CONSTRUCTION KNITTING

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ABSTRACT

CONSTRUCTION KNITTING

Construction as a term refers to the building of structural elements in a composition. This practice led methodology devises and investigates a design process that organises the arrangements of these structural elements as geometric shapes and parts for knitting. The design and production of these assemblages are led by principles of the geometric where hand making provides an essential foundation from which to generate innovative approaches for machine and digital knitting processes. The pattern grids of the geometric designs reveal more than just aesthetics, and are analysed as visual apparatus and conceptual tools that decode and simplify the technical complexities and superfluous jargon of knitting. This study considers how such narrative can be integrated into a more generic design dialogue, by referencing the geometric as the basic, primary and universal components of all design.

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ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed: ______________________

Date: 28 January, 2016

ACKNOWLEDGEMENTS

I would like to thank Anthony Chiappin for his constant and continued support, and my supervisor Dr Amanda Smith for guidance throughout this project.

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INTRODUCTION

RESEARCH AIMS

My project investigates working with geometric shapes as a method for knit design. The research seeks to discover how the geometric operates as a visualisation tool, and a design and thinking tool in the planning and construction of knitting.

Looking beyond the field of textiles, the project investigates how the geometric is used as a fundamental design construct, in order to reflect it in the process of knitting. This requires addressing the contextualizing of knitting and the challenges this poses.

This practice based research was developed in two phases and represents 80% of the thesis. The first phase of the research is in the making of small geometric forms to investigate structural, spatial and dimensional concepts of knitting. The research aims to highlight the importance of hand making in the process of understanding these aspects of knitted material and construction.

Through a visualisation process the associated patterns create a trace of the making and assemblage of the knitted shapes.
The research analyses how this trace informs physical reasoning of the constructional elements of knitting, in particular the transition from two-dimensional to three-dimensional composition.

By recording the methodological approach of the procedure, strategies and rules that are evidence of the making process in the first phase of the research, I have compiled visual apparatus and a glossary of design terminologies encountered associated with the geometric. This aspect of the research seeks to show the skeletal grid or system at work beneath the design.

To provide insight into the purpose of this method for knitting, I aimed to translate how it could be used in the second phase of the project, by applying it to garment design outcomes. The geometric is used as the overarching concept across three different knitting technologies; hand-knitting, two-dimensional manual machine knitting and three-dimensional computerised knitting. Thus trialling how the design's visualised geometric counterparts can act as an agency of communication to simplify the complexity of each knitting process.

BACKGROUND

DESIGN EXPERIENCE

Framing this research is the experience that I bring into the project as a designer which has ranged from small artisan studio practice to industrial knitting designer roles in Australia. The Textile Book defines "the Creative" in the textile industry into separate types of design practices such as the "Textile Designer, Designer-Maker, Craftsperson and Textile Artist" (Gale & Kaur, 2002 p.5), where each is identified by the approach to making, associated product and environment of practice. As my design experience has intersected and paralleled along aspects of all of these types of practices I cannot be slotted neatly into any one of their set titles. I can, however, concede that hand-making, being the core interest of my practice fits me into the "rather blurred new categorization of designer/artist/textile professional" (Gale & Kaur, 2002, p. 33).

CULTURAL PERSPECTIVES ON KNITTING

At the inception of this research project, discussions with non-specialist peers of their perception of knitting, fell outside of the "well worn stereotypes ... of old ladies" (Turney, 2009, p. 4), and yet ranged within post-modern associations of (mostly) amateur knitting activated by "craft appellations such as Stitch 'n Bitch" (Oakley, 2014, p. 1); all bound by material associations as "woolly objects" (Turney, 2009, p. 1). But none recognised it as an industrialised manifestation, even though they may be wearing it daily as mass-produced clothing such as underpants, socks, hosiery and t-shirts. Even where the knitting is embedded in the title of the product such as the new Nike 'Flyknit' (fig. 1) fashion sports shoe, the 'knitting' has in a sense dematerialized from appearance to a layman's eye.

Knitting's material poses a problematic frame of reference for this research because it's seeped in "sociocultural meanings" from a non-specialist perspective, and existing "in its own language" from a specialist perspective (Turney, 2009, p. 4). Turney (2009) seeks to emphasize through a series of critical essays "knitting as (it's own) culture" to de-marginalize it from "academic discourse" (Turney, 2009, p. 4). But perhaps knitting being positioned within its own vernacular, too cryptic for outsiders to understand, causes such disengagement.

What if knitting can be explained or visualised in design terms that can be more readily understood? Within my research, by applying the geometric shape to the design and construction process of knitting I invoke modes of vocabulary and visualisation that are known and understood within social and linguistic values of design that could possibly transcend the limited exchange or technical language of knitting.

This research looks into the design process of knitting, defines the geometric, and interprets definitions of design to form analogies between these parameters in respect to knitting and this design project.

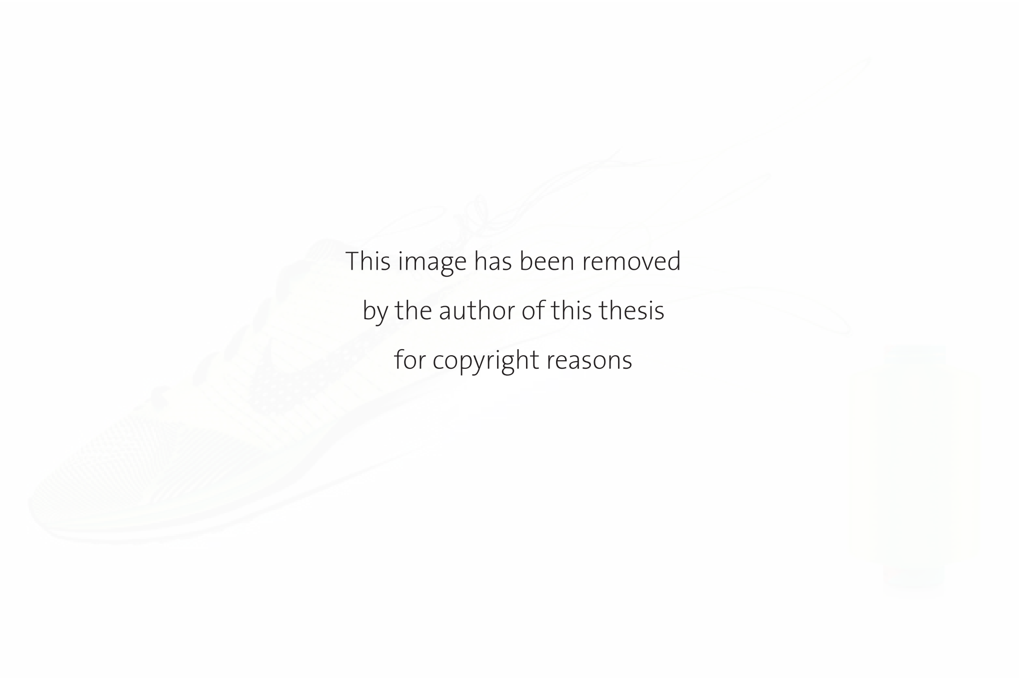


Fig. 1.

Nike. (2012.) Nike ‘Flyknit’ Shoe Advertising Campaign. Shoe design utilising flat-bed knitting technology.

http://www.bloomberg.com/bw/articles/2012-03-15/is-nikes-flyknit-the-swoosh-of-the-future

THE RESEARCH PROJECT

RATIONALE

CREATING ANALOGIES BETWEEN KNITTING, THE GEOMETRIC AND DESIGN

Central to my own practice in knitting is the shifting exchanges between material and form. The design process is a negotiation of these two parameters and subject to the space that the knitting is carried out in. The space becomes the context. As the contexts change, both the form and material of knitting are employed with specific communication systems that are complex and tend to be incompatible between contexts.

In an attempt to communicate knitting free of its complex jargon and technical language I propose paring it back to a basic, elementary visual representation. The visual used in this project is the geometric shape. Through practice led methods, the geometric is trialled as a mode of developing design, and a way to communicate designs for knitting, across different types of knitting technologies.

Geometric shapes; according to the book Foundations of Art and Design, are "simple, mechanical shapes ... the first shapes we learn to identify and explore as children in toys where we connect shaped pegs with their corresponding holes" (Pipes, 2003, p. 48). Reminiscent of the earliest form of learning, geometric shapes are also referred to as "primitive shapes" (Pipes, 2003, p. 48), and also as the "elementary (and) the basics" of design (Lupton & Abbott Miller, 1993, p. 5). Isotype, is a design theory developed by philosopher Otto Neurath in the 1920's, and to this day is studied in graphic design to make possible the understanding of diagrammatic thinking through "simplified pictures" (Lupton, 1986, p. 47), where the geometric is regarded as a "universally readable language of vision" (Lupton, 1986, p. 47). The most famous design application of this concept was in the pedagogies formed by the Bauhaus (fig. 2) where the geometric was emblematical as "paradigmatic of the formal laws underlying all visual expression" (Lupton & Abbott Miller, 1993. p. 5).

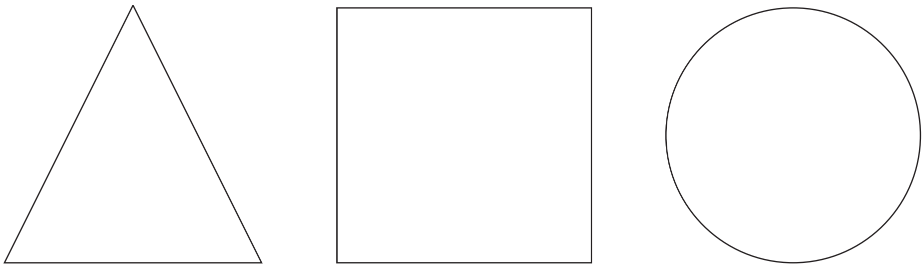


Fig. 2.

Gabriel, N. (2015).
Triangle, Square and Circle, symbolising the basis of Bauhaus Design Theory.

This research seeks "not to quantify aesthetics through geometry but rather to reveal visual relationships that ... lend insight into the design process and give visual coherence to design through visual structure" (Elam, 2001, p. 5).

HOW THESE ANALOGIES LEAD TO A DESIGN PROCESS

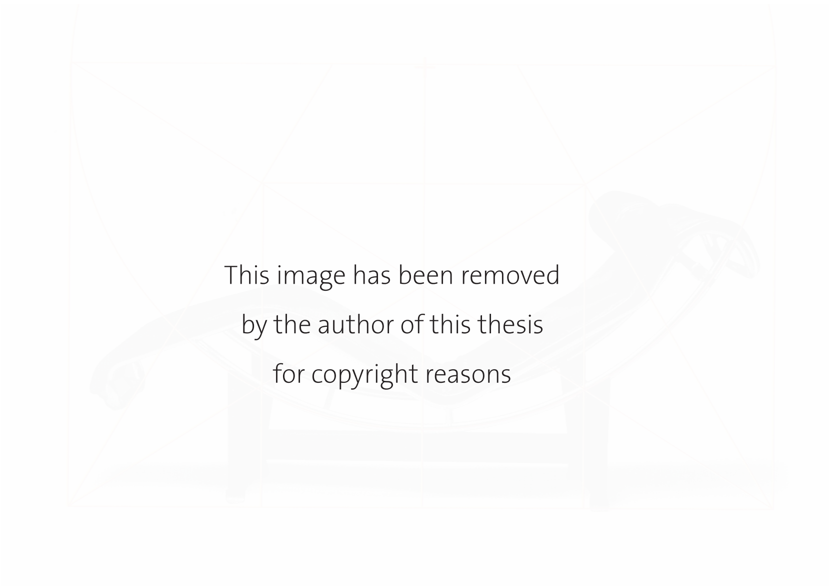


Fig. 3.

Le Corbusier. (1929). Chaise Longue. Image from: Elam K. (2003). Geometry of Design.

As a two-dimensional construct, the geometric aids a visual reasoning of design composition as seen in the analysis of harmonic proportion of the Le Corbusier Chaise Longue design in figure 3. Design educator and theorist, Gabriella Goldschmidt (1994), describes this 'Visual Thinking' process as a means to "record the production of ideas", where the "geometric shapes provide descriptions of functional, spatial or symbolic properties of some of its components of the design concept" (Goldschmidt, 1994, p. 8).

Other components of the design concept is in combining what Goldschmidt refers to as knowledge "precedents" (Purcell & Gero, 1998, p. 391), which in this case is my understanding of the material and modes of production of knitting that I bring into the project. This utilises the geometric as a three-dimensional construct enabling the engagement of the physical potentials of the geometric shape to be used to resolve constructional problems in the knitting. This leads to design methods that can be used as a means to apply the geometric for simplifying the complexities of knitting, where jargon and lengthy textual explanations can be replaced by simple, clear visual aids.

These design steps would entail a back and forth process between the conceptual, physical and abstract elements of the project making adjustments along the way to arrive at creative and innovative ways for knitting. This overlapping exchange of "action and reflection" as a research method is described by Birkhofer (1994) as an "interplay between systematic procedure, based on scientific work, and a creative thought and action, based on experience and intuition of the individual designer" (p. 5).

Academic writers Purcell and Gero (1998), explain a similar synopsis of a design process for architecture where they stipulate:

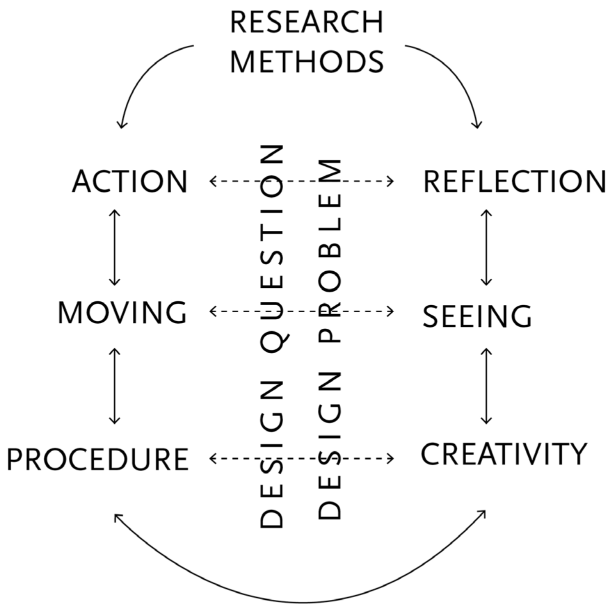
> Schon and Wiggins argue that design consists of sequences of seeing– moving–seeing with the unintended consequences of moves allowing the designer to bring more and more facets of their knowledge into conscious thought allowing them to handle the complexity associated with ill-defined problems.
> (Purcell & Gero, 1998, p. 391).

Design, essentially being a study of problem solving, is usually framed by its design problem, or its design question. An ill-defined problem is "opposed to a "well-defined" problem where the problem is clear, and the solution is available through some technical knowledge" (Curedale, 2013, p25).

Fashion researcher Otto Von Busch (2008), talks about a type of design research that does not "reach clear cut conclusions ... compared to more technical research in design it might be less "precise" but instead all the more connected" (p. 13). Figure 4 illustrates the interconnections of the research methods employed for this project.

Fig 4.

Gabriel, N. (2015) .
Research Model.



The scope of this research is not to compile an implicit technical guide on the use of the geometric for the design and construction of knitting, but to present a creative design approach to knitting that can explore and highlight the problems inherent within the complexities of knitting. The theme is to develop conceptual connections of design to the craft and technology of knitting that can generate alternative ways of thinking, seeing and making in the area of fashion and textiles.

CONTEXT

KNITTING, FASHION AND THE GEOMETRIC

Knitting being operative within the intersections of craft and technology is according to writer Sandy Black (2012), "always destined to be seen in parallel to fashion" (p. 217). The geometric is not a new concept as a design construct in fashion and knitwear, but when it has emerged, it is viewed as an alternative approach to convention. Nanni Strada, as early as the 1960's sought to change the rules of fashion by using geometrical clothing constructions to "modify the productive process to introduce a new innovative way of assembling and producing" ("The dress down the body", 2008). (fig. 5)

Assemblage and modularity feature within geometric clothing construction concepts, as proportion and in particular harmony are components of geometry. Designer and sculptor Julianna Turcu since the 1970's has applied a system of golden ratio proportional patterning techniques to a geometric modular design system for knitwear as a "method for dividing and joining structures" (Verashaka, 2014).

Structure and dimension are also highlighted as geometrical aspects, applied to minimal principle in just the use of a line, in Isabel Toledo's designs where she "develops a structural framework – often as simple as a single seam" (Hodge, Mears, & Sidlauskas, 2006, p. 218). Toledo's 'Packing Dress' from her Spring/Summer collection 1988 forms a circle shape when laid flat, and takes voluminous form when worn. (figs. 6.1, 6.2)

To great effect the temporality between two and three dimensional form can be seen (fig. 7) in the contemporary and complex geometrical configurations of Issey Miyake's '132. 5' collection where the clothing designs are "decided by the fold lines and cut lines" ("132. 5 by Issey Miyake", 2010). Flat two-dimensional geometrical shapes transform into three-dimensional clothes "determined by all acute angles and triangles that make up the structure" ("132. 5 by Issey Miyake", 2010). Miyake in collaboration with a "research and development team" uses the geometric as an "exploration into the process of creation and production" ("132. 5 by Issey Miyake", 2010).

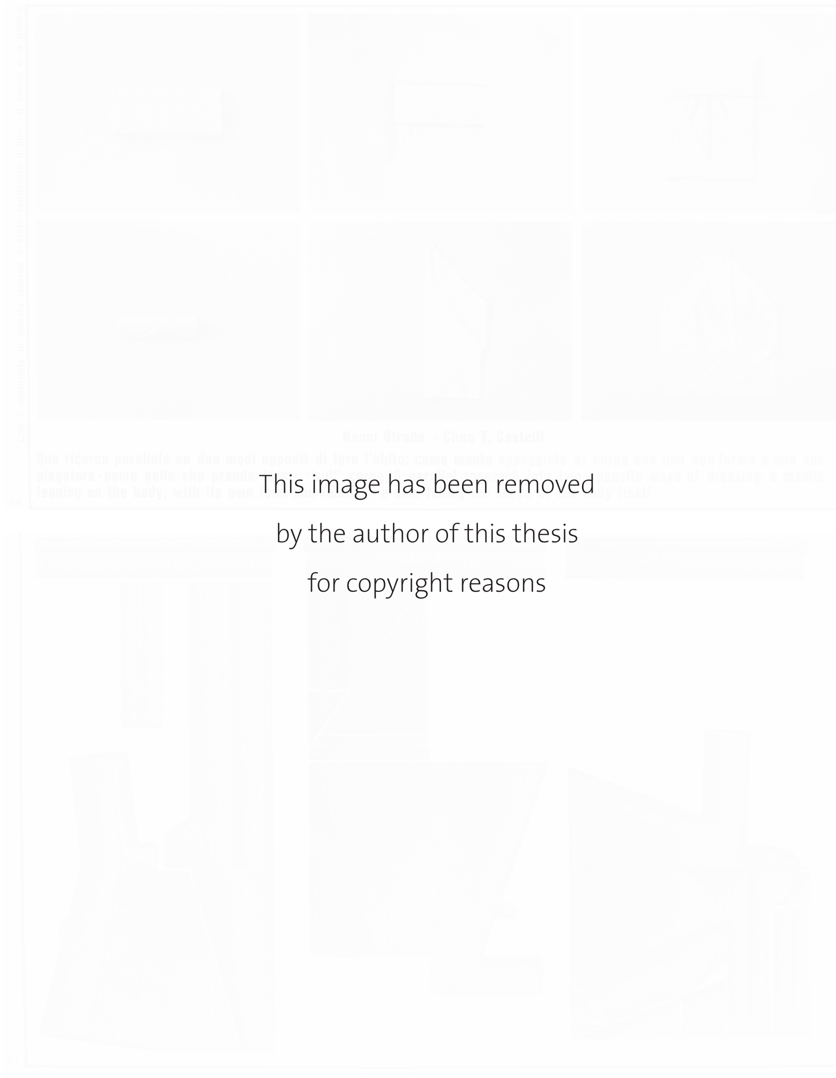


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Fig. 5.

Nanni Strada (1974). Ill Manto AlaPella. Casabella Magazine. Image retrieved from: http://plusacne.org/2013/05/05/nanni-strada/

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Fig. 6.1.

Isabel Toledo. (1988).
Packing Dress Flat.

Fig. 6.2

Isabel Toledo. (1988).
Packing Dress Three Dimensional.

Images from
Skin & Bones
2007, p219

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Fig. 7.

Issey Miyake (2010).
132 5. Image retrieved from :http://www.Dezeen.com/2010/10/05/132-5-by-Issey-Miyake/

The constants of these innovative applications of the geometric in clothing are; as parts and assemblage, modification to production, the design constructs of two and three dimensionality and the use of the line within the design process.

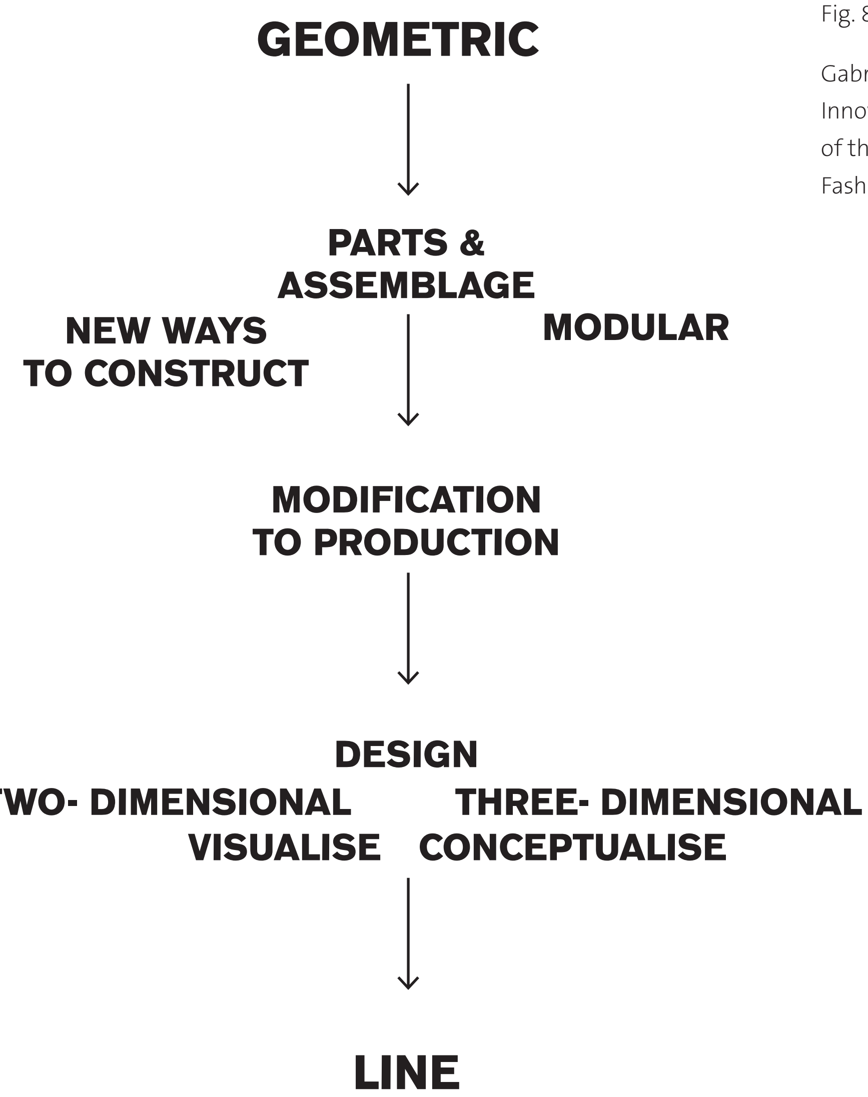


Fig. 8.

Gabriel, N. (2015). Innovative Applications of the Geometric in Fashion & Knitwear.

KNITTING IN ACADEMIC RESEARCH - THE GEOMETRIC, TECHNOLOGY, CRAFT.

The line becomes a key feature in the methodology of this research project where it is explored to act as a trace for the generation and activation of sequential design activity in the transition from two-dimensional to three-dimensional design thinking in knitting. Academic research in the field of knitting discusses this engagement between dimensions as a type of complex tension between material, form and therefore, product, the recurring fundamental conditions of knitting.

Jenny Underwood (2009), addresses these conditions from a programmer's[1.] perspective and specifies it as a "relationship between surface and structure for the construction of form" (p. 3), and Sharon Evans-Mikellis (2011), from a designer's approach, as "integral knitting" (p. 13), while Amanda Smith (2013), describes it from both a programming[1.] and design perspective as "production's relationship to form, materiality and the fashioning of things" (p. xix).

The research discussed in the previous paragraph all develop working methods of three-dimensional design strategies for knitting and gives insight into the specialist's complex language for the use of this technology, contributing new knowledge for the designer.

Jyoti Kalyanji (2013), follows on from Underwood's research to address such complexities of knitting and proposes "building an anatomy of shaping functions" as a "three-dimensional toolbox" (p. 55), to make these functions more accessible for the designer. Theorist, Peter Dormer (1997), emphasises the importance of simplifying tools when sharing information, in that "keeping things simple does not mean that the objective is only to make simple things ... the objective is to make complicated things with procedures that are as simple as possible" (p. 142).

[1.] Programming is a process of generating coded instructions for the operation of computerised seamless knitting machines, a complex operation performed by trained knitting technicians.

Karin Landahl (2013) approaches her academic research as a maker, where she defines the knitting process as “only one design parameter...with form as a foundation” (p. 11). Through a hand-making process Landahl favours a “free-form thinking” over a geometric framework (Landahl, 2013, p. 35). This approach would entail disengaging the line, resonating an intuitive design process rather than a visually or conceptually planned one. But even the awareness of line as absent, is in response to knowing where it would normally be positioned within a form. Such understandings of form are associated to principles of the geometric. According to design theorist Wucius Wong (1993), “relational elements are positions of direction, space and gravity, while conceptual elements are point, line, plane and volume” (Wong, 1993, p. 18).

Relational elements such as “direction, space and gravity” (Wong, 1993, p. 25), (fig. 8.1) become more apparent within the making process and my research emphasizes the value of hand-making as a fundamental knowledge base to developing such dimensional reasoning in the methodology chapters.

Hand-making can be described as a process that defines “the actions we feel in order to calculate” (McCready, 2014, p. 64). Sensation through “physical manipulation of materials” is discussed by Rachel Philpott (2012), where she describes handcraft as the “embodied knowledge” that informs the “maker’s creative responses to ... process and material” when the design is introduced to “automated machine production” (p. 54, p. 56).

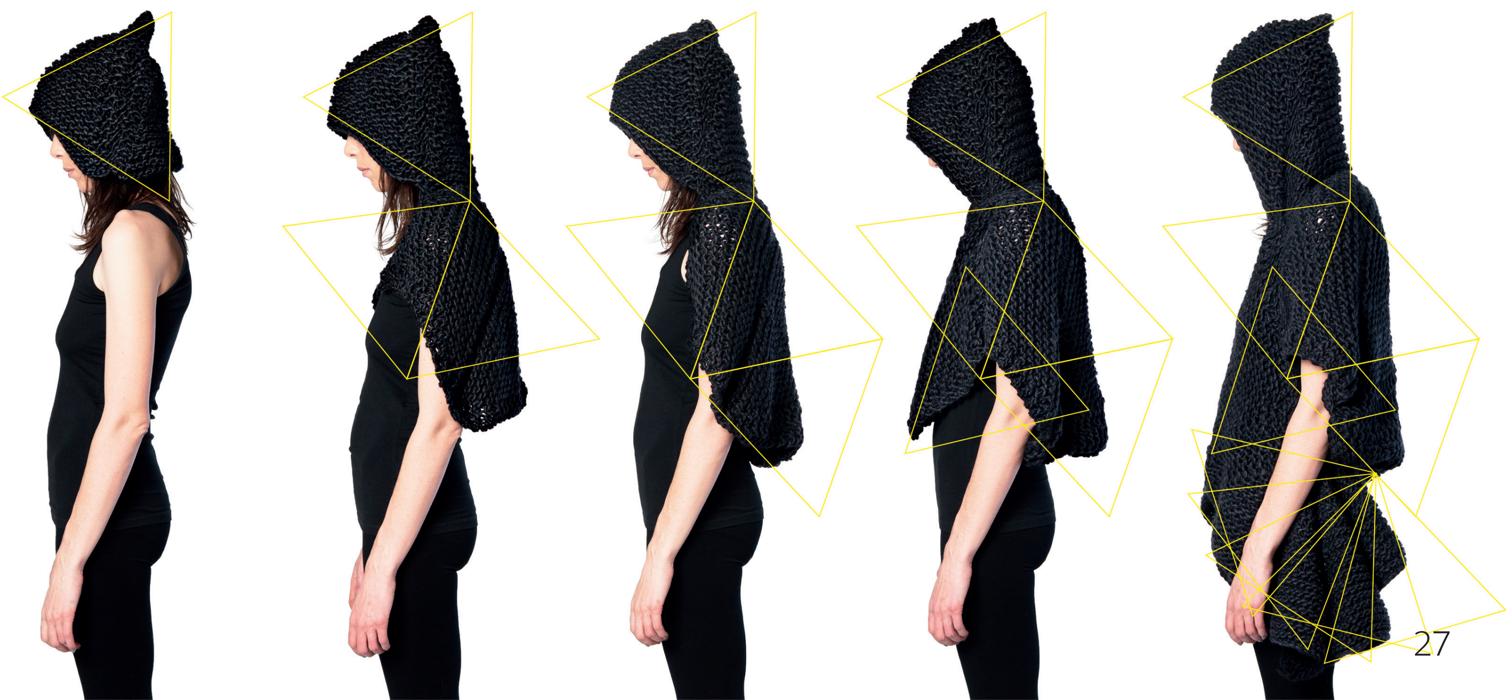
Design homogeneity is not a core issue of this project, but as it is a problem prevalent in the use of certain knitting technologies[2.] it becomes inherent within the design process, and this is where designer's subjectivity through choice of materials and stitch techniques can be linked to hand making craft processes and derived tacit knowledge[3].

[2.]Knitting technology: referring to seamless three-dimensional machines, where standard garment styles are pre-programmed into the machines, which allows limited sizing and shaping adjustments. The designer has the scope to customize the design with knitted stitch structures and yarn applications, however the resulting garments tends to have a sameness in the look and feel of knitwear produced on these machines. The designer liaises with a knitting technician who programs the seamless machine to knit an interpretation of the designer's specifications and proposed design.

[3.]Tacit Knowledge: The inner knowledge developed through experience that is difficult to record, as it is intuitive, sensational and emotional, but often referred to as the insight on which one's explicit knowledge is highly dependent upon.

Fig. 8.1

Gabriel, N. (2015).
Construction No. 4
The Line mapping a visual trace of thinking in the accumulation of form in the design using knitted triangle shapes; showing the relational and conceptual elements of the design.



METHODOLOGY

As an initial demonstration earlier in my research I used the following examples of hand-knitted garment projects to reveal how the geometric can be applied for garment designs (fig. 9), showing the visual geometric counterparts alongside images of the garments.

Fig. 9.

Gabriel, N. (2015). Geometric Forms and Garments for Knit Design.

In my experience of presenting such work to non-specialist peers, the conversation of the look of the garment and its silhouette tends to dominate and therefore trivialise and limit the potential discussion of form as a broader design concept for knitting. The removal of the garment aspect for this discussion at this stage of the research gives way to investigating the abstract potentialities of the geometric as the condition of form, and as the primary analysis within design. (fig. 10)

> Roy Behrens (1998) on 'Art, Design and Gestalt Theory' quote Lupton and Miller; "design is, at bottom, an abstract, formal activity" in which the ... subject matter is secondary, added only after the mastery of form" p. 301.

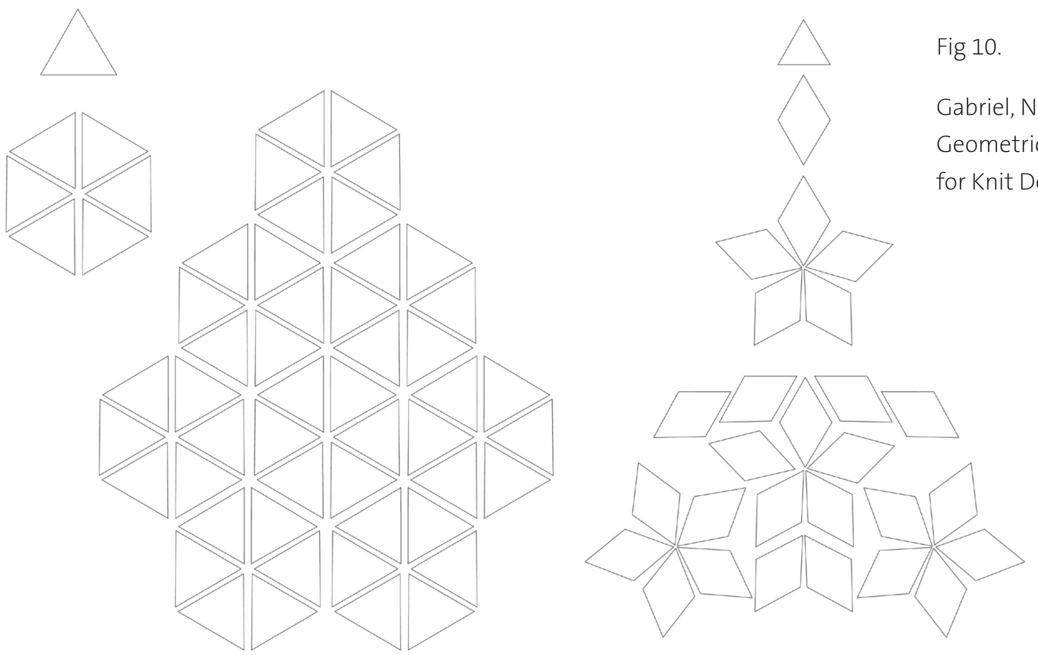


Fig 10.

Gabriel, N. (2015). Geometric Forms for Knit Design.

PHASE ONE OF THE METHODOLOGY

THE MAKING OF SMALL GEOMETRIC OBJECTS

To investigate the geometric in knitted form, I first engage in the making of small projects (fig. 11). Otto Von Busch (2013), refers to Bauhaus teacher Josef Albers; where Albers gave his students similar small scale exercises where they “explored different patterns, scales and relations of form” (p. 15). The “students were not aiming at final products, but the qualities of the interconnected abstract mechanics, or protocols, of their models” (Von Busch, 2013, p. 15).

In a like manner, this series of making is not for the intention of creating usable products, but is an exercise to determine how the geometric shapes correlate with the different processes of knitting. This determines certain tools and strategies for the making of larger objects such as garments.

Form generation is the objective of these first exercises, and the materials that were chosen for the making of these models were based on their textural and tactile qualities in their ability to hold shape. (fig. 11) These Bast[4.] fibres are course and stiff, and are not usually used for garment apparel due to the lack of elasticity in the fibre and their roughness in touch. The reason for using these fibres is to avoid the finished pieces being judged as wearable woolly accessories.

[4.] Bast fibres refer to vegetable fibres made from the tissue of the plant. The fibres used in this research are from rayon, ramie and paper plant origins.

Fig. 11.

Gabriel, N. (2015).
Small Handmade
Geometric Shapes.
Various Paper, Ramie
and Rayon Fibres.

HANDKNITTING

PIECE AND ASSEMBLAGE

This process began by working with the triangle shape (fig. 12).

Fig. 12.

Gabriel, N. (2015). Knitted Triangle in Silk Paper.

Fig. 13.

Gabriel, N. (2015). Knitted Triangles in Silk Paper.

A knitted triangle is an engaging exercise to understand rhythm and order to knitting when determining shaping frequencies, and directions of knitting. (fig. 13).

Once knitted the pieces were joined into configurations toying with vertical, horizontal and diagonal placements of the triangles in the assemblages.
(figs. 14.1, 14.2.)

Fig. 14.1. 14.2

Gabriel, N. (2015). Knitted Triangles in Silk Paper. Grouped and Assembled into forms.

These assemblages were then unattached at seams, to see what happened to the forms. (fig.15.)

Fig. 15.

Gabriel, N. (2015). Knitted Triangles in Silk Paper. Unattaching seams.

I created diagrams of the assemblages (fig. 16), as a means to provide a trace of the process. The red lines show where the seams were removed.

This part of the making provided insights into cognitive design activity such as perceptual grouping and disruption to patterning. These observations along with insights of temporal dimension are discussed further in Appendix 2.

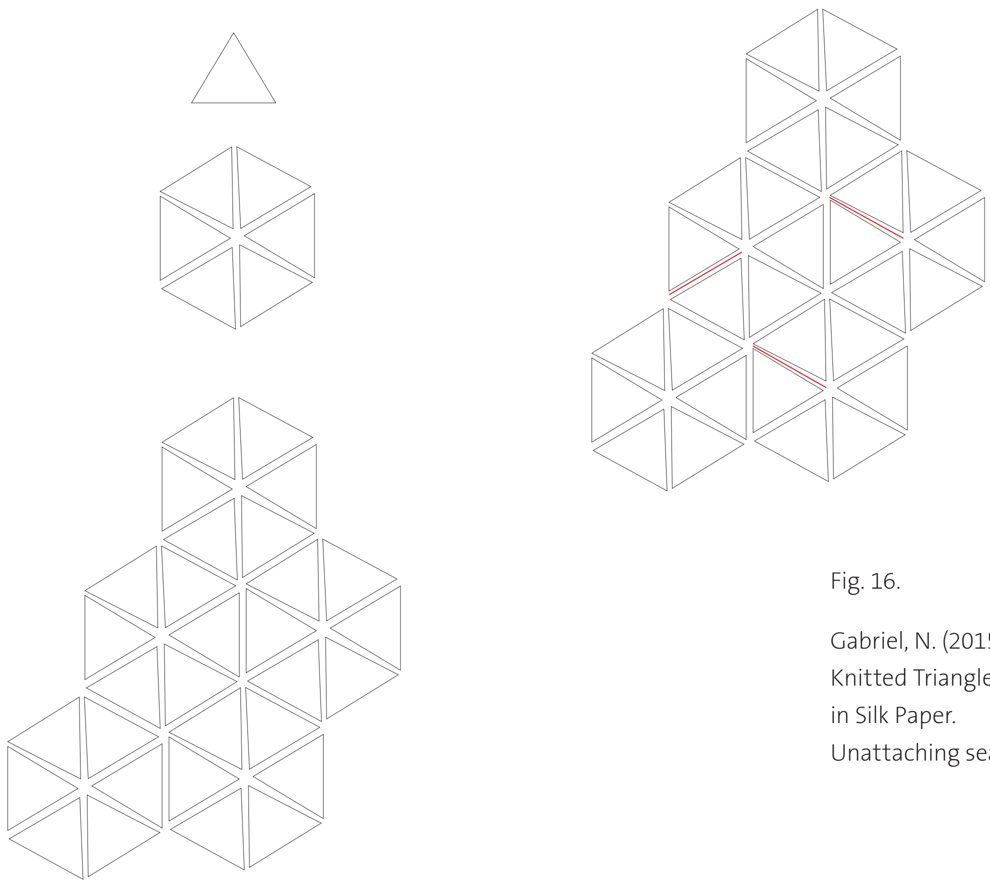


Fig. 16.

Gabriel, N. (2015).
Knitted Triangles
in Silk Paper.
Unattaching seams.

The squares and triangles correspondingly formulate a knitting calculation grid system shown in figure 17. These schematics generate a visual stimuli for the design process shown further in Appendix 1.

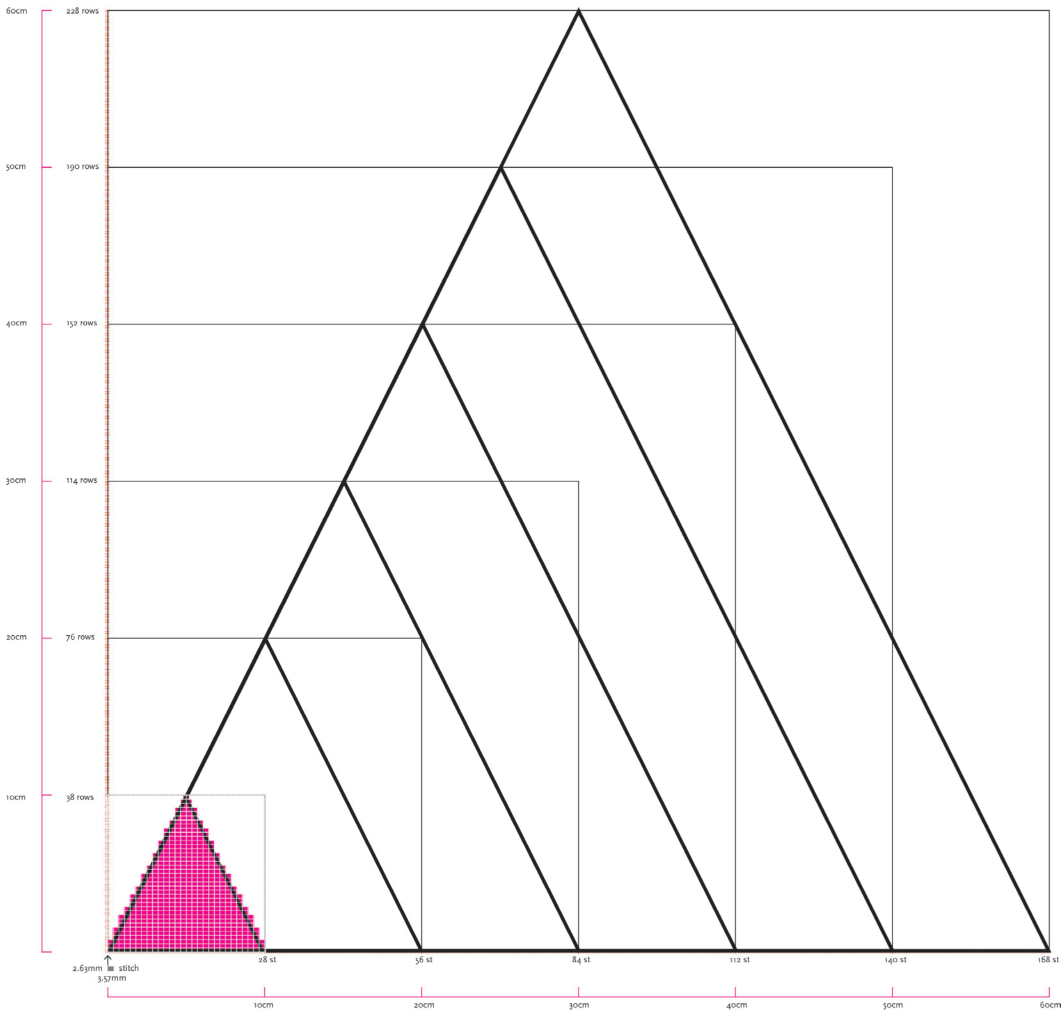


Fig. 17.

Gabriel, N. (2015). Calculation schematics of Triangles & Squares.

In the next exercises I investigated how triangle shapes naturally morph into square shapes, leading into seamless forms by knitting internal shaping as opposed to joining separate pieces.

The following images show from left, a square and three triangles within one continuous shape (fig. 18.1), knitting four triangles in one continuous shape (fig. 18.2), and folding a square into triangles. (fig. 18.3). The graphic images visualise this process in figure 19.



Fig. 18.1, 18.2, 18.3

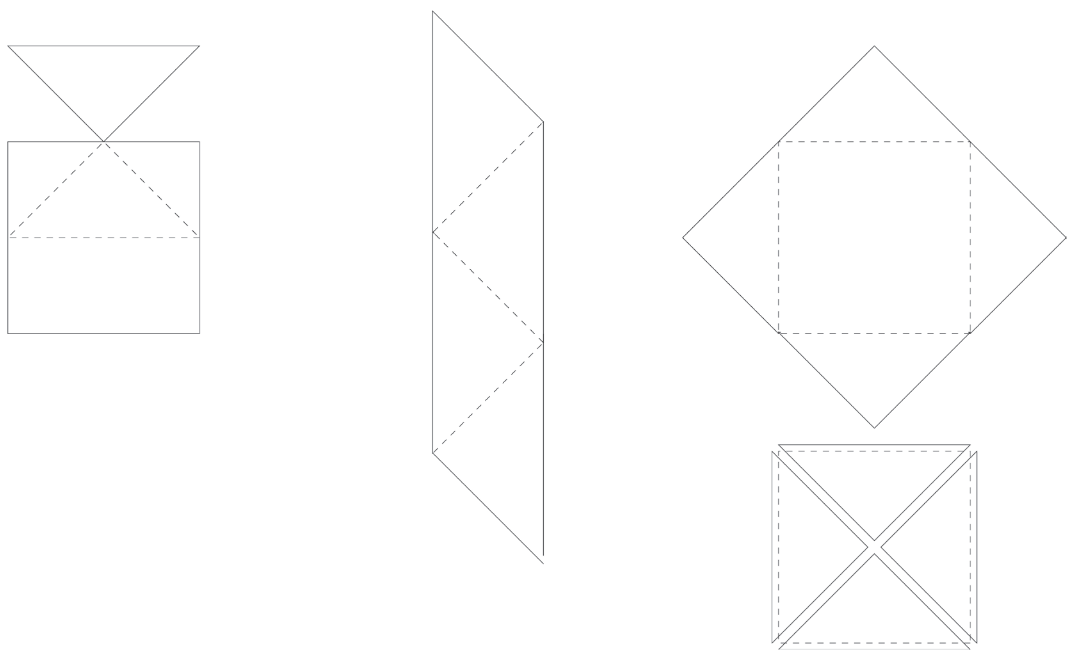
Gabriel N. (2015). Morphing shapes.

A process of removing seams and creating the shaping within the kntiting.

The shaping affected changes to the fabric grain, altering the direction, movement and stretch of the fabric, hence the structural forces in the knitting. This is an affect of horizontal and vertical changes in the line discussed in Appendix 2 (Line, pg. 89).

Fig 19.

Gabriel N. (2015). Visualisation of the process of removing seams and creating the shaping within the kntiting.



MACHINE KNITTING / TWO-DIMENSIONAL

MANUAL DOMESTIC KNITTING MACHINE MORPHING SEAMS

After several attempts at emulating the hand knitted triangle with machine knitting, it became apparent that this type of shaping is not optimal usage of this knitting technology[6.], as it slows the machinery and produces a poor replication of that geometric shape. For this project, I resolved that machine knitting is efficient when operating on its fast continuous vertical knit motion to produce square and rectangle panels.

To apply an expanded notion of knitting with dimensionality; I decided to make a cube from squares. Instead of knitting separate square panels and joining them, I aimed to make a cube in one whole piece, within the vertical motion sequence of knitting. (figs. 20.1, 20.2) This entailed thinking of dimension in the process of making to determine where to place the joins and construct the cube whilst knitting.

[6.] The manual domestic knitting machine knits in one vertical motion emulating industrial automated flat bed two-dimensional knitting machines.

Fig. 20.1. & Fig. 20.2

Gabriel, N. (2015).
Manual Domestic
Machine Knitted
Cubes in Rayon.

Within this construction process new metaphors were sought to develop a reasoning of dimensions within the form, as per the following table and drawings. (figs. 21, 22, & 23.)

Two Dimensional Reasoning Width & Length	Three Dimensional Reasoning Height and Depth
Backward, Forward	Inside, Outside Around, Over Above, Below Together, Apart Between Up, Down

Fig. 21.

Gabriel N. (2015).
Reasoning of
Dimension

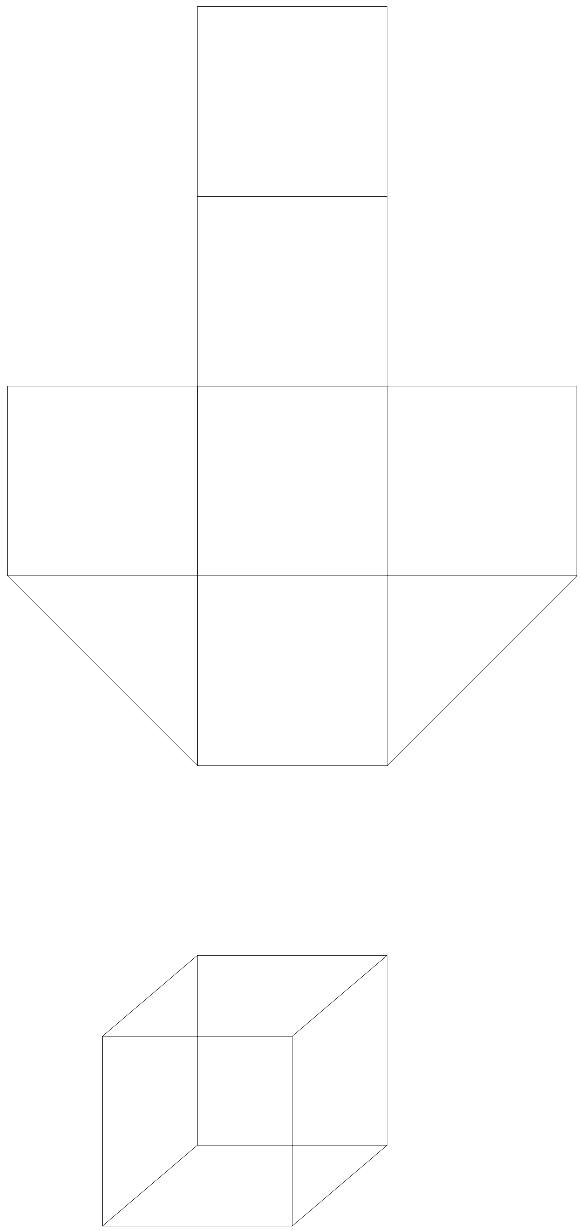


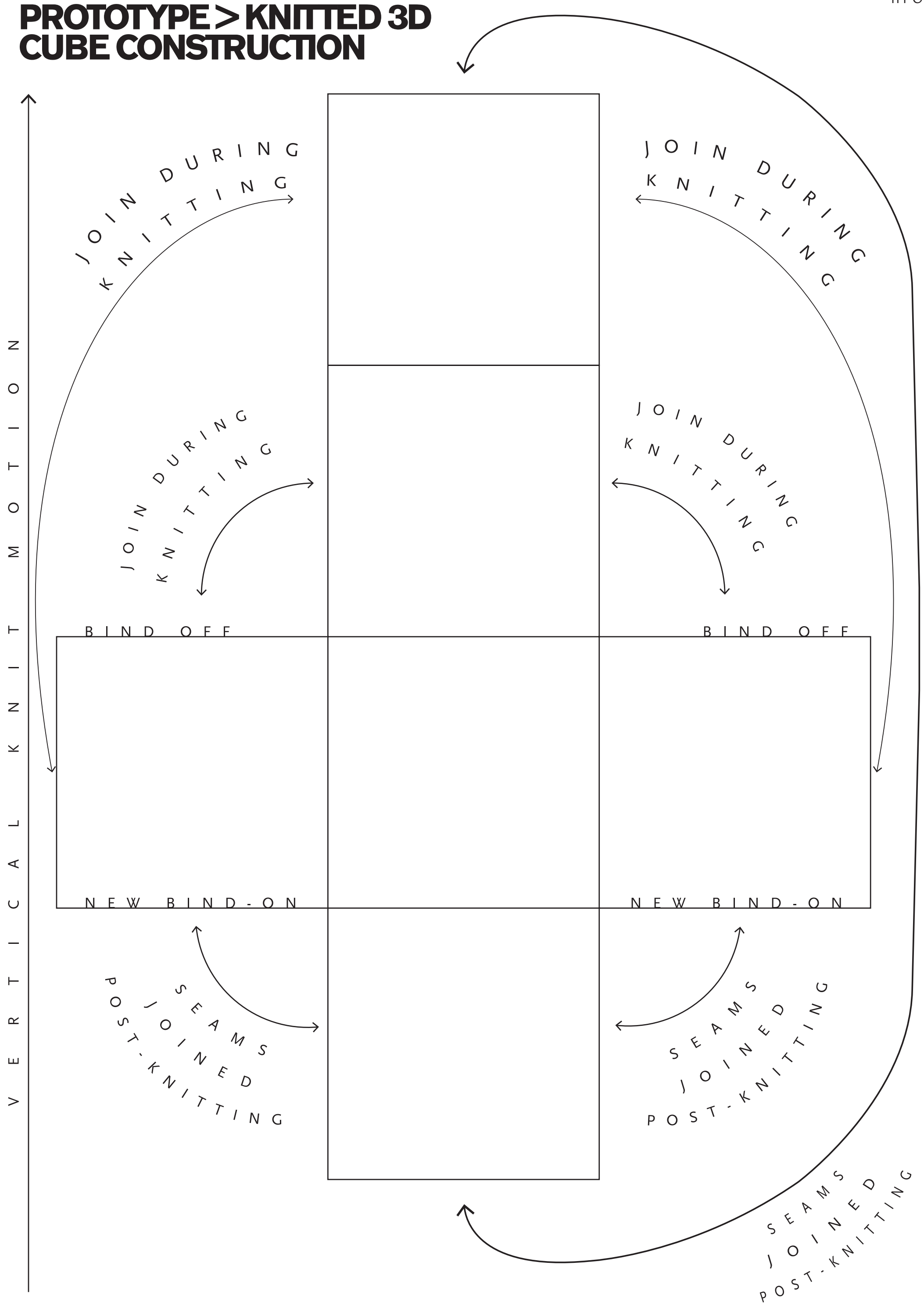
Fig. 22.

Gabriel, N. (2015). Illustration of Knitted Cube with 2D Machine Knitting.

Fig. 23.

Gabriel, N. (2015). 3D Cube Construction. The directions of joins within a cube construction knitted in one vertical motion.

PROTOTYPE > KNITTED 3D CUBE CONSTRUCTION



In search of further structure within this form, I knitted extra material that could be folded back into the cube to create a solid shape. (figs. 24.1, 24.2 & fig 25). This exercise highlighted challenges with the nature of knitting's materiality and its use as a pliable structure as opposed to a form-giving structure, which is discussed in the summary on page 44.

Fig. 24.1 & Fig. 24.2.

Gabriel, N. (2015). 3D Cube Construction. A knitted cube in wool made in one complete vertical knit motion, with extra fabric that folds back into the cube, filling it to create a solid structure.

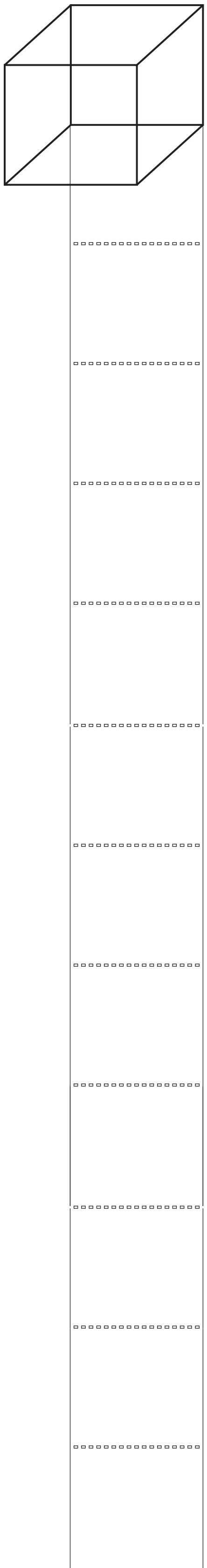


Fig. 25.

Gabriel, N. (2015). 3D Cube Construction. Graphic Rendition of knitted cube with additional fabric that folds back into structure to make a solid form.

SUMMARY OF 2-D MACHINE KNITTING MAKING

Through these exercises I became more aware of dimensionality concepts such as depth and density in the thinking process of designing for knitting.

It could be argued that there is no purpose or reason for dimensional constructs for textile or knit design due to the very nature of the material and its intended use as wearable. (The current design system is based on knitted product being inhabited by the body, which gives it form and dimension, and therefore there is no need to incorporate those aspects into the knitting process). However it is this very complicity to textile design that limits its practice and innovation to material and surface treatment only, restraining its application to only some elements of design, and not others.

It is for this reason that for this part of the research I have diverged from the discussion of knitted product (and it's generalised associations of use), as the point of investigation for form making. Instead, I am searching for clues of form construction within the process of knitting itself. Here, the role of geometric is in its convergence of dimensional properties within the making of knitting. I've explored the properties of the geometric and summarised them in terms of their roots in classic design principles in the glossary in Appendix 2. These insights into basic design principles establish some grounding for this methodology and its research question in "describing the basis ... (to a) rigorous approach (of) ... visual /design literacy" (Noble & Bestley, 2011, p. 27).

SUMMARY OF PHASE ONE OF THE METHODOLOGY

INTEGRATING CONSTRUCTIONAL ELEMENTS OF THE GEOMETRIC INTO THE KNITTING PROCESS.

Drawings are two-dimensional visualisations of form, and can be described as the conceptual elements of design. Three-dimensional designing consists of constructional elements and the concrete realizations of the conceptual elements. During this three-dimensional designing process it becomes natural to improvise, alter and adapt set forms according to other sensations of creativity and individual approach. This process is a progression of relational elements and the basis for all design, for example a point becomes a line, a line becomes a shape and a shape takes volume.

In the previous context chapters, I have identified that the linking conduit of the geometric in use, is in the application of the line. The line is the information path that links two-dimensional relational concepts to the three-dimensional constructional concepts.

Within this methodology I've used the line as a trace of the development of process. "Traces are created by processes … (and) process might be considered as a learning" (Koffka, 1955, p. 547). In this project, the line links the connections and transformations of geometric shapes that can be communicated as a design system. Koffka (1955), explains that the "first arousals of processes … must be as inclusive as possible", as "available traces modify new processes" (p. 544). By working with the line in basic shape formations such as squares, rectangles and triangles, this information can then be used for the making of garments in the second phase of this research.

An integration of knitting and the geometric have been developed as conceptual tools for making, based on the observations from the first phase of the methodology, the 'making of small objects', where the rules evident in those knitting processes are translated as visual apparatus.

The intention of these visual graphics is to present a format that is not too technical or procedural as a guide. The focus is to operate on a conceptual basis driving a creative design process for knitting.

PHASE TWO OF THE METHODOLOGY

The following phase of the project engaged three different knitting technologies of hand-knitting, two-dimensional manual machine knitting and three-dimensional automated machine knitting in the making of garments. As explained in the Research Aims and Rationale chapters from page 11-20, the plan to engage all three knitting technologies in this project was to exercise the geometric as the fundamental agent of communication to neutralise the complexities of jargon incompatibility between each knitting process. The aim is to bypass the limited domain of flowery knitting terms around stitch type, fabric drapes and yarn weights, or specialist industrial technical knitting language, to evoke a broader design conversation based on a logical visual scheme.

The garments were divided into numbered sections in progression of the automation of the knitting process, and through illustration of the knitted geometric shapes, this Phase Two of the Methodology demonstrates how the design from each garment stage successionally informed the next. Within this design process, the research sought to emphasize how in correlation with the geometric, hand-making and manual manipulation of knitting generated sequential development of knitting calculations which facilitated innovative applications for machine knitting, and in effect demonstrates a design system.

Handknitting. Garment CONSTRUCTION NO. 1.
Piece & assemblage (with seams) knitting process.

Machine Knitting. 2D Garment CONSTRUCTION NO. 2, CONSTRUCTION NO. 3 & CONSTRUCTION NO. 4.
Semi-automated piece & assemblage (with fewer seams) knitting process.

Machine Knitting. 3D Garment CONSTRUCTION NO. 5.
Fully automated (seamless) knitting process.

THE MAKING OF GARMENTS

The domains of both knitting and the use of the geometric shape in the field of design are vast, and so I have had to limit the possibilities of scope for garment design within this project's timeframe.

Framing the design objectives within this method is:

1. The use of the geometric as a resolution to the simplification of the complexities of the technical domains of knitting.

2. Overcoming design homogeneity with innovative use of production methods of knitting by approaching shape construction from a creative and non-conventional method of making.

3. Personalising this approach according to my own style of designing and making that is a reflection of my own practice and experience of knit design, pointing to the scope for variety that can then be applied through a maker's use of this method.

THE GEOMETRIC IN USE

This aspect of the project works with the square shape as the unit of production across the three knitting technologies . The squares and configurations of squares are rendered as flat two-dimensional shapes and are based on a measurement of 35cm x 35cm.

In consideration of the time constraints of this research project, I have also had to limit the variables of knitting by working with only basic knit stitch structures.

The following units of production are based on the measurement of the first square. Each knitting process shows a progression of automation and therefore transformation of the design process, as the squares become more consolidated into bigger forms showing fewer requirements for assemblage and seams.

Fig. 26.

Gabriel N. (2015). Unit of Production for Hand-knitting. A single Square applied within a Piece & Assemblage Process where each square is joined.

Fig. 27.

Gabriel N. (2015). Units of Production for Two Dimensional Machine Knitting. There are less joins for this knitting process; the rectangle shape is a multiple of 4 squares. The smaller rectangle shape is the 4 square-rectangle folded into half to make a 2 square rectangular tube. The lines shown measures 1 square in length and 4 squares in width.

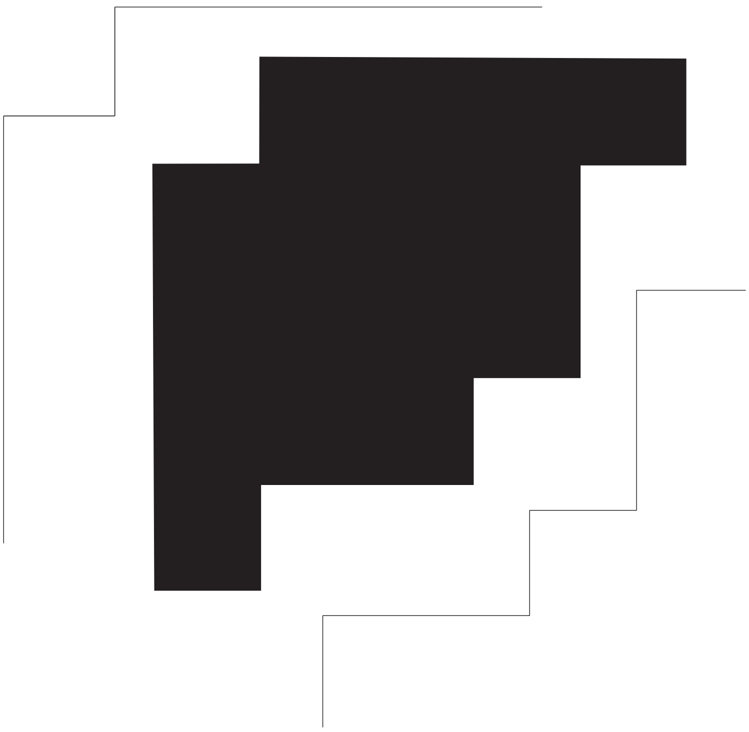


Fig. 28.

Gabriel N. (2015). Unit of production for Three Dimensional Knitting (Wholegarment™).
The measurement unit that shapes the construction for three-dimensional knitting is the whole garment, which is comprised of calculations based on the square. This two-dimensional flat drawing represents a tubular three-dimensional shape. The above shape mirrors its shape beneath it. Each part of the line equals either the measurement of a half square, 1 square, 2 squares, and 3 squares.

HANDKNITTING.

GARMENT CONSTRUCTION NO. 1

DESIGN PROCESS

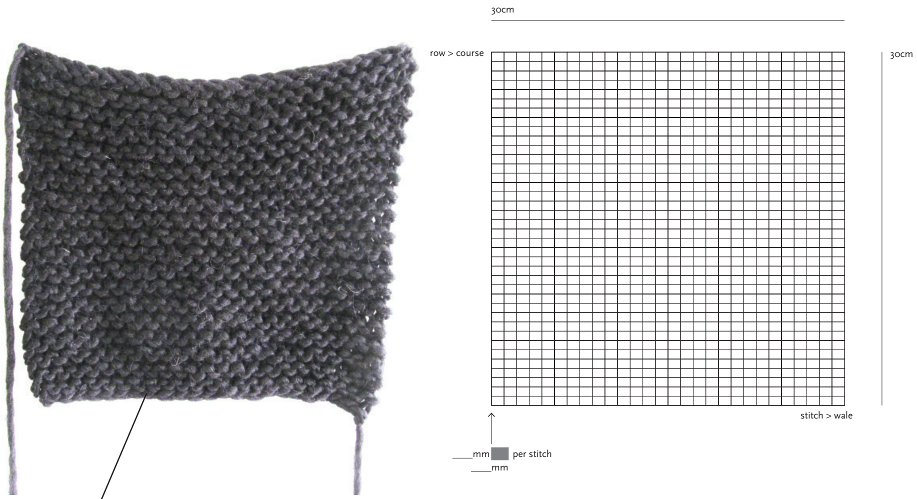


Fig. 29.

Gabriel, N. (2015). Hand-knitted Square Measurement Grid. 35cm x 35cm.

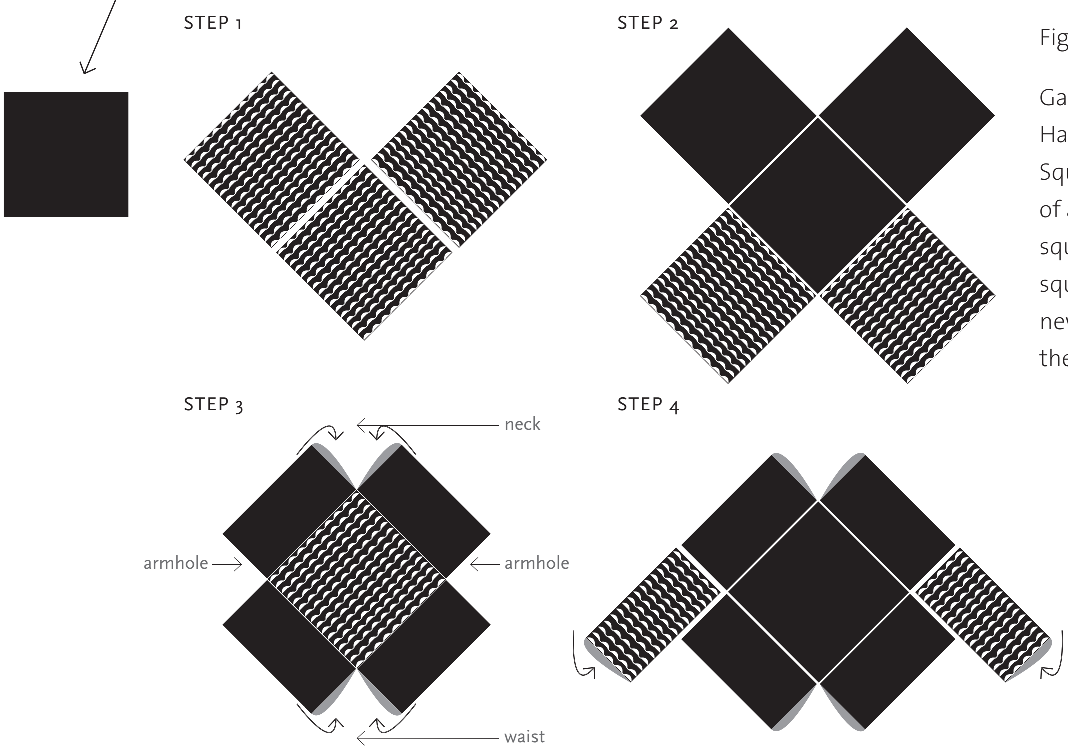


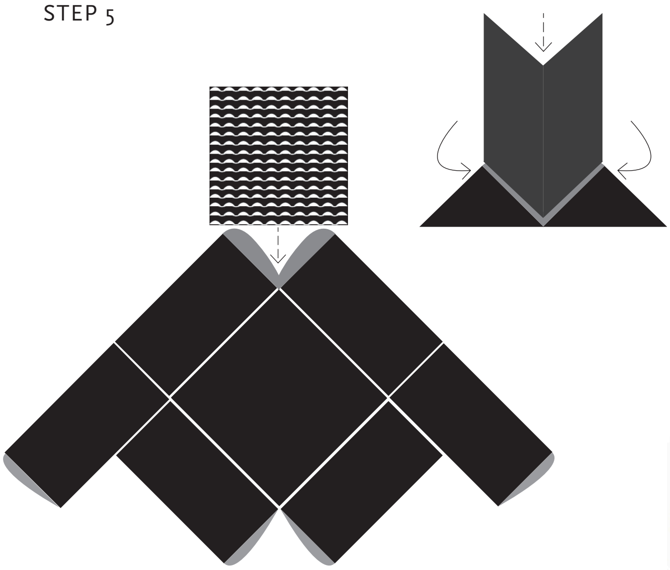
Fig. 30.

Gabriel, N. (2015). Hand-knitted Square. The making of a garment using squares. Each grey square represents a newly added square to the construction.

Fig. 31.

Gabriel, N. (2015). Hand-knitted Square. The addition of a square to make a collar, and the finished hand-knitted garment.

STEP 5



KNITTING PROCESS

1. I chose a chunky wool yarn and a basic knit stitch for this garment design (fig. 29), to alleviate the labour intensity of the hand-knitting by the speed and easy repetition of basic stitch technique with big needles.

2. This chunky knitting also demonstrates the scope for variety of yarn and knitting gauges that can be applied to the *construction knitting* method as the machine knitting processes require much finer yarns.

3. This garment is made from 9 squares. As understood from the ‘small projects’ exercises, within a hand-knitting process the assemblage of shapes can be placed in many different directions, which creates an interest to the both the constructional and surface elements of the garment where the stitch direction and fabric grain moves vertically, horizontally and diagonally. (fig. 32)

SUMMARY

SIMPLIFICATION: The calculation of knitting is simple being that it is pared down to the measurements of a square. However, this configuration can adapted to further knitting complexity, such as embedding shaping instead of separate pieces, as explored in the 'small making objects' exercises. Other shapes can easily be adapted to this type of design process, such as triangles, rectangles and even circles.

CREATIVITY & PERSONALISATION: Responses to the knitted fabric generate decisions on where to place squares based on how they feel to work on. Stretch and fabric grain challenges of the material generate a haptic response to designing. This is a subjective approach (instead of following conventional pattern rules of construction). Whilst this first sample is made in a basic stitch, there is the potential to apply other interesting and more complex stitch structures to this garment.

Fig. 32.

Gabriel, N. (2015). Handknitted Garment Construction No. 1 with arrows indicating the various directions of knitting in the garment composition.

Figure 33 below shows the placement of the squares, and half-squares (rectangles) showing all 9 squares in the garment composition. These are not technical drawings, but intended as artistic renditions as a mode of visual apparatus for knitting.

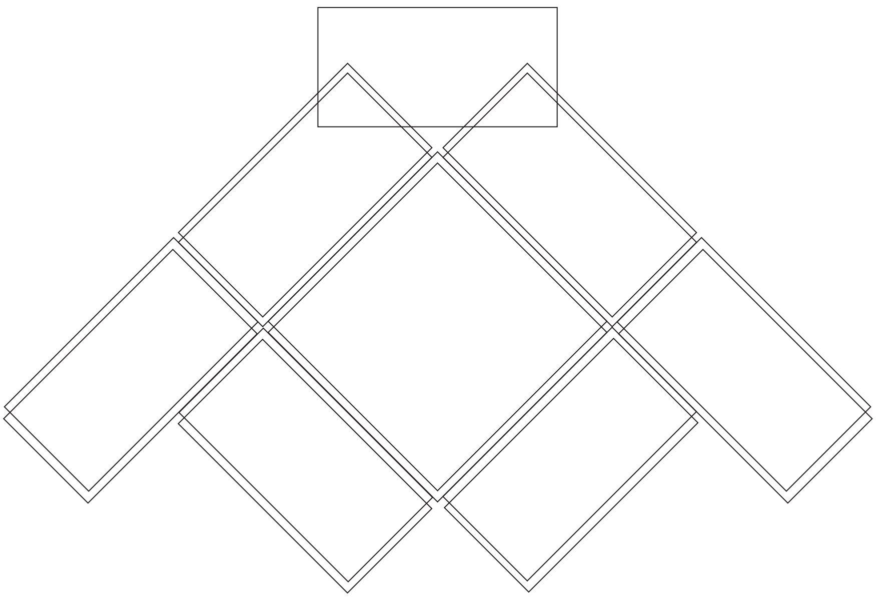


Fig. 33.

Gabriel, N. (2015). Graphic Render of squares and rectangles in Garment Construction No. 1.

2D MACHINE KNITTING.

CONSTRUCTION NO. 2, NO. 3 AND NO. 4.

From Phase One of the Methodology it was decided that manual machine knitting is more productive applied in a continuous vertical knit motion for the construction of square configurations. Therefore, it was necessary to consider morphing some squares into rectangles to avoid too much stop-start motion and time consuming joining in the knitting, for making a version of the garment design from Construction No. 1. The geometric was used as a building block to enable a process of diagrammatically thinking through the rearrangement of squares to locate where it was possible to eliminate some seams. This led to a decision to converge the squares into rectangles at the front and back of the body section of the garment and cross them over as illustrated in fig. 34.

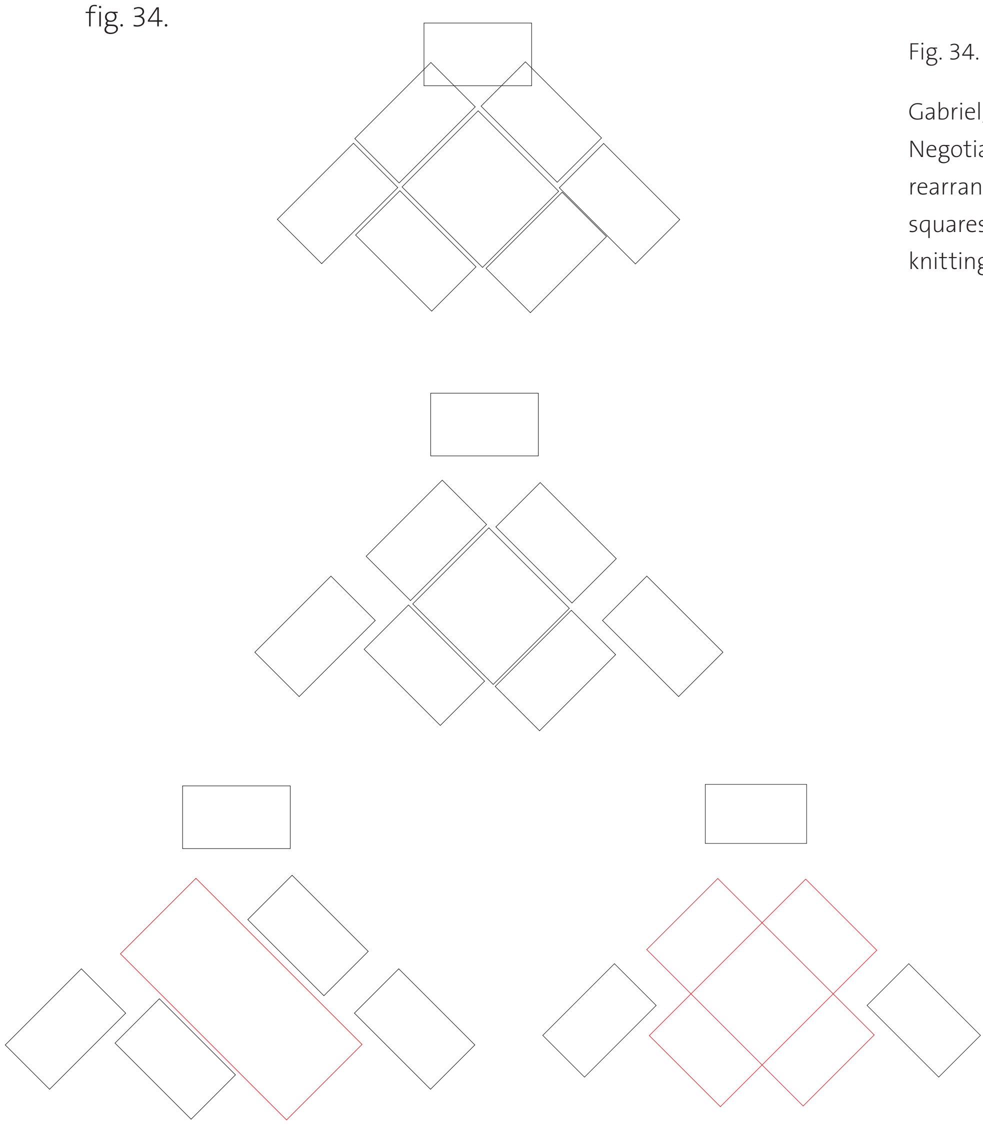


Fig. 34.

Gabriel, N. (2015). Negotiating the rearrangement of squares for machine knitting.

MACHINE KNITTING. 2D GARMENT CONSTRUCTION NO. 2, NO. 3 AND NO. 4.

DESIGN PROCESS

Fig. 35.

Gabriel, N. (2015). Domestic Manual Machine Knitted Square. 35cm x 35cm. Parts to make Garment Construction No. 2A.

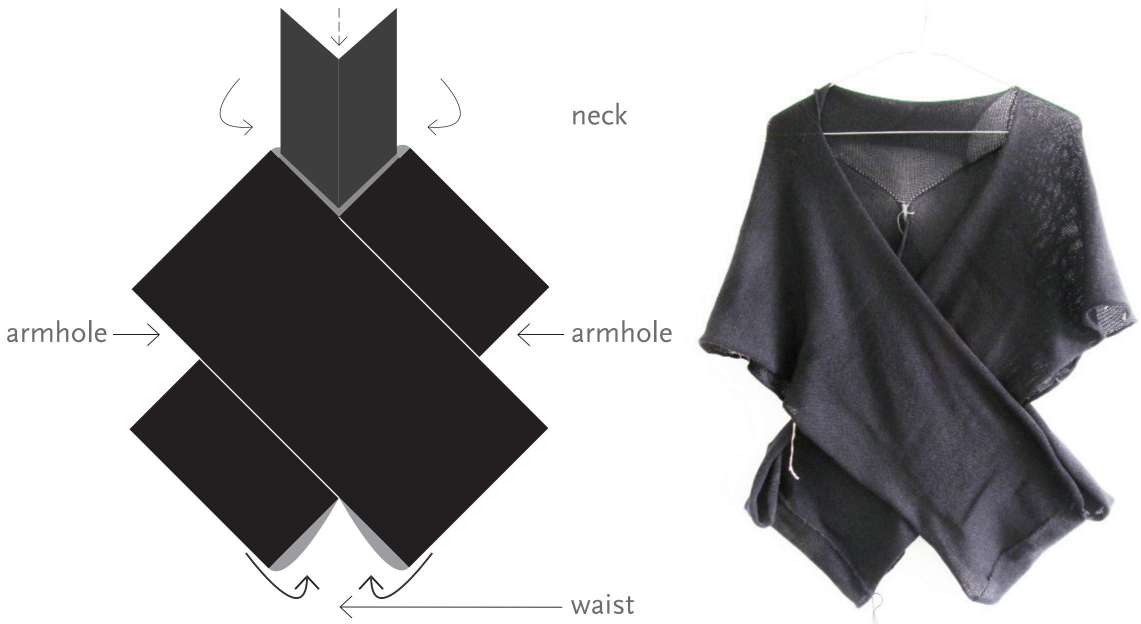


Fig. 36.

Gabriel, N. (2015). Two-Dimensional Garment Construction No. 2A.

Figure 35 shows the machine knitted square on the right, and the rectangle on the left equalled the measurement of 4 squares, knitted as a tube. Two of these rectangles were made for the next garment. Figure 36 shows the graphic rendition and knitted version of the design where the tubular rectangles were crossed over in the front and the back of the body, and a single square was worked into the neckline. The rectangle tubes eliminated the need for joining single squares, making a faster and therefore more time efficient adaption of the use of squares in this design process.

Fig. 37A.

Gabriel, N. (2015) Two-Dimensional Garment Construction No. 2B with arrows showing various knit directions in the garment composition.

Fig. 37B.

Gabriel, N. (2015). Two-Dimensional Garment Construction No.3B with arrows showing various knit directions in the garment composition.

Figure 37A demonstrates how Garment Construction No. 2A from the previous page, transforms into Garment Construction No. 2B above, with the addition of two squares joined on as sleeves in the garment.

Figure 37B shows a different transformation of Garment Construction No. 2A which became Garment Construction No. 3B. This garment referred to as Construction No. 3B has sleeves constructed from rectangles (comprised of 3 squares each), which were joined from the neckline, twisted around the back and rejoined on to the garment at the sleeve openings. The experiment here was to engage extra dimensionality to knitting with additional fabric, hence the addition of squares. This making was inspired by the cube constructions in the small objects exercises which explored such dimensional constructs in the knitting of a three-dimensional cube (fig. 23).

The arrows in both garments indicate the direction of the knitting, which in this methodology is referred to as the line in the design. Validated by its interpretation within a design context (Appendix 2, Line p. 89); horizontal, vertical and diagonal lines alter tension and resolve balance in a design. Here it depicts the Fabric Grain (Appendix 2 p. 88), which is what determines the structural forces, movement and energy in the knitting.

While making the garments I generated sketches (figs. 38 & 39) to map out how the squares inform the design and then re-rendered this into a graphic version (figs. 40 & 41). The graphic version is not meant to function as a technical drawing, but more an artistic rendition of how the squares engage an aesthetic process in the design.

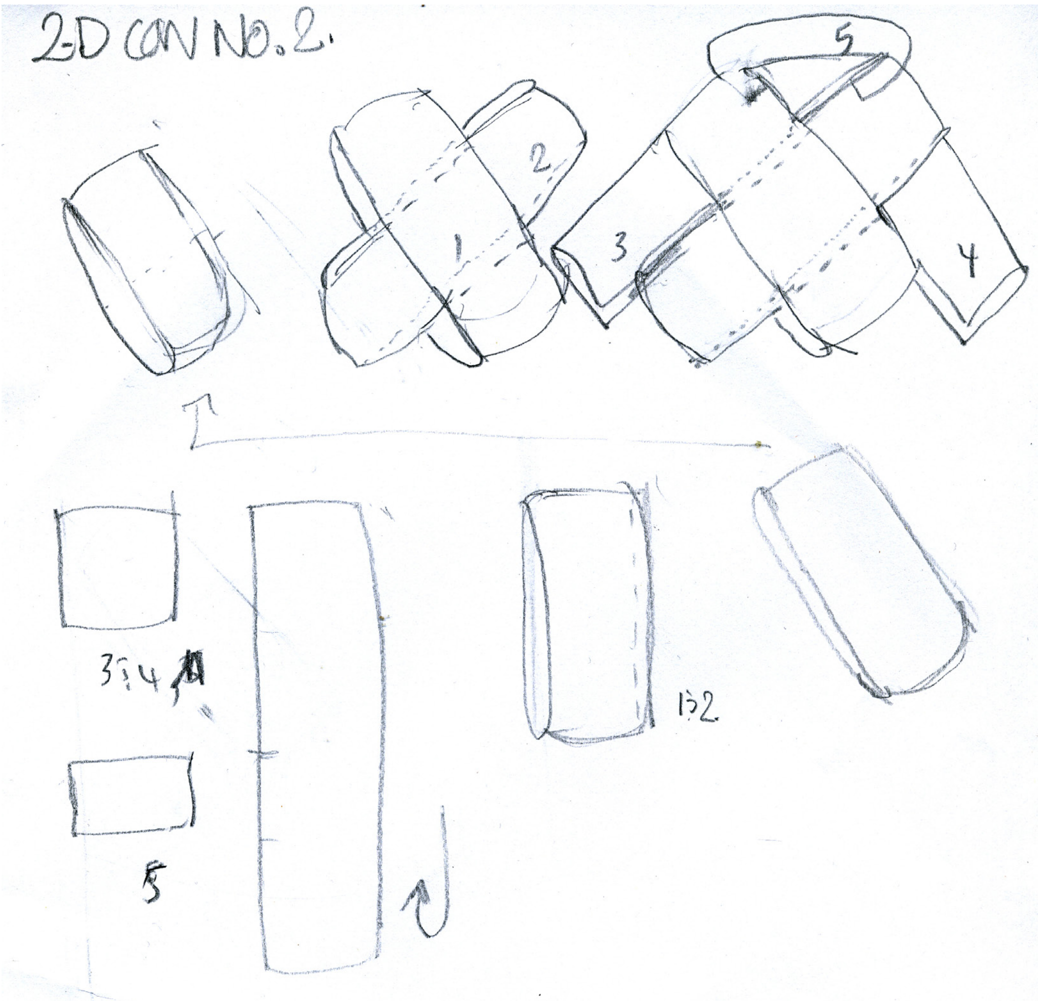


Fig. 38.

Gabriel, N. (2015). Hand sketches of the making process of garment 2D Construction No.2, made on domestic knitting machine.

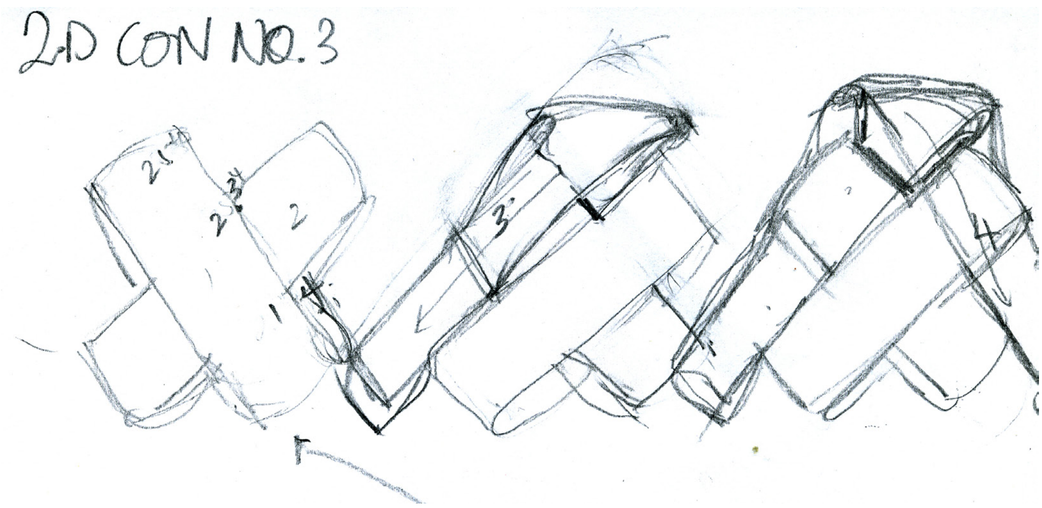
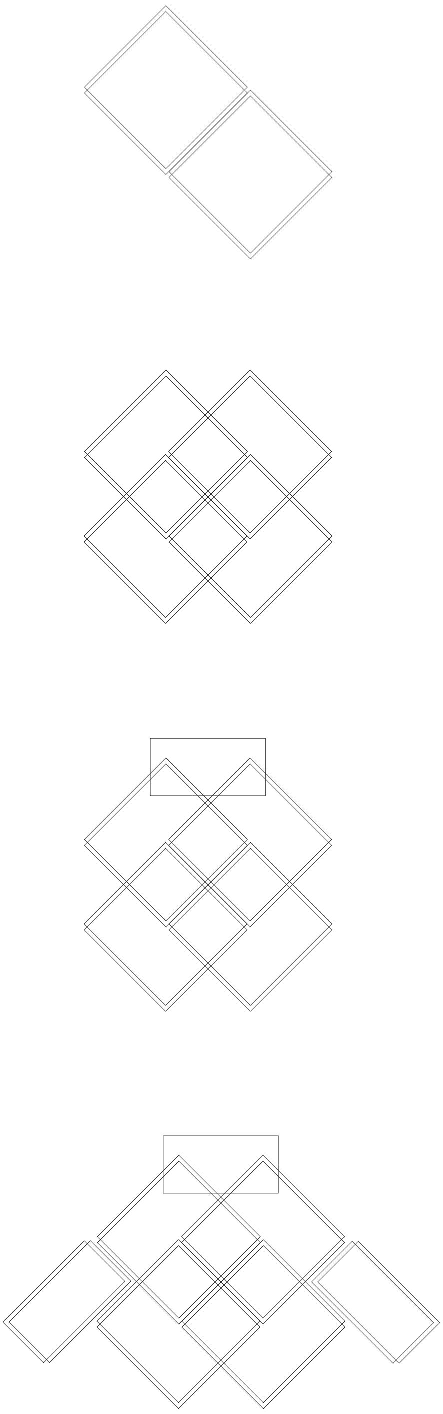


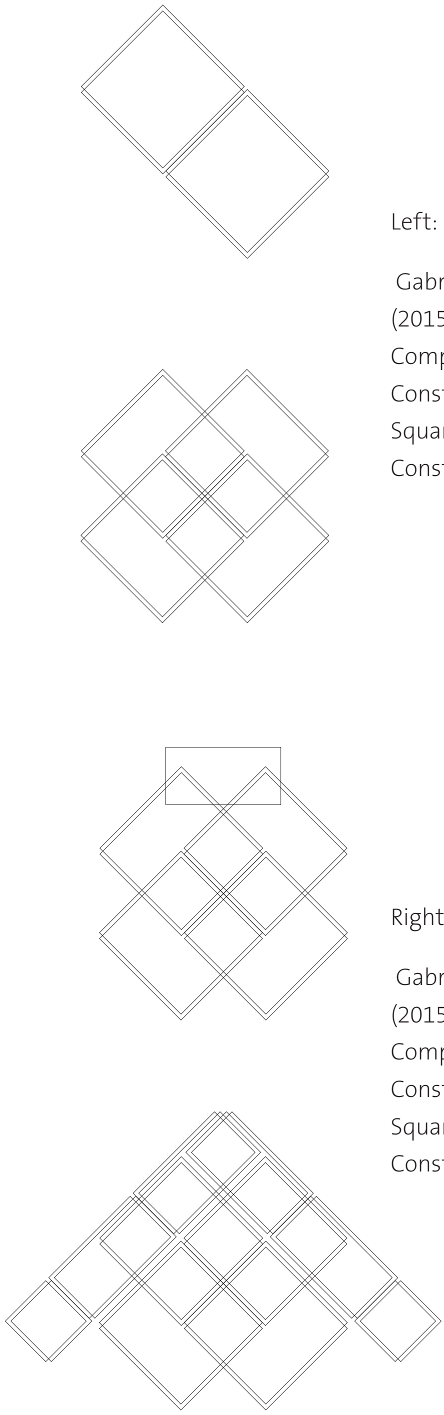
Fig. 39.

Gabriel, N. (2015). Hand sketches of the making process of garment 2D Construction No.3, made on domestic knitting machine.

CONSTRUCTION NO. 2.



CONSTRUCTION NO. 3.



Left: Fig. 40.

Gabriel, N. (2015). Sequential Composition of Construction of Squares for Garment Construction No. 2.

Right: Fig. 41.

Gabriel, N. (2015). Sequential Composition of Construction of Squares for Garment Construction No. 3.

For the next garment designs on the following page, I used longer rectangle shapes to investigate extra folding and dimensionality increasing the complexity of form. Figure 42 shows the parts made for assemblage, and figure 43 shows the steps and explanations of garment construction, while figures 44 and 45 show the hand rendered sketch designs and graphitised versions.

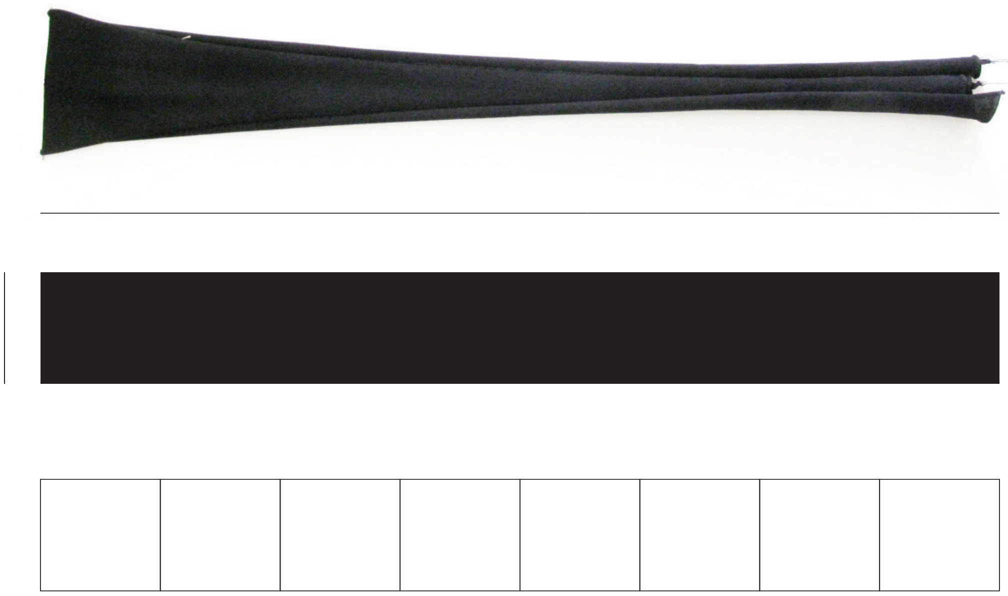


Fig. 42.

Gabriel, N. (2015). A rectangle equivalent to 8 squares was used for the following garments.

CONSTRUCTION NO. 4A.

CONSTRUCTION NO. 4B.

CONSTRUCTION NO. 4C.

Fig. 43.

Gabriel, N. (2015). Two-Dimensional Garment Construction No. 4; Steps A to C of the garment construction, with arrows to show the various knitting directions in the composition.

The sequence of actions were as follows:

Step A: Following the construction of the previous garment (Construction No. 2, (fig. 36), two long rectangles where wrapped diagonally across each other at the front and the back (fig. 41). The extra fabric lengths at the front were wrapped around to the back of the body to be re-joined onto the garment at the sleeve openings in step B (middle garment). Step C; (right), the extra fabric at the back of the garment was folded towards the front of the garment, re-joined onto the garment at the front of the sleeves. The back of the garment is shown in step three. This twisting and folding of extra fabric was inspired by the cube experiment from the ‘small objects’ exercises. (fig. 23)

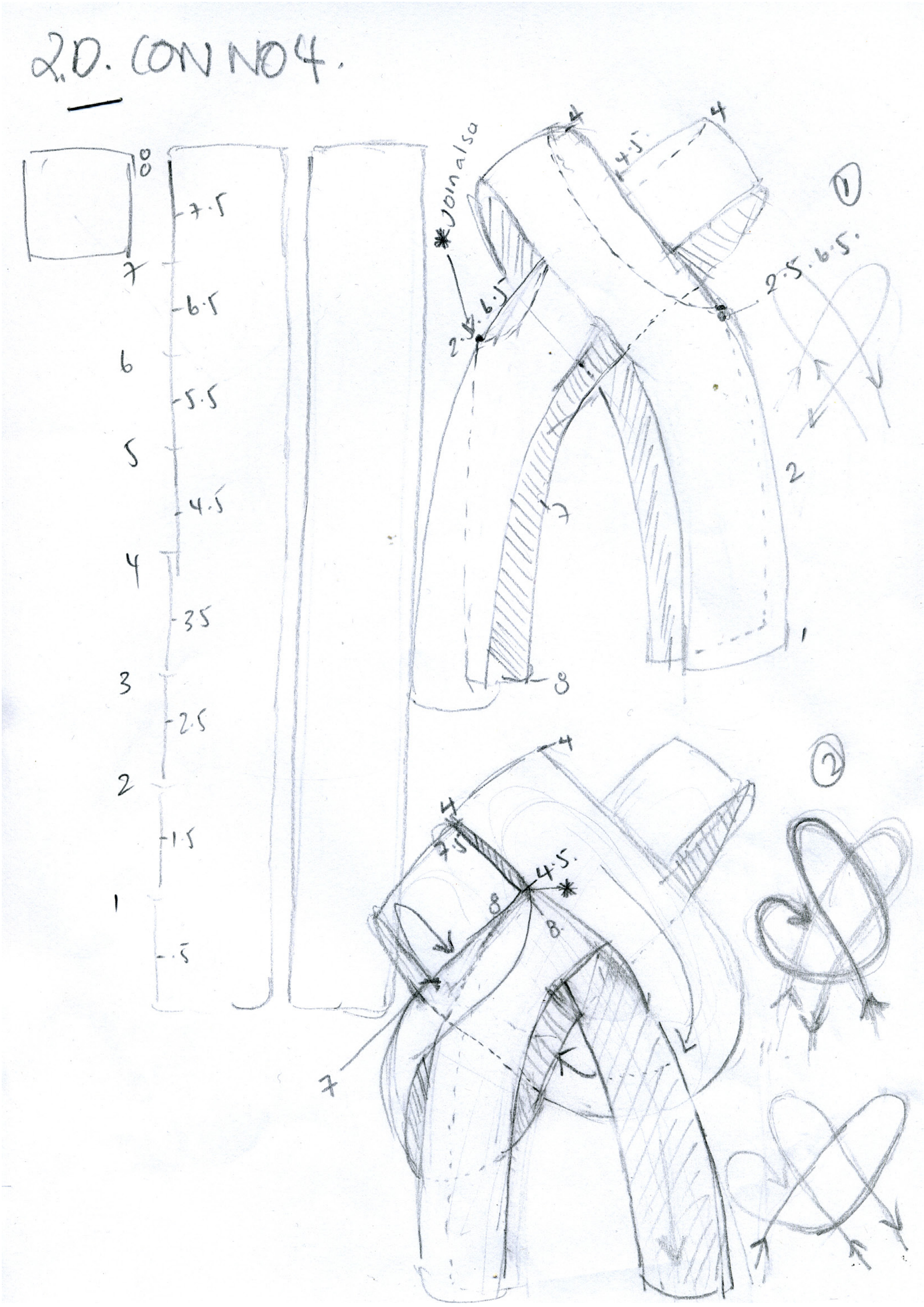


Fig. 44.

Gabriel, N. (2015). Hand sketches generated after the making process of garment 2D Construction No. 4, made on domestic knitting machine.

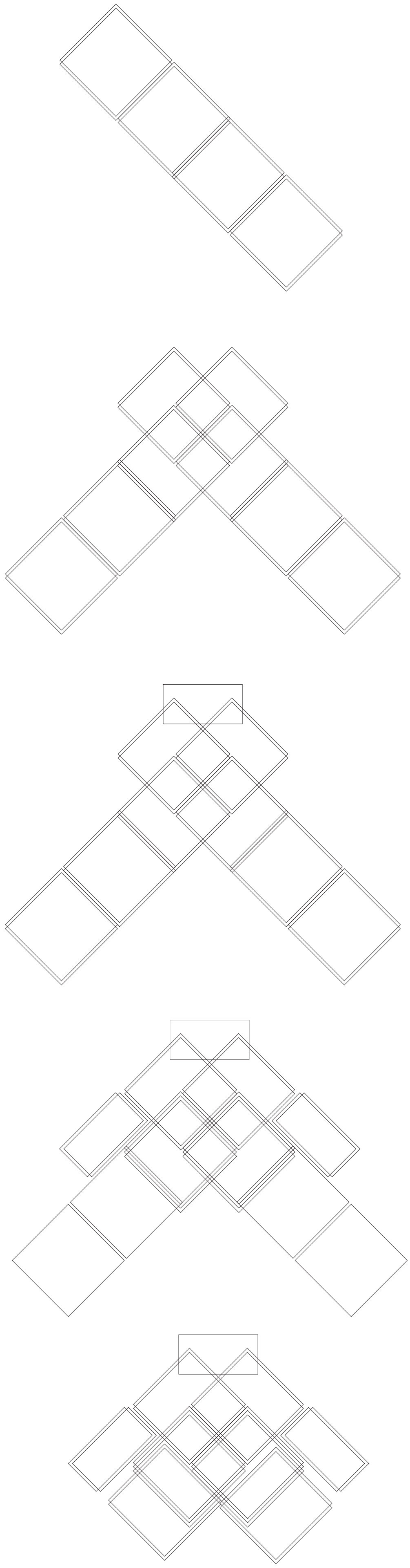


Fig. 45.

Gabriel, N. (2015). Graphic rendition of Two-Dimensional Garment Construction No.4, showing the sequential steps of the configuration of squares in the garment.

KNITTING PROCESS

1. I chose a 2/30Nm (see Appendix 2. Yarn Guage, p. 92) Wool to use on the knitting machine, and knitted with two threads to suit the knitting machine's gauge, for a light and soft single jersey fabric.

2. The intention of this part of the project is to adapt the first hand-knitted design process in its use of squares for a machine knitting process.

3. As the knitting machine knits works efficiently in one vertical knit motion, it was decided to combine squares into lengths of rectangles, to avoid labour intensive joining. The rectangles wrap around the body following the garment silhouette of the first hand knitted construction (fig. 32). The square as a building block informed the dimensions and calculations of the garment configuration, e.g., one square across the body, half a square over the sleeve, etc. This created an effective method for simplifying the making of a complex garment, converging three-dimensional design concepts of spatial and depth constructs into the knitted form.

SUMMARY

SIMPLIFICATION: The line which represents the calculation of the square supplies a trace of this making process to adapt new calculations of knitting.

CREATIVITY & PERSONALISATION: Further modification in the making of longer rectangles to twist, drape and envelope the form was stimulated through the handling of the knit fabric, and a response to machine knitting capabilities. Based on my own experience and "embodied knowledge" (Philpott, 2012, p. 69) of knitting, I can imagine that there is further design potential if extra lengths of fabric were used where more squares can be layered.

Figure 46 is Garment Construction No. 4, superimposed with its geometric pattern of squares as yellow lines. The lines show the layers of the equivalent of 16 squares folded and intersected in the garment construction.

Fig. 46.

Gabriel, N. (2015.) Two-Dimensional Garment CONSTRUCTION NO.4 with relational elements shown as yellow lines.

3D MACHINE KNITTING CONSTRUCTION NO. 5

DESIGN PROCESS

I decided to move straight into the garment phase in the use of this machinery, and omit the 'small objects' exercises due to limited access to this technology. The fundamental purpose of this aspect of the project was to test if the construction knitting method can be applied to the mode of computerised three-dimensional machine knitting, and in turn, simplify the communication process between knitting technician and designer. Within this process, can the use of the geometric be a tool to innovate design within the tight procedures of the use of this technology, and find "avenues to manipulate these procedures so that they add to the design"? (Healy & Bigolin, 2010, p. 5).

Due to a small window of opportunity to create work with this machine, I deduced that any shaping manipulation was a time-consuming programming and knitting process and therefore not a viable productive application of the research method in question.

Therefore I decided to follow the theme of the squares as a production unit, with minimal design manoeuvre, and find a creative solution for the knitting process. The geometric entices a way of thinking differently for the knitting of garments as the visualisation of the design thinking steps show on the next page.

Figure 47 shows the transition from the hand-knitted squares which is a piece and assemblage process, to the three dimensional knitting process where there is no assemblage required. The whole garment is rotated on its side to change the knitting direction.

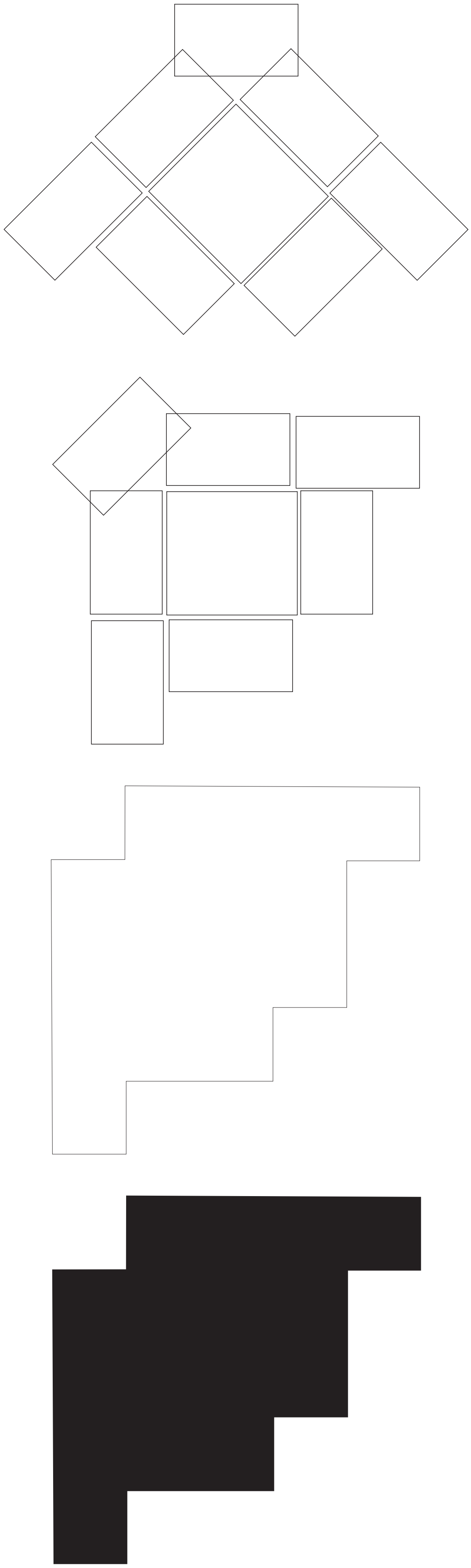


Fig 47.

Gabriel, N. (2015). Graphic depiction of the transition of separate piece and seams knitting process to seamless knitting process.

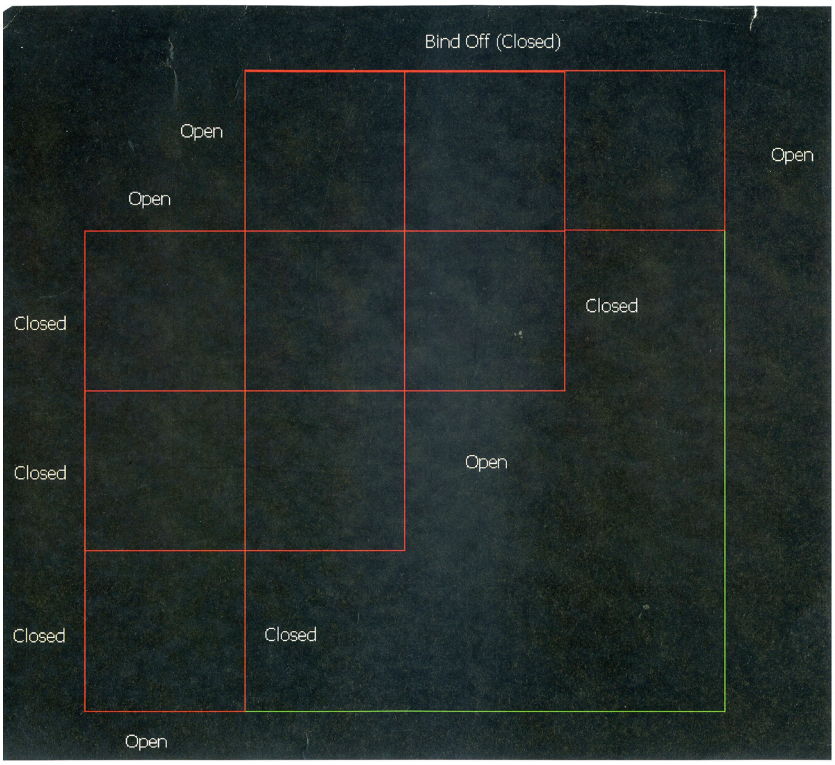


Fig. 48.

Gabriel, N. (2015). Three-Dimensional Garment Construction No. 5. Screen shot of the knitting technician's design process of three dimensional computerized machine knitting.

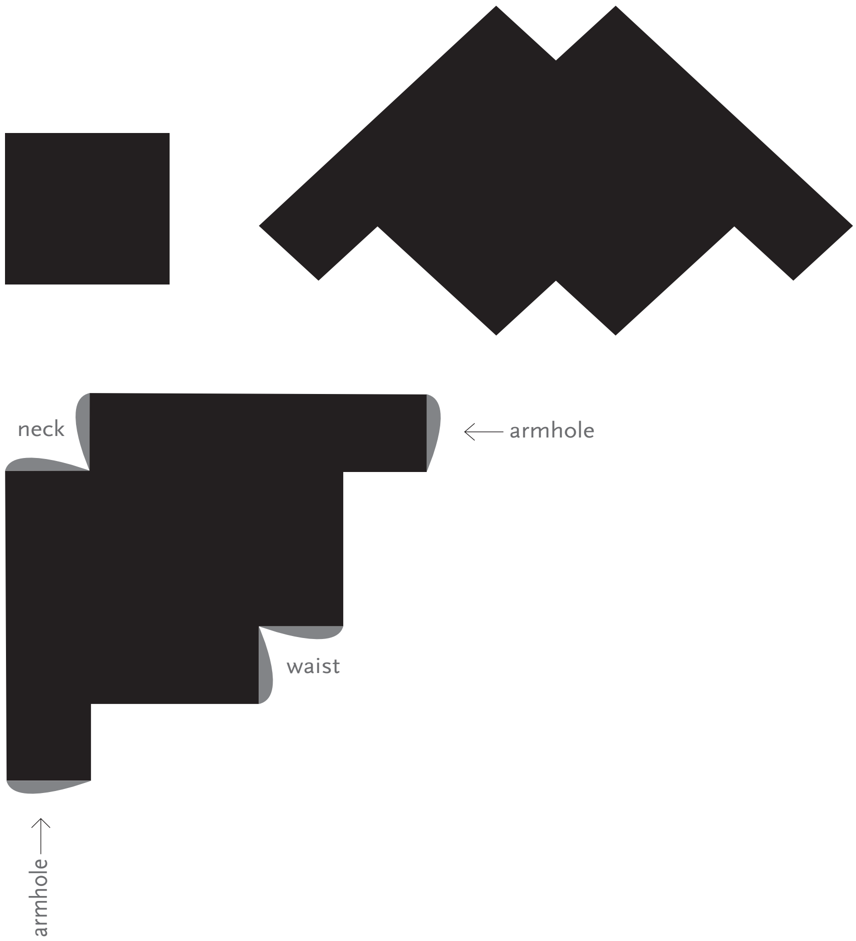


Fig. 49.

Gabriel, N. (2015). Three-Dimensional Garment Construction No. 5. The design process visualized. Showing the square as the unit of production, converged into a garment shape (following the silhouette and construction of the hand-knitted garment (fig. 32)), and rotated for a vertical knit direction.

Fig. 50B.

Gabriel, N. (2015). Three-Dimensional Garment Construction No. 5. The knitting process showing the converged squares as one whole measurement unit and the waste yarn attached.

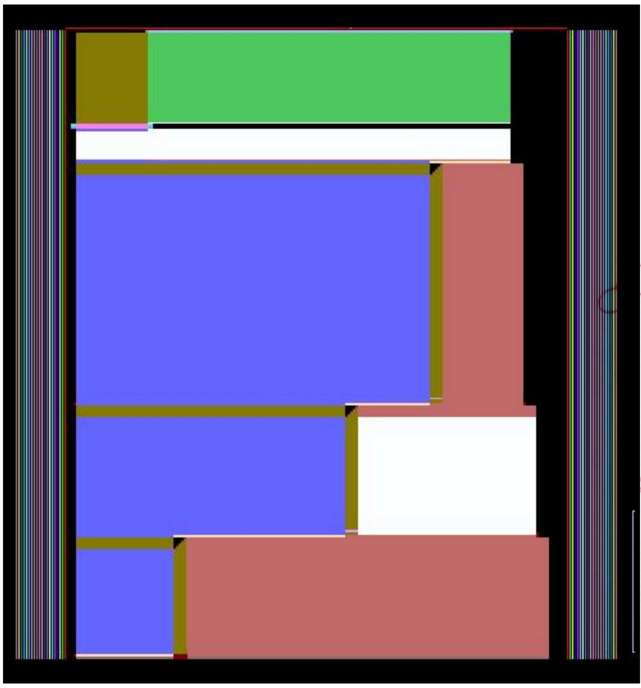


Fig. 50A.

Fraser, G. AUT TDL. (2015). Three-Dimensional Garment Construction No. 5. A screen-shot of the Shima-Seiki knitting program of the garment.

Fig. 51.

Gabriel, N. (2015). Three-Dimensional Garment Construction No. 5. The design process showing the converged squares as one whole unit of production. By following the silhouette and construction of the hand-knit (fig .32), and rotated for vertical knit direction means no extra shape engineering. Also shown on the hanger with the neck and waist openings positioned how it would be worn.

KNITTING PROCESS

1. I used the first hand-knitted garment as a working sample to discuss the design with the knitting technician, and applied the squares as the unit of communication for design specifications. Therefore the collaboration process began with me requesting a garment knitted on its side where the shaping is made of a configuration of squares, where each square measures 35cm x35cm.

2. We discussed the making specifications, where the start and end of the garment was, and its openings and closures (fig. 48), while the technician indicated where the waste yarn[7.] (fig. 50) would be knitted in. The technician understood the concept of the configuration of the squares easily, which once he had calculated the measurement of one square in the knitting machine's equivalent of wales and courses, the rest of the garment was a simple programming process.

SUMMARY

SIMPLIFICATION: The square is pivotal in simplifying design communication between designer and technician, particularly as no (time-consuming) shape engineering is required to knit squares.

CREATIVITY & PERSONALISATION: The liaison with the knitting technician tends to be prohibitive to the technician's interpretation of a design, as he controls the machine's knitting capabilities. The knitting technician has know-how of the machine's technical ability that the designer does not possess. As highlighted earlier, in finding a solution to working innovatively within a short time frame, the square was conduit to thinking differently for a garment solution for this knitting process and has proved as an effective solution to communication and innovation working collaboratively with the technician. The design was kept to a productive outcome for the application of this methodology working within limited creative intervention, but such is the design process of working with this technology. The hands-on knitting process in the making of the

[7.] Waste Yarn knitting is applied as a fake start or provisional cast-on, that is connected to the real start of the knitting with a ravel cord. The ravel cord is a fine and strong nylon thread which is removed to disconnect the knitted waste yarn post-knitting.

other garments, had significant influence on developing an integral creative approach to working with this automated hands-off process where derived tacit knowledge of cause and effect impacted design decisions.

However, if the opportunity to work collaboratively with a knitting technician is increased to a more routinely comprehensive practice, there is scope to further explore the potential of the geometric in the use of this knitting technology particularly for deeper exploitation of the machine's three-dimensional knitting capabilities.

Fig. 52.

Gabriel, N. (2015). Three-Dimensional Garment Construction No. 5, with arrow showing direction of knitting.

SUMMARY OF PHASE TWO OF THE METHODOLOGY.

Figure 53 shows an artistic graphic rendition of squares applied in the production of garments across the three knitting technologies. The squares are shown as yellow lines superimposed over the garments as layers of constructional elements. The lines demonstrate the increasing levels of folding and dimensional complexity from the hand knit to the machine knit until the point where there are no lines to define any seams in the wholegarment™ knit.

The removal of seams in the progression of working from hand to computerised knitting processes required a correspondingly progressive understanding of dimensionality and the material of knitting. In the hands-off process the nature of the knitted materiality became more challenging to control, symptomatic of its pliable and therefore unpredictable character. The accuracy of the shape measurements became compromised as being close enough to the actual geometric shape. This threw the symmetry of the last garment slightly out of balance, as shown in figure 54 with the garment folded flat. However, this is the nature of the medium when making changes to its fabric grain, a condition of knitting discussed in Appendix 2, (p. 88).

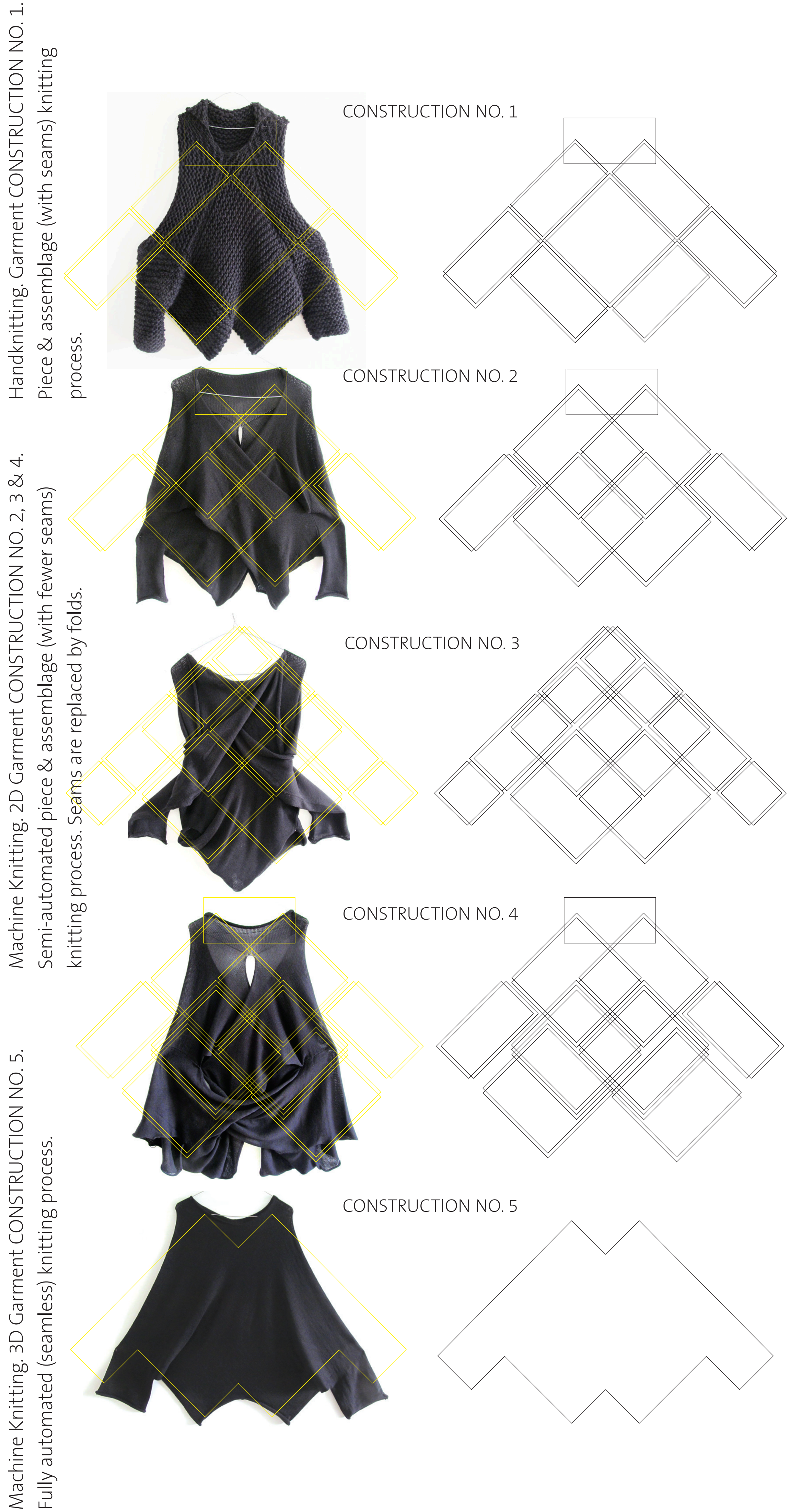


Fig. 53.

Gabriel, N. 2015. Artistic rendition of squares applied in the three modes of production, hand-knitting, 2D machine knitting and 3D machine knitting.

Fig 54.

Gabriel, N. 2015. Construction No. 5 Garment folded in half, showing the symmetry of the garment slightly out of balance by 2.5cm, due to the challenge of making the knitted material a true geometric shape.

Creativity could be described as disruption to standardised production processes, and within this methodology these instincts were developed through hand-making, where the insights were correlated to develop a design solution for automated knitting processes. While this method explored a narrow range of garment styles that I have designed for this research project, I believe that creativity is the only limitation for the designer using this method. There are countless other ways one could explore creative outcomes using squares for knitted applications.

The geometric facilitated a sense of order and logic within creative exploitation of these projects, as it provided a traceable system as a means to pause to re-think ways of the production of knitting. Production and its productivity infer to the quality of how something is made, and creativity should contribute to this, but not necessarily as a disruption to procedure. A pause effect can be a small interruption, which can transform into a manageable design system.

CONCLUSION

The research question began with investigating how the geometric could inform the design and construction of knitting, and in turn simplify the complexities of its processes.

The methodology experimented with using the geometric as a 'parts and assemblage' design process. The adaptation of parts are particularly evident in the physical changes of each according to the knitting and design procedures of the three different knitting technologies. The geometric graphics visualises this process clearly which demonstrates a design system.

The methodology cannot provide evidence of this system overcoming the demarcation between the knitting protocols and procedures of each technology, without user testing this method. However, the methodology does reveal ways for alternative reasoning of some of the protocols of knitting, by challenging the normal perception and the negotiation of knitted form within its design and production process. The glossary in Appendix 2 attempts to frame this into acknowledged design language.

There is a utopian element to this methodology where it seeks to reconcile production with the individual by bypassing ranking specialist jargon in creating a simplified and unified visual code that connects the designer to wider literacy and wider community of design discourse. This equips the designer with conceptual resources to optimise creative exploitations through accessible modes of hand-making production processes, adding their own self-authorship to the practice.

The fashion researcher Otto Von Busch (2013), affectionately terms such individualized tinkering with the "protocols" of knitting as "bastard techniques" (p. 12). Von Busch explains further that "to understand knitting from the perspective of protocols, we should neither look at the silhouette of a garment ... (nor) focus on the ... knitter('s) artistic intentions", as the intervention is in the "decentralizing" of knitting itself (Von Busch, 2013, p. 10).

There is the potential to investigate this methodology further, by extending the variables of both the geometric and knitting which could lead to the development of resourceful design strategies and tools, particularly in synergising craft processes with industrialised applications, and transitioning two-dimensional to three-dimensional design thinking.

There is scope to structure this concept as an educational approach to knit design, as modularity being a feature of this method, activates a sequential learning process. A participatory design project formed by this methodology could be a creative and engaging way for students to learn knitting from the very basics of hand-making to more complex and industrialised applications.

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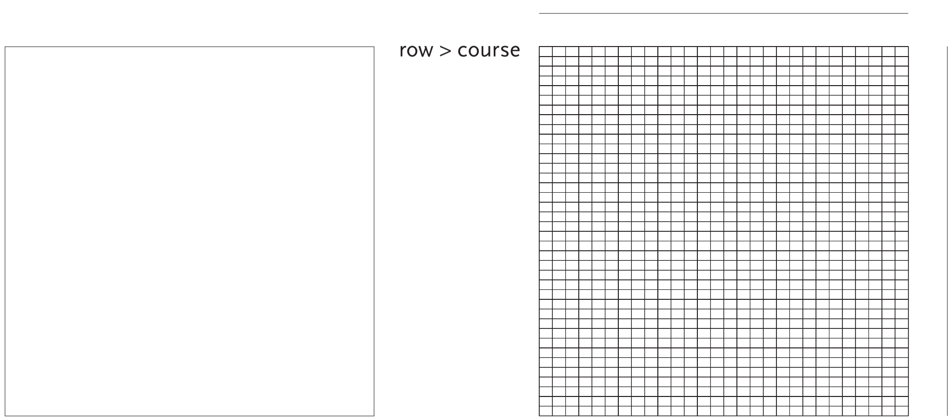
APPENDIX 1

GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015). KNIT CALCULATION GRIDS OF SQUARES & TRIANGLES. NO. 1. This chart shows the basic value relationship between the knitted stitch (knitting) and the square (geometric shape) as applied in these projects.

10 cm SWATCH MEASUREMENT >



_____PLY YARN

_____GG K_________ NITTING MACHINE TYPE

_____mm KNITTING NEEDLES

Stitch/Course
Knitting is built from yarn being looped around a needle, which is called a stitch.
In hand-knitting terms this unit is referred to as a stitch,
in industrial machine knitting terms it is also referred to as a wale.

Row/Wale
A series of consecutive looped stitches. In hand-knitting terms this is referred to as a row,
in industrial knitting terms, a course.

Knitting consists of a number of consecutive rows of interlocking stitches. Each stitch is a like a pixel in the square.

Mm: millimetres

Cm: centimetres

Ply: The measurement of the thickness of yarn. The higher the number, the finer the yarn weight.

Nm: The industrial measurement of a yarn weight, known as 'count'.
The determination of the proportion of length to weight, eg Nm2/28 = 2 refers to the amount of threads twisted together, 28 refers to 28km of this yarn weights 1000g. The lower the number, the thicker or heavier the yarn weight.

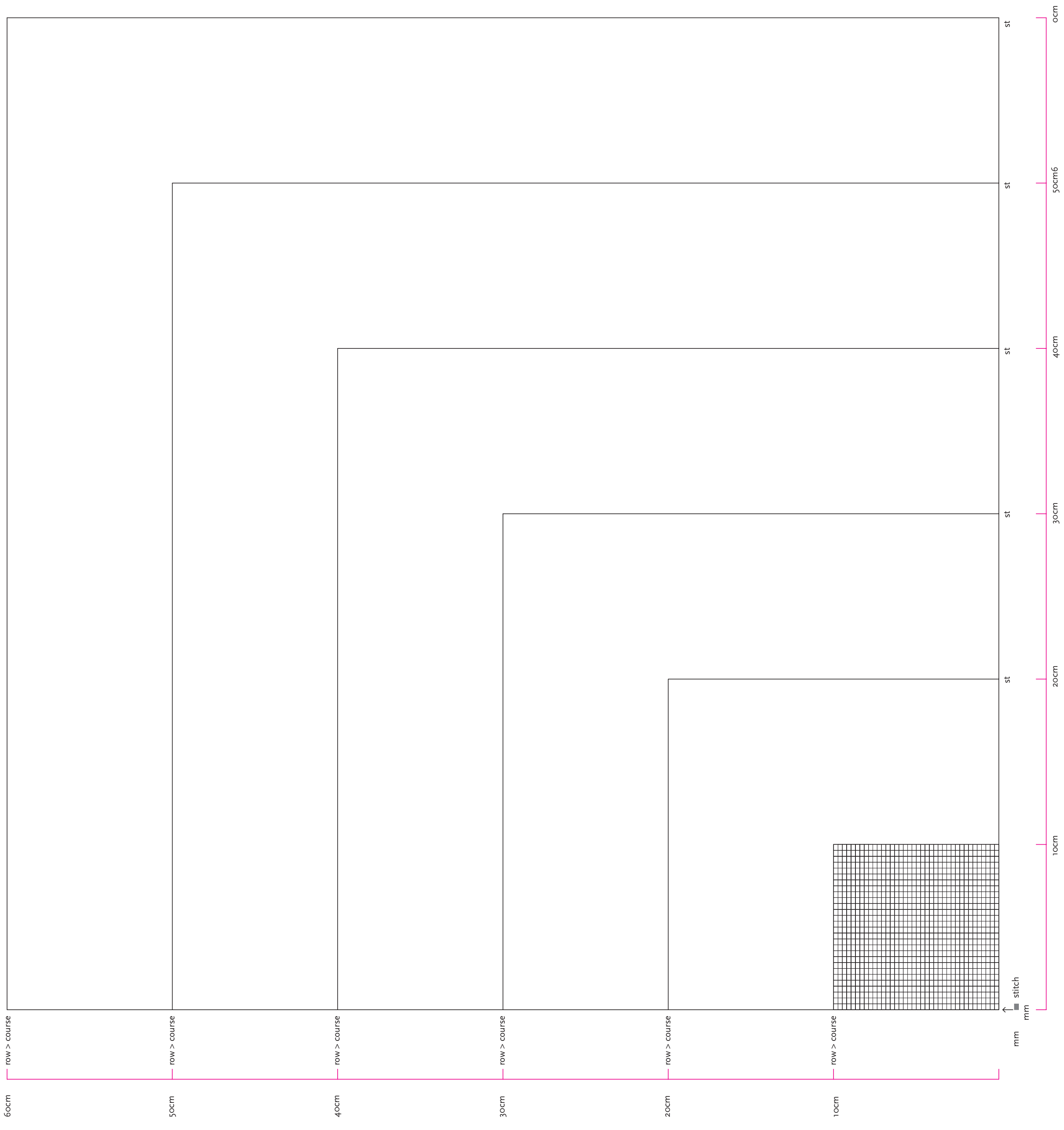
GG Gauge: Refers to the fineness of heaviness of a machine's knitting;
the measurement being defined by number of stitches/wales and rows/courses per width and length measurement.

APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015). KNIT CALCULATION GRIDS OF SQUARES & TRIANGLES. NO. 2. These shapes and lines show the development of the relationship from measurement, to shape, to line used in the design process, to illustrate the type of visual thinking applied in these projects.

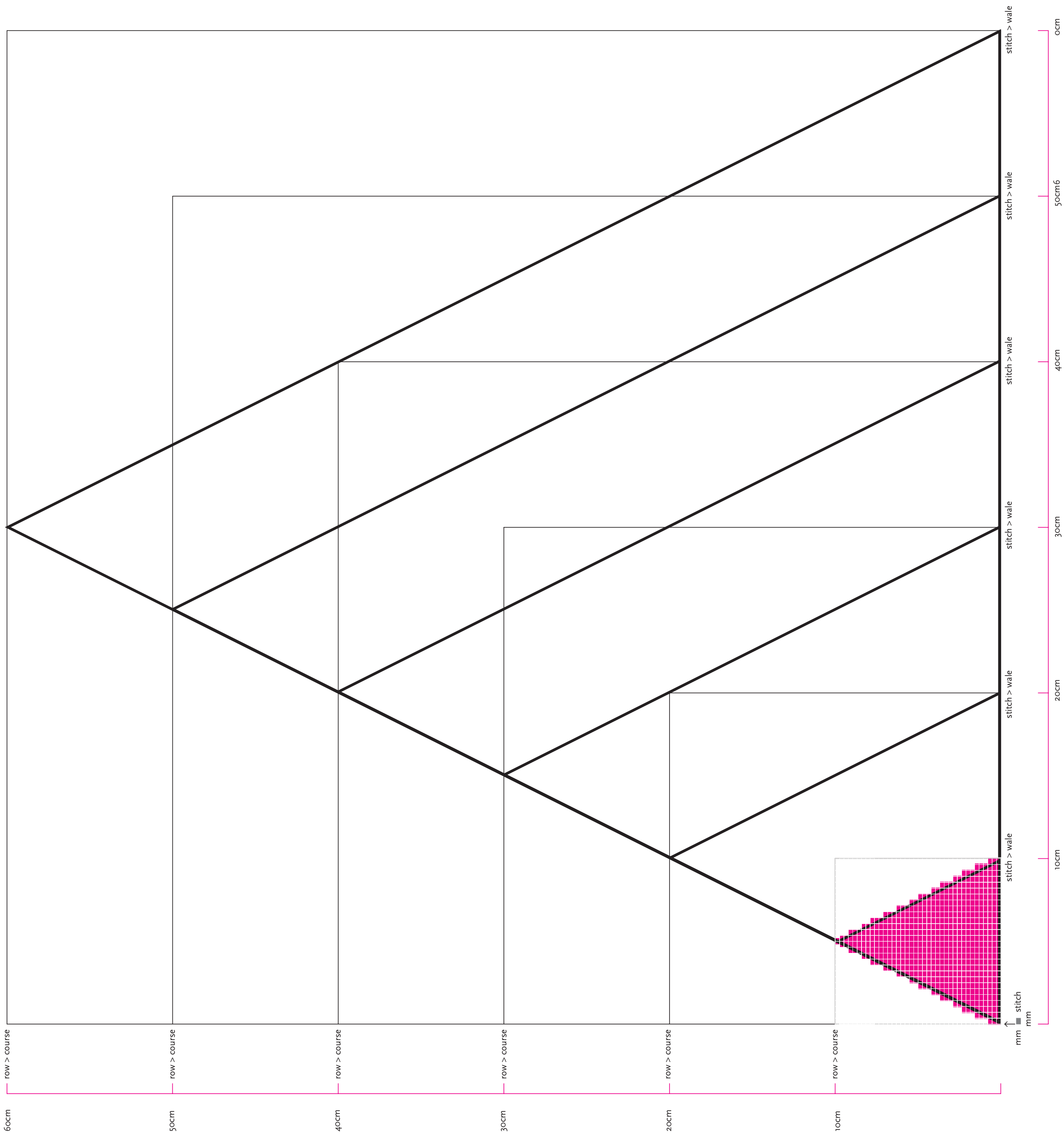
APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015) KNIT CALCULATION GRIDS OF SQUARES & TRIANGLES. NO. 3. The basic grid generates scale-values demonstrating how the geometric-knitting calculation relationship works.



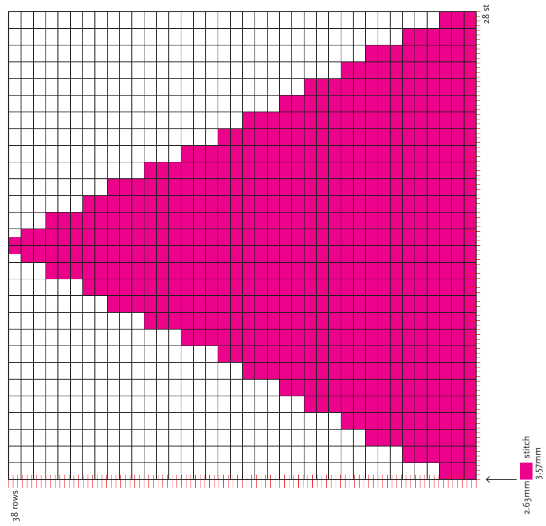
APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

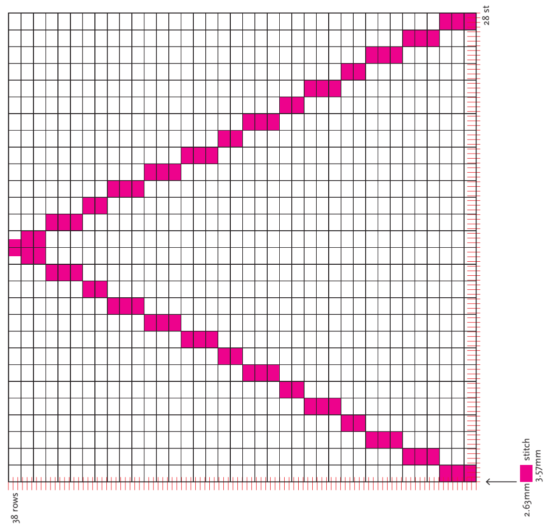
GABRIEL, N. (2015) KNIT CALCULATION GRIDS OF SQUARES & TRIANGLES. NO. 4. This chart demonstrates how the preceeding square grid can lead to generate knitting values for triangle shapes as applied in these projects.

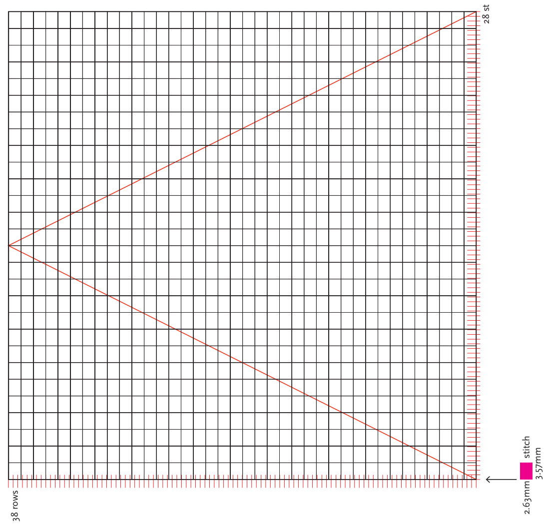


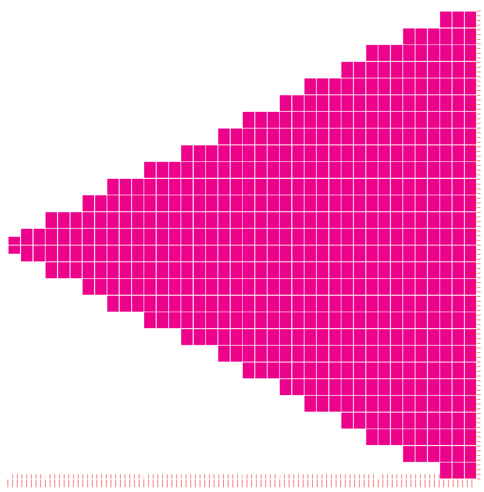
APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015) KNIT CALCULATION GRIDS OF SQUARES & TRIANGLES. NO. 5. These diagrams detail the geometric-knitting square-triangle value relationship explored in the previous chart No. 4.



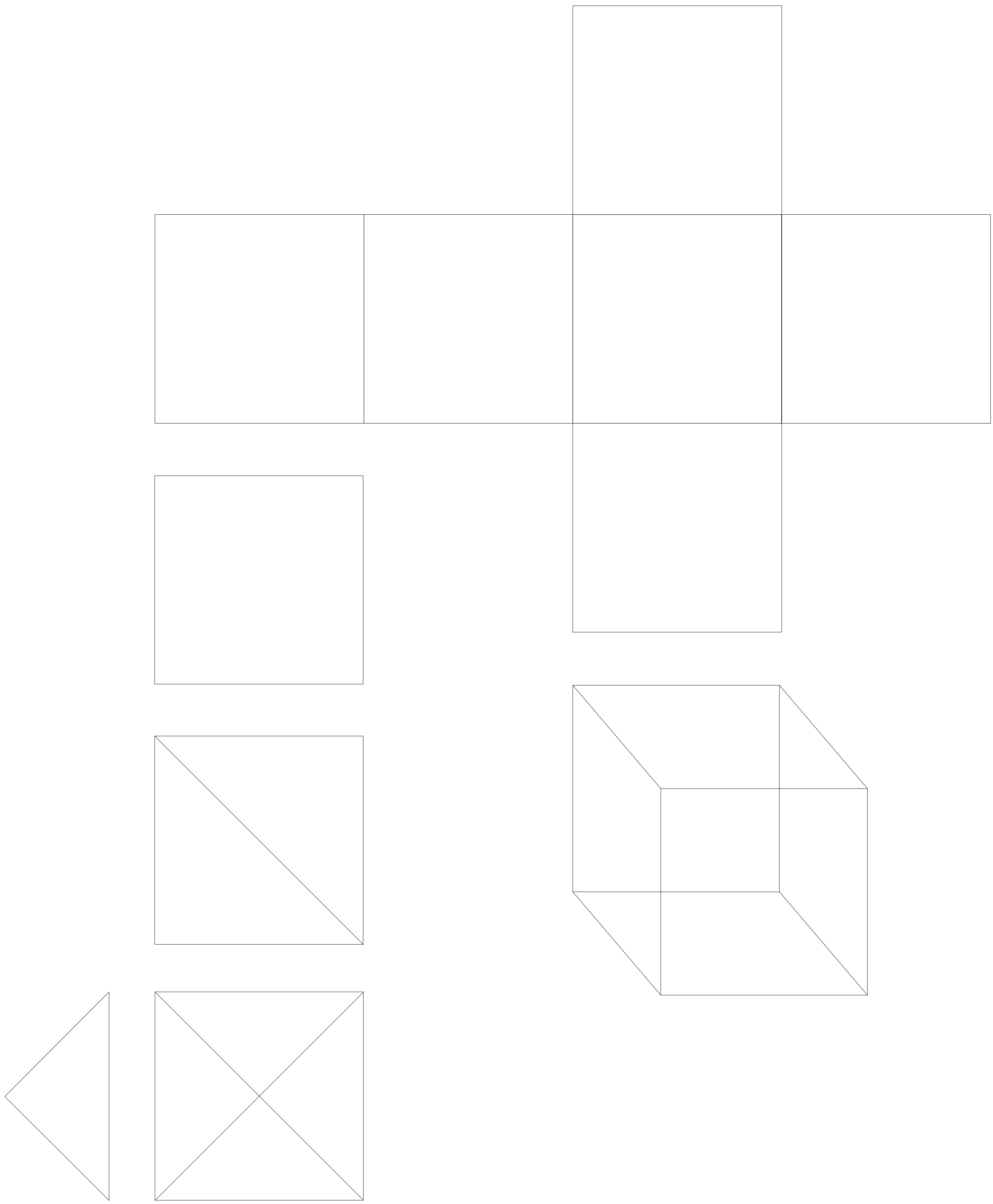






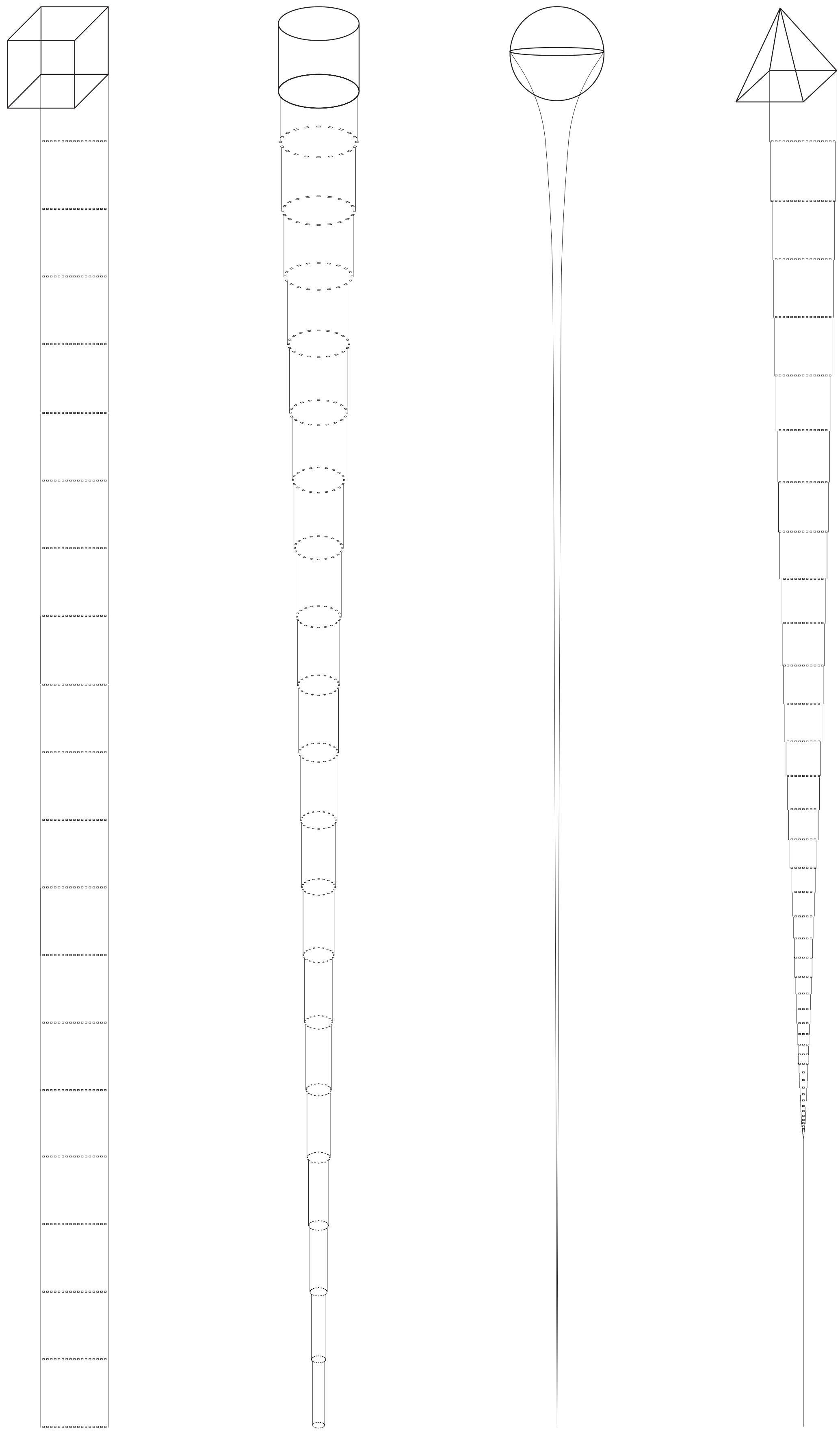
APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015) VISUALISATION OF SHAPE RELATIONSHIPS AND DIMENSIONALITY. These diagrams show the visual thinking process of the transition from two-dimensional to three-dimensional thinking in design for knitting. The application of knitting values as explored in the previous charts, enable the calculation from rendition to construction.



APPENDIX 1 GEOMETRIC SHAPES USED IN THE CONSTRUCTION KNITTING METHOD

GABRIEL, N. (2015) VISUALISING THREE-DIMENSIONAL GEOMETRIC SHAPES FOR KNITTING WITH EXTRA FABRIC TO FOLD BACK INTO SHAPE. These diagrams support the idea of knitting structural three-dimensional geometric shapes. While only the square was constructed for this research project, the other shapes were also calculated as possible to knit both two-dimensionally with seams and three-dimensionally without seams.



APPENDIX 2

GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

AESTHETICS

Can refer to the look and feel of a thing, classified by generalities of style or fashion, pertaining to perception and experience.

See PERCEPTION.

BUILDING BLOCK

Geometric Shapes are used as a type of building block in this project. Firstly, as a visual aid in representing the design in a two-dimensional format. Secondly as a construction aid in the three-dimensional design process of making.

The elementary formations of shapes such as squares show only the necessary, pared-down constructional elements in a design, revealing logic in the design. Reductive Design is an action link to this process.

See LOGIC, REDUCTIVE DESIGN PROCESS.

CONSTRUCTION

Within knitting; the process of making of a three-dimensional form.

Within the geometric; the distinction between two and three-dimensional design thinking.

Two-dimensional design refers to the flat visual elements of a design composition.

Three-dimensional design refers to the constructional elements of a design composition, within the play of depth and flow of space.

See METAPHORS FOR DIMENSIONS. STRUCTURAL, SPATIAL, DIMENSION.

CRAFT

The practices of hand making processes, and the paradigm of which the context of hand knitting is positioned. A broader prospect of the term craft is the employment of a highly specialised and articulated skill, that which embodies tacit knowledge and an extensive scope of application (especially of material), more than automated industrial systems are capable of.

See TACIT KNOWLEDGE.

DECONSTRUCT

In this project deconstruct refers to the demystification of a process by breaking it down into components and analysing each component. The geometric is used as a deconstruction process to modify the production knitting techniques.

See, DESIGN CONDUIT, PRODUCTION EFFICIENCY, TECHNOLOGY PRECONDITIONS.

DESIGN CONDUIT

A trigger that activates an idea or thinking process.

In this project the Geometric is a conduit to thinking n three-dimensions, and considering alternative methods to production.

DESIGN THINKING

A cognitive process of rationality and analysis in developing insights and solutions to design problems.

DIMENSION

A spatial construct. A measurement or notion of width, length, and in the case of three-dimensions; depth.

See also THREE DIMENSIONAL. VISUALISATION. SENSE OF SIGHT AND REASON.

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

DIRECTION

The line in which a thing faces or moves.

A value of dimension enabled by sense of sight and reason.

See METAPHORS FOR DIMENSIONS, SENSE OF SIGHT AND REASON.

DISRUPTION

During the process of production there is a modification of the sensations which in Gestalt theory is a described as a disruption to the mentality of pattern, referred to as a "higher order and another intelligence", based on "perception". (Behrens 1998 p13) This describes the thinking process during the action of making, where the mind moves from structured and patterned economy, to 'what else can be done with this formation?'.

ELEMENTARY

The most rudimentary or fundamental of the principles present in a composition.

See also REDUCTIVE DESIGN PROCESS, 'SQUARE, CIRCLE TRIANGLE'.

FABRIC GRAIN

The standard knitting production process knits fabric in one direction, which means its movement and stretch capability is in the one direction. This is called its stretch grain.

With the use of the geometric and the creation of three dimensionality within a knitting action, the addition of curvature, vertical or diagonal shaping inserted into the internal frame of knitting shifts the directions of the grain, hence adds new structural forces and movement and energy to the fabric.

Brought about by the new dimension in the fabric this can be described as an addition of kinetic and dyname elements to knitting.

See KINETIC, THREE DIMENSIONALITY.

FIT

The size or shaping of a garment, based on standardised garment and body shapes.

Used in fashion in context to form.

The project provides geometric shapes to explore dynamic thinking of form so to unfreeze the static fashion conventions of both Fit and Form.

FLAT DRAWINGS

A fashion specific term of garment specifications, detailing measurements of a garment design when laid flat.

Measurements recorded are length and width.

FORM

Material Construct: A Three Dimensional Shape.

Mental Construct: An Abstract, an Idea, a Possibility (what hasn't yet being imagined)

Further reference: Plato's Metaphysics.

Used in fashion reference pertaining to Fit in garment functionality, and Silhouette in garment frame or aesthetic, grounded in generalities of style.

See FIT, PLATO'S METAPHYSICS, SPATIAL, STRUCTURAL.

GARMENT TEMPLATE DESIGN SYSTEM

A function of the ShimaSeiki wholegarment™ machine where standard garment styles can be preselected for knitting.

Certain designer adjustments can be made such as width, length, stitch and material applications.

There is the potential to further examine the concept of inserting depth as a 'designer adjustment' within this project's methodology, using the geometric as a three-dimensional reasoning process.

See THREE DIMENSIONS, GEOMETRIC SHAPES, DESIGN CONDUIT, GEOMETRIC SHAPES.

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

GEOMETRIC SHAPES

A defined set of points and lines enclosed within a space. In this project geometric shapes are observed outside of their mathematical provenance and employed symbolically or as signifiers of spatial, structural and dimensional perceptions within a form.

Geometric shapes are easily recognisable as they are based on elementary, foundational and classic principles of design.

See ELEMENTARY, 'SQUARE, CIRCLE, TRIANGLE', PERCEPTION.

GESTALT

"The appearance of parts is determined by wholes" (Behrens, 1998, p. 301). This quote summarises Gestalt Theory, which is a study of psychological organisation. Within this theory the premise is the two perceptual actions of Grouping and Disruption to grouping, are interdependent.

See GROUPING, DISRUPTION.

GROUPING

There is a natural grouping action that operates as an intuitive process in using the geometric shape, for example, matching proportional sides and repeating shape formations. I have formed links with this process to some of the Gestalt principles "Laws of Visual Organisation" (Behrens, 1998, p. 13). This tendency to group likeness, is understood as inbuilt knowledge where terms such as "structural economy", and "good continuation" are used, where this is described as "sensation in the traditional sense". (Behrens, 1988, p. 13)

See GESTALT, DISRUPTION

ISOTYPE

Isotype is a theory developed by Viennese Philosopher, Otto Neurath in the 1920's based on creating a visualised communication system of simplified images that neutralises social and cultural hierarchy of language. "Neurath hoped to establish a global standard for education and to unite humanity through one ordered, universally readable language of vision" (Lupton, 1986, p. 47). Isotype, along with Gestalt "powerfully influence the modern design disciplines" (Lupton, 1986, p. 49).

See GESTALT

KNITTING GUAGE

Knitting Gauge refers to the weight of a fabric, in how fine or heavy, based on the size of the knitted stitch. It is abbreviated as GG and used in both hand knitting and machine knitting processes.

LINE

"A line can be thought of as a chain of points joined together. It indicates position and direction and has within itself a certain energy; the energy appears to travel along its length and to be intensified at either end, ...the space around it is activated.' (de Sausmarez, 1964, p. 21).

Horizontal and Vertical: "Operating together, horizontal and vertical lines introduce the principle of balanced oppositions of tensions." (de Sausmarez, 1964, p. 21).

Diagonal: "Introduces powerful directional impulses, a dynamism which resolves balance in vertical and horizontal suspensions" (de Sausmarez, 1964, p. 21).

See FABRIC GRAIN, DIRECTION.

LOGIC

Reasoning. A thinking process that generates explanation links.

Applied in this project as a sequential problem solving design process, by unpacking design actions through step-by-step visualisation.

See DESIGN THINKING.

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

MATERIALITY

The surface treatment of knit design such as texture, fabric structure and colour of the design composition, defined by yarns and stitch architecture.

The characterisation of a knitted object.

See KNITTING YARNS. KNITTING GUAGE. STITCH ARCHITECTURE.

METAPHORS FOR DIMENSIONS

A way of seeing:

TWO DIMENSIONAL: Left/ Right, Up/ Down, Backwards/ Forwards.

THREE DIMENSIONAL: Inside/ Outside, Around/Over, Above/Below, Together/Apart/Between.

OBJECT

In this project an object can exist independent of the required end-use of the material. Simply put, the end-product can be considered beyond garment or fashion functionality, or expected use of knitting.

PIECE & ASSEMBLAGE KNITTING

The garment is made in pieces, (sleeves, body, front and back are knitted separately) and joined with seams.

Within this project these knitted pieces are geometric shapes. The shapes become parts of the garments, for example a square can become a sleeve, or a triangle can become a collar.

See TECHNOLOGY PRECONDITIONS. DESIGN PRODUCTIVITY.

PERCEPTION

A subjective view.

Design Dictionary (2008): "Perception mediates between the sense and the intellect based on experience and a range of subjective and cultural biases" (Erlhoff & Marshall, 2008, p. 295).

PLATO'S METAPHYSICS

The Design Dictionary edited by Erlhoff and Marshall (2008), describes FORM as "a mental, not physical, construct." (Pg 169).

The historical roots of this particular conception of form are found in Plato's metaphysics. Plato evokes two distinct worlds, the World of Becoming and the World of Being. The World of Becoming as the name suggests, is ever changing. In contrast the World of Being is immutable. Erlhoff M, Marshall T (2008)

See also FORM.

POINT

"The simplest unit (in visual construction) a point, not only indicates location but has within itself potential energies of expansion and contraction which activate the surrounding area. When two points are added, there is a statement of measurement and implied direction and inner energies create a specific tension between them which directly affects the intervening space" (de Sausmarez. 1964, p. 20).

See SPATIAL, KINETIC, DYNAMIC.

PRODUCTION EFFICIENCY

The speed, economy and quality of how the knitting is made.

PRODUCTION TECHNIQUES

The way the knitting is to be made.

An early design consideration, as it affects the visualisation and construction process.

Production techniques defined in this project are hand-knitting, manual two-dimensional domestic machine knitting and computerised three-dimensional knitting technology.

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

REDUCTIVE DESIGN PROCESS

Employing an analysis of a complex subject into a simplified form.

The use of the geometric in this project is an approach to this, where the geometric aids the visualisation and construction elements to be reduced back to what is essential and elementary in a design composition.

See ELEMENTARY, CONSTRUCTION.

SEAMLESS KNITTING

An industrialised knitting process that knits the whole garment in a three-dimensional tubular format without the need for post knitting finishing or joining. The sleeves are knitted, one from each yarn feeder simultaneously as the body from a third yarn feeder. The sleeves and body join at the armholes and the knitting is transferred to one feeder, finishing at the neckline.

SENSE OF SIGHT AND REASON

The faculties for determining comprehension of the third dimension, enhanced by a tangible experience of this dimension. For example, physically knitting a cube construction develops a visual reasoning of the cube's dimensions through the tangibility of the experience.

See DIMENSION

SPATIAL

Pertaining to the space a shape holds.

A term used to describe the construction elements of a knitted form; in how it envelopes, uses or holds space within and immediately around its existing shape.

The benefit of the geometric in this use of spatial concepts is the easy recognition of form (see SQUARES, CIRCLES, TRIANGLES). This encourages the mind and sensibilities to conceive and invent spatially. (see DESIGN CONDUIT)

Spatial making exercises are applied in this project through the making of small knitted objects, to create physical involvement, and body-felt interpretation of dimensional design in this project.

See SENSE OF SIGHT & REASON, DIMENSIONAL, TACIT KNOWLEDGE, PERCEPTION.

SQUARE, CIRCLE, TRIANGLE

The most fundamental planar figures associated with the linear relationship of vertical-horizontal, diagonal, curvilinear.

STITCH ARCHITECTURE

The design of stitch formation within the structural composition of knitted fabric, in the creation of its patterning or textural effect.

See MATERIALITY

STRUCTURAL

Refers to the composition (arrangement) of a form in the way it's held together.

The viewpoint of the whole composition in the relationship of its parts.

For Knitting: The structural framework of a garment or object would refer to the relationship of the material's application (yarns and knitting process) within its form (its shape and construction).

For Geometric: refers to mode of shape, for example, a Square or Cubed Structure.

The benefit of the geometric as a design tool is due to the rudimentary nature of the for example , a square, the mind bears a visual coherence of the shape.

TACIT KNOWLEDGE

The inner knowledge developed through experience that is difficult to record, as it is intuitive, sensational and emotional, but often referred to as the insight on which one's explicit knowledge is highly dependent upon.

In this project, tacit knowledge is developed through the practice of making.

See also PERCEPTION.

APPENDIX 2 GLOSSARY OF DESIGN TERMS INTERPRETED FOR APPLICATION IN THE CONSTRUCTION KNITTING METHOD

TECHNOLOGY PRECONDITIONS

The explicit rules and procedures of how a technology can be used to knit a design.

Within an industrial knitting context, it is usually the manufacturing system that sets and determines these preconditions. Seamless Knitting technology has very set processes in place for standardised production that make innovation difficult, but not impossible. Therefore understanding preconditions stimulates utilitarian and productive design approaches that are precepts to innovation in this project.

See UTILITARIAN, REDUCTIVE DESIGN PROCESS, PRODUCTION EFFICIENCY, DECONSTRUCTION.

TEMPORAL DIMENSION

In this project, knitted forms as geometric shapes took on temporal dimension during the process of assemblage as there was a sense of them holding space within and immediately around the existing shape during the making. The finished object however, whether a small artefact or a garment tended to collapse with gravity due to the nature of the knitted material. Therefore it is not the finished object that provided insight into the design process, but it was during the process of making the object.

See SPATIAL

THREE DIMENSIONAL

An object that has a measurement of width length and height or depth.
See also KINETIC, CONSTRUCTION, POINT, LINE, METAPHORS FOR DIMENSIONS

TWO DIMENSIONAL

An object that has a measurement of width and length.

Used as a Visualisation of design.

Flat drawings usually used for design rendition for knitwear.

VISUALISATION

The drawing of design.

In the use of the Geometric in this Project: The organisation of various elements to establish visual harmony and order in a design.

Estimating dimensional relationships is at the root of applying geometric shapes as a visualisation tool in this project. “To be able to estimate and locate points on a surface precedes the more complex task of estimating and locating points in three-dimensional space” (de Sausmarez. 1964, p. 29).

YARN GUAGE

The measured thickness of a yarn. Different yarn weights suit different knitting techniques.

Hand Knitting The measured thickness of a yarn referred to as (in Australia and New Zealand); ply. Opposite to industrial yarn measurements, the higher the number, the thicker the yarn. For example 2ply is fine and lightweight, and on the opposite scale 12ply is a chunky, heavy yarn weight.

Industrial Knitting: NM: Based on an industrial measurement system. 1nm = 1000 metres of yarn per kilogram.

As a rule of thumb, the most suitable yarn to use for the Shima Seiki 28GG industrial knitting machine is a 2/28 NM weight yarn. 2 = the amount of threads twisted together, 28 measures the thickness of yarn. The smaller, the number the finer the yarn gauge.

APPENDIX 3

PRESENTATION AND EXHIBITION

The Construction Knitting project was presented for examination and public viewing as part of the AUT AD15 Graduate Showcase in the WE Building. The work was exhibited in a room the size of 284cm x 345cm, containing 4 walls for the display of work.

The project was laid out to reflect the Construction Knitting methodology as a design process and design system. Work was presented to give the viewer insight into how the geometric applied to the knitting process within the making of objects and garments, arranged according to the sequential development of the project.

The exhibition was divided into 4 wall sections:

Wall 1: Phase One of the Methodology, the Making of Small Objects.

Wall 2: Phase Two of the Methodology, the Making of Garments.

Wall 3: The Geometric Patterns in the Garment Constructions, and

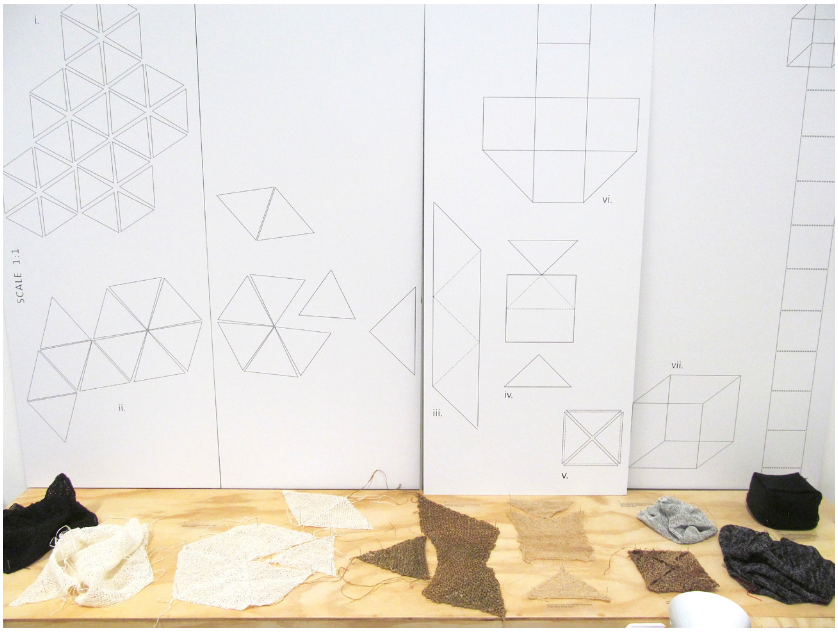
Wall 4: The Garments.

The image below illustrates a panoramic view of the space displaying Phase One and Two of the Methodology artefacts placed on custom-made trestle tables laid out in an L-formation, and their corresponding graphics mounted on Wall 1 and 2 on the left. Facing the trestle tables was Wall 3, which contained mounted photographic images of the garments and their geometric pattern blocks. To the right of this, placed against Wall 4 was a custom-made rack displaying the knitted sample garments.

Wall 1: Phase One of the Methodology, the Making of Small Objects.

Knitted samples were placed and pinned onto a plywood trestle table (200cm x 50cm x 120cm). The samples were labelled with a numbered key describing the knitted object and its material. Graphic geometric drawings corresponding to the knitted objects were wall mounted above the table.

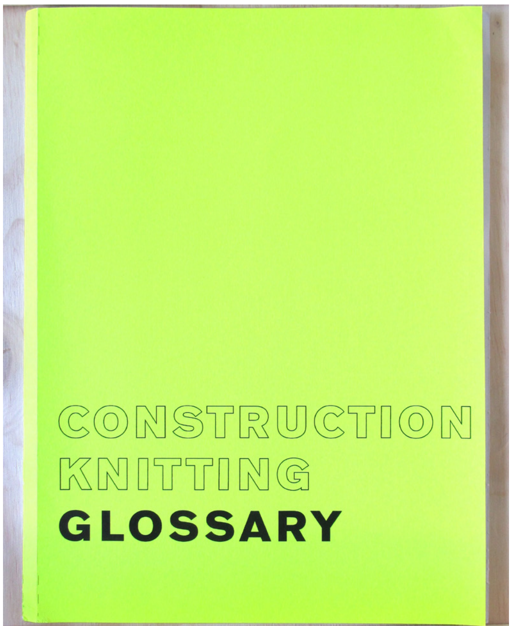
This display was designed to demonstrate to the viewer the experiments in converging geometric shapes with the knitting processes of hand knitting and two-dimensional machine knitting.

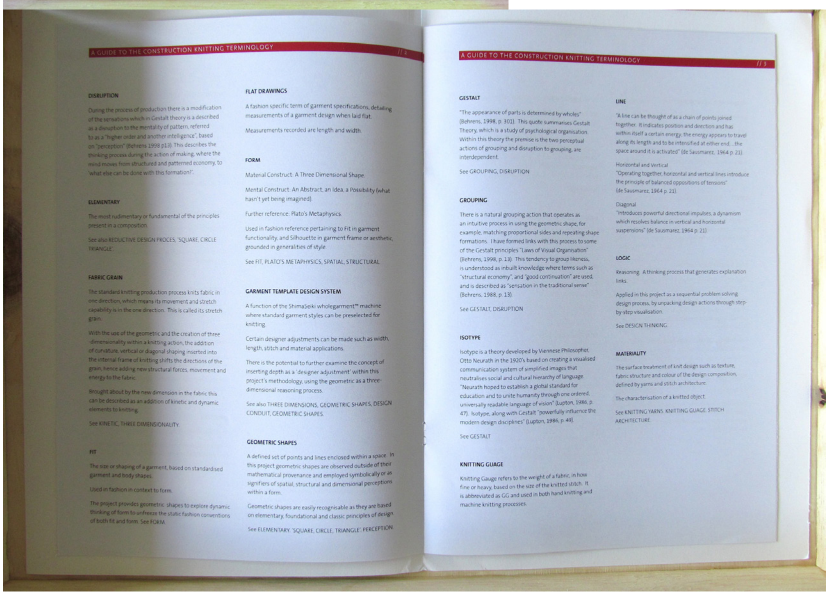


Wall 2: Phase Two of the Methodology, the Making of Garments.

Knitted samples of squares were arranged and pinned to the table, and the corresponding graphic geometric shapes were mounted on the wall above. The accompanying descriptions explained how the square as a production unit altered in adaptation to each knitting technology. The knitted samples and corresponding visual geometric shapes were numbered and labelled according to the knitting methods of hand-knitting, two-dimensional machine knitting and three-dimensional machine knitting.

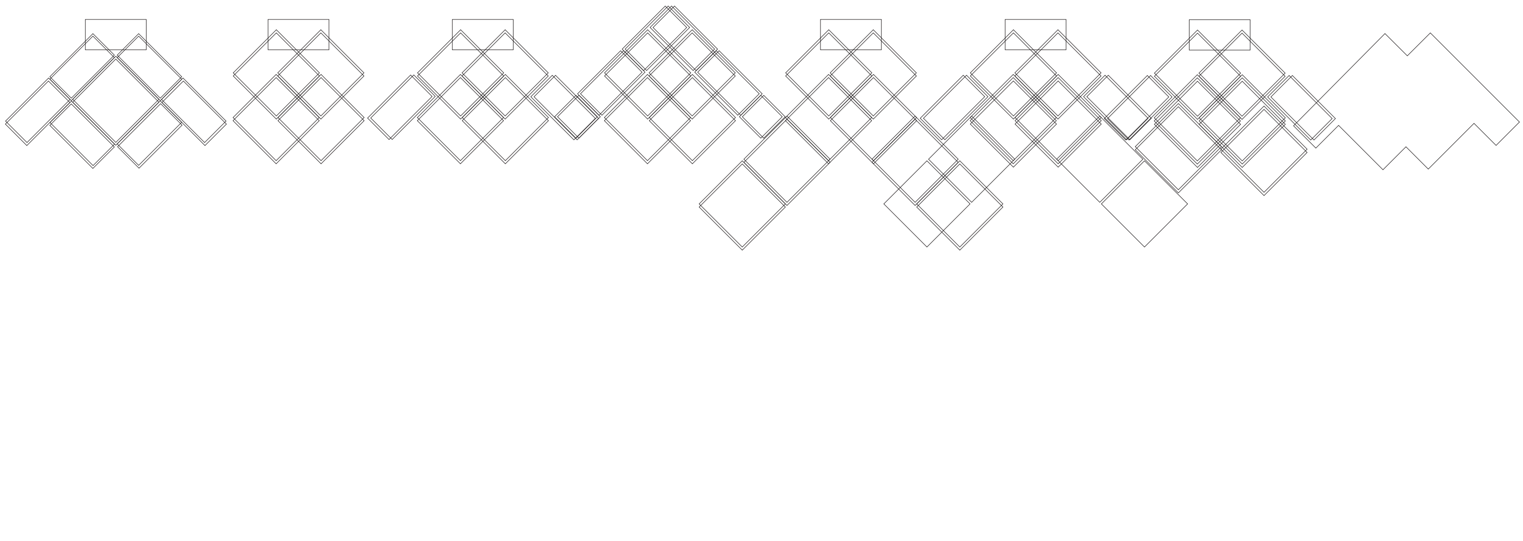
A 10 page printed booklet titled ‘Construction Knitting: Glossary’ was included with this display for the viewer to explore the broader visual design literacy terms encountered beyond the field of knitting, through the exploration of the geometric for this project.





Wall 3: The Geometric Patterns in the Garment Constructions.

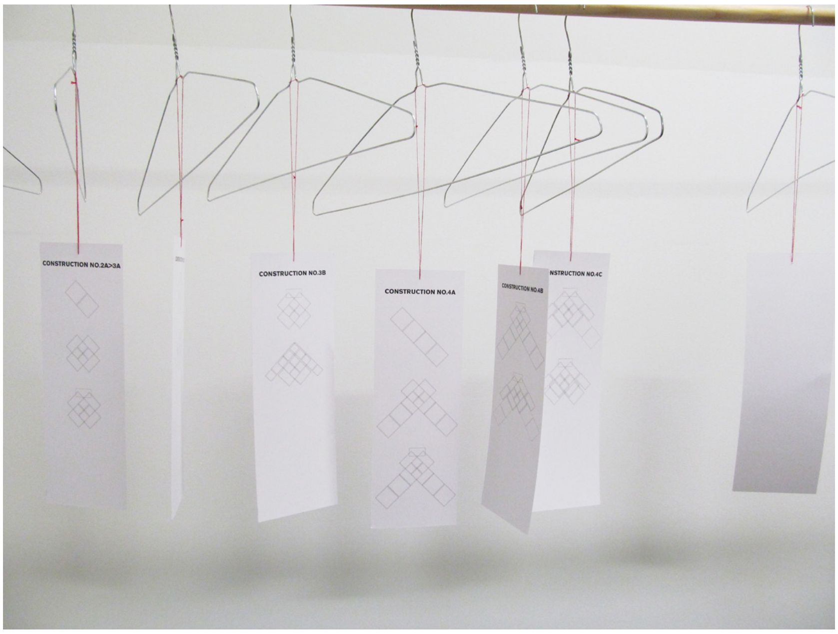
Mounted images of the garments photographed on mannequins were placed to provide the viewer with a perspective of the geometric constructed within the knitted silhouette.

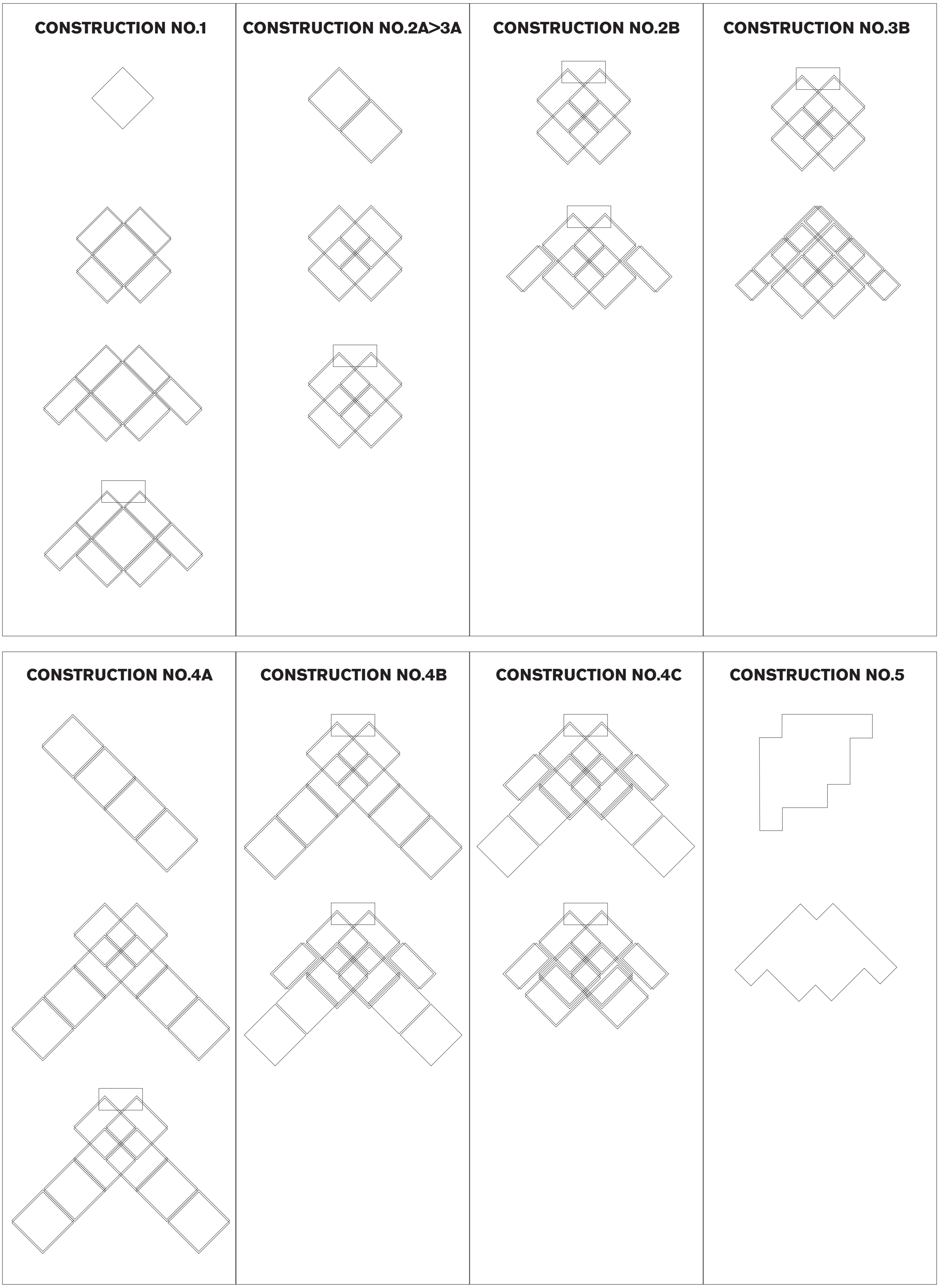


Images of the exhibited knitted garments photographed on a mannequin.

Wall 4: The Garments.

The knitted garment samples were displayed on a rack identified with printed tages to display the order that they were knitted, e.g. Construction No. 1, Construction No. 2, etc, with the geometric shapes visualising the progression of how each design informed the next.





Graphic Artwork of the tags that were attached to each knitted garment.

Additional Three-Dimensional Knitted Garment.

The exhibition included a final three-dimensional garment knitted with a vertical rib effect stitch. This was created to demonstrate clearer visibility of the direction of knitting in the garment (and the line in the design) for the viewer.


CONSTRUCTION NO.5

APPENDIX 4

DESIGN DEVELOPMENT

The project involved a series of detours that were omitted from the main body of the research. These experiments and subsequent peer feedback of the work informed the direction of the methodology, which was also instrumental in generating the list of theorised design terms formed in the glossary. This appendix highlights some of these key contextual moments.

LIST OF IMAGES

HARMONIC PROPORTIONS

The project explored the Golden Section as a property of the geometric, for knitting. The idea was to test how the geometric can be broken down into parts, to generate a series of modular knitted compositions, while engaging in classic design principles by applying harmonic proportioning systems to the design process.

This image has been removed by the author of this thesis for copyright reasons

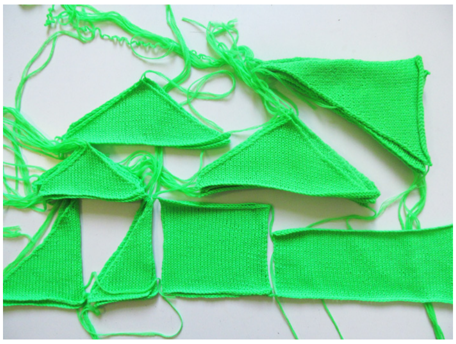
Fig i.

Elam, K. (2001). Golden Section Dynamic Rectangle System, *Geometry of Design*, Studies in Proportion and Composition.

Fig ii.

Gabriel, N. 2014. Knitting Experiments following the shaping of the Golden Section Dynamic Rectangles.

I noted that maual knitting processes generate an experience of dimensions which heightens an awareness of the design and constructional potentials of knitting, while developing material and tool handling skills that reinforce design cognition.



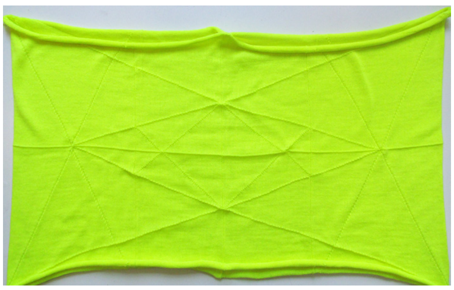


Fig iii.

Gabriel, N. 2014. Three methods of Knitting Production.

Three modes of production were explored to experiment with this concept and to test how the idea translated between each system of production; hand-knitting, 2D machine-knitting, 3D machine knitting; applying different gauges of knitting yarns suitable to that method of making.

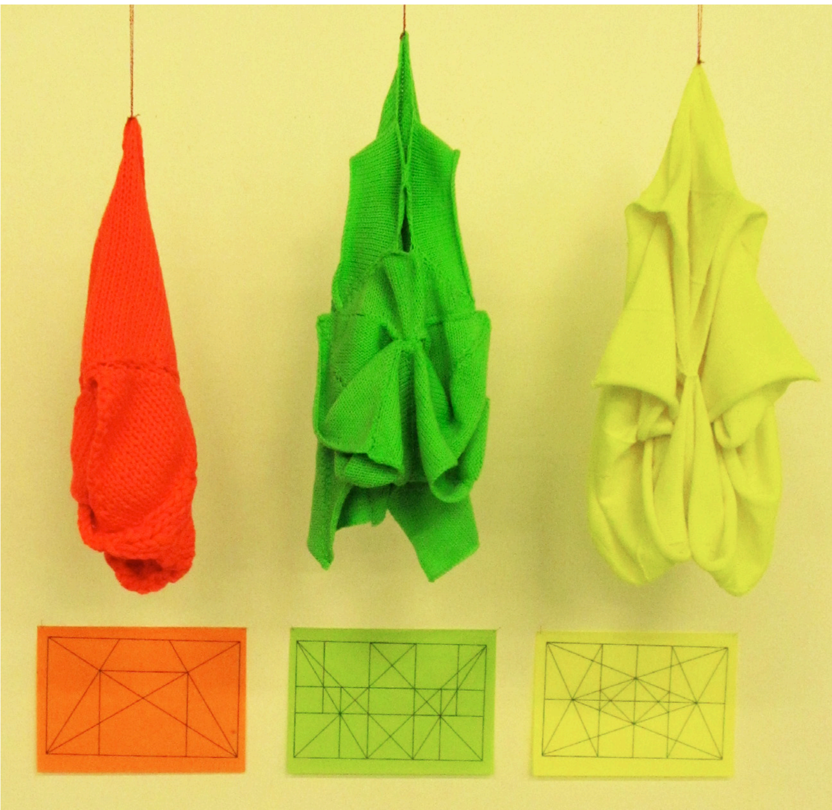


Fig. iv.

Knitted Objects exploring Folding and Origami Techniques based on harmonic proportioning systems.

The knitted compositions were to present evidence of such aspects and to transpire as objects where the focus was on form generation to highlight the rules evident in the knitting/design process.

The intended visual information in these sculptural knitted objects as an origami exploration of surface and depth was too novel and therefore cryptic as a presentation of knitting. As a result, peers resorted to commentary on the material and functional nature of knitting. The feedback was based on their perceptions of what knitting should be, and in this instance the objects were perceived as elaborate knitted beanies, while the design process was ignored. Therefore I had to reconsider ways to demonstrate the research idea.

I transferred this idea to the making of garments, to project the design concept relative to the existing perceptions of knitting, i.e. knitting is created for wearable purposes.

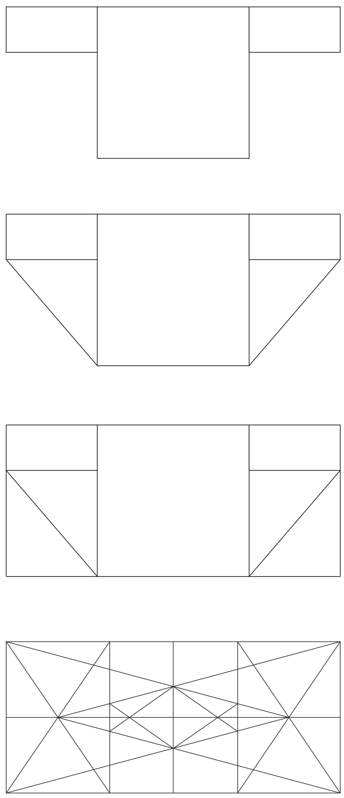


Fig. v.

Gabriel, N. 2014. Harmonic Proportions for Garments.

I reduced the knitted shaping to a most basic structural form, starting with a jumper in the shape of squares, and then forming links between the aspects of the project which were; the perception of knitting, the application of the geometric shape, and the shape broken down into its harmonic proportions based on classic design principles (as a bridge to create a wider conversational reference of knitting).

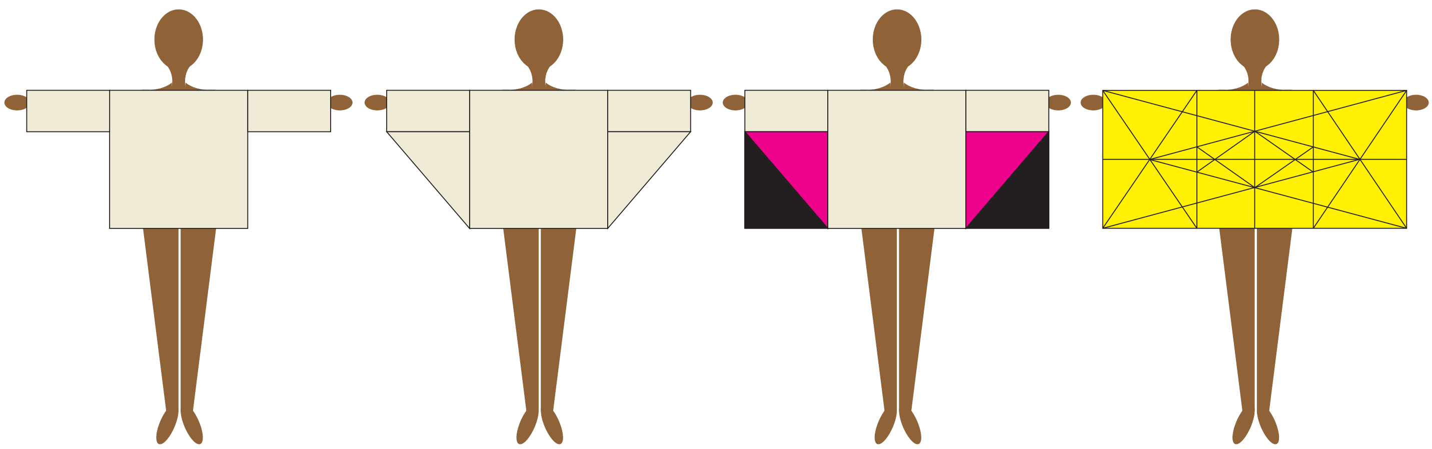
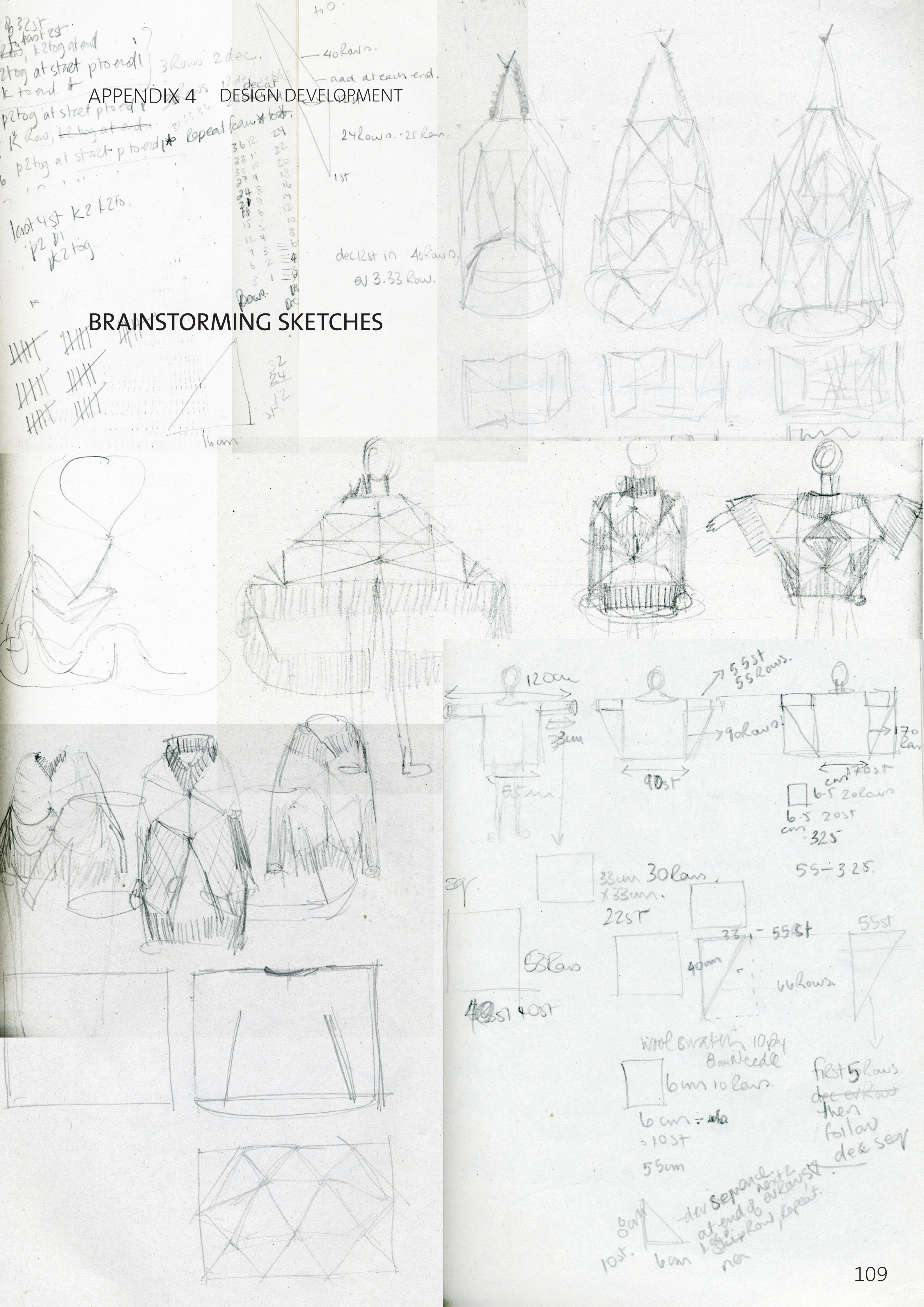


Fig. vi.

Gabriel, N. 2014. Harmonic Proportions in respect to Garments on the Body.

Modular building gives coherence to the design, in transforming a previous form by adding, deleting, modifying or replacing certain parts; a key feature of using the geometric in this research.

BRAINSTORMING SKETCHES



This section of the work was observed and perceived as geometrical clothing by peers. This work therefore was misrepresenting my research, as the intention of applying the geometric was not to generate a particular geometric aesthetic to the clothing, but to investigate how the geometric facilitates a design and thinking process for planning and making of knitting; thus demonstrating a design process/system.

The overall design concept also translated as too simple. Complicated design resolution based on dimensional, structural and technical issues around knitting, and the role of the geometric within such design problem solving became secondary information to the viewer. I sought to reapproach this idea to show the skeletal framework of the design as the primary information, and the finished garment result as the secondary information in this research.

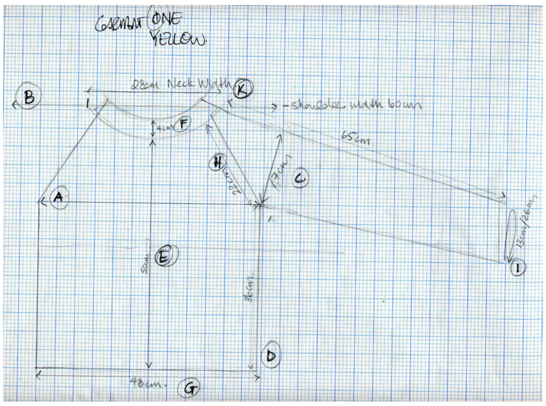
Fig. vii.

Gabriel, N. 2014. Knitted Garments following Harmonic Proportion exercises.

The garments were knitted from heavy to fine yarn guages from hand-knitting to two-dimensional machine knitting, to three-dimensional machine knitting.

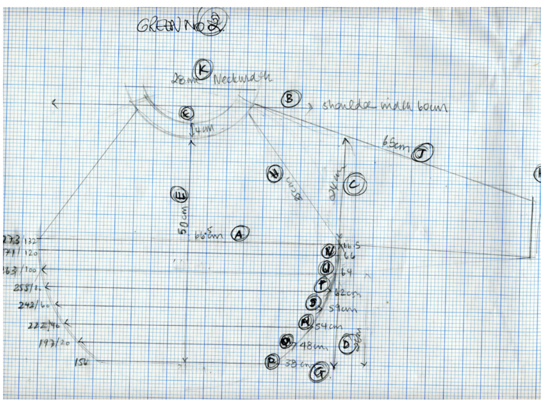
THE CIRCLE SHAPE

The project then explored the geometric by attempting to demonstrate the complexities of three-dimensional automated knitting processes, and experiment with ways the geometric could resolve such complexity while adding to the design. I reflected that as this knitting perfomed in a tubular formation, I would investigate how circle and spherical geometric shapes could be associated with the design process. I instigated a series of knitting experiments that used the geometric as a design conduit to thinking and planning three-dimensionally for the use of the machine, instead of the conventional two-dimensional design approach. The underlying question to this approach was: As design procedures for seamless technology requires flat two-dimensional measurements of width and length only, could depth also be included or considered into the calculation of the design to create three-dimensional formation? If so, how could geometric reasoning be applied to this design process



GARMENT NO. 1 – YELLOW
From Shima Seiki Database.

MEASUREMENTS FOR:	NO.1 - YELLOW	WALES / COURSES ?
A. Chest/Bust Width	48cm	
B. Shoulder Width	60cm	
C. Armhole Depth	17cm	
D. Armhole to garment start	36cm	
E. Garment Length Total	50cm	
F. Neck Length	4cm	
G. Hips (start of garment width)	48cm	
H. Underarm Circumference	22cm	
I. Width of Sleeve at Cuff	13cm	
J. Sleeve Length	65cm	
K. Neck Width	28cm	

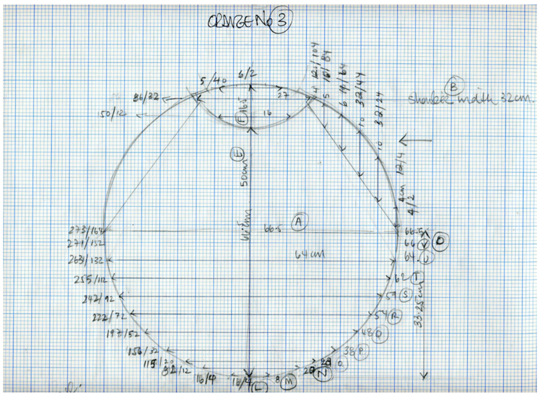


MEASUREMENTS FOR:	NO.1	NO.2 GREEN	WALES/COURSES
A. Chest/Bust Width	48cm	66.5cm	273 w
B. Shoulder Width	60cm	60cm	
C. Armhole Depth	17cm	24cm	99 w
D. Armhole to garment start	36cm	26cm	132 c
E. Garment Length Total	50cm	50cm	244 c
F. Neck Length	4cm	4cm	20 c
G. Hips (start of garment width)	48cm	38cm	156 w
H. Underarm Circumference	22cm	35cm	
I. Width of Sleeve at Cuff	13cm	13cm	54 c
J. Sleeve Length	65cm	65cm	
K. Neck Width	28cm	28cm	
Circular Shaping from Start of Garment to Armhole (every 4cm):			
L.			
M.			
N.			
O.			
P.		38cm	156 w
Q.		48cm	197 w / 20 c
R.		54cm	222 w / 40 c
S.		59cm	242 w / 60 c
T.		62cm	255 w / 80 c
U.		64cm	263 w / 100 c
V.		66cm	273 w / 120 c

Fig. viii.

Gabriel, N. 2014. Design Specifications for Three Dimensional Knitting of Circle Shaped Garments.

The idea of productivity failed, as I became aware that each knitted prototype required a brand new set of programming code for the knitting technician, which created an unnecessarily large workload for the production. Hence only 2 garments could be produced for this experiment as time ran out for the third circle garment to be made.



MEASUREMENTS FOR:	NO.1	NO.2 GREEN	NO. 3 ORANGE	WALES/COURSES
A. Chest/Bust Width	48cm	66.5cm	66.5cm	273 w
B. Shoulder Width	60cm	60cm	32cm	
C. Armhole Depth	17cm	24cm	*	
D. Armhole to garment start	36cm	26cm	33.25cm	
E. Garment Length Total	50cm	50cm	50cm	
F. Neck Length	4cm	4cm	16.5cm	
G. Hips (start of garment width)	48cm	38cm	2cm	
H. Underarm Circumference	22cm	35cm	**	
I. Width of Sleeve at Cuff	13cm	13cm		
J. Sleeve Length	65cm	65cm	***	
K. Neck Width	28cm	28cm	28cm	
Circular Shaping from Start of Garment to Armhole (every 4cm):				
L.			4cm	16 w / 4 c
M.			8cm	16 w / 12 c
N.			20cm	82 w / 20 c
O.			28cm	115 w / 32 c
P.		38cm	38cm	156 w / 52 c
Q.		48cm	48cm	197 w / 72 c
R.		54cm	54cm	222 w / 92 c
S.		59cm	59cm	242 w / 112 c
T.		62cm	62cm	255 w / 132 c
U.		64cm	64cm	263 w / 152 c
V.		66cm	66cm	274 w / 164 c

as a catalyst to thinking in the third dimension? A condition of the use of this technology is basing design on pre-existing garment templates, and therefore I decided to use the most basic jumper structure as a starting point to pursue designer adjustment that fell within reasonable productivity aims with the use of this machine.

In addition to this, I was testing how this the process could generate a type of calculus that a designer could apply as a set of knitting values (number of wales and courses) that linked with the design adjustments of the shape. This could equip the designer with a numerical system associated with the geometric shape that could network with the technician's specification requirements when designing for whole-garment knitting. I also had the impression that if the shape generation was sequential from one garment to the next, then both the designers' and technicians' set of values applied for the first garment could be used with minor adjustments for the second garment, so as to not loose the productivity advantage of the wholegarment™ machine.

This challenged the experiment based on the standard protocols in the use of this knitting technology as described in Fig. viii, ix and x.

Fig. ix.

Gabriel, N. 2014. A standard garment morphing into a circle shape knitted on an automated 3D machine.

The technician worked heuristically by eye in manipulating the knitted material into shape using close enough proportions to the specifications, and steaming the material to stretch it into shape, as opposed to working with the set values of the shape supplied by the designer.

Fig. x.

Gabriel, N. 2014. Making a knitted circle on a 2D machine manually.

I worked to emulate the circle shape on the manual flat bed machine and even though I had calculated set values for circle shape knitting, the shaping required step-by-step adjustments, leading to a heuristic approach much the same as the knitting technician works. This led to re-visiting the advantages of hand-making which creates experience of dimensional properties generating an understanding of the material causes and effects for the automated knitting process, and equipping me with a proficiency to translate shaping suggestions to the technician based on the technical scope of knitting.

The combination of the nature of the knitted material (its pliability to sretch into shape) and the technician's interpretation of the design was generating a poor replication of the circle shape. While the experiment generated much insight into the workings of the technician and this technology, it did not advance the idea of three-dimensional design application using the geometric for this knitting process. Limited access to the knitting machine also meant this project had to be halted at this point (before the internal circle shaping was resolved), and reconsidered for more time efficient design experimentation.

This approach also created a set of technical parameters that were relative to a specialised knitting audience only and therefore difficult to communicate in general design terms, making the project's findings inconsequential to a non-specialist audience. Therefore I decided to structure the methodology to link with design terms that were more widely and readily understood based on the geometric already existing within a design vernacular. This led to generating the Glossary in Appendix 2.

For the next part of this experiment, I decided to skip the actual knitting of the circle, and just embed dimensional imaginations of depth derived from circle shapes, into a garment design. The following images are the outcome of this experiment.

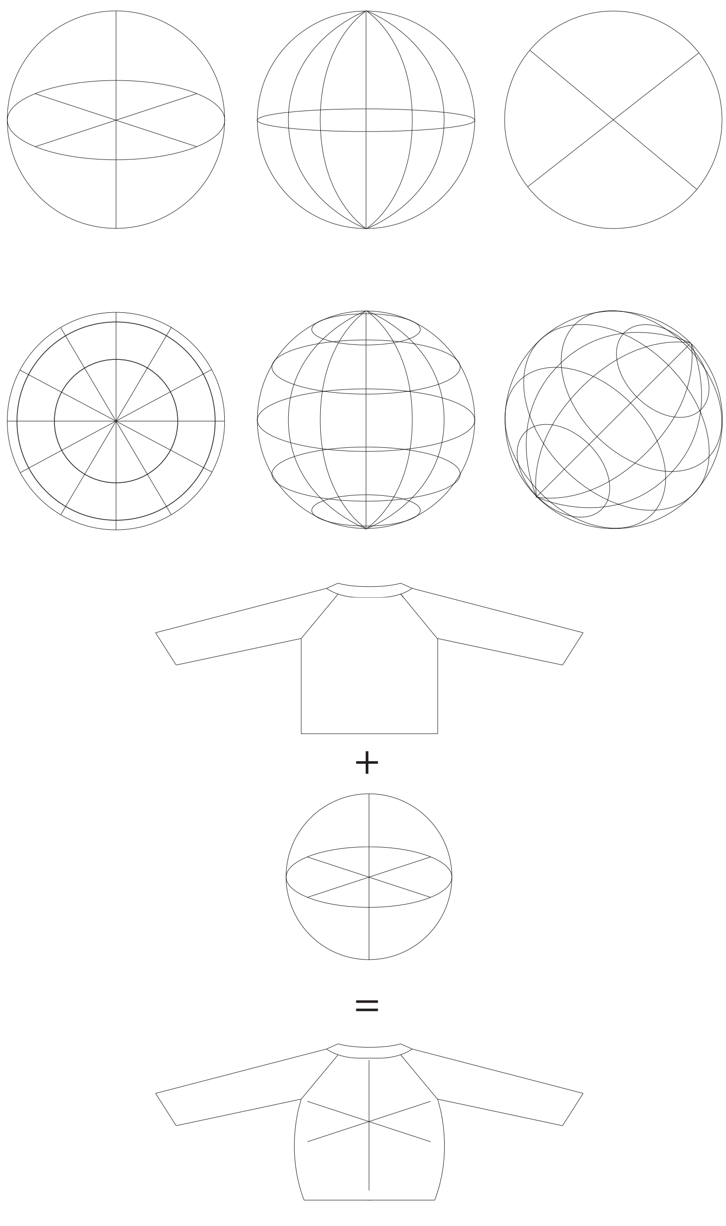


Fig. xi.

Gabriel, N. 2014. Dimensional Properties of Circle Shapes embedded into a Garment.

Fig. xii.

Gabriel, N. 2014. Knitted 3D Garments from Standard non-shaped garment, to Shaped garment with embedded Circular Dimensional Properties calculated in the knitting.

This experiment proved to be more successful as a technique to embed dimensional constructs into the design of knitting using three-dimensional knitting technology. However in communication with the technician the idea proved too abstract, as design language and knitting protocols have little compatibility. For example the technician did not understand any explanations of extra 'dimension' in the shaping, as the standard process is to only work with two-dimensional design values of length and width proportions. This miscommunication caused the first samples to be knitted with the internal shaping embedded ornamentally, and not structurally. Adding to this are the exigencies of the knitting technician's operations loaded with jargon, which is little understood by the designer and difficult for the knitting technician to interpret his processes in design contexts.

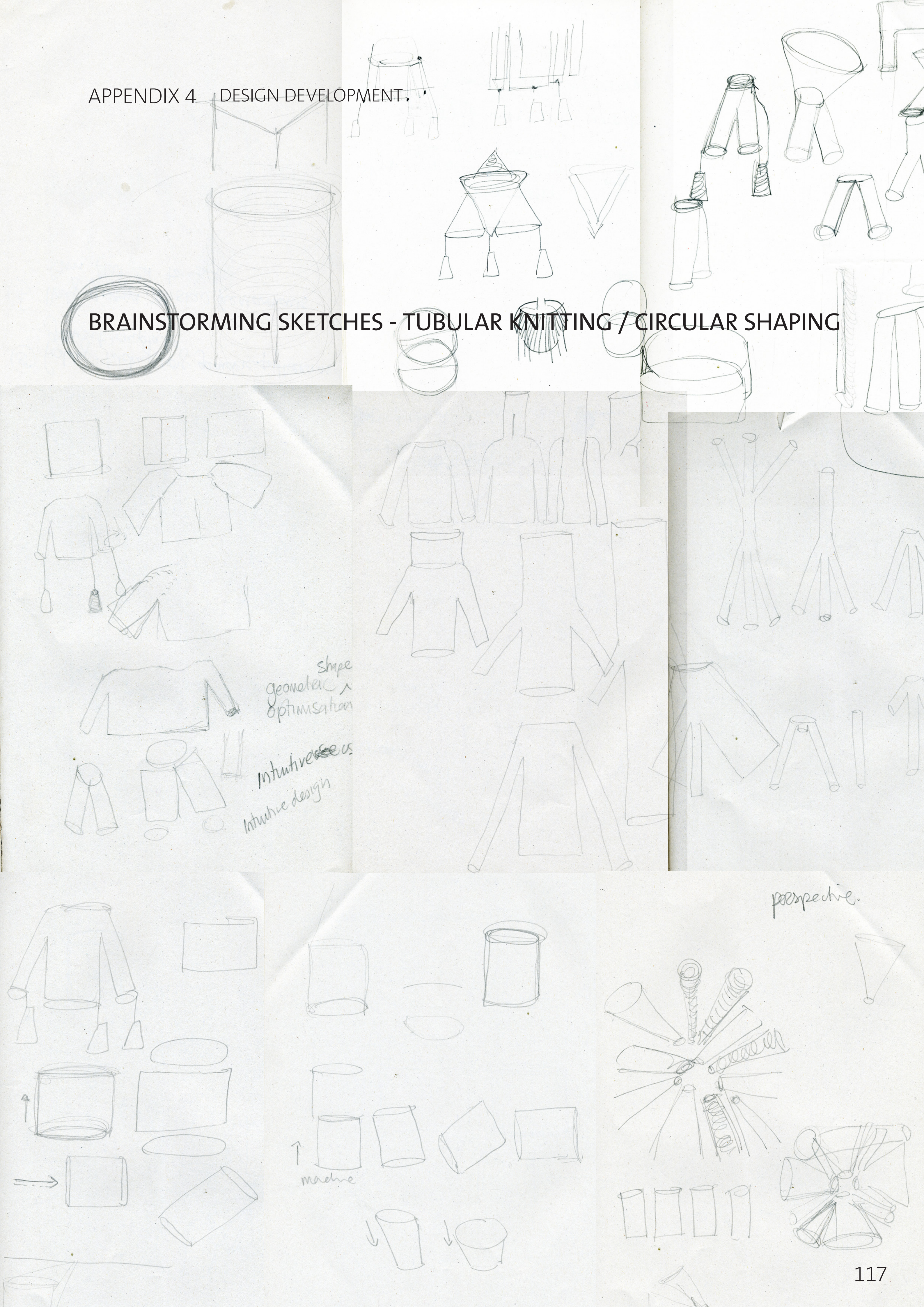
The internal shaping also slowed down the machine, compared to conventional shaping that is normally worked at the edges of knitting. This is a factor taken into consideration later in the project, discussed in the methodology chapter in the Three-Dimensional Machine Knitting projects.

However, these initial experiences led to further investigations of types of research based methods which are based on ill-defined problems where solutions are not precise, but do lead to further investigative dialogue. This contrasts the traditional research model of design problem solving that can be resolved through technical solutions.

Conditions of knitting and pre-existing perceptions of its associated product and processes highlighted the areas of misinterpretation in the work. Thus, contexts of knitting became a key issue in framing the methodology. It became important to emphasize what this project was not aiming to do, which is a point that arises intermittently in the main copy of the research as a means to clarify the project's objectives.

Accordingly, I decided to pitch the tone of the project as less of a technical approach and more as a design ethos, and as a way of thinking. These experiments show the journey of this developing voice which I carried into the main content of this research project.

BRAINSTORMING SKETCHES - TUBULAR KNITTING / CIRCULAR SHAPING



APPENDIX 4 DESIGN DEVELOPMENT

BRAINSTORMING SKETCHES - TUBULAR KNITTING / CIRCULAR SHAPING