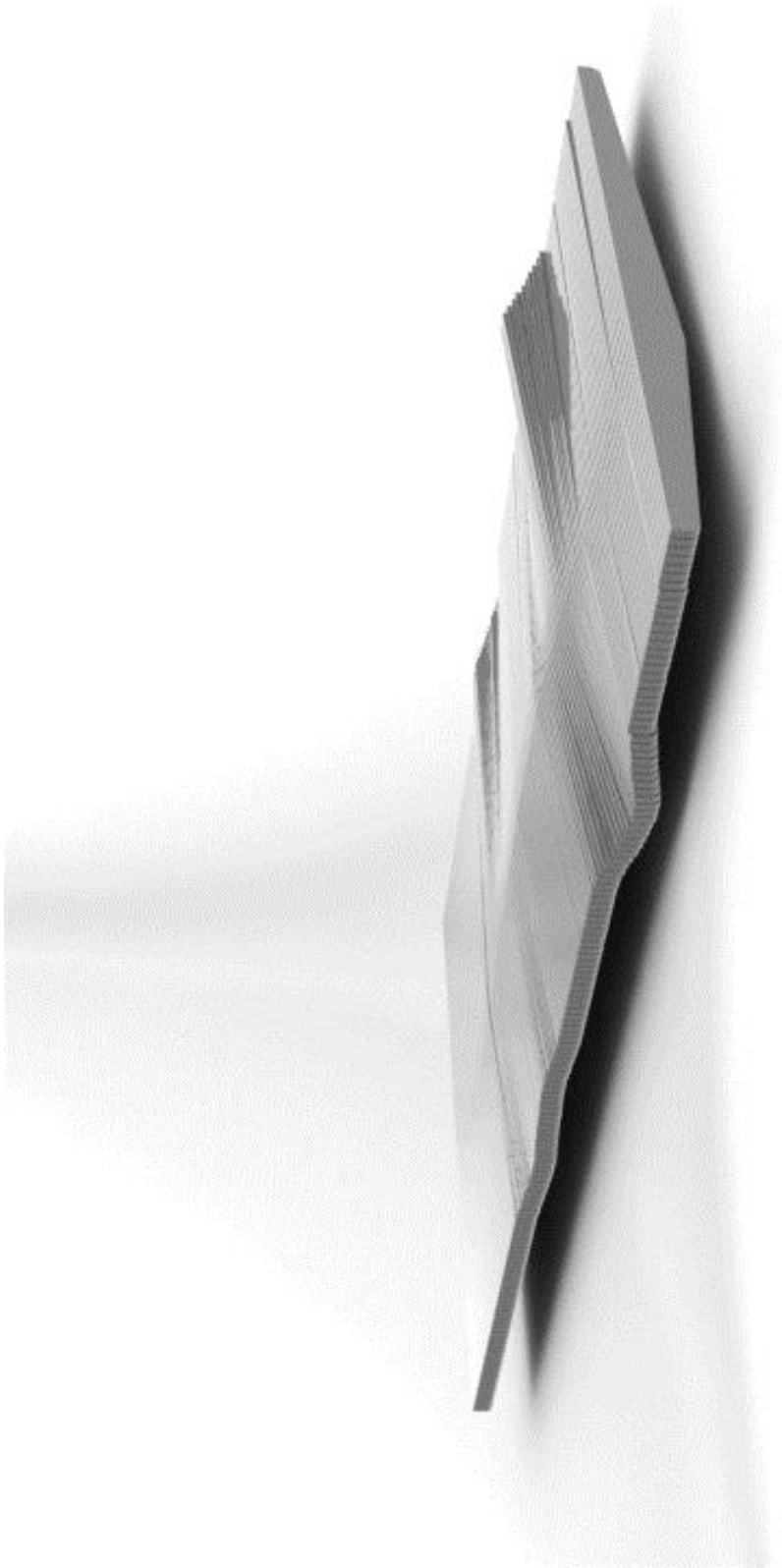

Figure 80: ***Digital Simulations of the Floor Model if Forces Are Applied*** **1 (Said, 2014)**

Figure 81: ***Digital Simulations of the Floor Model if Forces Are Applied*** **2 (Said, 2014)**

This digital model is then used to cut the segments using the CNC machine. I cut 150 pieces of resin-coated plywood; each is 18 mm thick. The segments are connected with high duty elastic ropes. Large pieces of foam of various shapes and density are placed underneath. The ropes allow coordinated movement between the segments when forces are applied, while the various pieces of foam enable the segments to recover their positions after the forces are removed. Figures 82, 83, 84, 85, 86 and 87 show several stages and details of the assembling process of the prototype until finishing.

Figure 82: ***Setting Up the Collapsible Floor Prototype*** **(Said, 2016)**

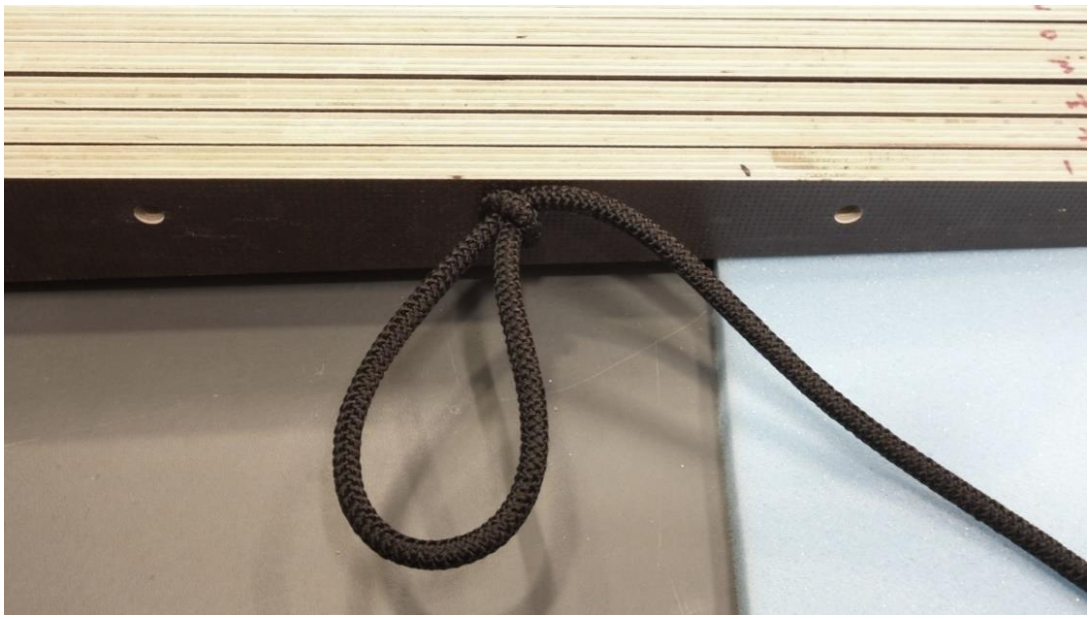

Figure 83: ***Detail of the Elastic Rope that Connects the Wooden Segments*** **(Said, 2016)**

Figure 84: ***Tightening the Ropes that Connect the Segments*** **(Said, 2016)**

Figure 85: *Assembled Collapsible Floor Prototype* 1 (Said, 2016)

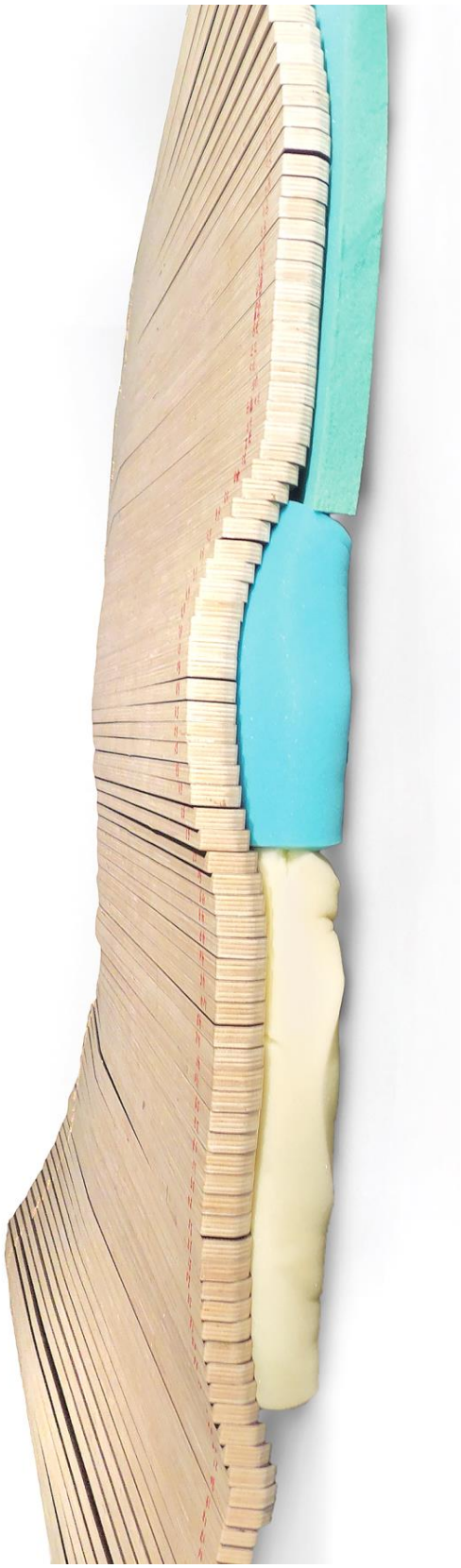

Figure 86: *Side View of the Collapsible Floor Prototype* (Said, 2016)

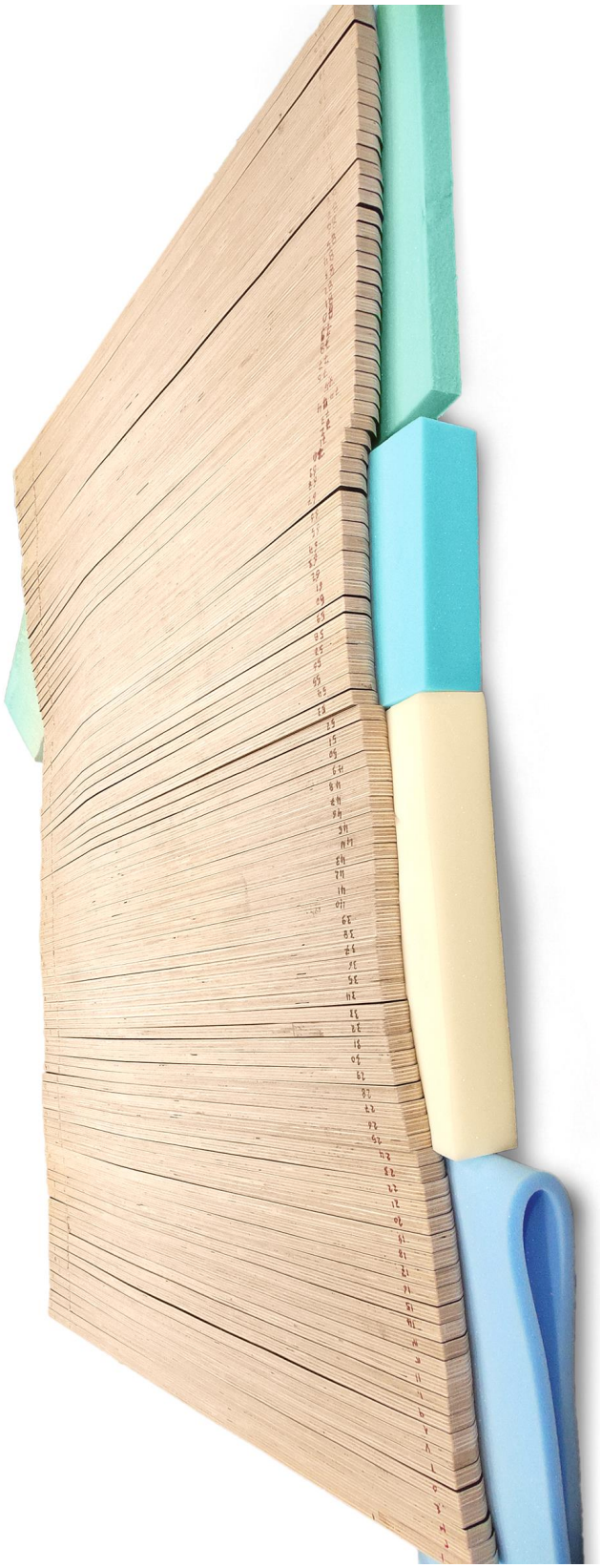

Figure 87: *Assembled Collapsible Floor Prototype* 2 (Said, 2016)

5.5.3 Interacting with collapsible floor

Figure 88 and 89 shows how, when stepping on the collapsible floor prototype, the forces applied cause the segments to rock, the foam to compress and the ropes to stretch. This, in turn, affects the neighbouring segments accordingly. When taking the next step, the foams that were compressed expand back, pushing the segments back up and pulling along the ropes. The interaction with the floor encourage playful activities such as pouncing and rocking (4 video recordings 1, 2, 3, 4 of this experiment are included in the CD enclosed with this thesis).[21]

When two people walk on the floor their movements impact each other. This feature creates a sense of surprise because, if one person applies force on one side, the other side is lifted. Therefore, it impacts on the way the second person interacts with the floor (see Figure 89) (two video recordings 1, 2, of this experiment are included in the CD enclosed with this thesis).

[21] The videos are in the CD folder: *Experiments – Large-Scale Collapsible Floor – Studio Experiments.*

Figure 88: ***Two People Interacting with Collapsible Floor Prototype*** **(Said, 2016)**

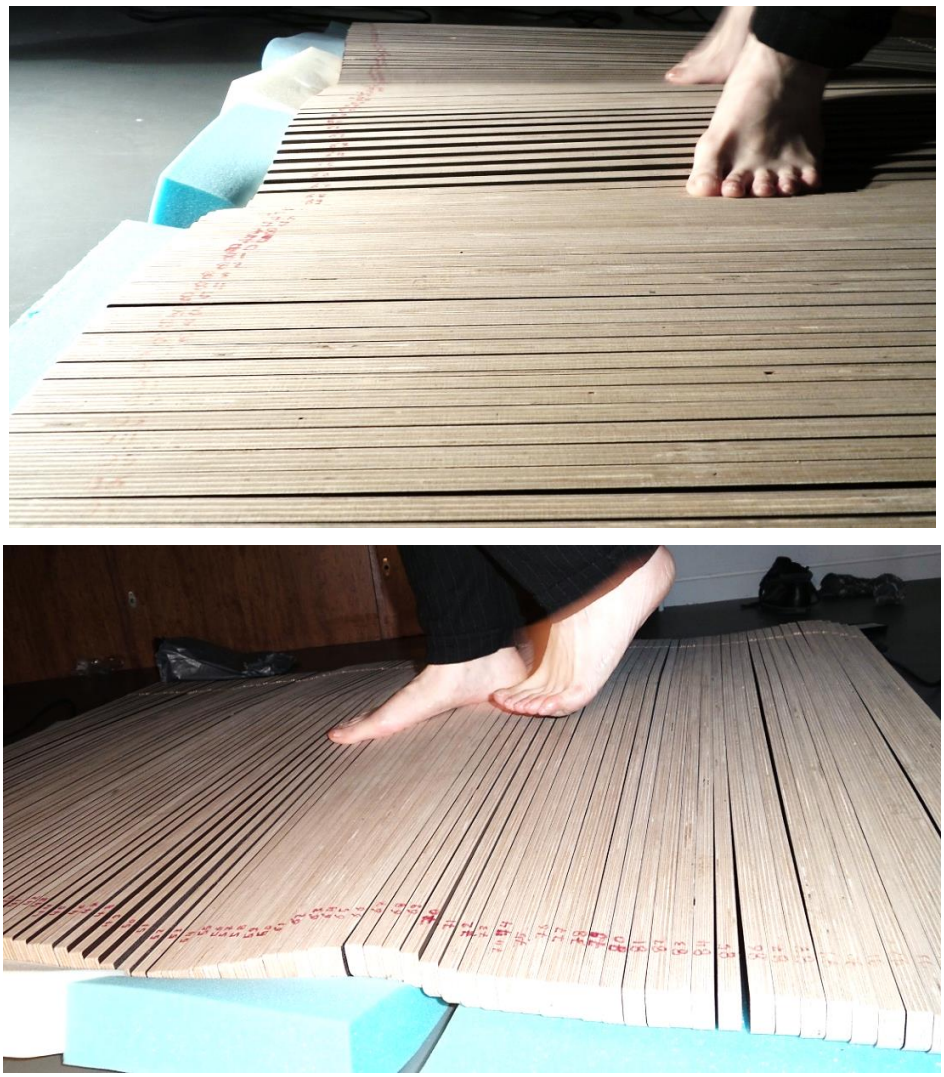

Figure 89: ***Video Images of Interacting with Collapsible Floor Prototype*** **(Said, 2016)**

To explore further how people interact with such a floor, I took the prototype to a public beach. The sea, the sand and nature around, I assumed, would assist in making people more open to interacting with an unstable floor. I also chose the beach because people are often barefoot; this offers closer contact with the floor and therefore a more amplified experience.

At first, most people were apprehensive of walking on an unstable floor; however, as the floor started to respond to their movements, they started to experiment in a playful way of walking and bouncing. The responsive feature of the collapsible floor encourages various physical movements; people started to experiment with a range of walking behaviours to explore how the floor would respond (four video recordings; 1, 2, 3, 4 of this experiment are included in the CD enclosed with this thesis).[22] Figure 90 shows several images of people experimenting, including children.

When more than one person is interacting with the floor prototype, and many forces are applied, the floor responds variably. Some people would feel the floor is slightly raised underneath or folded down unexpectedly. These behaviours are more likely to have been caused by another person interacting with the floor on another side. The floor prompts shared experiences with people on the same surface.

[22] The videos are in the CD folder: *Experiments – Large-Scale Collapsible Floor – Portobello Beach.*

Figure 90: ***Video Images of Interactions with Collapsible Floor Prototype*** **(Said, 2016)**

When taking the foam off and putting the floor directly on the sand the floor still exhibits collapsible behaviours. However, foam compresses when force is applied, then pushes the segments slightly up after the force is removed. The sands only shift from underneath the structure when forces are applied. The void and mass within the sand structure can only be deformed by displacement. In other words, the grains of the sand are shifted and displaced under forces, but do not shift back until new external forces are applied. The structure of the foam, on the other hand, has integral force that allows it to gradually decompress back.

In general, floors are a key factor of feeling stable and secure. According to Abercrombie: "We enjoy the knowledge that the structure beneath us is solid, firmly fixed and level." (1990, p.47) However, the dynamic capacity of the collapsible floor seems to question people's expectation of the stability of the floor. This type of interaction creates a sense of surprise and anticipation among the people interacting with the prototype at the same time. These experiences seem to bring about conflicting feelings, as walking on an unstable floor appears to be an exhilarating, playful and unsettling experience at the same time. To some extent, this prototype demonstrates how fragile our understanding is of security and its relation to stable objects such as a floor. Despite being humans, it means that we are designed to walk on natural surfaces that are not totally firm, even or static, like of sands, grass, gravel, pebbles, soil and mud. The idea of walking on an unstable floor that gives when people step on it, seems to make people sceptical. The instability of the collapsible surface seems to affect the way they relate to surfaces.

The experience of walking on an unstable collapsible promotes new behaviours. The collapsible capacity of the floor transforms it to become actively dynamic, which in turn transforms its relationship with people as they both enter a new dynamic relationship where the interaction between (the floor and the people) shapes and impacts both. The floor behaviours impact how people feel and how they react; hence, the floor, in turn, changes its configuration accordingly, leading to further new interactions.

The form of the floor is produced by the forces people apply. The various forms of folds that emerge on the surface and fade away are temporal forms of temporal forces. The range of folds is determined by the parameters that determined the design of the collapsible structure. For example, in the initial small-scale prototypes, shown in Section 5.5.3.1, the segments are made of thick MDF (12 mm). In the large-scale final prototype, the segments are 18 mm thick. This parameter impacts the shape of the folds of the floor. The thinner the segments, the smoother and more defined the shape of the fold is. Another design parameter is the elastic ropes and how they connect the structure. In the initial prototype, the latex rope was not very tight; this allows the segments to tilt/angle slightly when forces are applied (see Figure 74). On the other hand, the ropes that connect the segments in the final prototype are tight and strong. The rocking segments, therefore, have less freedom to angle/tilts. Similarly, when changing the foam density, this could also affect how quickly the floor recovers its shape. Say, if we were to place metal springs instead of foam underneath, the collapsible floor would bounce back much more quickly.

Schumacher refers to such an approach as "parametric design" (2015). This approach, he says, means designers can typically change one small parameter that causes a change; yet it can cause dramatic changes in the configuration of a space and the way people interact with it. For example, just by slightly changing the direction of a chair you can define a new dynamic and interaction between people (Schumacher, Personal Communication, Feb. 2012) (transcripts are included in Appendix 2, p.16).

5.6 Discussion: Collapsible Capacities Activate New Affordances

Gibson has coined the term *affordances* as the fundamental capacity of a thing that can be discovered in the very process of its use (Gibson, 1979, p.127). According to architect Schumacher, affordances denote potentials. He distinguishes between "actual" capacities that indicate current affordances utilised within a system and "virtual "capacities that have

yet to be discovered. These, he states, are potential affordances that, when actualised, can transform to become an actual function (2012, p.13).

The collapsible capacity of the floor prototype activates new hidden affordances related to new interactions and new communications. By a new affordance of interactions, I mean that the collapsible capacity of the floor liberates its form, so it is not simply a passive object or surface. The design structure and the collapsible capacity of the floor enable it to not only respond to force events but also initiate new events. It is both respective of forces and interactive at the same time. For example, when the floor prototype is positioned on sands without the foam underneath. The structure adjust configuration in response to people walking, but then stays the same until new forces are applied. Whereas when the foam is placed underneath the foam compresses in respond to forces but then initiates another counter adjustments by bouncing back. Experimenting with different collapsible capacities of the floor prototype by changing elements within its structure, appear to impact the way people interacted with the floor prototype.

The floor seen through this lens, 'as collapsible', can contribute to re-shaping people's experiences with a space or a place, by being not only shaped and consumed by people but also an entity that contribute to shaping new experience.

The collapsible capacity activates a new affordance of communication. The floor structure behaves like fabric or a rug that folds and unfolds in response to ever-changing forces. The floor as a collapsible structure become devoted to motion. Such a notion, it could be argued, reinforces the basic concept of the floor as a medium of movement and interaction. This capacity means the floor becomes a communicative and expressive system, with complex yet readable meanings. The **fold events**, as signers, can be read and tell a story about the **force events** or activities that have produced them. A floor as a collapsible event is an expressive site of signs of impermanence and change.

Such a collapsible capacity empowers an element like a floor as it undergoes a transformation in relation to how limited a floor is perceived before. The collapsible capacity enables a floor to produce folds/forms in response to forces. These new folds/forms can be read and interpreted in association with the forces that caused them. On the other hand, when we walk on traditionally designed static floors, their structures do not communicate force events that are applied.

5.6.1 Surface/System

Traditional design approaches to floors lack such a collapsible capacity. In general, floors perceived as surfaces are often perceived to have a lesser significance than deeper and more substantial objects. At the moment it seems that interior designers perceive surfaces, like floors, as a texture, a material and colour that contribute to atmospheres of interiors. There are two approaches to designing surfaces in interior design: 'found' and 'applied' (Brooker & Stone, 2010, p.50) Applied surfaces are used to cover the fabric of existing buildings using various sheathing methods or and materials; stones or wood etc. (Brooker & Stone, 2010, p.50). The found surface is an exposed surface that tells a story to preserve history (Brooker & Stone, 2010, p.50). Such approaches can be seen both limited and limiting. Such approaches assume that surfaces are passive entities.

Glenn Adamson and Victoria Kelley, criticise such approaches to surfaces. In the introduction to their book *Surface Tensions: Surface, Finish and the Meaning of Objects*, argue that skin-deep, shallow, decorative and superficial is the language that conditions our understanding of surfaces (p.1). Kelley argues that contemporary Western culture tends to assume that everything that is important lies in some deep interior and, therefore, a surface is regarded as shallow, lacking in content (Kelley, in Adamson and Kelley, 2013, p.22). She also argues that the surface of an object is often held to be of less significance than an object itself; a surface, however, is the topmost and outmost part of any interaction with an object.

> "Surface is often contrasted with what lies beneath or within, in a series of binary oppositions: surface/depth, surface/structure, and surface/core. Such contrasts often suggest, at least in everyday language, that the real value or interest lies in the second half of the pairing, not the superficial, but the in depth – but what might we find if we stop at the surface and consider it in material and metaphorical terms? (…) Surface is the topmost or outmost layer of an object or substance. It is the part of an object that is most accessible to our senses, often the only part that can be directly seen, or touched, at least at first encounter (…) Many objects have not one but many surfaces, layered upon each other (clothed bodies, lacquered wood): indeed, some objects, most notably textiles, are all surface." (Kelley, in Adamson and Kelley, 2013, p.13)

Similarly, architect Mark Wigley criticises current approaches to surfaces as superficial covers. He says:

> "Architecture turns out to be nothing more than texture. To wear a building, by entering it is to feel its weave. More precisely, to feel the surface is to enter. Occupying a space does not involve passing through some kind of opening in the surface, like a door, to find an interior. To occupy is to wrap yourself in the sensuous surface." (Wigley, 2001, p.25)

More recently, many theorists and scholars comment on the importance of understanding surfaces within their deeper meanings. For example, according to architect Sylvia Lavin, architectural surfaces are vulnerable turning points that are full of potential; they represent the top layer, which is as worthy of attention as an inner depth (2011). Similarly, artist and photographer Sandra Plummer states that surface is "*not to be read in opposition to depth or as a ground on which events unfold. Rather, a surface is a place of continuous unfolding and becoming that enters into composition with the effects that cause it*." (Plummer, 2007, p.240) Deleuze argues that "everything that happens, and everything that is said happens or is said at the surface" (Deleuze, 2004, quoted in Plummer, 2007, p.240). Gibson also assigns great significance to the meaning of surfaces in relation to interaction. He says:

> "Surfaces are where radiant energy is reflected or absorbed, where vibrations are passed to the medium, where vaporization or diffusion into the medium occurs, and what our bodies come up against in touch. So far as perception is concerned, surfaces are therefore 'where most of the action is'." (Gibson, 1979, p.23, quoted in Ingold, 2011, p.22)

In a lecture (April 2015) titled *What If the City Were an Ocean, And Its Buildings Ships?* at Edinburgh College of Art, Ingold raises many concerns about the general misleading perception of surfaces/floors/grounds (three audio recordings 1, 2, 3 of this lecture is included in the CD enclosed with this thesis).[23] He argues that our perception of the concept is very fragile. This is because it is a very intricate issue to define where the surface starts and where it ends. Surface is a problematic notion (Ingold, Personal Communication, 2012) (transcript is included in Appendix3, p.30).

What these views aim to demonstrate is that in surfaces of interiors are of great importance. However, current approaches to surfaces, such as floor, are limited. A surface as an interactive and expressive site through the lens of the concept of collapsibility seems to offer wider possibilities for interactions. In other words, the floor surface perceived as a collapsible system as seen in the floor prototype suggest a greater design role involving people interactions. Implementing such an approach within interior design would transfer interiors to complex sites and dynamic systems. I believe that surfaces of interiors, including floors, are to be seen as noteworthy systems, where all the events can unfold and fold.

To design floors as eventful collapsible systems can be seen as an unattainable and a hard task using the same knowledge and skills required to design floors as practical or

[23] The lecture is in CD folder: *Tim Ingold – Lecture and Interview.*

decorative covering materials seen in industry. Surfaces as systems of interactions, seen in the collapsible floor, require skills and knowledge that extend beyond interior design. For example, a floor as a collapsible structure requires an interdisciplinary approach that involves engineering knowledge of material capacities and structure, and also engineering software and computer modelling processes. In Section 5.3 of Creative Floor Projects in Art and Design Fields, some of the collapsible behaviours involve an interdisciplinary team's knowledge and range of skills, from interior designers, product designers, semioticians, artists and engineers. In comparison, interior design roles within the floor industry, as discussed in Section 5.2, are often a matter of designing a flat covering material, which is both functional and decorative. The knowledge and skills required to design flooring products seem limited to textures and patterns.

Given the limitation of skills and roles of interior designers within floor industries, the collapsible floor approach underpinned by the notions of force events, fold events, and collapsible capacities) provokes more questions than answers about how to process it within industry. Such an approach disrupts the usual course of people's interaction with the floor. The instability of the floor seems to create new meaning that challenges the assumed identity of the floor as stable and permanent in form. The interaction, in other words, challenge many of the given cognitive, aesthetic and social expectations stable floors represent. The floor as collapsible (non-stable) can be seen as a radical idea. The collapsible floor serves to challenge our designers' views, and also questions humans' comfortable set of ideas about what a floor is.

5.6.2 Fictional/disruptive design

On a positive note, the conventional attitude of industries can be challenged through appealing themes such as fiction. Such themes, as discussed in the section concerning Forbo (Section 5.2.2), can engage industry with innovative ideas because it is thought of as a marketing tool, which can reflect a manufacturer's pioneering and futuristic vision.

The fictional collapsible approach allows me to negotiate my position more as visionary; thus, empowering my limited role as an interior designer within such an industry.

Similar approaches are emerging in design recently under the umbrella of the themes of disruptive design (Moser, 2014), futuristic design (Near Future Lab, Bleeker, 2009; Design Future Lab, Koltick, 2013), or fictional design (Bleeker, 2009; Sterling, 2009). Such themes extend and shift humans' perceptions from what is accepted as reality to what is perhaps a possible scenario (Dunne and Raby, 2008). Such approaches, Anthony Dunne and Fiona Raby, in their book *Speculative Everything* (2013), argue, embrace speculations and push fixed norms beyond their limits; thus, assisting in gaining insights (Dunne & Raby, 2013). Such tools involve asking strategic questions including 'What if?' and 'What could be?' To ask 'What if?' Rajchman (1998) argues, is to stimulate possibilities and provoke new ways of thinking, designing and interacting with spaces.

On the one hand, the collapsible floor prototype itself is not necessarily progress towards an industrial prototype. Here the prototypes of floor serve to explore the applicability of my framework on the concept of collapsibility in challenging static and passive design ways of thinking and designing. Removing the prototype from its production context, the prototype is an explorative design to challenge the permanent and unresponsive forms of traditional floors, which humans interact with daily.

This study does not imply that every surface in the interior, including floors, should be collapsible and the design should not be taken or read as evidence for good floor design. What I aim to demonstrate is that permanent structures, in many cases, can paralyse the potential for new designs, expressions and possibilities.

On the other hand, I believe that collapsibility can be seen as a design tool to make sense of form and designs of objects. The prototype experiments and people's interactions provide new insights into force events as the driver of new aesthetics. Collapsibility is the capacity to produce these new aesthetics of objects. Such an understanding of aesthetics

can bring about a new dynamism in interior design. In other words, the form and meaning of the collapsible floor are not fixed. A floor configuration is never the same. With every step and force applied, different folds appear. Not at any time will the form of the floor look exactly the same. In fact, it is hard to recreate the same configuration again or reposition the segments in exactly the same place, as every force applied produces a unique system of folds. The forms and aesthetics of the floor in this sense are predetermined by the interactions and forces applied. These forms and aesthetics are within a range of parameters that designers can determine. This is to say that interiors and elements within a collapsible event of pressures, pulls, twists, rolls, turns, stretches and squeezes brings design of interiors away from aesthetics of geometrical abstraction. A similar approach to a non-geometrical aesthetic is discussed by architect Thomas Thiis-Evensen in his book *Archetypes/Architecture* (1987). Thiis-Evensen locates the nature in meaning of the structures in three non-aesthetic qualities of motion, weight, and substance (Wilwerding, 2013, p.83).

In line with this, Le Corbusier argues that engineering principles are progressive where other ones that are based on style and taste are a move backwards (Le Corbusier, 1974, p.7, quoted in Sparke, 2004, p.90). Abercrombie (1990) argues that shapes and geometrical visually pleasing forms should not be the main driver for successful experiences of interiors. Collapsibility as a new interior design approach to design forms that are active and responsive can enhance and enrich people's experience of space. In every drawn line, interior designers make an assumption about how people use or interact with the built environment. Architect Gary Moore argued in his paper *Environment – Behaviour Studies* that behavioural factors can go beyond a function to the dimensions such as psychology of the users, interactions, meanings and perceptions (Moore, 1979, p.47). In many cases, however, architects' design assumptions are uninformed of such dimensions (Moore, 1979, p.47).

5.6.3 **Floor as Collapsible Event**

To activate collapsible capacities of an object or a structure is to enable it to become receptive to forces; therefore, extending its affordances to become more interactive and communicative. The collapsible capacity of the floor allows it to generate a wide range of expressions in response to forces; thus, it becomes communicative.

To design a collapsible floor means that to focus on perceiving, interpreting and designing interaction with a floor as an 'event' rejects the belief that it is an object, and to return to the sense of what a floor is, i.e. as a folding event and a 'subject' of interactions.

A surface as a collapsible event is not a superficial layer or a passive outer layer, but itself should be perceived in positive terms as a complex system of interactions. The collapsible capacity empowers an element, like a floor, by fusing both the object (i.e. a surface to walk on and navigate) and the subject of interaction (i.e. the event of walking) together. In other word, the floor through the framework of collapsibility collapsible is not only to be understood as events of folding/unfolding/refolding forms, but also understood as events of folding/unfolding/refolding interactions.

The main task of this experiment is to examine how the conceptual framework of the concept of collapsibility can contribute to a new design process that challenges current approaches of stability and permanence. The design of the floor prototype, while reflecting key elements of the concept of collapsibility force, fold, and collapsible capacity, shows that by activating the collapsible capacity the floor is able respond to force events through fold events. The floor form is impermanent, and it is never at any stage exactly the same. The segments of the floor move each time there is some step, which in turn changes the form of the floor. The timescales of the collapsible event of the floor depend on the relationship between the floor's integral forces and external forces. For example, the foam (underneath the segments of the floor) allows the structure of the floor to bounce back more quickly than when the sand is underneath.

This experiment also shows that material rigidity and constraints do not have to be understood as limitations to collapsible capacity, but rather as parameters that can help determine the value of collapsible deformation, as seen in refinement of the slots' size and segments' width. Void as a key parameter in the structure of the floor, seen as slots or bubbles in foam, in material density, offers significant advantages over the consistency of mass in common floor deigns. Its variation produces a gradation of collapsible capacities and in resistance to the force. This notion gives rise to the significance of considering void in designing collapsible structure. In this sense, void is not the same as a gap in structure to be filled, but to be designed.

Considering three elements; 'collapsible capacity', 'fold events' and 'force events' will allow new design possibilities for interiors that challenge current assumed principles of stability and permanency. As a framework these elements are connected through a semiotic relationship that is readable and expressive. For example, the floor becomes expressive of what is happening on its surface because of its collapsible capacity to respond and engage with forces. The fold events become signifiers of time. The floor form is constantly unfolding, folding and refolding in time. It is only through time that a collapsible event can be encountered. Designing collapsible events means designing impermanent gestures and expressions as they occur in time. The collapsible event becomes an expression of impermanence and change events.

Using the framework of collapsibility as a design method helps defuse the tensions between an object (the floor surface) and subject (the interaction namely walking). The floor as an object (a surface) becomes transparent when collapsible capacity is activated. The main subject of the floor, seen as walking and navigating, becomes the focus. The relationships between people and the floor therefore become the focus of attention through folding and unfolding events of the floor. While the object of the floor as a passive surface of covering material fades into the background of these events.

The concept of collapsibility as framework provides an instant coupling between an object and its subject during a ‘collapsible event’. This merge can be seen as what Lefebvre refers to as a ‘super code’: “A code of this kind must be correlated with a system of knowledge. *It* brings an alphabet, a lexicon and a grammar together within an overall framework; and it situates itself… [between] the *lived* and the *perceived*.” (Lefebvre, 1991, p.65).

Collapsibility, as a new lens, can assist in challenging current interior design approaches of floor and surface from static and permanent. It challenges common design approaches by challenging everyday experience, as it opens a new paradigm of reflexivity and interaction.

5.7 Summary

The framework/formula of the concept of collapsibility of forces as fold/form-giving and collapsibility as capacities for fold/form-making expands my understanding of materials’ capacities. It assists me in uncovering a collapsible capacity of a rigid material like wood. This concept as a new approach, can be seen as a design tool that pushes the power of form and meaning-making forward within built environments. The understanding of a collapsible event provides an insight into the very forces that cause it and therefore an evolution of new theory of design aesthetic of impermanence begins.

In summary, floors, in their current design approaches, as well as many similar passive and permanent design surfaces, represent a great canvas for exploring new possibilities of interactions within interiors. Collapsibility as a new design approach offers a new tool in the form of a design formula for understanding impermanency and designing a responsive structure. The purpose for such an approach is to enhance people’s experiences of built environments.

"What if we thus said that at no time can we ever be quite sure what our bodies can yet do, our lives become, the shapes they might assume, the spatial arrangements into which they might enter."

(Rajchman, 1998, p.1)

Chapter 6 **Research Conclusion|Collapsibility: New Interior Design Approach**

6.1 **Restatement of Research Hypothesis**

This research started by posing the question: How can an in-depth understanding of the concept of collapsibility contribute to interior design processes so that it challenges currently assumed principles of permanence and stability?

Debates attended by experts and scholars in design fields collectively address the need for well-formed frameworks for understanding dynamic notions such as change and impermanency (as discussed in Chapter Two).

In this thesis, I challenged established architectural frameworks upon which interior designers rely in Chapter Two; in particular, the *Shearing Layers of Change* framework of a building by theorist and architect Stewart Brand (1994). Such a framework, I argued, lends primacy for permanence and the fixation of structures over impermanency and ambiguity of reality. This is by mistakenly assuming that building systems and changes within them are physical matters, defined within fixed boundaries of layers, and can be calculated.

I therefore pointed towards alternative approaches that acknowledge notions of impermanence such as established theories of ‘folds’ by Deleuze (1993) and the concept of ‘soft logic’ by Serres (1991). Such theories offer a dynamic way of thinking about built environments. However, I argued that their abstract knowledge is hard to render into design practices without constructive formworks or a formula. In view of that, I proposed that researching the concept of collapsibility can provide a framework that helps decode the abstract knowledge of such theories into practice.

In Chapter Three. *Exploration of Collapsible Events*, I studied the etymology of the word 'collapsibility' and analysed collapsible events in various contexts of everyday life to deepen my understanding of this concept. The etymology of the word 'collapsible' expanded my vocabulary and widened the scope of the research, providing insights about collapsibility manifesting as a system of intermediary events instead of dual (for example, fold and unfold). The semiotic analysis revealed that understandings of fold events of objects are inseparable from, and arise through, understanding their collapsible capacities. In addition, the workshop *Exploration of the Everyday Collapsible Acts* uncovered a new conceptual dimension of collapsible events such as sound, air pressure and heat wave expansion and contraction events. When I began to understand in depth how collapsible events operate, I began to realise the extensive range of hidden conceptual collapsible events around us that happen at various scales in time, nature and size.

To understand how collapsible events operate within a larger scale than an object and more within a system, I analysed the tensegrity of the collapsible system of the Bedouin tent in the fourth chapter, *Bedouin Tents Case Study: Semiotic Analyses and Practical Experiments.* Both the semiotic analysis and the practical experiments within this case study expanded my understanding of how collapsible events operate as a system of folds and force. This case study also revealed that activating the collapsible capacity of an interior element, like the rugs in Bedouin tents, extended their affordances to become a communicative system of impermanent events. This understanding I constructed in a framework-formula that stands for forces as fold/form-giving and collapsibility as capacities for fold/form-making. A set of principles underpinning the framework of the concept of collapsibility extracted from this formula. These are:

- **Fold event**
- **Force event**
- **Collapsible capacity**

Reflecting on these principles, in Chapter Five, *Collapsible Floor Challenging Design Principles of Stability and Permanence,* allowed me to explore and understand different

levels of collapsible capacities of materials and structures. It also enabled me to challenge rigid materials such as wood by activating their hidden collapsible capacities. These material experiments gave me insights that I then used in designing the collapsible floor structure of both rigid and soft materials.

The collapsible capacity of the floor prototype enabled it to change its forms/folds in response to people walking. By enabling a floor to respond to forces, its affordance was extended to enter into a dynamic relationship with people walking on its surface. Such a collapsible capacity proved to extend the communicative and interactive affordance of the floor. The floor, as a collapsible event, transformed to a site of impermanent expressions of folds. Traditional floors of assumed principles of stability and permanence lack a collapsible capacity, and hence lack these affordances too.

I have therefore concluded that the framework-formula concept of collapsibility as a new approach can be fed into design matters concerning understanding and designing impermanence. Thus, challenging the assumptions of permanence and stability in interior design. This is by extending affordance and capacities of elements of interiors to change configurations in response to forces.

The pie chart in Figure 91 below illustrates, with pictures, the key investigations and practical explorations that contributed to the conclusion of this thesis.

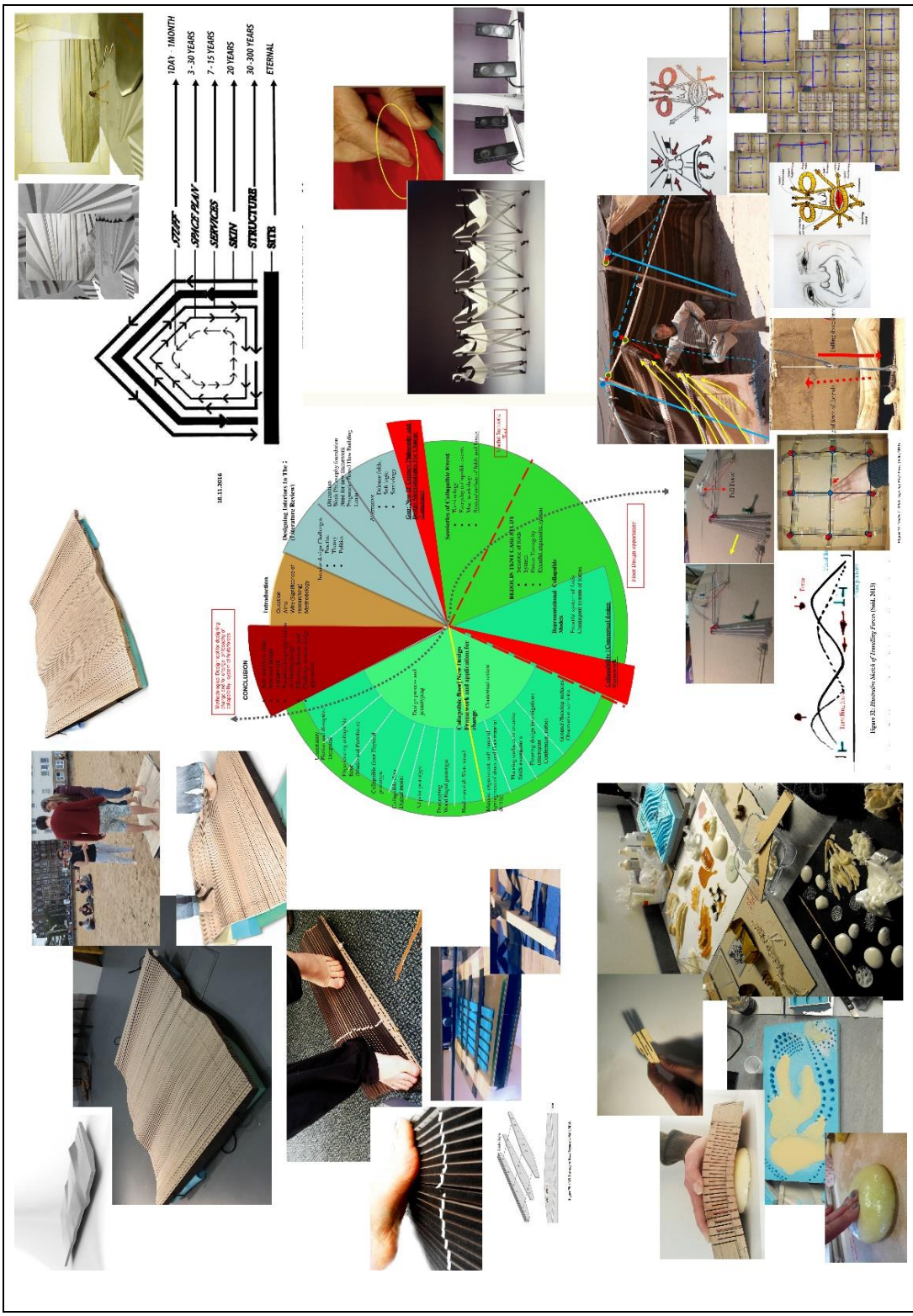

Figure 91: *Pie Chart of the Whole Thesis* (Said, 2017)

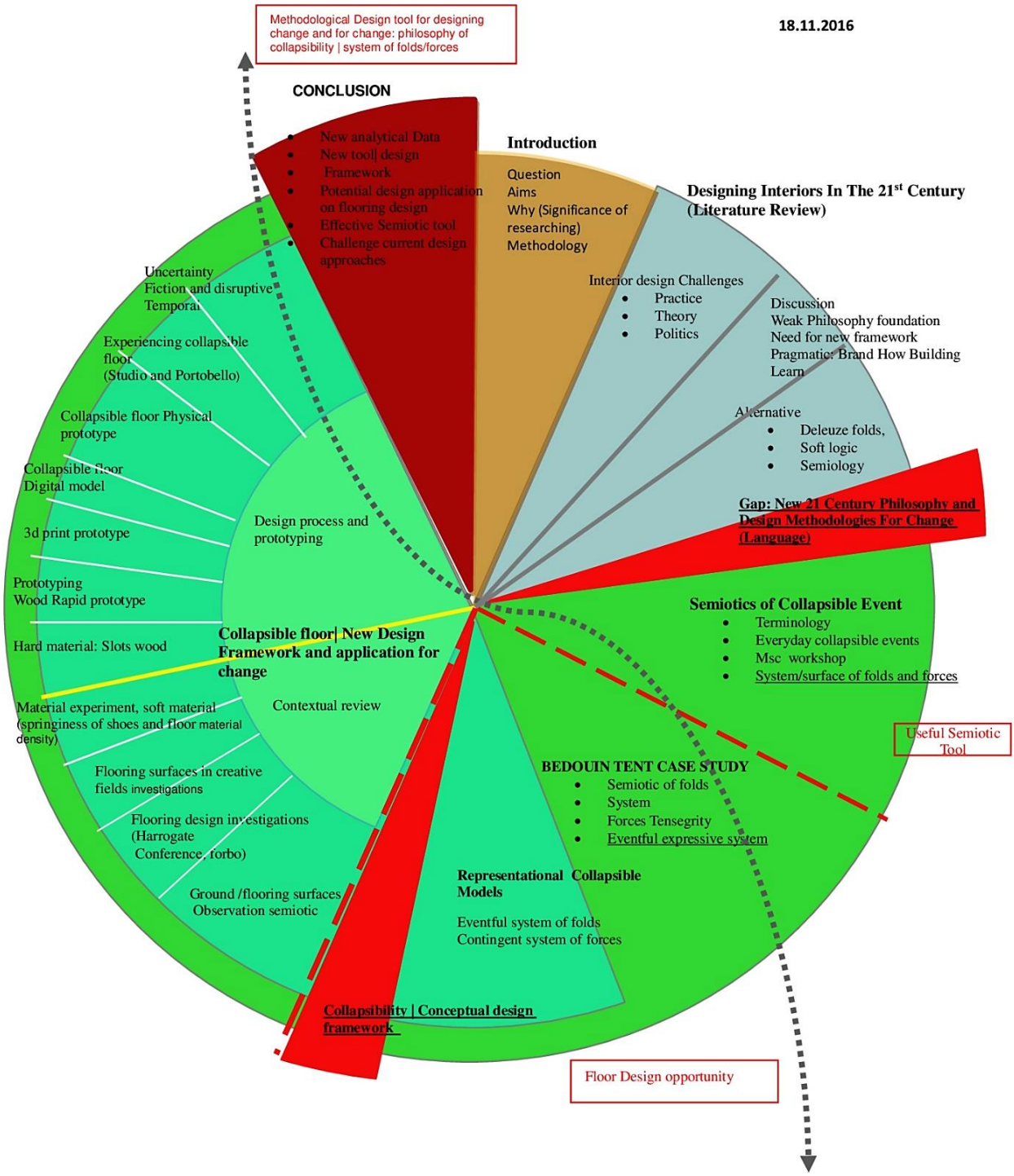

Figure 92: ***Close-Up Pie Chart of The Whole Thesis*** **(Said, 2017)**

6.2 **Limitations of the Study**

Constructing a coherent research methodology with a wide scope was a challenging task, especially in the absence of research that studied the concept of collapsibility in depth before this.

The flooring design experiments revealed potential related to o the area of ergonomic research related to feet. This notion highlights an ergonomic design potential related to a foot's interaction with floors. That is to say that shape and curvatures of human feet suggest different designs of floors other than flat and rigid. However, the nature of the data provided by the design practice experiments of flooring, unfortunately, does not allow us to determine or be certain whether such designs have any ergonomic benefits for foot health. To design collapsible floors that can bear people's weights and respond without breaking required engineering knowledge that I lacked. On a positive note, it highlights the significant role interdisciplinary work has to play in the future of interior design discipline.

6.3 **What I Learned**

Through this research I learned that in order to design for a world characterised by change, designers need to embrace change that involves impermanency of forms and not change as replacements. Researching in depth the concept of collapsibility provides a framework to understand, and therefore design, notions of change and impermanence that are not reduced to replacement. Collapsibility is a form-giving capacity. Objects as collapsible events are impermanent expressions of temporal social, functional, physical and natural force events. For example, floors as collapsible events are in a constant state of readiness to fold/unfold/refold in order to express new forces.

6.3.1 **How did I use this knowledge?**

As an interior designer, I aspire to create thoughts and designs that can enhance and positively impact people's experience of a space. In this research, I assert the significance

of notions of impermanence in design. The purpose is to influence the way interior designers design interiors as dynamic; thus, positively impacting people's experience of interiors. For example, people's interaction with the collapsible floor prototype influenced the way they walked and animated their bodies and sometime how they felt. Such experiences are usually eliminated when walking on a stable, passive floor.

6.4 **Research Outcomes**

This research shifts design approaches of the concept of collapsibility outside the teleological understanding as a mechanism for objects. Collapsible objects usually have predefined functions such as space saving, storage, convenience, transportation. Collapsible events as seen in Chapters Three and Four, provide two insights. The first is a continuum of folding/unfolding and refolding events. These are seen as manifestations of impermanence. The second provides a new framework-formula, based on the concept of collapsibility for thinking and designing impermanence and change. This framework is underpinned by three notions; force events, fold vents, and collapsible capacity. And its formula stands for forces as fold/form-giving and collapsibility as capacities for fold/form-making.

In Chapter Five, the collapsible floor project was not designed with an intention to be a finalised product. The design project is experimental and serves to explore the practical application of the framework-formula of the concept of collapsibility. Insights that are derived through the process of designing a collapsible floor, however, can be seen as original contributions to design knowledge that challenges common passive and permanent design approaches to floors.

This approach extends Otto's form-finding to opens a new realm of form possibilities and continual discovery of form. For example, through the lens of collapsible events the floor prototype experiment demonstrated how forms are not found, but 'forms occur'. The form of the floor through the lens of collapsible events is transitory/impermanent. It constantly emerges through fields of force.

The concept of collapsibility decodes philosophies such as *The Fold* and *Soft Logic* into physical forms. This framework-formula serve as a super-code that bridges the gap between the conceptual and the physical knowledge of such theories through connecting the understanding of notions of folds, forces as events and the collapsible capacity. This thesis showed that understanding 'folds' through the ontology of collapsible events assigned more primacy to 'folds' as 'events/processes' of folding, unfolding and refolding instead of 'folds' as 'forms'.

The ontology of the word collapsibility, this thesis shows, offers some advantage in communicating a specific meaning of impermanence as folding, unfolding and refolding again and again. For example, in the workshop '*Everyday Collapsible Acts'* the word 'collapsible' informed the participant students' new understanding of change events. The term 'collapsible events' proves to evoke a unified meaning through the drastic reduction of a system of events into one expression.

This framework-formula helped in designing a floor as a 'collapsible event'. This approach embraced impermanence of both the form and the meaning of floor. Such an approach proved to pushes the power of form and meaning-making of design aesthetic of impermanence forward within interiors. Such strategies have not fully developed yet in the discipline of interior design.

Reflecting on the methodology of this thesis, both semiotic analysis tools and design practice prove resourceful.

6.4.1 Semiotic analysis

Because of the lack of research on the subject of collapsibility, the journey started with observing and analysing collapsible events, mainly using semiotic analysis. The semiotic analysis in Chapter Three and Four serves in generating new data. This initial semiotic analysis helped to uncover a wide spectrum of collapsible events. Analysis then revealed that collapsible events operate through a system of force events and fold events. The

semiotic analysis also assisted in locating new design opportunities related to surfaces/floors/rugs (explored in later stages in Chapter Five).

In Chapter Four, the semiotic analysis provided insights into understanding the connection between notions of folds, forces, and collapsible capacity. In other words, the framework of the concept of collapsibility connect notions of folds, forces and collapsible capacity through the constructive system of semiology. The semiotic nature of this framework serves as a deliberate tactic to bridge the key concepts of this research: fold, force, collapsibility and impermanence. The semiotic analysis was an instrumental tool in discovering key principles of a collapsible event. But more importantly, semiology through the understanding of signs, signifier and signified explains how these principles are connected (see table below). Semiology was not only a means to an end to analyse collapsible events, but also a key method that connects syntax of the framework of collapsibility as illustrated in the table below. The semiotic analysis table used for analysing collapsible events also contributes to the conception of a new theoretical framework of the concept of collapsibility. Semiology was the grammar that holds these principles, forces, folds, collapsible capacities, to form the meaning of the framework of collapsibility. This notion reveals a significance of the use of semiology in interior design research.

Signification: Impermanence change event	
Signifier Fold event	**Signified** Force event
Sign Collapsible capacities	

The Framework of The Concept of Collapsibility **(Said, 2020)**

6.4.2 **Design practices**

The design practices in Chapter Four served as physical models of collapsible systems, and assisted in verifying, in a practical sense, the finding of the semiotic analysis, and together served to conceptualise the framework-formula of the concept of collapsibility. Whereas the design practices in Chapter Five, namely the collapsible floor and material experiments, serve to demonstrate the practical design applications of the conceptual formula of the concept of collapsibility. Other material experiments, in Chapter Five served to gain experiential knowledge of material collapsible capacities. This knowledge proved to be very useful in later stages during the design process of a collapsible floor.

The practical experiments of collapsible floors show that the formula served as a design tool for new design aesthetics of impermanence by extending interactive and communicative affordances of objects/system.

The collapsible floor prototype demonstrated the value of using the framework of collapsibility to reflect on notions of impermanence by establishing how the key elements of the framework of collapsibility, fold events, force events and collapsible capacity, guided my design reflection of a particular impermanent design, i.e. the collapsible floor.

My prototype of a collapsible floor, in comparison with some of the existing floor projects undertaken by others discussed in Section 5.3, might seem, on the surface level, similar. However, in this research the thought-making processes and application of the formula are what can be considered as original. The prime aim is to provide a design framework to assist with the understanding and designing of change and impermanence in the 21st century, based on the concept of collapsibility. The main purpose of the collapsible floor is to demonstrate how such a framework-formula can guide practical designing processes.

As the practice of designing a collapsible floor is a tool to communicate a new idea rather than to produce new ideas, this approach was sometimes challenging. Being a designer could not help through the processes, but did sometimes help to shift to problem-solving

mode. Throughout designing process experiments of the floor, I found myself sometimes asking questions related to the potential of the application of function, purpose, usefulness to ergonomic design. For example, a sample of materials related to the notion of ergonomics can be found in Appendix 23.

6.4.3 The framework of the concept of collapsibility

Three principles underpin the framework of the concept of collapsibility. These are:

- **Fold event**
- **Force event**
- **Collapsible capacity**

In this research this framework is used to design collapsible floor. Reflecting on these principles in Chapter Five I experimented with material's and structures capacities to express change and impermanence. The framework is not steps to be followed, but more principles to reflect on and their relationship through the processes of designing impermanence or a change.

This framework assisted in exploring new meaning that translates impermanence into forms in ways that can help other designers build many other possible forms and meanings. For example, this framework helped in designing the collapsible floor structure that supports interpretation of impermanence and change. This collapsible floor prototype is not a finished product but should be seen as a new design paradigm that recognises formal and experiential principles of impermanence.

Interiors, seen through the lens of the concept of collapsibility, are never permanent, as everything is in a transitional state, waiting for new changes to happen. Such an approach can open up new ways of designing surfaces as expressive systems that would otherwise have escaped notice.

By reflecting on the principles of the framework of the concept of collapsibility, interior designers, I believe, have a better chance to contribute to new modes of impermanent

design expressions in the 21st century. I believe that interior designers' consideration of the three key principles that constitute the framework, fold, force and collapsible capacity, make it feasible to achieve more balance between practical and theoretical meanings and values of interiors in the 21st century.

This thesis's body of thought is in the form of the framework aligned with architectural/design theory. This framework of the concept of collapsibility can be of interest to those in the creative fields of architecture, interiors, product design and fashion.

6.5 **New Knowledge Contributions**

This research demonstrates a new way of thinking that challenges dominant design assumptions by arguing that it is impermanence rather than permanence that characterises our human condition, and thus should also characterise the design of our interiors. Current interior design approaches either negate changes by using permanent structures, or force changes by encouraging the type of change that involves replacements. Exploring the concept of collapsibility in such detail also makes a timely contribution to the literature, which, to date, has little to offer on this topic. This research provides an alternative design framework based on the concept of collapsibility and is built around understanding forces as form-giving and seeing the capacity in the collapsible for form-making. The framework consists of three key principles: fold events, force events, collapsible capacity. This formula is original because it is based on a new foundation of thoughts and practical observations.

Considering both the theoretical and practical implications of collapsibility, this research contributes to understanding subjects of change/impermanence/temporality and their applications as it continues to emerge within interior design and architecture fields.

6.6 **Recommendations for Future Research**

Semiology can be seen as an important analytical design method in this research, especially when combined with a phonological perspective. However, the potential of

such a tool in fields of interior design is still to be explored further in research through practice. There is an intricacy in using such a tool, as it requires analytical precision with terminology that is rather complicated. However, this research simplifies the use of semiology to the basic elements and levels of signs. Sign is the most important tool in any semiological box, as Rose argued (2011, p.106).

I aspire that my tentative approach to design floors as collapsible will be confirmed as applicable and relevant to ergonomic floor design systems in the coming future. The insight this research provides, in relation to ergonomic floors as collapsible, I believe, is a noteworthy area of exploration in the future.

The floor/rug in the Bedouin case study led me to ask what the effect would be of overturning prevailing assumptions of stability of floors in interiors. However, many new design terrains would be opened up and more questions than answers would be generated when considering this question as part of an agenda for future design research.

I aspire that the design formula of collapsibility this research offers will grow to become a design philosophy that describes the dynamic of the21st century we live in. However, this will not be possible without further research into the subject of collapsibility. Collapsibility as a philosophical design approach, I believe, can serve to understand change events and reflect the troubled, complex, and dynamic conditions we humans perform or are exposed to everyday. For example, stretching/reducing, scrolling/unscrolling a web page, or compressing and stretching information using links.

6.7 **General Outlook Conclusion**

In summary, it is impermanence rather than permanence that characterises our human condition and argues that this should also characterise the design of our built environment. As was noted by Heraclitus, “the only constant in life is change” (535 BC - 475 BC). Modern society nowadays is characterised by the type of change that involves replacement. This idea spilled over into mainstream production of interior design, such as

the floors seen in the Harrogate exhibition. This idea is also implemented in mind of designers.

In this research, I turn to review and assert the significance of a different type of change that implies impermanence of form. Notions of impermanence in the research operate as systems of collapsible events. Such an approach for understanding impermanence proves to have both theoretical and practical competence and relevance in 21st century designs.

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