AALBORG UNIVERSITY
SPRING 2022 / MSC04-ID03

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POINTENETIC

THE LONG LASTING PERFORMANCE-READY POINTE SHOE

POINTENÉTIC

ABSTRACT

Projektrapporten indeholder præsentationsmateriale af afgangsprojektet Pointenétic, omhandlende et re-design af tåspidskoen, til professionelle balletdansere. Tåspidsskoen er balletdansernes eneste og vigtigste redskab, som de skal sætte deres lid til hver dag.

Denne traditionsprægede kunstart har faste og skarpe holdninger til dens æstetiske udtryk og mener, at man skal være tro mod de gamle metoder og kutymer. Dette har medført, at industrien er blevet forældet og feltet har, som en af de få atletiske disipliner ikke taget imod innovative teknologier, da dette primært bliver set som snyd. Det resulterer i, at professionelle balletdansere stadig anvender tåspidssko lavet af en materialekombination af pap, lærred og limpasta opfundet i 1930'erne. Balletdansere skal danse op til 12 timer om dagen, hvilket har sat højere krav til tåspidsskoen. Dette gør, at danserne er nødsaget til at bruge to timer pr. par, på at nedbryde skoen hurtigere. Hvilket gør, at skoen hurtigere er 'gået til', men medfører også at skoen holder maksimalt tre dage.

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TITLE PAGE

TITLE	POINTENÉTIC
THEME	BALLET POINTE SHOES
UNIVERSITY	AALBORG UNIVERSITY
PROJECT TEAM	MSc04 / ID3
PROJECT PERIOD	01.02.2022 - 25.05.2022
MAIN SUPERVISOR	Linda Nhu Laursen
CO - SUPERVISOR	Brian Lau Verndal Bak
PAGES	25

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THE WORLD OF

BALLET

Ballet is an artistic dance form that originated back in the renaissance. For centuries performed for the upper class and royalty of society but served and danced by the people.
Ballet is a system of physical education that fosters control, awareness, flexibility, and strength. Classical techniques provide the means to achieve weight transfers, centring and managing the weight mass around the centre of gravity when in motion. It further enhances the illusion when one is dancing very lightly, effortlessly, and almost levitating through the air (Paskevska, 2002).

To achieve this levitating look, a ballet dancer performs in pointe shoes, which is the dancer's primary tool to go "en pointe", french for "on the tip of the toes". By arching and flexing the foot, the ballet dancer can "roll through" the shoe and, with sufficient strength, be able to stand en pointe. If the dancer cannot do a roll through, the pointe shoe is considered a cheating object, helping and supporting the dancer too much. Rolling through the shoe needs to be muscle memory for ballet dancers to dance on their toes safely. To achieve the language of ballet, a dancer needs to master the physical attributes and techniques it requires to perform the challenging choreography while also being in complete tune with the music and expressing emotions and personifying the dance.

THE PROBLEMS WITH THE CURRENT

POINTE SHOES

The pointe shoe is the ballerina's most crucial tool, it is otherwise is impossible to dance on their toes. It must feel like an extension of the body, elongating the natural lines of the flexed feet and meanwhile must feel as worn as a favourite pair of sneakers. However, their current shoe does not live up to these standards. Professional ballet dancers dance up to 12 hours a day, creating high demands on their pointe shoes. Most Freed of London users reported shoes lasting 7,5 to 9 hours if they are in constant use (Buckner, 2019). The main problem with the pointe shoes is:

AS STIFF AS BRICKS

New pointe shoes are stiff and unbendable, making it impossible for the dancer to dance in them. Therefore, the professional dancers modify their pointe shoes by 'breaking them in' to make them feel worn and bendable, making them performance-ready.

PAPIER MÂCHÉ

Today professional dancers are only supported and held up by a combination of glue paste, canvas and cardboard when going en pointe. A construction similar to papier mâché.

PERFORMANCE-READY

The current pointe shoe materials cannot withstand the dancer's sweat, resulting in deterioration and breakdown of the shoe. This process is sped up by the process of breaking them in (p. 9). Overall, resulting in a pointe shoe lifetime of approximately three days and of these, one day of being performance-ready. The dancers combat this deterioration by switching between pairs.

POINTE SHOE

ANATOMY

An overview of the anatomy of the current pointe shoe and the most critical components necessary for supporting the dancer while en pointe.

SATIN SOCK

The exterior is pink or made in three different skin-coloured satins to mimic the dancers' tights or legs.

RIBBONS

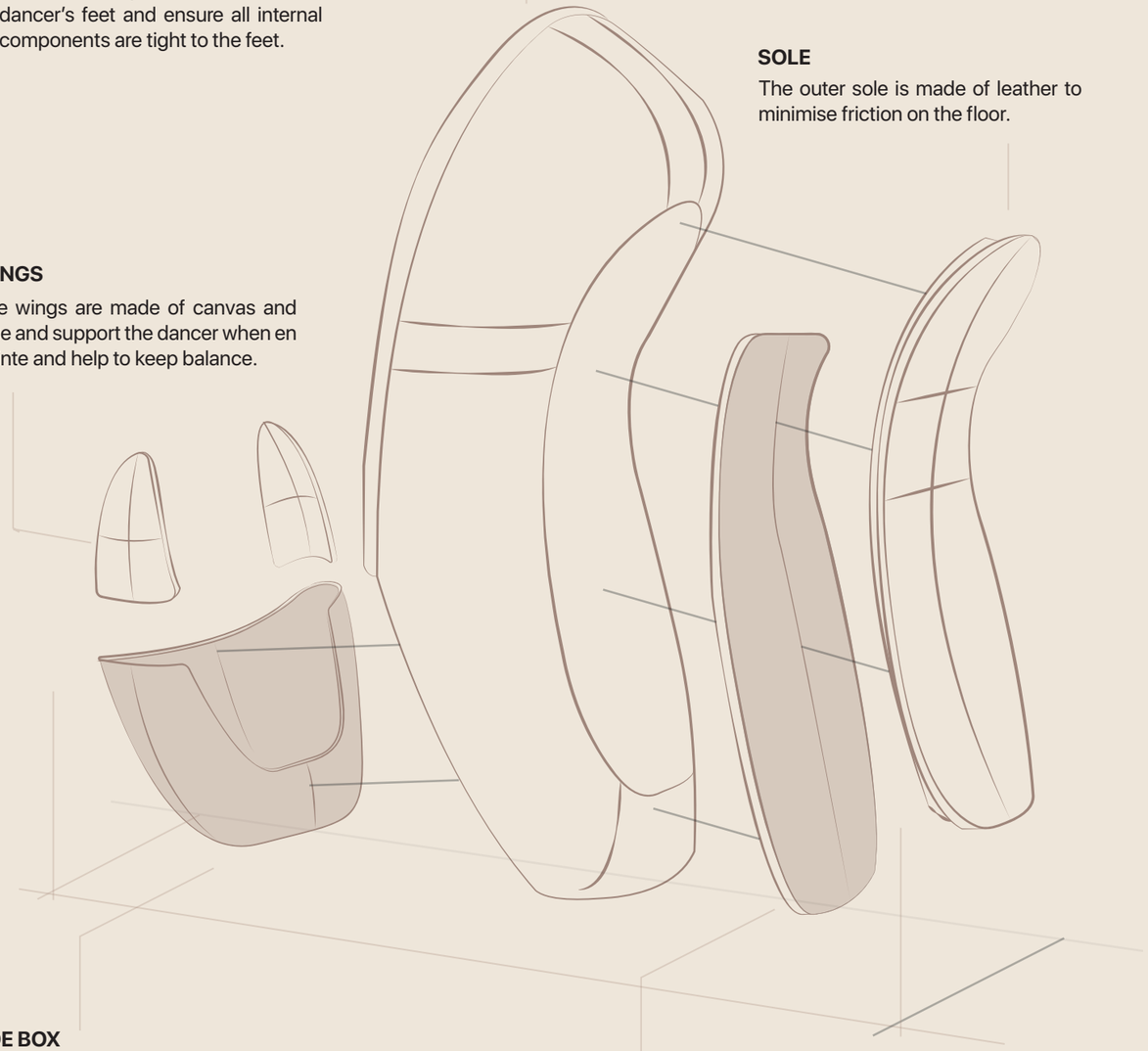
Elastics and satin ribbons are utilised to secure the pointe shoe onto the dancer's feet and ensure all internal components are tight to the feet.

SOLE

The outer sole is made of leather to minimise friction on the floor.

WINGS

The wings are made of canvas and glue and support the dancer when en pointe and help to keep balance.



TOE BOX

The toe box is made of layers of canvas and glue. It supports the dancer's toes when en pointe.

SHANK

The shank is made of a combination of cardboard and leather and supports the dancers arch when en pointe.

TWO HOURS

PREPARATION

Professional dancers spend two hours on each pair, preparing their pointe shoes to make them performance-ready. This process is completed on the eight pairs the dancer receives each month.

SOFTEN THE TOE BOX
Using a hammer or other tools

WIDEN THE PLATFORM
Sows on a broad edge

LOOSEN SHANK
Using force and tools

REMOVE METAL NAILS
Using a pliers

SOFTEN SOLE
Multiple bends with force

CUT SHANK
Using a hobby knife

SOW ON RIBBONS
Elastics & satin ribbons

STRENGTHEN AREAS
Using jet glue

LIFETIME OF A POINTE SHOE

LIFETIME

NEW

DAY ONE
NEW & STIFF

HALF DETERIORATED

DAY TWO
PERFOMANCE READY

DAY THREE
DEAD & NOT SUPPORTING

DEAD

PREPPING
DAY ONE

A pointe shoe's lifetime is around three days in total. New pointe shoes are stiff, resulting in the dancers not being able to do a roll through and correctly and safely go en pointe. The shoes feel like dancing on bricks. On the first day, the professional dancers spend two hours breaking them in and spend the rest of the first day dancing in them at practice to make them more bendable and worn in.

READY FOR THE STAGE
DAY TWO

The second day is where the pointe shoe feels worn in and performance-ready. The shoe is flexible to enable the roll through and run around on stage, yet stiff and hard enough to hold and support them while en pointe. The moment the shoe reaches this point it starts to deteriorate. The time frame is very limited and unpredictable, resulting in the dancers feeling strongly about their pointe shoes, like guarding them with their life.

DYING
DAY THREE

The pointe shoe is somewhere on the graph of reaching its dying point, meaning the shoes no longer have the structural integrity to support the dancer. The dying point could have been reached on the second day if the shoes were used a lot. The time frame is very unpredictable, as all shoes are different, resulting in the dancers feeling very anxious, nervous and stressed about the state of their pointe shoes, especially right before entering the stage. The dancers add glue as a safety measure to prolong the lifetime of the pointe shoes. However, this action is more of a placebo effect.

POINTENÉTIC

VALUE

POINTENÉTIC

Pointenétic is the first reliable, performance-ready pointe shoe to enter the market. Pointenetic does not deteriorate by sweat and neither does it need to be prepared or broken in, making it the only ballet shoe to remain in the performance-ready stage for an extended period. This results in the dancers not needing to stress out about their shoes before entering the stage. Pointnétic is inspired by 21st-century urban culture and streetwear while still referencing the archetypical and iconic lines of the traditional pointe shoe. This results in an overall edgy and athletic look, accentuating the body's natural lines and enhancing the dancer's floating movements.

INNOVATION

READY, SET, GO

Pointenétic consists of an innovative core that enables being performance-ready from the start. Through material properties, the core allows the shoe to flex during jump-offs and be stiff and supporting when performing lengthy and challenging positions en pointe, something expert ballerinas are expected to do. The inner core further speeds up the process of feeling worn in as the materials mould to the feet when dancing. Pointenétic is therefore the ultimate tool for professional ballet dancers as it allows for an easy roll through without restriction of toe movement or additional enhancement in the arc. Something that, when present is considered cheating and a sign of lack of expertise.

EXTENSION

PART OF THE BODY

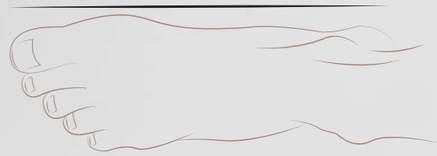
EXTENSION

As ballet is evolving into focusing on the individual dancer's body, structure and muscle lines, Pointenétic aim at extending the body's natural lines and movements. This is done by elongating the lines of the legs by creating a seamless transition between the dancer's leg or costume and the pointe shoe. Pointenétics' materials and the creation of the main artery, spanning from the platform of the shoe to the heel, emphasise the classical pointe shoe while also accentuating the illusion of dancing en pointe - especially when the spotlight is on the dancer.

WIDTH OF THE CROWN

LENGTH OF THE TOES

LENGTH OF THE FOOT



PERSONAL

FITTING

As professional dancers can dance up to 12 hours a day in their pointe shoes, the pointe shoe must fit them. Therefore, Pointenétic needs to fit several anatomies. By providing personal fitting sessions, the team ensures that the pointe shoes fit. To achieve a correct fitting, several measurements are needed. The width of the crown and the length of the toes determine the toe box's dimensions, and the foot's length and flexibility determine the shank geometry and the exterior of Pointenétic. A correct fitting prevents the dancers from developing possible bunions and other foot defects. A 3D scanning is therefore used to accommodate vulnerable bones and provide sufficient padding through the tailored foam interior of Pointenétic.

ELASTICS

FITS LIKE A GLOVE

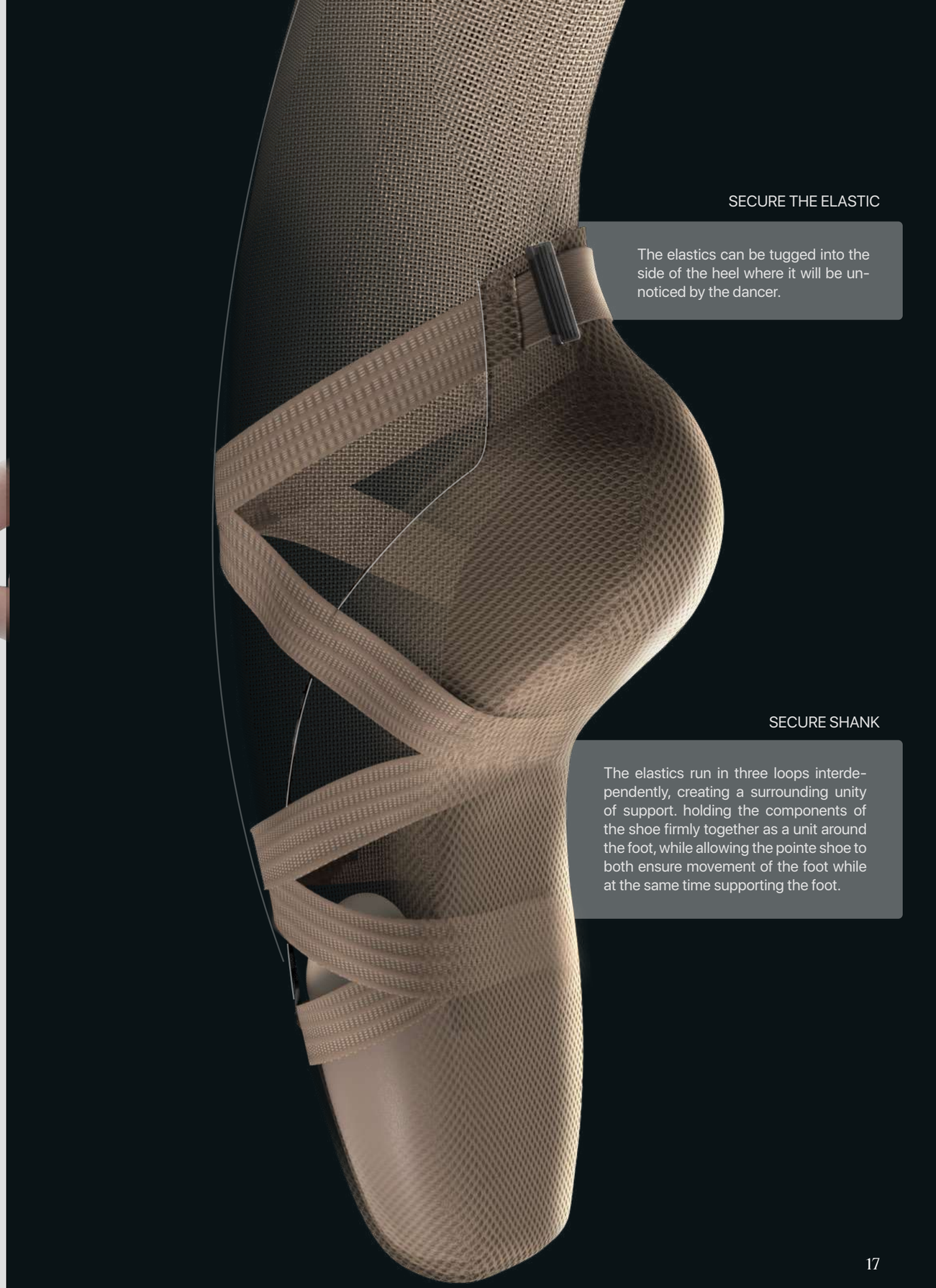
The elastics runs in directed paths under the surface of Pointenétic where they are strategically placed to fasten the internal components around the dancer's feet, in order that the dancer is supported and secure in Pointenétic. When tightening, the exterior creates a seamless and unnoticeable surface by minimizing potential creasing and air-gabs.

TIGHTEN THE CROWN

The elastics will secure the toe box to the dancer's feet with a single pull and ensure direct contact. Pulling them outwards will loosen the grip, and Pointenétic can quickly be taken off.

SECURE ARCH

The elastics end in a loop in the heel section, with one pull the shank can be secured to the arch with one pull and to ensure the dancer always feel supported. Lock and unlock the elastics with the rectangular lock by dragging it in place.



SECURE THE ELASTIC

The elastics can be tugged into the side of the heel where it will be unnoticed by the dancer.

SECURE SHANK

The elastics run in three loops interdependently, creating a surrounding unity of support. holding the components of the shoe firmly together as a unit around the foot, while allowing the pointe shoe to both ensure movement of the foot while at the same time supporting the foot.

EN POINTE

NO CHEAT

ROLLING EN POINTE

It requires years of traning and increasing foot strength and control for the dancer to go en pointe safely. The inner core of Pointenétic is designed to follow the feets' movements while not restraining the dancer's strength and flexibility. The geometry in the shank allows the dancer to bend their feet into a half pointe position and give the dancer support up to the arch when en pointe. The toe box is designed to compress and expand with the foot's movements and help support and distribute the force better on the whole foot rather than the toes, especially when getting into extreme dance positions when en pointe.

HALF POINTE

The shank is bendable in the midfoot, allowing the dancer to jump and run in Pointenétic.

EN POINTE

The shank in Pointenétic is 3/4 length to get the prefered foot shape in the field. This is prefered as it creates support in the arch when en pointe. The box is compressed around the toes when en pointe.

FLAT FOOT

When on flat foot, the toe box will expand with the foot when force is added to the joints.

PART OF THE BODY

INDIVIDUALITY

Pointenétic will be the dancer's most important tool and must become part of the dancer's identity. The dancer's name and left & right can be embodied into the sock and darning added. Those who have a signature darning can choose to do it by hand.

To ensure Pointenétic matches the individual dancers, their skin colour will be scanned and interpreted by software to calculate which eight colours predominantly make up the skin colour. An integral knitting machine will then match the colours and coils of threads.

DANCERS NAME

The professional dancer can have their name embroidered onto the sock.

LEFT AND RIGHT

Left and right are noted to highlight the difference between the two different shoes.

DARNING

The dancer can select if they want pre-sown darning to ease the preparation time of the pointe shoe. By adding darning is the preparation time reduced by 20 minutes per shoe.

EXPLODED VIEW

COMPONENTS

Pointenétic is constructed of new and innovative materials that are not broken down by sweat and which will mold to the type of feet of the dancer.

PET KNITTING

A combination of moisture-wicking silver ion fabric & PET integral knitting is used to accommodate breathability and a secure fit around the feet.

PC-ABS

Using PC-ABS, the shank can achieve the right flexibility and stiffness in certain areas and does not deteriorate by sweat.

HDPE

The toe box is produced in HDPE, which gives it the ability to compress and expand with the dancer's feet and support them when en pointe.

POLYESTER & RUBBER

The elastics are made of polyester and rubber to make them tight around the feet.

SHOCK-ABSORBING FOAM

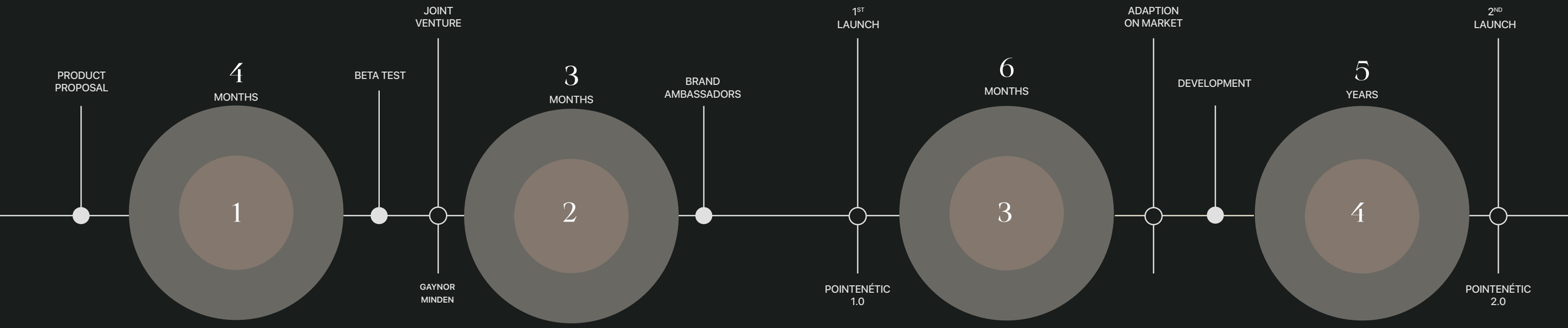
Layers of shock-absorbing foam are utilised on the heel and around the internal platform to reduce noise and impact on the feet.

EVA FOAM

EVA foam is used on the outer layer of the shank and inside the toe box as it creates a moldable surface for the dancer's foot defects and bunions.

FUTURE DEVELOPMENT

IMPLEMENTATION PLAN



DEVELOPMENT

Further development and improvement of the inner core. The concept is proven through a Beta test with help from ten professional ballet dancers to test the inner core with a two-week trial.

JOINT VENTURE

Creating a joint venture with the pointe shoe company Gaynor Minden (significant US market share) to reach the European market with a traditional exterior will help them implement a better technology better and help the conservative users adapt to the product better.

MANUFACTURING / 1ST LAUNCH

Preparing for the first launch by constructing the manufacturing process. Before the first launch, partnerships with brand ambassadors of professional ballet dancers will have been established. Following the launch of Pointenétic 1.0, with a traditional exterior and with an innovative interior.

FINAL DEVELOPMENT / 2ND LAUNCH

The industry now knows of the performance-ready pointe shoe and it is starting to get adapted to the market. Alongside this development of Pointenétic 2.0 is conducted through tests with loyal clients. Launching Pointenétic 2.0

COST & BREAK-EVEN

BUDGET

COST

69,60 DKK	139,20 DKK	1.530.000 DKK
PER SHOE	PER PAIR	START-UP COST

PRODUCTION COST

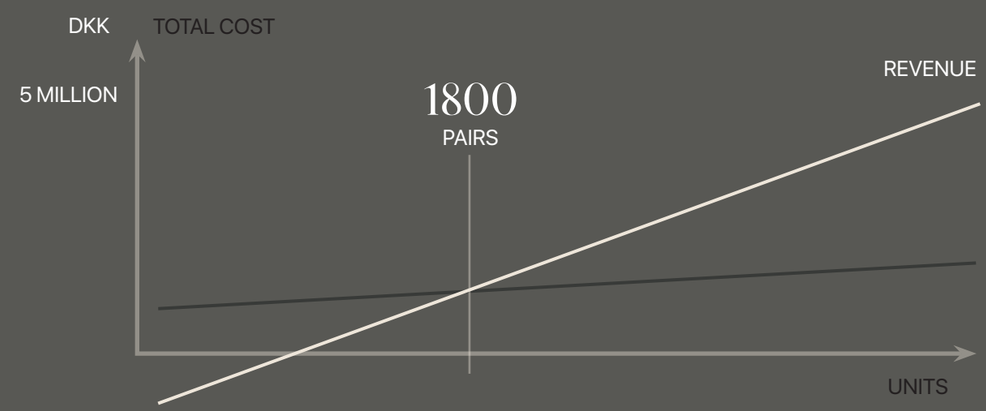
The production cost of Pointenétic is estimated through each component's material and tool cost. Machine cycle time, wages and assembly time combine the estimated cost per shoe. The start-up cost is a one-time payment which includes all tools and machines.

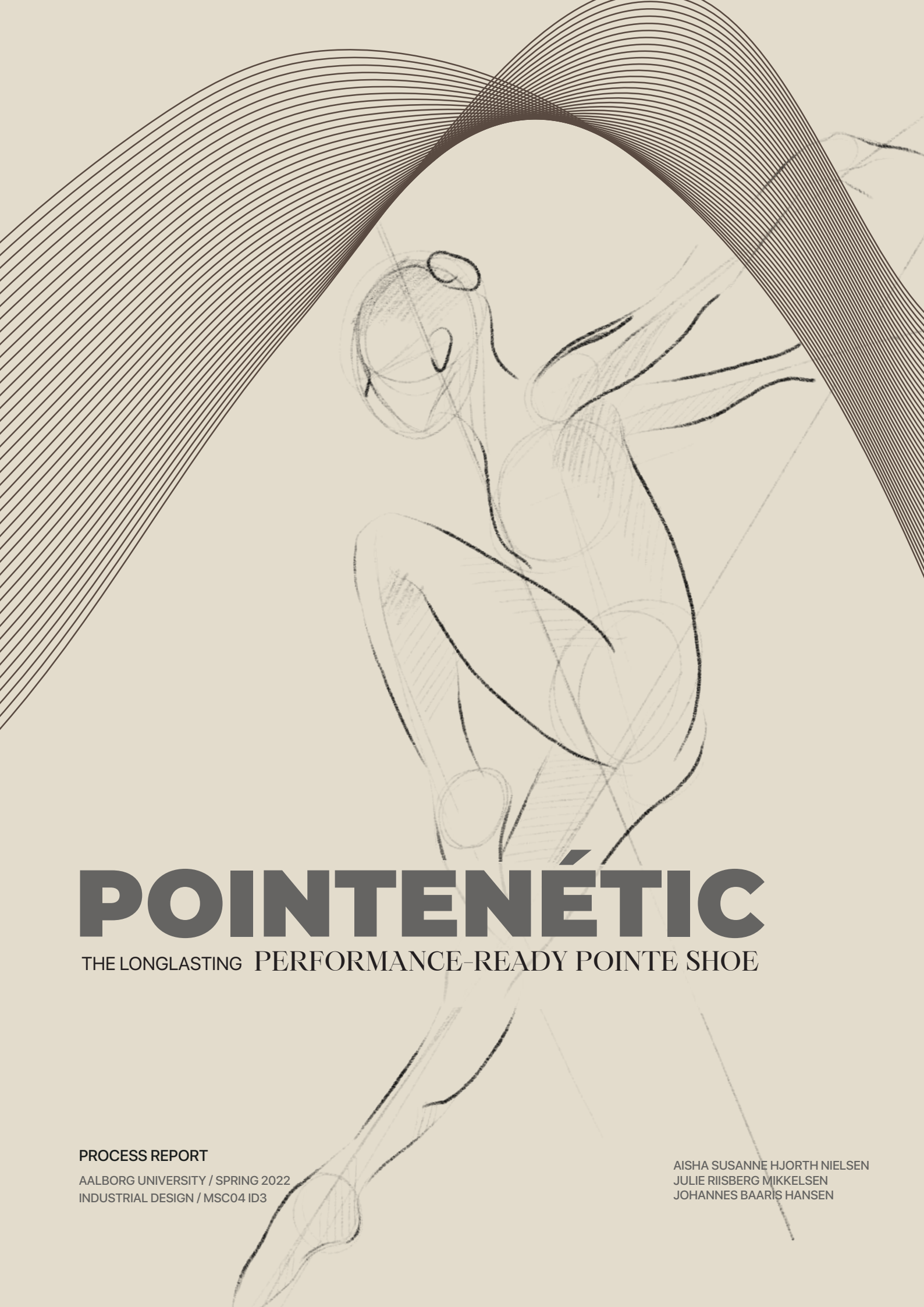
RETAIL PRICE

The unit cost is based on a market positioning ranging within the retail price of other innovative brands, giving Pointenétic a set price of 1000 DKK before taxes.

BREAK-EVEN

Break-even is based upon the cost estimation and set price. The break-even point is estimated to be reached at 1800 sold pairs and is equivalent to one year and two months of having one company of 67 dancers wearing pointe shoes as a client.





POINTENÉTIC

THE LONGLASTING PERFORMANCE-READY POINTE SHOE

PROCESS REPORT

AALBORG UNIVERSITY / SPRING 2022
INDUSTRIAL DESIGN / MSC04 ID3

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The team

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Thank you for five months of creative collaboration, fun fustrations and endless coffee runs...

THE

TITLE PAGE

Title:	PERFORMANCE-READY POINTE SHOES
Theme:	BALLET POINTE SHOES
University:	AALBORG UNIVERSITY
Project team:	MSc04 / ID3
Project period:	01.02.2022 - 25.05.2022
Main supervisor:	LINDA NHU LAURSEN
Co-supervisor:	BRIAN LAU VERNDAL BAK
Pages:	91
Appendix:	46

ACKNOWLEDGEMENT

Thanks to our main supervisor, Linda Nhu Laursen for guidance, support and pushing the team throughout the project and to co-supervisor, Brian Lau Verndal Bak for guidance and feedback throughout the process.

A big thank you to everyone who have contributed to important insights, knowledge and expertise in the process:

Former Principal Dancer at *New York City Ballet* and Ballet Teacher at *Royal Danish Ballet,* Ask La Cour
Ballerinas at *RDB*: Holly Jean Dorger, Isabella Cornell, Tomoka Kawazoe, Birgitta Lawrence, Rikako Shibamoto.
Physiotherapist at *Royal Danish Ballet*, Lærke Friis Hansen
Physiotherapist at *New York City Ballet*, Kirsten Kurie
Ballet Teacher and former Principal Dancer at *San Francisco Ballet*, Peter Brandenhoff
Former Principal dancer and Head of Shoe Department, Henriette Brøndssholm

Ask La Cour & Isabella Cornell, this project could not have been done without you!

AN OVERVIEW

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ABSTRACT

Projektrapporten indeholder præsentationsmateriale af afgangsprojektet Pointenétic, omhandlende et re-design af tåspidskoen, til professionelle balletdansere. Tåspidsskoen er balletdansernes eneste og vigtigste redskab, som de skal sætte deres lid til hver dag.Denne traditionsprægede kunstart har faste og skarpe holdninger til dens æstetiske udtryk og mener, at man skal være tro mod de gamle metoder og kutymer. Dette har medført, at industrien er blevet forældet og feltet har, som en af de få atletiske disipliner ikke taget imod innovative teknologier, da dette primært bliver set som snyd. Det resulterer i, at professionelle balletdansere stadig anvender tåspidssko lavet af en materialekombination af pap, lærred og limpasta opfundet i 1930'erne. Balletdansere skal danse op til 12 timer om dagen, hvilket har sat højere krav til tåspidsskoen. Dette gør, at danserne er nødsaget til at bruge to timer pr. par, på at nedbryde skoen hurtigere. Hvilket gør, at skoen hurtigere er 'gået til', men medfører også at skoen holder maksimalt tre dage.

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INTRODUCTION

Ballet is an extreme sport. Each day, ballet dancers are required to excel and "leave it all on the stage". Each day, pushing their bodies to their limits, train and perform 12 hours a day, constantly aiming for the extreme - all while standing effortlessly on the tip of their toes. Each day, ready for when the curtain goes up. But there is one big problem: their primary tool, the pointe shoes, are unpredictable and can break down any minute, leaving the dancer with no support and no choice but to proceed dancing in dead shoes. A scenario similar to a skydiver not being able to count on their parachute after jumping.

This thesis aims to uncover the complex world of ballet and navigate into the hearth of the traditions to understand the core problem and provide the users with what they wish for: a long-lasting performance-ready pointe shoe.

READING GUIDE

The project is documented in four parts.

Product Report: a presentation of Pointenétic 2.0.

Technical Drawings: a presentation of the product specifications.

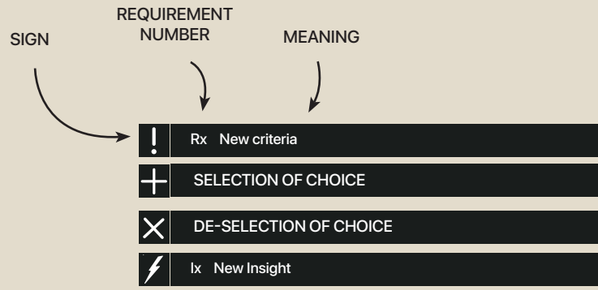
Process Report: presentation of the process

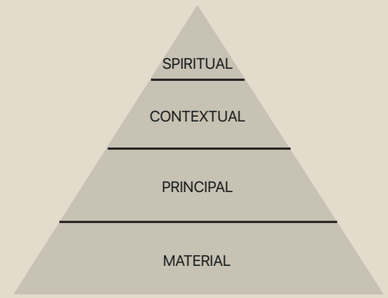
Appendix: a collection of worksheets, methods, illustrations and calculations.

This process report summarises the documentation and evaluation of the development process, consisting of 8 phases: User, Function, Construct, Market, Aesthetics, Production and Epilogue. The report uses "sum-up boxes" for readability (see the example to the right). A word explanation is included to help clarify notions and phrases within the industry (next page). A star (*) is marked next to the word when first introduced.

The Harvard Method is used for referencing, and the SI-unit notation describes the metric system.

Lehrdahls *model for a vision-based approach to design* is used to help navigate the different levels within product design. These are 1) the spiritual level, which relates to intention, 2) the contextual level related to expression, 3) the principal level that relates to the concept, and 4) the material level related to the physical product. By understanding and reflecting on the different levels, it is possible to notice how changing aspects in one level can influence the others and how there should be consensus across all levels. The model is intended to guide the design process and helps navigate the different phases and understand the interconnection (Lerdahl 2001, 100-106).





01 (Lerdahl 2001)

WORD EXPLANATION

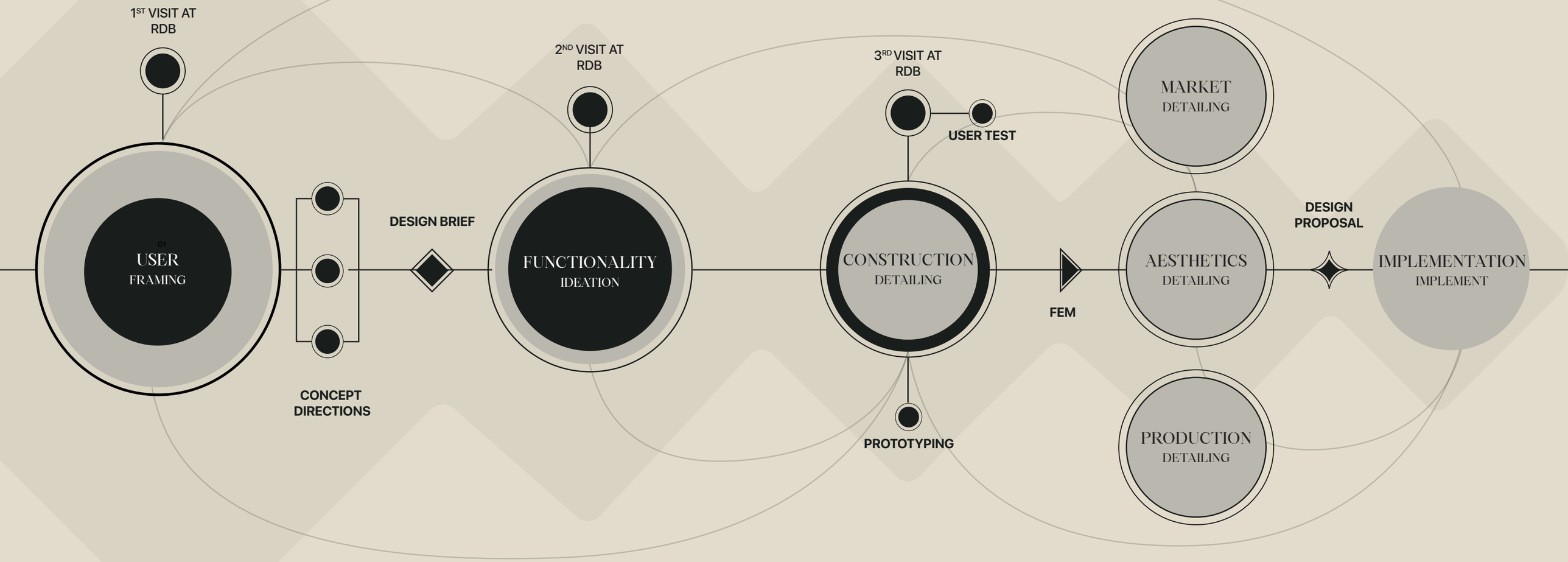
WORD	EXPLANATION	When is it first introduced
RDB	Royal Danish Ballet	P. 8
FEM	Finite element modelling	P. 9
Principal dancer	The highest rank of dancer within a ballet company (Expert)	P. 11
NYCB	New York City Ballet	P. 11
En pointe	When a dancer stands on her toes in pointe shoes (from french)	P. 12
Toe box	Stiff toe cup that encases toes. Includes platform and wings	P. 12
Vamp	The length of the toe box (part that covers toes)	P. 12
Wings	Soft sides of the shoes, creates inner support	P. 12
Ribbons	A strip of fabric ensuring that the shoe stays on the foot and that the shank is held in place	P. 12
Drawstring	Tightens the sock part of the shoe (fabric) around the foot	P. 12
Sole	Outer part of shoe that minimizes friction with the floor and helps absorb shock	P. 12
Shank	A stiff insole that provides support when going en pointe.	P. 12
Platform	The part of the shoe that touches the floor when dancers stand en pointe	P. 12
Satin sock	The exterior of the shoe combining all components together, made of satin	P. 12
Flexibility	The ability of a joint (group of joints) and muscles to move through a range of motion effectivly unrestricted and pain free	P. 12
Pointe shoe	A shoe that ballerinas use to create the illusion that they are standing on their toes.	P. 12
Corps dancer	Third highest rank, and beginning position of dancer within a company (Proficient)	P. 13
Apprentice	Third level within the education system of ballet (Competent)	P. 13
Die (shoes)	Then the shoes no longer provides support and is a danger to the dancer	P. 15
Inserts	Things that are inserted to the pointe shoe (such as tape, gel-pads, toe-pads, socks etc.)	P. 16
Breaking in	Purposefully destroying the pointe shoe, to speed up the process of being performance-ready	P. 16
Performance-ready (PR)	When the pointe shoes are in a state to be used in a performance. Must feel worn in by moulding to the feet, be bendable and able to do a roll-through/relevé in. Elaborated on page: (21, 24, 36, 38, 39, 43, 49, 50)	P. 16
Darning	A sewing technique made at the platform to expand the surface area	P. 16
PerfectFit	A product / insert constructed of a moldable material, used to relieve pressure on the toes	P. 16
Ground feeling	Have sufficient space between the toes, to be able to move and use them to find balance	P. 17
Bunion	A painful bony bump developed in the foot joint due to constant pressure on the joint.	P. 17
Company	A troupe that performs several different types of ballet (e.g. RDB & NYCB)	P. 18
Repertoire	The collection of ballets that is performed during the year	P. 18
Soloist	Second highest rank of dancer within a company (Proficient)	P. 18
Ballet Master	(Art Director) The person in charge of all creative decisions in a Company	P. 18
Character dancer	Retired dancers playing a short acting role	P. 18
Grit	A persons powerful motivation to achieve an objective (Duckworth, 2016)	P. 18
Rosin	Resin, solid amber residue. Used as adhesives and varnishes.	P. 19
Marley floor	A roll-out vinyl (or PVC) floor with spring effect, used as a dance floor	P. 19
Pointe shoe ruffer	A tool to scrape & clean the sole of the shoe to reduce slipping and improves traction with floor	P. 19
A barre	A stationary handrail that provides support during varying types of exercises	P. 19

WORD	EXPLANATION	When is it first introduced
Hammer toe	A toe deformity resulting in a bend or curled toe pointing downward instead of pointing straight	P. 20
Corns & Calluses	Thick, hardened layers of skin developed when trying to protect itself against friction and pressure.	P. 20
Banana foot	The perfect shape of the feet in pointe shoes, the arch on the front foot resembles a banana	P. 20
Tarsals	A group of seven bones between the fibula (leg-bones) and the metatarsals	P. 20
Calcaneus	Largest bone in the foot and in the tarsal-bone group (heal bone)	P. 20
Talus	Biggest upper ankle bone. Transmits the entire weight of the body from the lower leg to the foot.	P. 20
Cuboid	One of the seven bones in the mid foot and placed (under the middle foot)	P. 20
Metatarsals	A group of five long bones located between tarsal bones and the phalanges (middle foot bones)	P. 20
Relevé	A beginner ballet move, meaning "raised". The action of moving from flat foot to standing on the toes. Further elaboration on page 21 & 24	P. 21
Phalanges	The five bones that construct the toes	P. 21
Roll through	Same as Relevé	P. 21
Freed of London	A traditional British pointe shoe brand	P. 21
Gaynor Minden	A innovative pointe shoe brand developed to give injured dancers correct support	P. 21
Maker	A highly skilled caftsman creating handmade pointe shoes	P. 21
Pliable	Easily bent, and has flexibility in that point	P. 21
Break-points	Two areas on the shank where it needs to be pliable	P. 21
Classical ballet	A system of physical education that fosters control, awareness flexibility and strenght (Paskevska, 2002)	P. 22
Neo-classical ballet	A ballet form based on classical ballet principles though distinguishing itself as being freer and reinterpreting the classical line movements.	P. 22
Contemporary ballet	A ballet-style invented in the 1950s, much freer than classical ballet filled with emotions, expression and a "no-plot plot-line"	P. 22
George Balanchine	The frontrunner of Neo-classical ballet, considered one of the most influential ballet masters in ballet history.	P. 22
Half pointe	A position in which the dancer is on the balls of the feet. Half through a relevé or roll through	P. 24
The crown	Width of all joints between Metetarsals and Phalanges	P. 25
Plié	A bended knee exercise often performed at the barre. A plié is one of the basic moves in ballet	P. 41
Bubbling	A sign of poorly fitting, where the vamp is narrow resulting in the dancer "falls out" of the shoes	P. 41
Buckling	When the foot is moved out of the preferred position due to a poorly fitted shoe	P. 41
Knuckling	A sign of poorly fitting, where the vamp is too low, leaving the dancer with too little or no support	P. 41
FEA	Finite element analysis	P. 50
Pancaking	"Pancaking" is to put foundation on the pointe shoes to make it a skin colour	P. 66
Shoe last	A mechanical form shaped like a human foot used in the production of shoes	P. 77
Inner core	A combination of the shank, box and foam combi present within Pointenétic 1.0 and 2.0	P. 82

PROCESS TIMELINE

DOUBLE DIAMOND

Double Diamond (Dubberly, 2004) de an overall linear structure of the process with diverging and converging phases. This is used in combination with 'The Experiential Learning Cycle' (Kolb, 1984), where the process has been iterating between the different phases, has created the overview of the project.



PHASE OVERVIEW

The illustration shows how each phase is diverging in and converging out before the next phase. The sizes of the phases show the overall process is converging.

FRAMING

The fundamental understanding of ballet and the problem will be unfolded and uncover user needs and three possible directions, showcased in three concepts.
The phase concludes with a summary of one project direction and scope of the framing in a Design Brief.

IDEATION

Exploration of the problem and insights utilised from the 1st visit to the **Royal Danish Ballet (RDB)*** is executed in this phase. The team obtains a further understanding of the problem and investigates the solution space, which culminates in a second visit to the RDB.

CONCEPTUALISE

The concept is broken down into elements where iterations on the concept are challenged through prototyping and user testing with a 3rd visit to the RDB.
The phase concludes with a proof of principle using Fine Element Modeling (FEM)*.

DETAILING

The detailing phase is divided into three co-extending sub-phases. Elements of the concept are specified with materials, production and construction and the market potential is further investigated and detailed. Trends and tendencies are explored to push the industry and the phase culminates in a design proposal.

IMPLEMENT

The team creates strategies and an implementation plan to enter the market by making a feasible business model.

TASK

01. / 8.

USER

This chapter navigates in both the spiritual, the contextual level and the of the value pyramid (p. 5) and focuses on the user and understanding the world the user is in and uncovering needs and opportunities to include in the further development. Sketches and initial ideas for the product are generated. The phase culminates in a design brief, highlighting the target group, initial business potential and requirements.

Framing

02 Holly Jean Dorger, Principal Dancer at Royal Danish Ballet

ENTERING THE WORLD OF BALLET

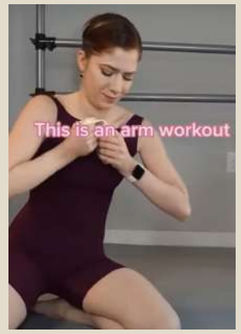
WHY THIS PROBLEM

By scrolling through the internet a team member stumbled upon several videos of ballerinas partially destroying their shoes in order to later dance in them. This lured the team into wanting to investigate this phenomenon further and improve on this seemingly very old design.

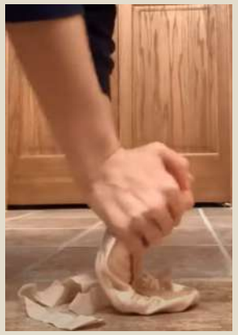
The usage of pointe shoes further showed that there is supposedly a need and a market for giving the ballerinas shoes that do not need to be destroyed, before using them.

+ INVESTIGATION OF POINTE SHOE

03 YouTube-video of hammering shoe



04 Tiktok video of breaking a shoe



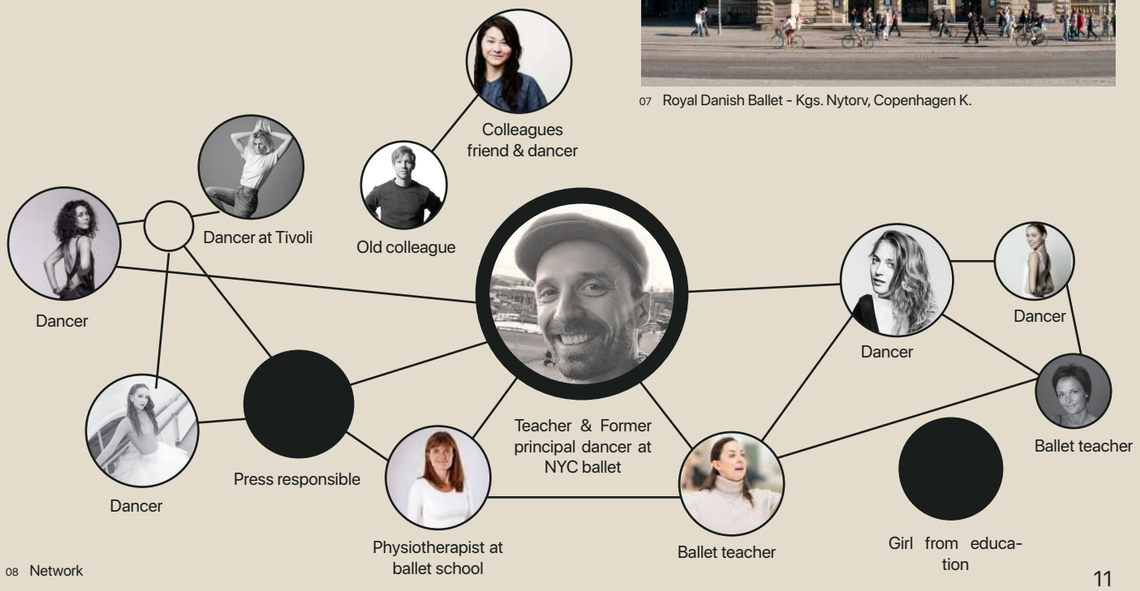
05 Tiktok video of breaking a shoe

06 YouTube-video of cutting shoe

ESTABLISHING CONTACT WITH: ROYAL DANISH BALLET

The team knew that in order to fully understand the complexity of the identified problem, it was necessary to achieve contact with real ballet dancers. This led to an extensive and systematic search for potential partners that would help the team gain access to inside the wall of Denmark's only institution of professional ballerinas - The Royal Danish Ballet (see Appendix 01). Contact was eventually established through Ask La Cour, former principal dancer* at New York City Ballet* (NYCB) and currently a trainer at RDB.

07 Royal Danish Ballet - Kgs. Nytorv, Copenhagen K.



08 Network

UNDERSTANDING THE FUNDAMENTALS

While establishing contact with The Royal Danish Ballet, the team tried to understand the fundamentals of ballet, pointe shoes* and the processes in between. This was mostly done through empirical data from books and online videos (see Appendix 02).

09 Forces (Orange) while a ballerina is dancing. Brown indicates gravity.

10 Reaction forces through body parts

DANCING

When ballet dancers are dancing on their toes, also referred to as dancing "en pointe"*, the dancers master great control, awareness, flexibility* and strength - which they have perfected through years of training. The pointe shoes are a ballerina's most important tool. Some dancers say that without pointe shoes, ballet would not exist (The Australian Ballet, 2018). When going en pointe the dancers rely on their strength and balance to stabilise their weight on their toes, while performing challenging positions or circling around their centre of mass while being in motion. If the technique is not performed correctly, the reaction forces that are passed from the foot to other larger parts of the body can create a bigger impact that can end in permanent injuries (see ill. 09 & 10).

I1 It is only women who dance in pointe shoes

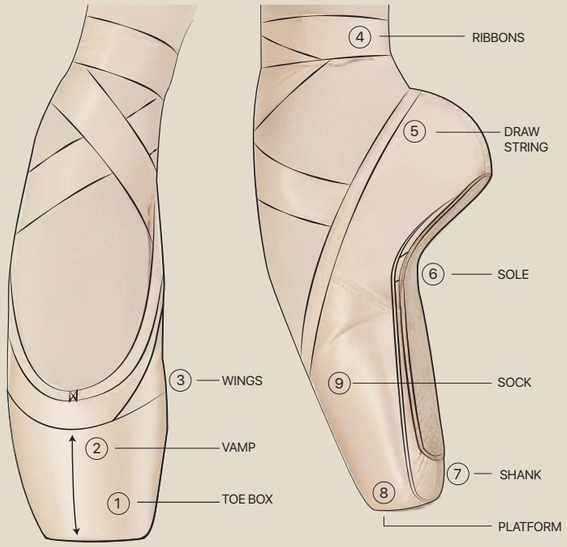
I2 Requires great strength and balance

POINTE SHOES:

BASIC CONSTRUCTION

To understand the construction of the current pointe shoe, the product architecture was investigated.
It consists of several elements with different functions (see Appendix 03).The shoe primarily consists of a papier-mâché like structure created by layering canvas and glue paste made of corn starch (Limbers dancewear, 2018) (Ballet fusion, 2021).

1. **TOE BOX***
   Stiff toe cup that encases toes. Includes platform and wings, made with layered canvas and glue
2. **VAMP***
   Height of toe box that covers toes
3. **WINGS***
   Soft sides of shoes, creates support
4. **RIBBONS***
   Ensures the shoes stays on the foot, made in satin
5. **DRAWSTRING***
   Keeps the satin sock tight on the foot
6. **SOLE***
   Minimises friction with floor, made of leather
7. **SHANK***
   A stiff insole that provides support, made of cardboard
8. **PLATFORM***
   The part the dancer stands and balances on when en pointe.
9. **SATIN SOCK***
   The exterior of the shoe combining all components together, made of satin



11 Pointe shoe vocabulary

I3 Very old internal materials and structure

CONCLUSION

All components within the pointe shoe have a specific functionality in order to keep the dancers en pointe, however, made of old fashioned materials. To fully understand the world of Ballet and the core problem of the pointe shoe the team need access to the industry.

FIRST VISIT TO ROYAL DANISH BALLET

During the three day visit to the Royal Danish Ballet the team utilised methodology within design ethnography and user research. These are primarily situated interviews and Shadowing, important activities are marked grey (see the full interviews in Appendix 04).

CONTACT TO ASK
Former principal dancer at NYCB & Trainer at RDB

Observation:
Morning Training

Interview: Holly Dorger
Principal dancer at RDB

Interview: Kirsten Kurie
Physiotherapist at NYCB

Interview: Isabella Rose Carroll
Corps dancer at RDB*

Interview: Toni Tanil
Masseuse at RDB

Observation:
Beer with Ask (Understanding of culture)

Interview: Lærke Friis Hansen
Physiotherapist at RDB

Arriving at
Royal Danish Ballet

Observation:
Audition w. Holly Dorger

Interview: Jess Templeton
Apprentice, Royal Ballet School (UK)*

Observation:
Tour of the whole ballet (Company), stages and school

Interview: Ask La Cour

Observation:
Training with apprentices at RDB

Activity:
Create mold of dancers' feet
(Tomoka Kawazoe + Holly Dorger)

Interview: Henriette Brøndssholm
Former ballerina and in charge (buyer) of all shoes at RDB

CONCLUSION

User insigts, problems, observations and new criterias was gathered from the visit to the RDB. These will be elaborated on in the following section.

THE DANCERS

The following section highlights all observations gained through interviews and observations with the four dancers. It emphasises the routines and actions that the dancers perform.

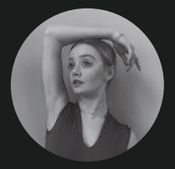
LEVEL OF EXPERTISE

Holly Jean Dorger
Principal dancer at RDB

EXPERT

Isabella Rose Carroll
Corps dancer at RDB

PROFICIENT



Jess Templeton
Corps dancer, at RBS (UK)

PROFICIENT

Caroline Iversen
Apprentice, at RDB

COMPETENT

EXPERT — NOVICE

WHAT IS IN THEIR BAGS

The team observed what the different dancers carries around in their bags, as they all brought big and stuffed bags with them to training. This knowledge is valuable to understand a ballerinas lifestyle.

12 Picture of what Holly brought with her to audition

1 **BAG**
Every dancer carry a functional bags with all their essentials - mostly consisting of multiple pairs of shoes or tools for their shoes.

2 **FOOD**
Dancers highly rely on sufficient energy - however, this juice was the first and only type of food observed encountered during the visit.

3 **WARM UP CLOTHES**
Dancers rely on their warm-up clothes to keep their muscles warm and durable throughout the day. All the warm up close was colourful and baggy in contrast with their leotards.

4 **INSERTS & TOOLS**
Many tools and inserts are lying around in the bag. Each dancer utilises several inserts in their shoes to releave the pain. More information on inserts later.

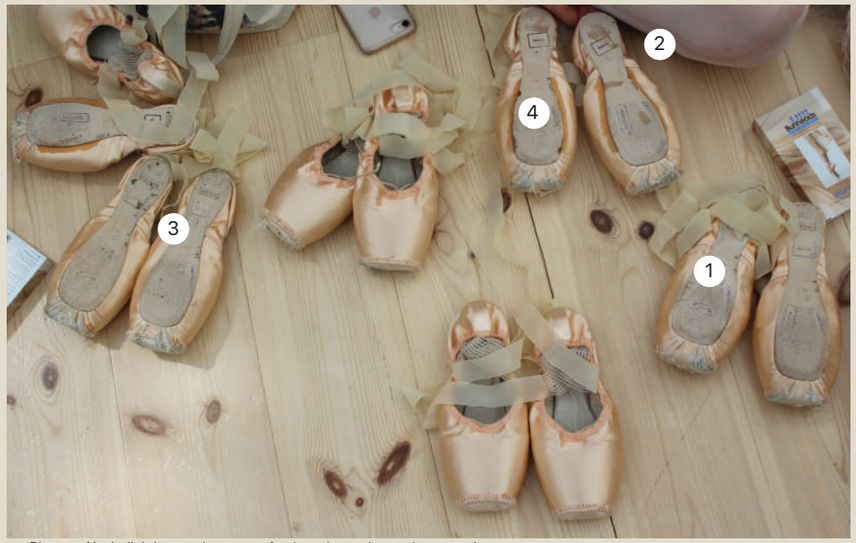
5 **CHARACTER PROPS**
Holly carries the props she utilizes for a specific role.

I always bring my bag with me everywhere. It contains everything essential.

! R1 Not add more components to the bag

SWITCHING BETWEEN POINTE SHOES

The pointe shoes are a ballerina's most important tool. Some dancers say that without pointe shoes, ballet would not exist (The Australian Ballet, 2018). Each day, they carry around 5-8 pairs in their individual bags. Some shoes are very used, others are newer. The reason for carrying around all these shoes is that a pair of pointe shoes only lasts between **one day to a week.** This means they constantly switch between pairs to extend their lifetime. The dancers mark their pointe shoes in different ways to keep track of its lifetime.



13 Picture of Isabella's bag and amount of pointe shoes she carries everyday

1 **NAME**
Dancers note their name to distinguish them from all other dancers

2 **DATE**
Dancers date their shoes to better know how long they have been in use

3 **RIGHT & LEFT OF SHOES**
Pointe shoes are uniformly produced, dancers mark them with left and right to tell them apart

4 **GLUE**
Dancers glue their shoes to make them last longer (w. Jetglue)

WHY THE SHOES ONLY LAST A DAY

The reason why a pointe shoe only last a day is that the shoes break down - also called dying*. Dying means that the shoe no longer provides the needed support for the dancer to safely go en pointe.

When dancing in pointe shoes, friction, heat and sweat are created. The materials inside the shoe (canvas and glue) start absorbing the sweat resulting in a deterioration of the material properties. After a whole day of dancing, the shoes are completely ruined, though most dancers switch shoes after a couple of hours, due to the massive accumulation of sweat. The sweat makes the dancer glide around, creating friction in their shoes, causing them to lose their control and ground-feeling.

I try on all the shoes I carry with me to test which pairs are performance-ready

I4 A pair of pointe shoes only last between a day to a week

I5 By switching between pairs the sweat evaporates, making them last a day longer

I6 Use of low practical methods to keep track of pointe shoes

× Shoe should not be breaking down so fast

\+ Create feeling of Individuality in the pointe shoe

14 Picture of Caroline glueing her shoes while she should be performing, instead another dancer is stepping in

CONCLUSION

Dancers carry around six pairs of pointe shoes in their bags plus all their tools, inserts, warm up clothes etc. to get through a day. Their current pointe shoes last between one day to a week as the old fashioned material deteriorates. This combined with the constant usage does not corrolate. To combat this the ballet dancers try to extend the lifetime by adding glue and switching between pairs.

BREAK IN* OF POINTE SHOE

As first discovered on social media of ballet dancers breaking their pointe shoes before dancing, the team got the insight that it is a standard procedure for all the ballet dancers at the RDB. The team received a run trough of all the steps the dancers do to break their shoes in.

Breaking a shoe in, is when the dancer is trying to speed up the process of getting their pointe shoes ready and feel worn in. A feeling similar to wearing a favourite pair of sneakers. The shoes need to be comfortable and ready to wear on stage. This is called when they call them performance-ready* pointe shoes.

When the dancers receive a new pair of pointe shoes, they are very hard, stiff and unbendable. They are too stiff for their liking, which makes them purposefully destroy the shoe to expedite the process or else it would feel like dancing with bricks. The shoe have to be bendable for moving the feet in different positions that is required in ballet. As the professional ballet dancers are dancing 12 + hours a day they do not have time to naturally wait for this process. 'Breaking them in' is their only solution to make them performance-ready for the stage.

5 MIN.

01 - Soften box by stepping on it or with hammer - requires force or tool

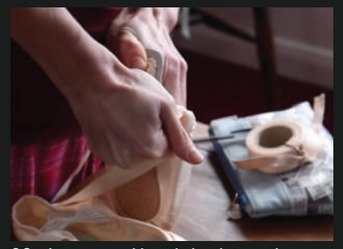
20 MIN.

02 - sows darning* on platform to make it larger and creates an edge - requires hard needle and darning

3 MIN.

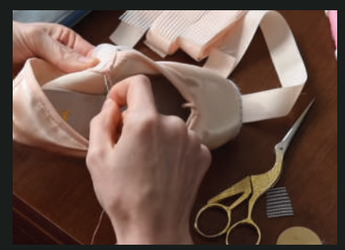
05 - Removes metal nails from sole and shank to avoid blisters on heel - Require a tool

5 MIN.



06 - Loosen and bend shank to make more pliable - Requires a lot of force

15 MIN.



03 - sows ribbons & elastics on - requires needle and threat

2 MIN.

04 - Burn ribbon ends so they do not floss - requires tool

5 MIN.

07 - cuts shank to 3/4 size - requires a knife

5 MIN.

08 - glues platform, box & shank where it needs to be stiff and hard - requires glue

I love making my shoes look nice and neat, I put great pride in my darning

TOOLS USED FOR BREAK IN

- Darning & sowing thread
- Scissor
- Thick and thin needles
- Pliers
- Hobby knife
- Jet glue

The estimated time is based on Isabella's break in, but the time is dependant on the individual dancers own precision and dedication to make them look neat. Isabella use approximately two hours on one pair of pointe shoes. The dancers carry all the tools with them, which enables them to prepare their pointe shoes when having a small gap of free time, such as in the subway or during small breaks their day.

The massive break-in process is something that only professional ballerinas do, as it makes the shoe die* quicker, which is not something many can afford without a contract.

I7 Spend two hours per pair of pointe shoes to make them performance-ready

Pre-sown darning

INSERTS INSIDE POINTE SHOE

After break-in, it was observed that all dancers apply some type of inserts* inside of their pointe shoes to accommodatet the pain, blisters and bad fitted shoes.

Tape, blister patches, cut socks and tights are seen inside every pointe shoe. Whereas gel toepads, toe spacers and PerfectFit* are means to relieve the pressure on the toes. Each dancer uses different inserts, which clearly indicates that despite every pointe shoe being made specifically to each individual dancer's feet, alterations still are being made due to the shoes not being comfortable enough.

Despite using several different kinds of inserts, the dancer's feet still look bruised and worn down, especially to the average person, however, for the dancer it is perceived as a battle scar, something they cherish with great pride and humbleness.

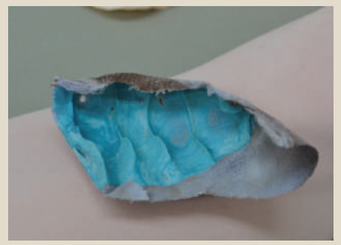
01 - Tapes toes and foot where there is bunions or areas in need for more protection

02 - Apply friction stick to minimize friction inside pointe shoe avoiding blisters

05 - Adds blister patches to avoid direct contact between wound and tights.

06 - Tights to avoid scratching on top of front foot. They hate tights, though have to wear them.

03 - Take on individual gel toe pad and toe pad made of a cut off sock



04 - Insert silicone toe spacer or Perfect Fit

07 - A sock cover is worn around the toes to create a softer surface inside the shoe.

08 - Their feet are swollen red and blue when they take off their pointe shoes after dancing

Dancers carry their inserts in their bags, enabling them to change into new inserts or apply more protection on hurting areas of the feet. The constant change of pointe shoes also affects the feet as they need to adapt to new shoes multiple times during a week, which creates blisters and worst case also bunions*. The tape allows for the dancer's wounds to heal, whereas without them the tights it would constantly stick to the open and bloody scars and flair them up, once the tights are removed.
The dancers cannot just fill in all the air gaps in the toe box as they need wickle room to create stability and balance with their pinky toe when en pointe.

I8 The dancers need to have ground feeling* to ensure control and balance en pointe

I9 The inside of the pointe shoe is not created to accommodate different toe lengths

Minimize workarounds for dancer

I have spent most of my career to find something to help me relief the pain.

My second toe is longer than my big toe, so i need extra gel patting on my big toe to ease the pain

CONCLUSION

The dancers spend two hours per pair of pointe shoes to make them performance-ready and able to dance in them. They use every gap of freetime prepping their shoes and about eight different tools to break them in.
The dancers have to wear inserts in their pointe shoes to ease the pain and comfort in the shoes as they have to wear them all day. The dancers have all sorts of homemade solutions for this.

THE CONTEXT

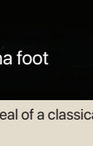
To the average person ballet seems like a closed world, one has to be a part of it in order to understand it. However, once showing sincere interest in the industry, you are greeted with immense hospitality and reciprocated curiosity - a genuine feeling of being welcomed into their family. The context describes all the circumstances surrounding the dancer: the structure, the people and the facilities.

BALLET MASTER*
Nikolaj Hübbe, his role is to choreograph the ballet and structure the repertoire*. He has the last saying of everything.

COMPANY*

All professional ballet dancing is performed at a Company - a troupe that performs several different types of ballet (see full organisational structure in Appendix 05). A company has a home theatre, where most dances are performed, but many companies also tour their home country or internationally. A company is therefore a place where ballet dancers perform and train ballet – and a ballet school is therefore often connected to a company.

A company has a very clear internal structure or hierarchy. The ballet master controls everything and everyone follows his decision, spanning from young dancers to experienced dancers to the costume- and scenography workers. In order to be hired at the company or move up in rank, you need the Ballet Masters' approval.



It's a dictatorship, the boss, decides what he wants, Nik (Nikolaj Hübbe) is aware of change.

Corps dancers might be the hardest position, as they are in most performances and always need to execute.

TRAINING

PRINCIPAL DANCERS
The highest rank of dancer
Dances the main character

SOLOIST*
The second highest rank of dancer
Mostly plays a supporting role

CORPS DANCER
Starting position at a Company.
Dances in the background at most performances.

APPRENTICE
The highest level of ballet school is equivalent to High school.
Needs a contract with a company to proceed with ballet

BALLET SCHOOL
Kids between the ages 6-15 years old

CHARACTER DANCER*
Retired dancers playing a short acting role

HEALTH

PHYSIOTHERAPISTS
They are available between 8.00-16.30 every weekday for the dancers

MASSEUSES
They are available between 8.00-16.30 every weekday for the dancers

PILATES INSTRUCTORS
They have pilates two times a week

APPEARENCE

COSTUME
Four departments; Hats, jewellery, shoe painters and costume designers

SHOES
They have one person on full time to who is in charge of shoes

17 RDB organisational structure

CULTURE

For ballet dancers, ballet is much more than an art form, it is a lifestyle. From as early age as five years old, children commit to the culture, which entails dedication, precision and above all commitment and grit*. Ballet shapes them into the person they are today and even if somebody stops at ballet they still cherish the qualities that ballet brought to their daily life (TEDx Talks, 2017). But like much else, ballet has a shadow side. The old and traditional art form has, despite not evolving much, developed strong characteristics of what it takes to be a ballet dancer and what that looks like physically - and the objective is narrow.

A pale, white skinny petite frame is preferred. The longer and slender the limbs are, the better they accentuate the lines of the body when performing intricate positions. For centuries a uniform look upon the dancers has been preferred as this magnifies the continuity of movement across the stage.

18 The ideal of a classical ballerina

The sad part is that you get roles based on your appearance. You are either the virgin, the slut or the mother

I14 Use three to four hours a day to recover
I15 Possible direction: help recover quicker
I16 Possible direction: make new floor

THE STAGE

Through the observations and interviews doing the tour of the RDB it became apparent what a performance night is. It is a ballet performance spanning between one to three acts which last about two to three hours. Doing these hours the principle dancers are switching between being on and off stage, whereas corps dancers are remaining on stage in the background where they might have to dance three hours straight.
Many dancers have individual routines and rituals before entering the stage. The stage is made of marley floor* (vinyl floor with spring) which is different than what is used in their rehearsal rooms. However, three things remain the same: each dancer use rosin* and a ruffer* to scrape and clean the sole of the shoe to reduce slipping and improve traction with the floor and most importantly, they triple check their pointe shoes before entering the stage (Ballet Theater Company, n.d.). If they do not find performance-ready pointe shoes before entering the stage they have to take a deep breath and dance in dead pointe shoes through the whole performance.

Dancers are deducted in pay if their pointe shoes untie during the performance.

19 A box filled with rosin where the dancers step on it and a pointe shoe ruffer.

I always stress out about my shoes. I like to test them out on stage, before a show. When the right pair of shoes are found, then the stress goes way down.

Anti friction on platform
I10 Principal dancers aim at being lead in all major classical productions

20 Feet exercisers

THE REHEARSAL ROOMS

The team observed a morning training and audition in the rehearsal room. This is where the dancers spend most of their day, around six hours. This is where they are training, warming up and stretching.

Doing morning training the room is filled with laughter and competition. Despite it being a rehearsal room, it is where the dancers are constantly evaluated upon. Both internal and external teachers are looking at the dancers and evaluating their potential. The dancers are always correcting and perfecting their every single move.

The dancers need tools to properly warm up their feet and muscles. Dancers either utilize a tennis ball or the barre* to do the warm up prosidure in the joints of their feet. On a hot day the the shoe dies faster. The floor is softer than the stage and gives more spring effect.

I11 The dancer gets psychological pleasure by perfecting moves (Jordan, 1997)
I12 Possible direction: mobility product
I13 Ballet dancer dance up to 12 hours a day

FACILITIES

The RDB ballet provide the dancers with great facilities such as personal rooms for storage, a gym, sauna and ice bath the dancers utilizes when they need to recover from their training, auditions or performances. Each times the dancers have danced they approximately use one hour to cool down afterwards which they do multiple times a day. This contains stretching their whole body and ice bathing their swollen feet. The dancers spend around three to four hours a day just to prepare, strengthen and cool down before and after dance training. It was observed that in each occasion the dancers stretched their feet and joints with different tools to speed up the process.

21 Dressing room with saved shoes

22 Dancer stretches

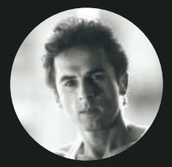
CONCLUSION

There is a traditional hierarchy in the RDB ballet where the ballet master always has the last saying. The traditional industry has developed a drastic beauty ideal the dancers must follow to get the lead rolls.

THE EXPERTS

The RDB houses many experts to help and guide the dancers to stay safe and in prime condition. Underneath are four experts who helped gain important insights and knowledge throug semi-structured interviews.

Kirsten Kurie
Physiotherapist at: New York City Ballet



Toni Tanil
Masseuse at RDB

Lærke Friis Hansen
Physiotherapist at RDB

Henriette Brøndsholm
Former ballerina and in charge of all shoes at RDB (Buyer, part-time)

THE EFFECTS OF DANCING BALLET

Ballet is considered an extreme sport (Henderson, 2022) and with this comes great consequences, especially regarding the body. Sheri Henderson argues that the force on the platform of their shoes can equal ten times their body weight, which is why there is a general consensus in the world of ballet, that dancers should not dance in pointe shoes before they are at least 10-12 years old and have acquired the necessary foot strength.

Common injuries when dancing ballet are especially problems in relation to the feet: Arch pain, Join pain (especially in the big toe), hammer toe*, painful corns and calluses*. Generally, stress-related problems in connection to knees, hips and back. Frequent injuries have resulted in a ballet-dancer career only lasting up to the age of 40. The short career leads dancers to risk everything on the career once they are in it, and once retired most remain in the business.

As Kirsten is mentioning it is dangerous to cut the shank lower than 3/4 (see ill. 23.) of the length as there is a bigger risk of the shank pressing up between the calcaneus* and cuboid* or the cuboid and metatarsals* (see ill. 24.) If pressure is placed between the bones it results in an opening on the other side of the foot where a gap occurs between the Talus and Tuber* (see ill. 24). Dancers cut their shank to push their feet into a banana* shape as it makes them feel like they are being held up by the shank. This is because the edge of the shank goes directly into the Calcaneus, which results in them feeling as being able to just stand on toes the whole day. However, the shank needs to support the calcaneus in order to be safe.

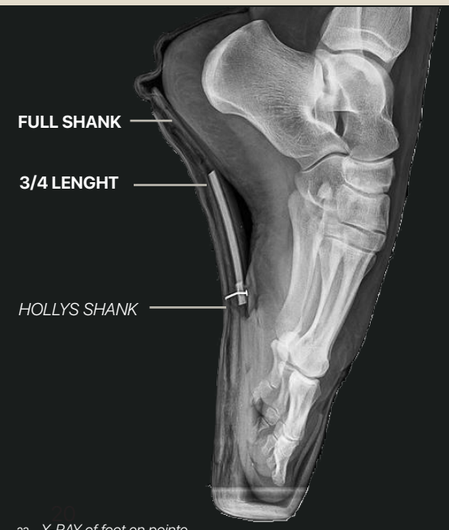
Everyone's feet are different, both in terms of size, width and toe length. But the tissue inside the feet is also different, meaning that some are more flexible (can easier achieve a banana foot) than others and can compress more than others (see Appendix 04). Especially the mid foot area is where most mobility lies.

There is a popular modification where dancers cut their shanks shorter, right under the heel so it supports the heel.
A full shank supports the talus (top bone). A shank shorter than 3/4 is dangerous as it creates gaps in the middle foot, which is very dangerous over time (Holly does this).*

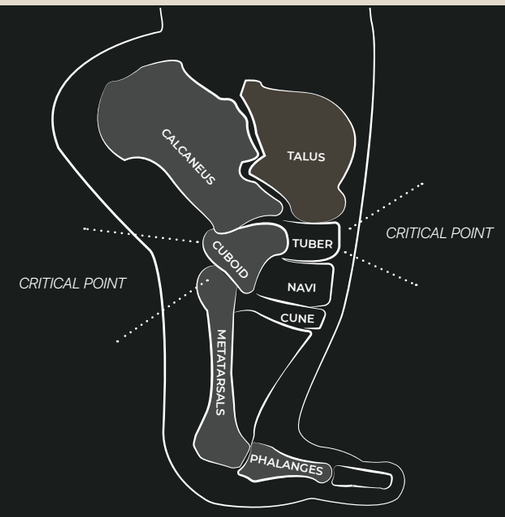
DANCER'S DILEMMA
Dancers priority

PUSHING BODY TO EXTREMES ← CHOICE → PROTECTING BODY

+ No shank shorter than 3/4 length



23 *X-RAY of foot en pointe*



24 *X-RAY of foot on half-pointe*

SAFELY GO EN POINTE

When measuring young dancers' progress and readiness to go en pointe, the teachers train a fundamental ballet move - called Relevé* or "The roll through"*. It teaches young ballerinas to utilize their foot strength and restrain gravity. Essentially the same movement as doing a push-up. The move is first taught in demi-pointe (half pointe) and later en pointe.

Some have more flexibility than others in their joints, these dancers need more support. Whereas dancers with a straighter foot, need a more pliable shoe.*

I17 Dancers have diffent flexibilities

25 A walk through of the move Relevé

FLAT FOOT

HALF-POINTE
Half relevé

EN POINTE
Full relevé

POINTE SHOES AT RDB

The pointe shoe is the dancer's primary work tool and before getting hired by a company the dancers must buy their own shoes, whereas after they are hired at a company the company pays for the provided pointe shoes. In Denmark, the RDB gets supported by the state and the pointe shoes are paid through the society's taxes.

As the dancer's feet can change by injuries or added bunions, the dancers get re-fitted by the contracted pointe shoe brand once a year. The RDB have a contract with the brand **Freed of London***. The ballet dancers are technically free to choose whatever shoe brand they prefer however, but the culture at the company indicates that all dancers are forced to wear a 'Freed' shoe whether they like it or not. The reason being that Nikolaj Hübbe prefers Freed of London because it is beautiful. Ironically, given he never danced in pointe shoes. Only one dancer dances in another brand called **Gaynor Minden***. The reason for this is that the dancers are not allowed to wear Freeds anymore because her feet are severely injured and the Gaynor shoe is the only one that gives her enough support.

Ultimately we want to keep the dancers safe. And to do so, it is all about the correct form and technique - where the most important is rolling correctly onto pointe.

Most injuries come from poor technique. Poorly fitted shoes lead to injuries, so if a dancer has trouble - we automatically look at their shoes first.

SHORTAGE OF SHOES

The team entered into the halls of pointe shoes at the RDB with five long rows of pointe shoes on either sides, categorized specifically for each dancer. The room next door was filled up with huge boxes that were yet to be categorised.

Each dancer is given 8 pairs of pointe shoes every month. Every quarter, Henriette estimate and orders the needed pointe shoes for the entire company. A complicated task, given that she is unaware of the dancer's parts in the following productions. The lead parts are as a rule, given extra shoes as a bonus, however, not knowing this makes it very hard to estimate, and Hübbe does not give her a heads up. This leads to dancers prolonging each pair and essentially dancing in dead shoes for far too long. Each pair of Freed shoes are handmade by a "maker"*. Each dancer dedicates themselves to one maker. If a maker is sick or at some point stops producing pointe shoes, it leaves several dancers devastated and heartbroken, especially given that the current lead time for a pair of Freeds is three months.

I18 3 months lead time on pointe shoes

Dancers sometimes dance in another persons fitted shoes when they have run out of pointe shoes.

RDB	NYCB
80 DANCERS	95 DANCERS
ANNUAL BUDGET 1.75 MIO DKK	ANNUAL BUDGET: 780,000 USD
YEARLY ORDERED SHOES 4000	YEARLY ORDERED SHOES 8.500
(Brendan Hayes, Financial Manager, RDB), (RDB, 2022)	*(Fireberg, 2020), (Fuhrer, 2018), (Persad, 2013)*

26 One row of pointe shoes divided into individual dancers

CONCLUSION

The professional ballet dancers care more about their appearance and achieving the banana foot than taking care of their body, which is required to be healthy if the ballet dancers want to dance until they are 40 years old. The RDB use an annual budget of 1.75 mio. DKK and Henriette has to predict the number of pointe shoes the dancer is going to wear the next season.

CONCLUSION FROM VISIT

The team returned to Aalborg after a three day extensive program from early in the morning to late at night. The team immediately felt included in the world and started to see possible dilemmas and potential problems spaces. With an overall, well-rounded perspective of ballet, due to the honest willingness of everyone met at the RDB, the team left, filled with extreme eagerness. Eagerness to help the dancers receive a new pointe shoe, that they all so desperately long for.

To the right are the three possible directions, observed from the visit. However, there was a clear consensus, based on the abundance of insights and observations, that the team needed to explore the challenging task of developing a new pointe shoe. The three other directions were immediately considered potential backup-plans.

+ Redesign of a pointe shoe

! R2 Minimise friction on platform

! R3 Pointe shoe must be breathable

! R4 Limit inserts

! R5 Widthstand 10 times the weight of a ballerina

! R6 Fitted to dancers individual anatomy

! R7 Give control to dancer

MOBILITY EQUIPMENT
Help the dancers to warm their body's joints up faster. Either prior to or after training as the dancers do not have time to do an extensive body warm-up before their training doing the day.

HELP RECOVER QUICKER
Help the dancers to recover quicker, as they spend at least one hour of recovery after every three hours of dancing. This they have to do multiple times a day.

NEW FLOOR
There are used low practical floors on stage and in rehearsal rooms and each individual floor is different. The direction could be to create a floor that easily can be adopted into different rooms.

INTERVIEW W. PETER BRANDENHOFF

Peter Brandenhoff is a former principal dancer at *San Francisco ballet, Boston Ballet, Hamburg ballet,* and *Royal Danish Ballet*. He has had a long career and retired as 40 years old, but has for the last 20 years been coaching and teaching ballet around the world.

CHANGES IN THE INDUSTRY

Brandenhoff has danced around the world and seen ballet and its differences across continents. To the teams' luck, he ended up in Aalborg, working at ballet school *Nordkraft*. Through a long interview, Brandenhoff desired to enlighten the team of his knowledge and expertise and help see the culture from a perspective outside of the RDB.
Generally, the industry has changed the most during the last 30 years. This is due to George Balanchine and his invention of Neo-classical ballet and later the introduction of contemporary ballet. These new ballet types have pushed the industry and developed it into subgenres in the artform, still based upon the classical ballet structure. The new development is pushing the dancers to constantly outdo themselves. It becomes increasingly extreme. Longer extensions of legs, higher and more flexible positions - to an extent where Brandenhoff believes the body has reached its limit and the body cannot evolve anymore.

Today there is a lot of gliding – dancers wears socks. That is only interesting in 30 seconds. It could be interesting if they slided and then was on toe.

CLASSICAL BALLET*

Invented in 1651 and performed at the aristocratic palaces. Ballet was invented based on a ruleset, still followed today. Created to give the illusion that dancers stand on their toes, is still very present today. Classical ballets are mainly performed on pointe, which requires the shoes to be very sturdy and provide sufficient support.

NEO-CLASSICAL BALLET*

Russian immigrant George Balanchine* brought principles from his teacher to USA. Principles that later became known as neo-classical. The style distinguishes itself from classical as being freer and more artistic (not so constricted, but still follows the main rules). Especially the moves of de-balancing from the centre axis is a characteristic trait.

CONTEMPORARY BALLET*

Driven by the neo-classical ballet movement, emerged contemporary ballet in the 1950s - filled with experimentation and creativity. Described with a "no-plot" plotline, it relies on expressiveness, emotions and human endeavour and flexibility. "There is already a story when you put two people together" - Brandenhoff.

CURRENT POINTE SHOES

As part of the interview, the current pointe shoes were discussed. Especially the Freed of London and the Gaynor Minden pointe shoes, as they are the ones represented at the RDB.

Young girls see their idols on Instagram and want the same as them - It trickles down

THE FREED POINTE SHOE

The Freed of London brand was established in 1929. A brand with traditions, hand craftsmanship and elegance. Dominating the pointe shoe market and considered the Rolls Royce of pointe shoes. Considered a high-class product with loyal customers, it has marked itself as being the it-pointe shoe.

PROBLEMS WITH FREED

As previously mentioned, Freeds only last a couple of days when dancing. When dancers receive 50 pairs, it might in reality only be 20 pairs that truly work and are actually danced in, due to inconsistencies in the handmade production. Freeds are known to vary a lot. A perfect shoe, a hard one can last an hour, whereas a softer one can last up to 30 minutes of good dancing.

27 Freed shoes

THE GAYNOR POINTE SHOE

Gaynor Minden is a newer pointe shoe brand, established in 1992, Eliza Minden and John Gaynor created the world's first innovative pointe shoe consisting of plastic. The Gaynor shoes are highly used in regions or countries where the lack of funds results in the need for a longer-lasting pointe shoe.

PROBLEMS WITH GAYNOR

Contradictory to Freeds, lasts Gaynors a very long time - so long that the outer satin completely deteriorated compared to the inside of the pointe shoe. A bigger problem though, is that the box and shank never mould to the feet and never reach a point where the dancer can do a roll through (see ill. 30). The aesthetics of Gaynor resembles a pointe shoe from two generations ago, being harder and studier on the inside and with a pointy exterior.

28 Gaynor shoes

A shoe is only a tool - it only depends on how you use it.

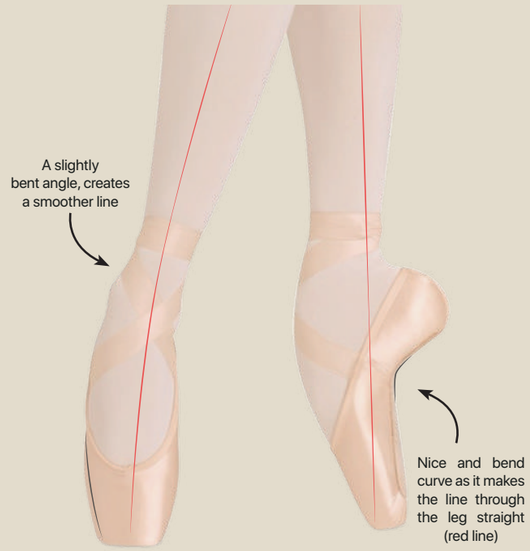
AESTHETIC LINEWORK

Peter further commented on his preferred aesthetic and linework and how to spot desired lines within ballet.

Brandenhoff is a classical man. He is an advocate for "less is more", especially when it comes to the lines in classical ballet. The art of ballet is to create elongated lines and illusions that one is dancing very lightly, effortlessly, and almost levitating through the air. The hurdle is that each foot is individual, some have wider feet, others narrower and the aim is a uniform look across the stage.
This is yet another ballet beauty ideal, to have as narrow feet as possible and many dancers try to squeeze their feet into smaller shoes. Brandenhoff wishes that the pointe shoe become a more integrated part of the leg, almost seamless - to further enhance the illusion of an extension of the leg. Though he emphasises that it is important that the shoe mimics the body's true proportions.

Brandenhoff elaborates and draws the prefered lines (see ill. 29). He is fond of this exact line work of these particular shoe as they are great at creating straight lines. The front of the box should be a bit tapered as it enhances the illusion of standing en pointe.

! R8 Uniform replicas



29 Preferred linework (Freed)

! R9 Follow lines of body

I19 Uniform look across stage

I20 Feet ideally should look as narrow as possible

CONCLUSION

The interview with Peter Brandenhoff gave clarity and insights into how to achieve the linework of the current preferred pointe shoe (Freed). However the most important part is that the shoe helps to enhance the lines of the body.

EVALUATION OF VISIT

After the selection of re-designing the pointe shoe, an evaluation of all the information must be performed (all observations, interviews and insights). The data will be analysed and investigated to further understand what parameters are important for the pointe shoe.

ROLL THROUGH

Throughout the visit, it was stated that the dancers did a break in of their pointe shoes (p. 16-17) in order to make them more pliable. This is mainly done so the dancer can do a roll through. To understand where the shoe needs to be flexible and where it needs to be stiff, a mapping of the different areas were made. This displays the critical stages throughout the roll through (see ill. 30), (see Appendix 06).

30 Flexibility and stiffness areas doing roll through

The mapping shows, that the dancer first needs support after the half-pointe mark of the roll through, which is when the dancer's Phalanges' no longer are supported by the ground, but instead need support given by the shank (see ill. 23). However, in this same area, a need for flexibility has occurred, creating an internal dilemma in the shoe.

When the dancer has rolled en pointe they need support in their arch and in the front of the toe box. This is to keep their toes locked in place, restricting them to not fall over and lose their balance. The wings in the shoes are also important, as they create balance for the dancer, supporting them in the other direction (so she does not fall to the right or left side in the shoe.

! R10 Be able to do a roll through

! R11 Support arch on and when going en pointe

EXPAND & COMPRESS

As illustrated in see ill. 31 & 32, there is a need for the toe box to have flexibility (see brown marked areas). To understand this functionality of the box it is important to know how the feet expand when adding pressure to the ground on half-pointe and compress when going en pointe (see test in Appendix 07).

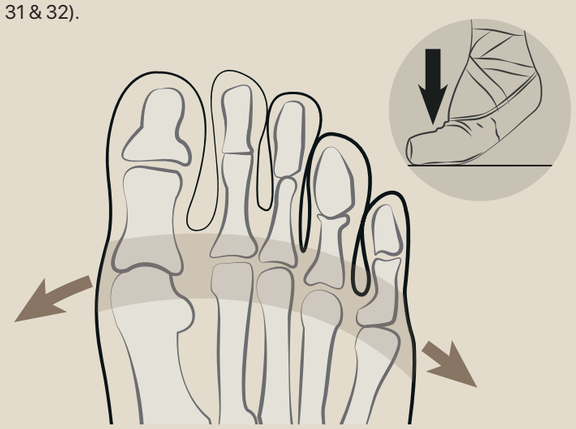
EXPANSION - 11 CM WIDE

31 Expansion resembles when dancer is in half-pointe

COMPRESSED - 10 CM WIDE

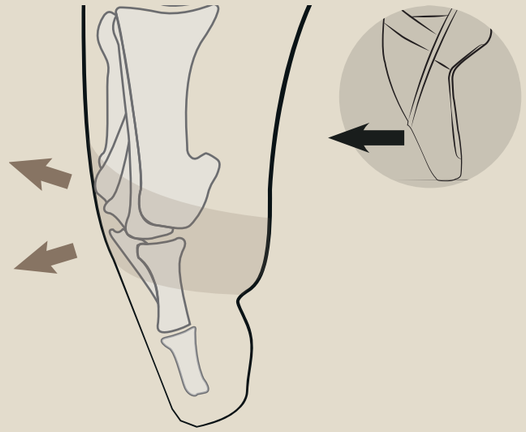
32 Compressed resembles when the dancer en pointe

When the feet are in half-pointe the force of the body goes down to the joints between metatarsals and phalanges* (see ill. 33). The five joints and bones expand away from each other, to each side, making the foot wider. Whereas when the dancer goes en pointe the joints are compressed together and expand in the other direction (see ill. 31 & 32).



33 Expansion and contraction in the crown* of the feet

On ill. 33 it can be seen how the bones and joints move outwards. To be able to do a roll through, the toe box needs to be able to compress and expand with the feet.



! R12 Toe box should expand and compress with feet

DIFFERENT FOOT TYPES

It was observed during the visit that all the dancers had different foot types and use different types of inserts, to equalize the pressure in the toe box when standing en pointe. However, a big dilemma is that if dancers put too much patting and inserts inside their toe box, they can lose the feeling of the ground and end up with no control over their movements.

The dancers use their pinky toes to stabilize their balance when being en pointe, like when you are using your arms to balance on one leg. This means the dancers cannot limit all air gaps in the toe box as they need room for the pinky toe to remain balanced (Larsen, 2014).

34 Different foot types

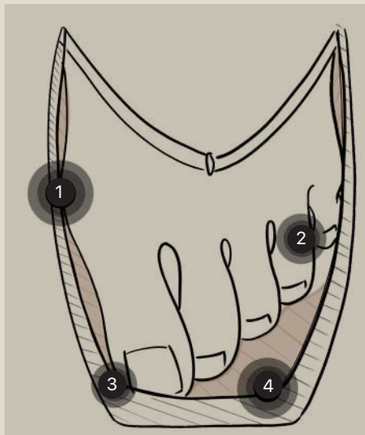
Look into the feet types. If you have a long middle toe (nr. 3) "you are fucked". As you see mine, the second toe has become inclined to tug under.

R7 Give control to dancer

! R13 Give dancer ground feeling

! R14 Equalize load pressure

EQUALISE LOAD PRESSURE



1 **BUNION**
Room for bunions

2 **BALANCE**
Winkle room for pinky toe

3 **GROUND FEELING**
Direct connection between big toe and toe box

4 **EQUALISING TOE PRESSURE**
Fit to different foot types

35 Focus areas in the toe box

CONCLUSION

Through evaluating the observed data the team has confirmed that people have different feet and tissue types. Which results in a potential solution needing to both expand and contract in some areas and provide flexibility in some areas and give stability in others. A set of complex criterias for a potential solution. Though concluding that sufficient space inside the shoe is vital to remain balanced while also having ground feeling.

LEVEL OF EXPERTISE

In order to understand the different segments and users within the context, the team mapped out the different levels of expertise according to the Dreyfus Model of Skill acquisition (Fadi, 2019).

The model describes how individuals (in this case women, as they wear pointe shoes) progress through various levels in their acquisition of skills in relation to how they learn through instruction and practise.

	BASIC INFO	LEARN	TRAINING	TO PASS LEVEL
EXPERT	Age: 20-40 Occupation: Full time job	Attitude Gives guidance to younger dancers Effortless and smooth movements in synch with music.	**7 days a week** From 9-17 and 19-23	
PROFICIENT	Age: 18-40 Occupation: Full time job	Express emotions and acting Different dance styles (see page 63) Its a lifestyle Hyper-awareness of feet Perfectionist	**7 days a week** From 9-17 and 19-23	Attitude Experience Dance = muscle memory Remember long choreographies Own flair and twist on dance
COMPETENT	Age: 15-19 Occupation: Middle- and high school	A small choreography Dance with partner (Pas de deux) More complex dance moves Jumps en pointe	**6 days a week** 4 hours pr. Class	Resistance and endurance Ability to successfully complete a choreography Correct body (see page 18)
ADVANCED BEGINNER	Age: 12-15 Occupation: Elementary school	Foot strength training Pointe shoe training (controlled roll through) Basic positions en pointe French vocabulary	**5 days a week** 1,5-2 hours pr. Class	Flexible and strong feet Understand, French ballet-language Willpower and determination Balance en pointe
NOVICE	Age: 4-11 OCCUPATION: Pre- & Emental school	Understand rhythms and beats Beauchamps 5 positions (see Appendix 08) Balance Strength in the feet	**1-3 days a week** 1,5 hours pr. Class	Beauchamps 5 positions Sufficient foot strength

CONCLUSION

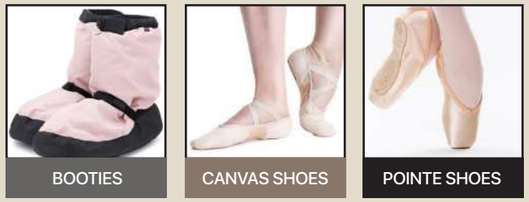
Based on the model, knowledge was gained about the potential users within the context. It became apparent that professional dancers span over two levels: the proficient and the expert level.
The next step is to evaluate what criteria would fit these two levels, as they differ from level to level.

Working with women +

Work with professional dancers +

A DAY AS A PROFESSIONAL BALLERINA

The life as a professional ballerina is very repetitive. The structure of the day is almost identical from Monday-Saturday, spanning from arriving at 8:00 in the morning and leaving at 23:00. The dancers use several shoes throughout the day, depending on if they want to keep their feet comfortable and cosy (booties and canvas shoes) or if they are performing (pointe shoes).
The letters shows the different shoes utilized throughout the day.



36 Different kinds of shoes

37 Shoes throughout the day

CONCLUSION

A dancer can use up to 9 different pairs of shoes throughout the day. This concludes one pair of booties, used several times a day, one pair of canvas shoes used two times a day and 7 different pairs of pointe shoes. As mentioned prior, is there a need to keep the shoes alive due to accumulation of sweat, but also due to needing a good pair of pointe shoes both at an important audition or the three different acts performed during the night's show.

I21 Different physical critias depending on the act.

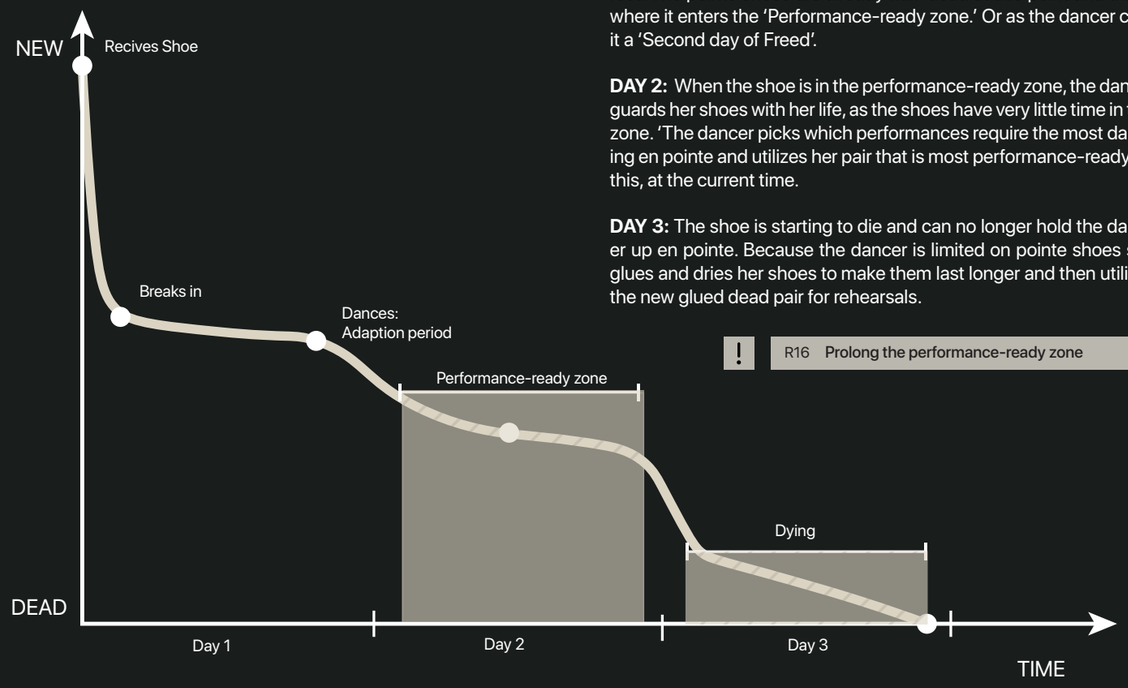
\+ Shoes can adapt to different acts (roles)

! R15 Minimize the amount of rotating pointe shoes

\+ A more reliable pointe shoe

LIFETIME OF POINTE SHOE

A graph of the current lifetime of the Freed pointe shoe was created in an attempt to translate the gained knowledge.



38 Lifetime of a pointe shoe

DAY 1: The dancers receive a new pointe shoe and start to break them in, following a whole day of dancing in them to mould to the feet. The pointe shoes are already half-dead at this point and this is where it enters the 'Performance-ready zone.' Or as the dancer calls it a 'Second day of Freed'.

DAY 2: When the shoe is in the performance-ready zone, the dancer guards her shoes with her life, as the shoes have very little time in this zone. 'The dancer picks which performances require the most dancing en pointe and utilizes her pair that is most performance-ready for this, at the current time.

DAY 3: The shoe is starting to die and can no longer hold the dancer up en pointe. Because the dancer is limited on pointe shoes she glues and dries her shoes to make them last longer and then utilizes the new glued dead pair for rehearsals.

! R16 Prolong the performance-ready zone

CONCLUSION

The aim is, therefore, to prolong the feeling of a performance-ready- or a "second day Freed" pointe shoe. This is due to the observation of the dancers constantly trying to have pointe shoes in this state.

PROBLEM SPACE - AS IS SCENARIO

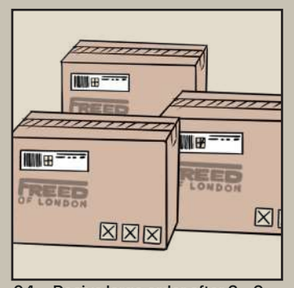
Based on evaluated insights from the ethnographic field study was a scenario performed (Bagger and Sperschneider, 2013). This is to gain knowledge of the entire lifetime of pointe shoes, from when it is needed to when it is discarded. The as-is scenario is based upon a huge mapping of the mentioned shoe journey (see Appendix 09).

Sometimes, you just get a bad pair of shoes. So sad. I can't tell if something is wrong with the shoes until after, I have spent two hours sewing and prepping the shoes" (Dorger, 2019)

01 - Personal fitting from brand

02 - Henriette predict next years order

03 - Maker produces his dancers pointe shoes by hand



04 - Recive large order after 3 - 6 months

05 - Dancer can get her 8 pairs every month

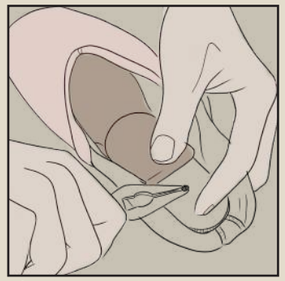
UNIFORM PRODUCTION

This direction aims to reduce both the lead time from once requesting the shoe to receiving them and the inconsistencies in the current handmade production method. Working with a hyper-aware and sensitive user, prone to feeling very small inconsistencies results in high demands regarding the tolerances. This is the reason the dancers commit to one maker throughout their careers.
The high inconsistencies of a 60 % working rate on the shoe (see p. 22 Brandenhoff interview and citation above from Holly) is highly problematic as the dancers only receive 8 pairs a month and utilise 5-6 pairs a day (p.15).

PERFORMANCE-READY

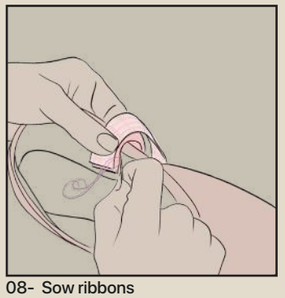
This direction aims to prolong the lifetime of the performance-ready pointe shoe. This is to both to limit the steps spent during the break in, but also to perform them at a lower frequency. Dancers guard their performance-ready pointe shoes, which indicates that this modification creates the biggest impact on the dancer's life. The break in process is for most dancers a tedious one - always performed on the go. This is the reason dancers spend their time during a commute, tv-watching and in between rehearsals sowing and customising their pointe shoes.

11 - Cuts shank



10 - Removes nails

09 - Loosen shank and bends



08- Sow ribbons

07- Sow darning

06 Steps on box

12 - Tapes feet in toes

13 - Usees friction stick

14 - Take on toe separator and individual toe pads

15 - Puts blister tape in

16 - Takes large toe pad on

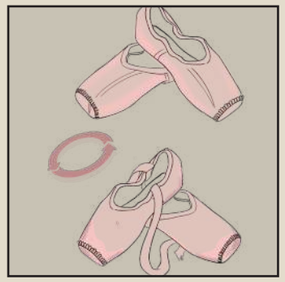
FITTING

This direction intends to create a solution that accommodates all different foot types and anatomies. It aims at reducing the highly diverse and homemade inserts used within the pointe shoes. Something that indicates that a proper solution for a correct insert, or just the correct shoe, would fix this massive problem. Especially considering that young ballerinas are not allowed to put anything inside their pointe shoes(Brandenhoff and Jess interview), as teachers want them to gain foot strength, and see many inserts as being cheating. The ban of inserts result in many young dancers quitting ballet as the pain is too much to endure.

TIMING

This direction aims to cement reliability in the solution, ensuring that it does not break down on the spot. This is the case in the current pointe shoe due to the accumulation of sweat, something that needs to be reduced regardless of the solution, as it is an irritation for the dancers, that they lose their ground feeling increasingly with the sweat buildup and their feet swell up. By limiting the unreliability and sweat buildup, comes an automatic decrease in shoe-switching, the massive use of Jet-glue (p. 15) and the drying time of sweaty shoes.

20 - Dances in the now performance-ready pointe shoe



19 - Shoe gets sweaty and start to break down

18 - Keep switching between pairs to prolong lifetime

17 - Shoe dies on the third day and cannot support dancer

Minimise swollen feet

CONCLUSION

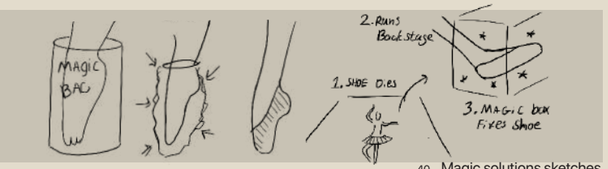
The use of an as-is scenario led to four directions; uniform production, performance-ready, timing and fitting, whereas the two middle ones (performance-ready and timing are compatible)

39 As is scenario drawn in 20 steps

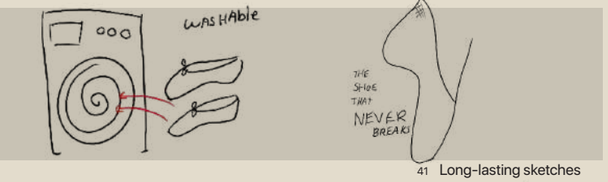
SKETCHING

Utilizing the insights from the first visit, the team started to ideate upon solutions to fit into the three categories; Uniform production, Fitting and Timing.
The team relied on timeboxed methodologies to kick-starter for the creative process, including Brain Pool (Tollestrup, 2004), systematic sketching (Agger, 1984) and What-if sketching (Tollestrup, 2004) (see Appendix 10). The last one especially helped push the team outside of the thought framework. Following this, the team utilized the clustering and sorting (Tollestrup, 2004) method to gain a pool of solutions to the problems.

ROUND 1



40 Magic solutions sketches



41 Long-lasting sketches

42 PR sketches

43 Fitting sketches

MAGIC SOLUTION

A reflection of the "what if"-sketching round. Solutions that are based on convenience.

LONG-LASTING

The solutions to long-lasting were few. It became apparent that it mostly is linked to the materials of the product.

PERFORMANCE-READY

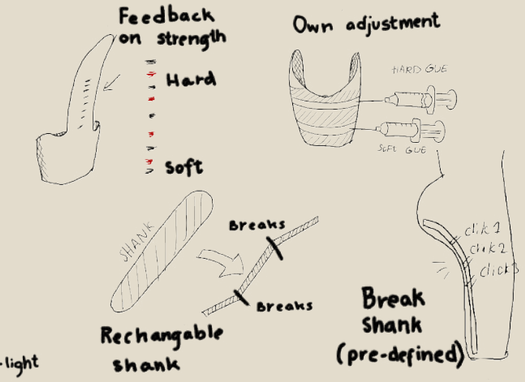
This highlighted that the solution did not have to be a shoe. It could be a device that helped the dancers track the lifetime of their shoes and plan when to stop or start using them.

FITTING

Most solutions tried to tackle fitting, as these mostly solved the user criteria found during the first visit.
Especially the different ways to reach a pointe shoe in motion that does not break down (breathable).

ROUND 2

Following this, the team set up a dilemma for each concept direction (Appendix 10) to help tackle the core issues found. A technology board (Appendix 11) was produced to help push the team to look into innovative and smart solutions. The chose principles from the board and started proceeding with an individual sketching round which refined and synthesises the concept while also revising it in action.



44 Sketches

OUTCOME

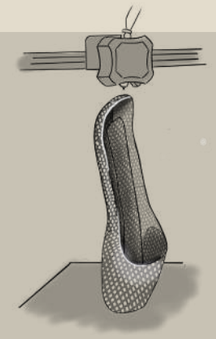
The sketching round helped the team see the solution space in a new light. With a much clearer understanding of the problem and its tameness, the team tried to evaluate the principles and criteria.

CONCEPT 1

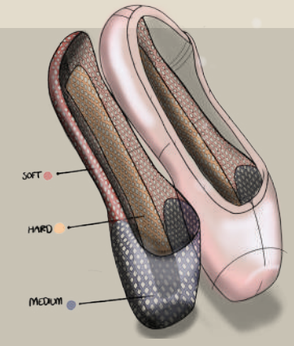
UNIFORM PRODUCTION

This concept relies on 3D scanning for getting a customised shoe to the individual. Through 3D printing, it can create custom shoes tailored to individuals' needs and wishes. The production method creates a uniform replica that minimises friction injuries (such as blisters, scratches etc.) by creating a product that the feet are used to.

3D scan of foot



3D printing of foot



3D printing shoes with different materials

45 Uniform production concept

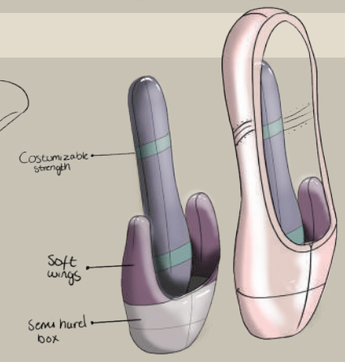
CONCEPT 2

FITTING

The second concept focuses on individual fitting and equalizing the toe pressure through moulding paste (see technology board Appendix 11). The moulding is executed through an active moulding process. The shank has integrated zones to help the dancer perform a roll through.

Moulding paste

Active moulding



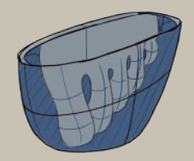
Molded box and shank with breakpoints

46 Fitting concept

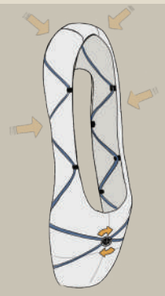
CONCEPT 3

PERFORMANCE-READY

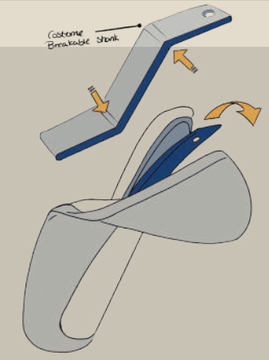
The third concept focuses on a Lego principle, where the box and the shank are interchangeable. This way switching between needed strengths in the box and shank to accommodate different roles. The aim is to provide a reliable and long-lasting solution.



Fitted and moulded box



Bore principle



Interchangable shank w. places to break the shank

47 Performance-ready concept

DIRECTION

The team considered a performance-ready pointe shoe to bring the most value to the ballet dancers. The direction to create a long-lasting performance-ready pointe shoe is thereby chosen. Fitting and uniform production are still two major problems, however, they can be a secondary priority in the project (see Appendix 12).

R17 Be performance-ready from new !

Need to test the solutions using mock-ups +

CONCLUSION

It became apparent that all the solutions are quite similar and none of them truly distinguishes from one another. Which made it obvious that the team need to rely on testing rather than 2D sketching. This led to the team never choosing a concept, despite evaluating them (see Appendix 12), as the team felt a lack of functional understanding to truly choose a direction.

DESIGN BRIEF

PROJECT OVERVIEW

Ballet is an excluded and traditional world, making it hard for innovation to come through. The slow development in the industry is causing the dancers to deal with time-consuming workarounds and routines to minimise injuries and pain in their pointe shoes. This opened four possible directions for re-designing the pointe shoe.
The dancers spend two hours preparing and one day dancing in them to make their pointe shoes performance-ready. This is considered the biggest problem space, as ballet is an extreme sport and the dancer's most important tool (pointe shoe), is not ready when needed and is highly unreliable. This dilemma is equivalent to a sky-diver not being able to count on their parachute after jumping.

The project aims to re-design a pointe shoe for professional ballerinas, resulting in a reliable, long-lasting performance-ready pointe shoe.

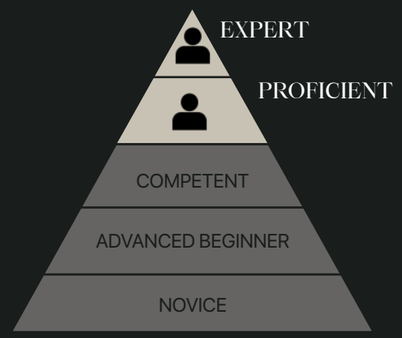
INITIAL BUSINESS POTENTIAL:

For a seemingly big market, considering the global interest in the art form, the possibility of new performance-ready pointe seems to have significant business potential. As it both improves an existing product, while solving a latent, yet obvious need for the primary user.

TARGET GROUP

As a target group, the team aims at professional ballerinas. This is due to their skill level and developed sensitivity to micro-differences in their pointe shoes (expert and proficient level). The professional dancer is dependent on every single pointe shoe that she puts on, whereas dancers on the competent level can get by with shoes not quite performance-ready. At this level, the requirements are mostly having a well-fitted pointe shoe. Dancers at the competent level have not spent enough time developing hyper-awareness to tell the difference between a good or a bad shoe or spend enough time dancing throughout the day for it to truly be a problem.

The primary user is the professional ballerina, and the secondary users are both Henriette: in charge of buying shoes and Nikolaj Hübbe: the ballet master.



48 Levels of expertise

PROJECT DILEMMAS

Be a helpful tool - not undermine the expertise

Give sufficient support to go en pointe - Not give too "much" support

Create an innovative product - created for a traditional user

REQUIREMENTS

A summery of all the requirements is listed below in a rank of being the most important to basic requirements.

R16	!	Prolong the performance-ready zone	R12	!	Toe box should expand and compress with feet
R17	!	Be performance-ready from new	R5	!	Widthstand 10 times of a ballerinas weight
R10	!	Able to do a roll through without any aditions to the pointe shoe	R3	!	Pointe shoes must be breathable
R6	!	Fitted to dancers individual anatomy	R9	!	Follow lines of body
R13	!	Give dancer ground feeling	R14	!	Equalize load pressure
R15	!	Minimize amount of rotating between pointe shoes	R4	!	Limit inserts
R8	!	Uniform replicas	R2	!	Minimize friction on platform
R11	!	Support arch on and when going en pointe	R1	!	Not add more components to the bag

TASK

02. / 8.

FUNCTION

CHAPTER SUMMARY

This chapter focuses on the contextual level and principal level of the value pyramid (p. 5) investigating the context of, and the principal elements of a pointe shoe. This results in working in the spiritual level, creating a project overview, with a new design brief of requirements, based on the previously collected insights and observations and an interaction vision.

Ideate

49 A ballerina's flexible feet

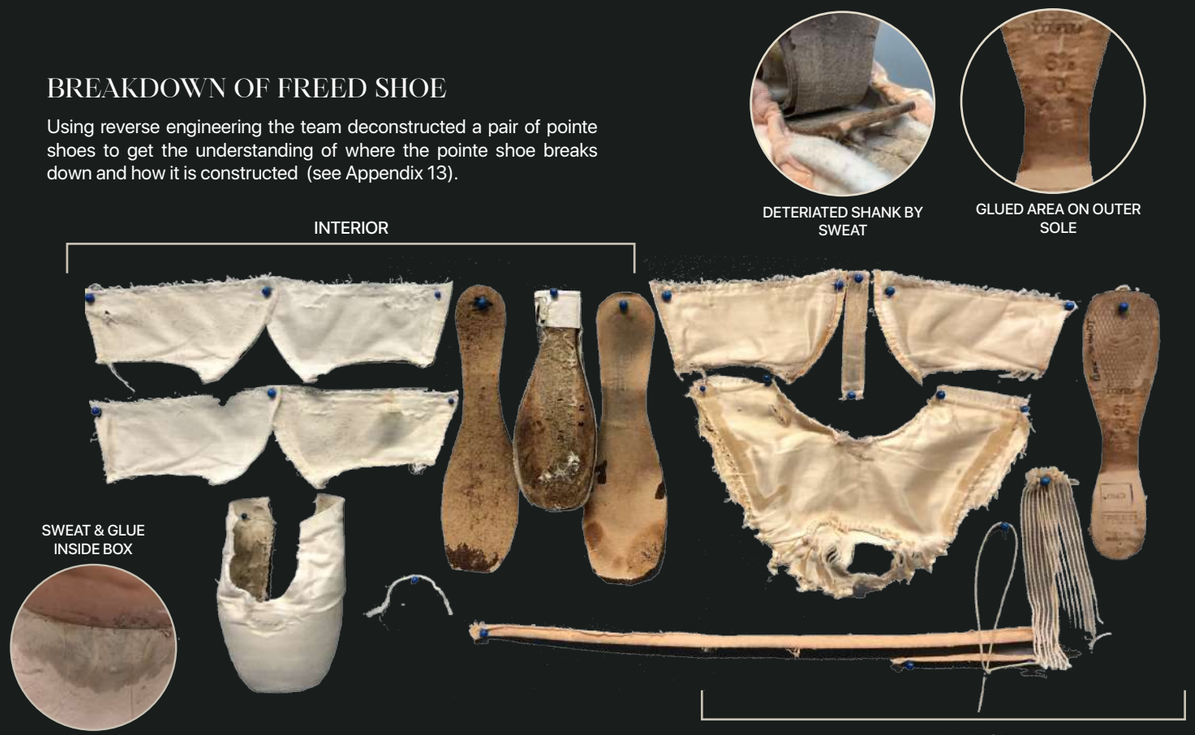
FUNCTION

The team is investigating exiting products on the market to understanding the working principles and what is accepted in the industry.

I22 Shoe dies where the breakpoints are. Also, where the dancers try to fix them with glue.

BREAKDOWN OF FREED SHOE

Using reverse engineering the team deconstructed a pair of pointe shoes to get the understanding of where the pointe shoe breaks down and how it is constructed (see Appendix 13).



50 Deconstruction of Freed shoe

! R18 Not deteriorate by sweat

The team got an understanding of the overall construction where the three key components of a pointe shoe is; the toe box, shank and sock. The shank was also here cut into a 3/4 length and It was clear that the organic materials was completely deteriorated of the sweat and it was areas the dancers 'break in' (page x) that was most broken down. The dancers have glued the critical areas to prolong the lifetime. The team can utilize the patterns and comonents for later prototypes and measurements.

PERFECTFIT POINTE

When creating the technology board (Appendix 11), used as part of the development of the three concepts, the team stumbled upon a solution called Perfect-fit. A solution also used and found inside principal dancer Holly's pointe shoe, developed to help dancers get a better-fitted pointe shoe and equalized pressure on the toes.

HOW IS IT USED?

The product consists of a kit, that enables the user to create two custom made inserts. The kit contains a silicone technology of two parts mixed together to form a paste that is moulded to the feet in active movement. The paste is connected to a performance textile to ensure the silicone stays in place inside the pointe shoe ("PerfectFit Inserts Kit," n.d.).

51 PerfectFit right after being moulded

CONCLUSION

The product markets itself as being a highly customized insert, that relieves toe pressure and improves control and stability. A great solution that has gained recognition and adaption, especially in the USA. The only downside is, as Lærke points out, that the silicone insert is too snug to the toes and does not enable them to move their toes inside, which is necessary to help find their balance.

The problem with products like PerfectFit is that it restricts the dancer's toe mobility, it is simply too snug.

POINTE SHOE BRANDS

Throughout the user research, it became apparent that two pointe shoe brands are essential to further investigate, the two being Freed of London and Gaynor Minden. The following section will investigate further into the brands and how they distinguish from one another and why these brands are used at the RDB.

52 All soles are stamped w. A sole puncher

53 A paste of cornstarch and glue is mixed

FREED OF LONDON

Freed of London was established in 1929 by Frederick Freed, in a basement in Covent Garden, where its flagship store is still located today (Freed of London, 2021, a). By 1947 the brand has already cemented itself as being one of the most prestigious and leading Pointe shoe manufacturers in the world (Freed of London, 2021, b). The brand thrives on its legacy and individual fitting possibilities.

54 The shoe is constructed inside out

55 Nails & several layers of canvas are added

PRODUCTION

Based on a video of the production (Insider, 2018) the team gained insight into how a Freed pointe is made. The process consists of a few steps performed through an assembly line.
The soles are stamped and baked (at 70 degrees), whereas the rest of the shoe is assembled manually, inside out, by gathering several layers of canvas with the glue and starch mix. The sole is then nailed to the canvas layers and flipped back around. The maker then shapes the shoe using a tamper. Lastly, the satin is finished off with biased tape and elastics.

56 Hand shaped by hitting it with a tool

57 Finished with sowing elastics on

58 The shank and box are combined an injection-moulded in PE-plastic

59 Shock absorbent foam is glued to the PE-plastic

60 The outer satin is hand sown

61 The satin is pushes outside of the inner core

62 The soles are stamped by machine

63 Lastly, the sole is glued on

I23 Users prefer a 3/4th length shank

Innovative production setup to reduce labour

GAYNOR MINDEN

In 1992, Eliza Minden created the world's first innovative pointe shoe consisting of polymer. She was a company manager she experienced both the economical aspect of constantly buying new pointe shoes but also the bad state all the shoes were in. Impressed by the innovation in athletic footwear, she decided to create a new type of pointe shoe, inspired by this technology.

PRODUCTION

Based on the video of the production (balletomanehk, 2008) the team gained insight into how Gaynor shoes are made, see the video as the pictures are very bad quality.
The inside of the core is produced in thermoplastic Polyurethane Elastomer, giving dancers more support. It is further enhanced by several layers of shock absorbent foam. The exterior of the pointe shoes has quite the same production method as the Freed pointe shoe - hand sowed, which equals extensive labour. The sole is stamped and glued onto the bottom.

CONCLUSION

The two pointe shoe brands are similar yet different. They both aim at providing an optimized experience for the dancers, Freed by customizing the shoes to the needs and Gaynor by giving additional support. Through investigatory research of user comments online (Appendix 14) It became apparent that both brands separate the waters and have user problems through their production.
Some users complained about finding bugs in their Freed pointe shoes, which apparently is a "common issue" amongst traditional manufacturers (Fuhrer, 2018). The users also had concerns about Gaynor, especially their change in production setup, originally in the USA, now moved to East Europe, creating a distinct difference in their pointe shoes. The users further struggle with the plastic, not being able to cut through the shank at the ¾, as they usually do. They further try to mould their shank with hair-dryers.

WHAT IS CONSIDERED CHEATING?

By further looking into user comments the team stumbled onto problems with people claiming that Gaynors are a cheating shoe, the same comments found at the RDB. The aspect of "cheating" within ballet will now be further investigated (Appendix 15)

I24 Dancers are willing to do everything to seem perfect

Do not want anything that could be considered cheating

64 Farches

FAKE ARCHES
"FARCHES"

Some dancers are not genetically blessed with their arches bending in the desired "banana"-way. Which has led to the use of Farches. An insole that both men and women wear to enhance the desired look (Kerollis, 2019)

65 Gel inserts

INSERTS

The gel inserts are also considered cheating this is due to it filling up the entire inside of the pointe shoes, leaving no room for the toes to naturally build strength and develop the desired ground feeling (Interview, Lærke.)

66 Gaynor Mindens

GAYNORS

There is a lot of prejudice against Gaynors, as they are perceived as "cheating shoes". This is due to a seeming lack of flexibility, disabling the ability to roll through the shoe while also supporting the dancer too much in the arch. However, people are saying unless a shoe dances for you, it is not cheating (Dancewear, 2018).

67 Toe without a nail

REMOVING NAILS

Some dancers get an operation to remove their toenails. This is to release the constant pain, especially in the toenails. This moderation provides an advantage. Similar to when body-builders take steroids or like the use of elective enhance performance surgeries (Hamilton, 2006)

WHAT IS PERFORMANCE-READY?

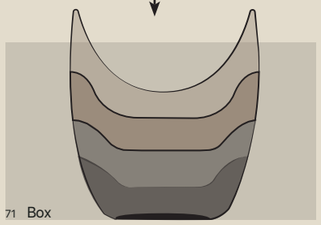
With the aim of creating a long-lasting performance-ready pointe shoe came the need to understand the underlying parameters that influence when a pointe shoe is performance-ready or not. The three main components found on p. 34 are evaluated through problem slicing to identify how each component contributes to the overall readiness of a performance-ready shoe. The following shows 3 hypothesises regarding the components, based on the found observations.

BOX

68 Original BOX

FLEX

STIFF

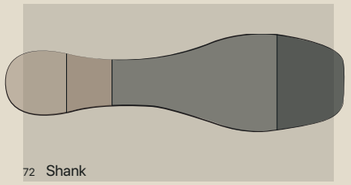


71 Box

It is assumed that the box has a gradience in the different layers, spanning from hard at the bottom to flexible near the top.

SHANK

69 Original shank



72 Shank

It is assumed that the shank contains four layers, likewise graduating from hard at the bottom to flexible near the top

SOCK

70 Satin fabric peace

It is assumed that the sock component is not significant for the readiness of the pointe shoe, resulting in deselection of focus.

CONCLUSION

The focus is now put on validating or invalidating the two hypothesises regarding the two components: the Box and the Shank.

Disregarding focus on the sock

PREPARATION FOR TEST

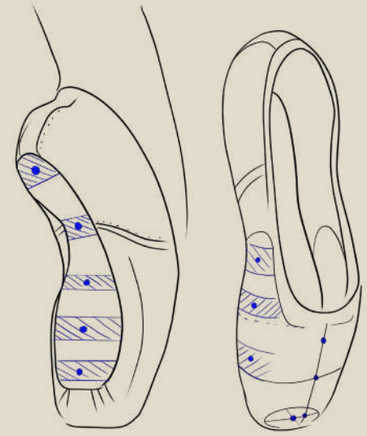
The team concluded that testing was necessary to validate or disregard the constructed hypothesises to see if it is even possible to construct a performance-ready pointe shoe. The following emphasises the thoughts and procedure conducted to conclude if this is even a plausible direction for the project.

A BRAINSTORM

Brainstorming and sketching rounds were conducted to figure out how to test the hypotheses the best (Appendix 16). The team had several aspects to figuring it out. The team wanted to detect any differences in the shoes, by measuring them. And to test if there were any measuring differences in the shoes, dependent on where the shoe was in its lifetime. The only way to tell or know the difference is to ask the dancers how they perceive their shoes. The desire was to test mainly three types of shoes: new, performance-ready and dead. The team had two major things to figure out. One, how to achieve the desired measuring and two without damaging their precious pointe shoes.

The team tested both a pulling method and a pushing-method, but eventually settled upon the pushing method, as it was easier to control all variables.

1. How to keep it steady during test
2. How to apply a constant force
3. What is a plausible force, without damaging the shoes
4. How to precisely read the data
5. How are we able to bring it inside the RDB



73 Nine measuring points

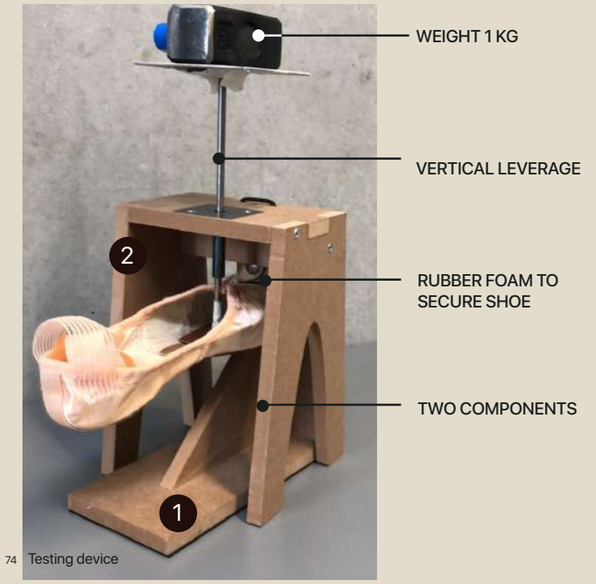
The team settled on measuring five points on the shank and nine points on the toe box (3 on the front and 3 on each side).

A TESTING DEVICE

Once the aim for the test was settled upon the team moved on to figure out what type of testing device could be beneficial. The team was not able to borrow a "Digital height gauge measuring tool", due to the value of the device. However, this device was also not suitable as it does not apply any force, so the device needed to be altered regardless. A small mobile testing device was constructed (see Appendix 17) to enable the team to perform the necessary test on the dancer's pointe shoes while convincing them that the device would not damage nor tamper with their beloved shoes.

The last iteration of the testing device is a two-component device with a fixed clamp by the end, padded with rubber foam, to secure it tightly (part 1) and a vertical leverage secured on legs (part 2).

The force applied during testing was 1 kg, circa 10 N. Substantial enough to see a difference in the deformation of the shoe. The team was aware that the testing scenario is not accurate, as the shoe is both submitted to pressure and endures pulling. However, this was a compromise to hopefully get any data.



74 Testing device

CONCLUSION

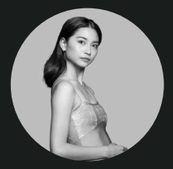
We will now proceed to test the device on as many dancers as possible, during our one day visit and hope to tell a difference between the shoes at different stages in their lifetime.

2ND VISIT AT RDB

The team went to the RDB to measure four dancers' performance-ready pointe shoes in the box and shank to get measurable deformation points to later be able to replicate this.

Isabella Rose Carroll
Corps dancer at RDB - Main test person

Tomoka Kawazoe
Corps dancer at RDB



Rikako Shibamoto
Corps dancer, at RBS (UK)

Birgitta Lawrence
Corps dancer at RDB

INTERVIEW WITH FOUR DANCERS

To get qualitative data, a semi-structured interview was prepared for the dancers to make them describe the feeling of a performance-ready pointe shoe. The team 3D scanned Isabellas feet to use in 3D CAD and measurements for later prototyping.

When the platform breaks down, I start to feel my big toe dig into the floor.

ALLIGNED LIFETIME

The dancers had a hard time describing what performance-ready felt like, other than saying they need support up until below the arch point. However they could describe everything that was not working. As it was noted that the lifetime of the different components in the pointe did not align. As the shank and platform broke down before the sock and toe box. It was observed that in multiple of the dancers' pointe shoes the shank had separated from the shoe due to the sweat breaking down the glue. The dancers use tape and glue to fasten the shank again and glued the platform to try and align the lifetime of all the components.

75 Isabella shows where she needs stability en pointe

76 One of the many seperated shanks deteriated by sweat

R19 Components lifetime must allign !

77 Isabella shows where she glues until

78 3/4 cutted shank

79 Glue up until half break-pointe

R20 Full and 3/4 shank !

I25 Dancer mold their break-pointes

R21 Have two break-pointes !

I26 Dancers have different flexibilities in their feet

BREAK-POINTS*

It was noticed that all the dancers cut their shank 3/4 length either on the outside on the sole or on the inside shank. It was explained that all dancers do this at the RDB, except the one with injuries. As Kirsten described in the first visit (p. 20).
They described their 3/4 shank as their arch break-point (BP) and they in fact had two break-points where the shank needed to be pliable. The second break-point is in their half-point. To achieve this the dancers bends the shank outwards and inwards until pliable enough. This is assumed to be the area that needs to bend, in the shank, doing a roll through.
The dancers did not measure their so-called break-points but cut and bent it out from their naked eye. They do this procedure 8 times a month or more, so they could place these points with closed eyes. The dancer leaves the two areas clear of glue allowing them to still be pliable, but when in need of more support they starts gluing again.

CONCLUSION

The dancers became more concrete of the areas in the shank that needed to be pliable and where it needed to be stiff. They had a hard time describing the box' function, however, they said that the two break points depended on the dancer's arch and half point. This is assumed to be the area that needs to bend doing a roll through. This has to be analysed on the anatomy of the foot.

MEASUREMENTS

To get quantitative data, four dancers' pointe shoes were measured to get the deformation points of the performance-ready pointe shoe (Appendix 18).

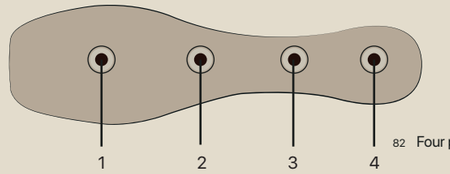
DEFORMATION POINTS

To understand how the performance-ready pointe shoe distinguishes between a dead and a new pointe shoe, the team tested on; new, performance-ready and dead pointe shoes from each of the dancers. If the dancer had pairs inbetween these stages, were they tested as well. The team used their own testing device with one kg force, to get the required deformation points. There were four points on each shank and the three on top of the box (see ill. 73). However, the team had only tried the testing device on dead pointe shoes before the visit and claimed one kg to be enough. However a performance-ready box was much harder than anticipated and there was not enough force to make deformation on the boxes.
The team retrieved all the measurements of the different shanks and plotted it into an excel sheet to calculate the average data for each point of a new, dead and a performance-ready pointe shoe (PR).
It was noticed that the shank had moulded itself to an S-curve in the PR pointe shoes.

80 Testing desvice at RDB

81 S-curve

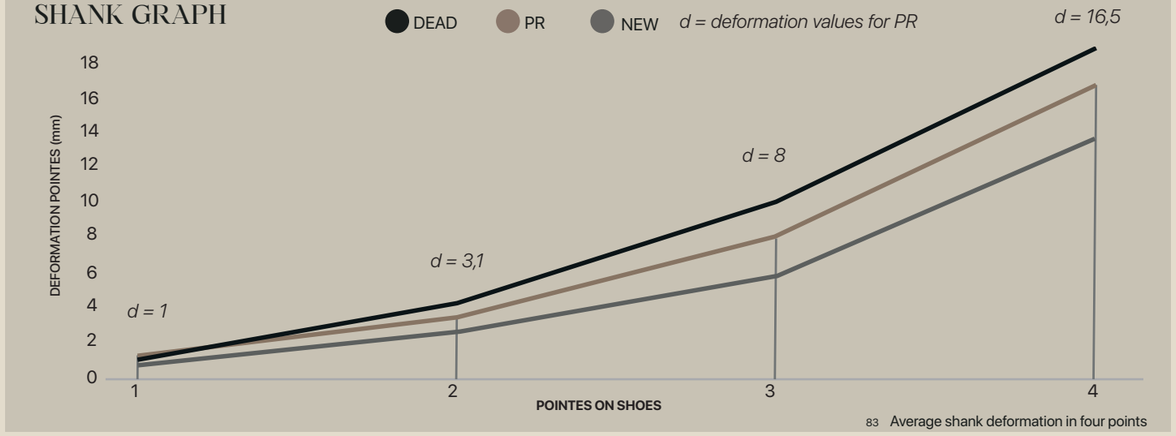
I27 The shank bends in an S-curve



82 Four points

AVERAGE SHANK DATA IN FOUR POINTS

SHANK GRAPH



83 Average shank deformation in four points

Through the calculated average data of each point of a new, PR and dead shoe it was coherent that the shanks being performance-ready was inbetween the dead and new pointe shoes. This also validates the prediction of the lifetime of the pointe shoe (page 27) .
Based on the test, the collected data of the PR deformation points can be utilised and replicated in mock-ups.

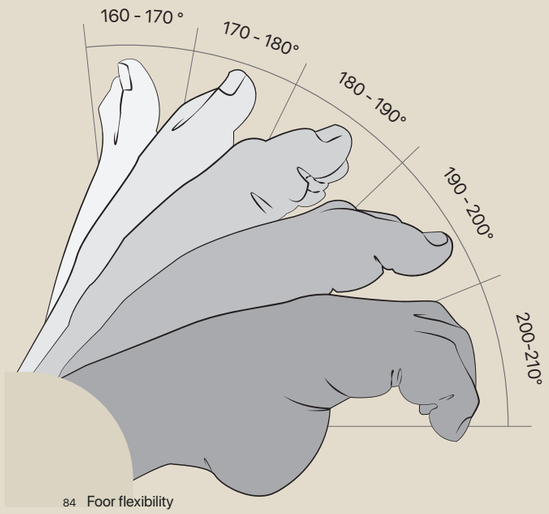
The team is aware of possible sources of errors, as it is not the real scenario of the real force impact on the shank and the dancers had different foot sizes which resulted in different placements of the four points (further elaboration in Appendix 18).

CONCLUSION

The team now has deformation pointes of a performance-ready shank to replicate in mock-ups. The next step is to get deformation points on a performance-ready box in another way, make prototypes and test on Isabella, the main test person.

FOLLOW UP WITH PHYSIOTHERAPIST

As investigated upon the different dancers shoes it became apparent that the dancers have different need in terms of shank strength. An investigation was therefore conducted in relation with the physiotherapist, Lærke Friis Hansen to figure out how much strengh the dancers needed in relation to their flexibility.



84 Foor flexibility

FOOT FLEXIBILITY

People have different flexibilities (A difference in motion in the joints). The degree of flexibility is influenced by the muscles and the connective tissues such as ligaments and tendons. The flexibility in the joints can be increased to a degree by stretching or by other foot strength exercises (Esco and PhD, 2012). Illustration 84 demonstrates a range of foot flexibility spanning from 160 -to 210 ° degrees. Each body type has limitations in the flexibility and 210 degrees is the complete extreme point. When examining a professional ballerina's flexibility it is only in the 190-210 ° degrees that is present, also referred to as hyper flexibility, as the dancers are required to have a certain level of flexibility to become a professional.

Below are three dancers and three different types of flexibilities.

DANCER #1

85 Flexibility dancer 1

220 DEGREES

The dancer has a banana curve in the arch of her feet (see brown marking) an a slight banana curve on top of the foot.

DANCER #2

86 Flexibility dancer 2

215 DEGREES

The dancer has a big banana curve on the top of her feet (see brown marking) an a lower banana curve in the arch.

DANCER #3

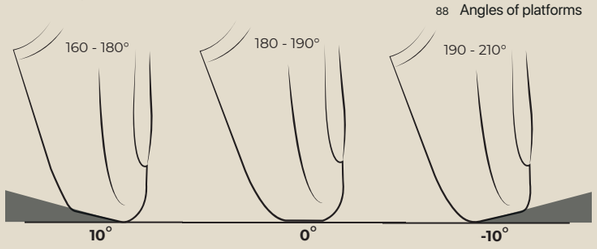
87 Flexibility dancer 3

205 DEGREES

The dancer has both a big banana curve on the top of her feet and a big banana curve in the arch (see brown marking). This dancer has also hyper flexible knees which effects her entire balance-point and hereby also her shoe strength.

The flexibility is influencing the platform of the pointe shoe. Dependent on the angle of flexibility it translates to either: en pointe (10°), neutral (0°) off pointe (-10 °). Yet all professional dancers have 10° to push their feet position more into a banana curve going against what is requmented.

88 Angles of platforms



CONCLUSION

Based on the investigation it is concluded that the professional dancers all want a 10° platform but require a -10°. Yet again the dancers pushing their bodys to the extreme. This was later confirmed by Henriette (head of shoes) that this observation was accurate. The box hardness is also dependent on the level of flexibility. Further tests will need to be executed.

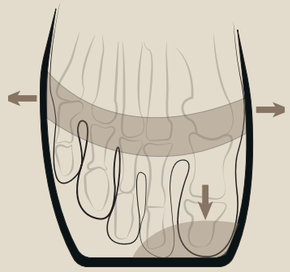
I28 The box hardness depends on dancers flexibility

INTERVIEW WITH: *FREED OF LONDON*

To further understand how a fitting process is executed, the team contacted Freed of London. A situated interview with **Sophie Simpson**, senior manager and head of fittings was conducted.

FREED OF LONDON TO THE CORE

Sophie Simpson is the true image of Freed of London. Her mother was also a fitter at Freed, she grew up travelling with her mother and fell in love with the brand. She has danced ballet till teenage age and has since helped thousands of dancers get correctly fitted Freed pointe shoes.



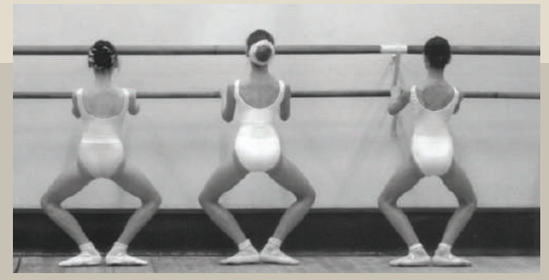
89 Pressure is reduced on toes due to equalising og pressure on bigger surface

SOCK

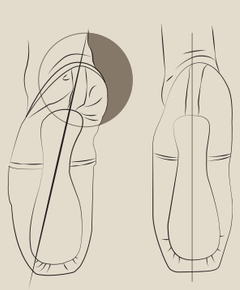
To fit the sock part of the shoe, Simpson makes the dancer stand in a first position, plié* and make them stretch as far down as possible (see ill. 90), also called Grand plié)(Appendix 20). If the sock tightens too much, around the heel and the toes the shoe (sock) is simply too tight. She explains that if the shoe is too uncomfortable in this position, it is simply too small.

MOST IMPORTANT POINTS WHEN FITTING

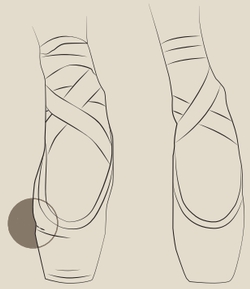
When Sophie is fitting a dancer (or just examining people in public) she automatically looks at how the individual carries themselves. She views this as a quirky work injury developed throughout the years. But her quick analysis is often extremely spot on. As the team needs to understand how her brain comprehends the data, a gathering of the most important points from the interview will be presented.
Simpson emphasises that the most important part of a fitting process is that the toes and feet should not be compressed - especially the toes that need enough space to activate mobility and balance. A perfect fit is when the toe box gently hugs the foot at the "cup" (see ill. 89). Simpson points out that contrary to what people think, it is not the toes that keep the dancers up en pointe, it is the hug around the crown of the feet.



90 Dancers in demi Plié, dancers heels does not leave the floor



91 1) Buckling & 2) fitted correctly



92 1) Bubbling & 2) fitted correctly

INDICATORS OF A POORLY FITTED SHOE

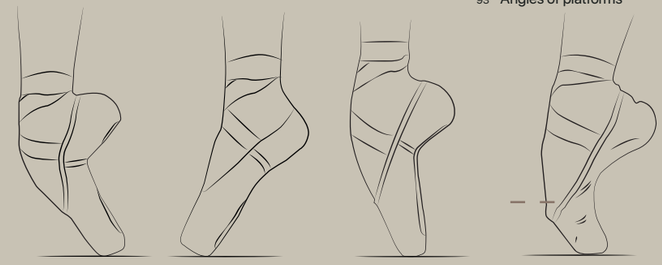
Buckling* is a concept, that best describes if a shoe is poorly fitted. When the foot is simply moved out of the preferred position, due to the fit of the box and the sock. The first teller (see ill. 91) is to look at the outer sole when on pointe, and check if the sole is correctly aligned with the foot. If not, there is too much fabric near the heel. This step requires alteration done with needle and thread, done by the dancers themselves. Another type of indicator is bubbling*: when the dancer almost "falls out" of their box (see ill. 92). This indicates that the dancer's box is too narrow.

Work with sock

BOX

Flexibility has a big influence on how a point shoe is fitted, as previously learnt by physiotherapist Lærke. Simpson however, evaluates their flexibility based on her expertise and the naked eye. She analyses the curve on the top of their feet and finds a fitting platform suited to their needs. If the toes buckle inwards, she provides a platform that pushes them back (a box of -10°, as leant on p. 40). The three shown illustrations are therefore how to accommodate the flexibility or lack of. Knuckling* is another concept where the box vamp is too low, resulting in a lack of support in the box (the brown line is where it could have been).

93 Angles of platforms



EVALUATION OF 2ND VISIT

The team evaluates the data collected from the 2nd visit at the RDB.

BREAKPOINTS

From the 2nd visit, it was clarified that the dancers mould their shank where it needs to be pliable in two areas called break-points. The first break-point is in the arch and the second is placed in their half-point. The team evaluated the break-points placements out from Isabella's and Tomoka's shank, measured doing the visit, and compared it to their feet's anatomy, utilising the mould of Tomoka's foot doing the first visit and to the 3D scanned foot of Isabella's from the 2nd visit (Appendix 21, 22 & 23).

It was established that the arch breakpoint lies between the joint of Calcaneus and Cuboid and the half breakpoint lies in the joint between metatarsals and phalanges. This was determined in both Tomoka's and Isabella's feet and shank (see ill. 94).
This has to be further explored and validated through tests and prototypes.

FLEXIBILITY

With the interview with Lærke and Henriette it was stated the dancers are going against what is ergonomically required to push their body out into the extreme positions to get the aesthetic appealing curve of their feet (Banana feet). This is assumed to be caused by pleasing the ballet master as he picks the rolls for the dancers (page 21).

It is established that in order for the dancers to adapt the team's product the 10 degree platform must be part of the product.

R22 Angle of platform 10° !

FITTING

Through the interview with Sophie from Freed of London it was established that the fitting of the shoe was a basic parameter in order for the dancer to be able to dance in their pointe shoes.
The most important measurements being; the width of the crown to reduce pressure from the toes, the length of the foot to avoid buckling and bubbeling and lastly the toe length to get the necessary vamp height and avoid knuckling (see ill. 95).

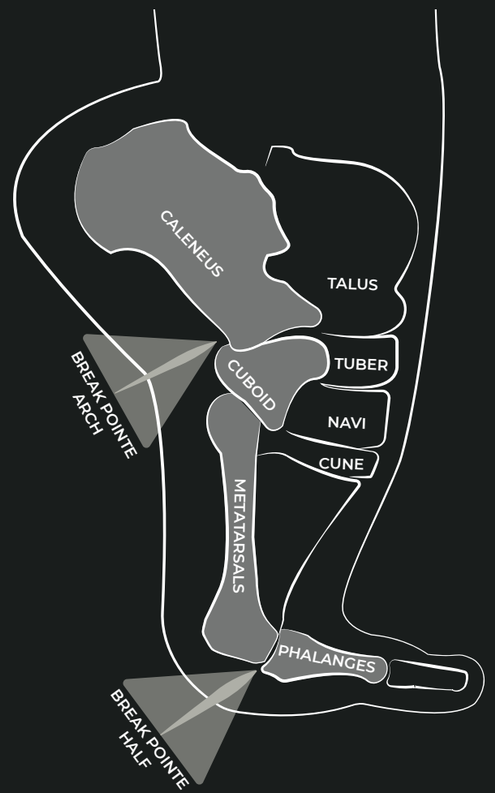
R23 Box (vamp length) fitted to length of toes !

R24 Width of box fitted to length of crown on feet !

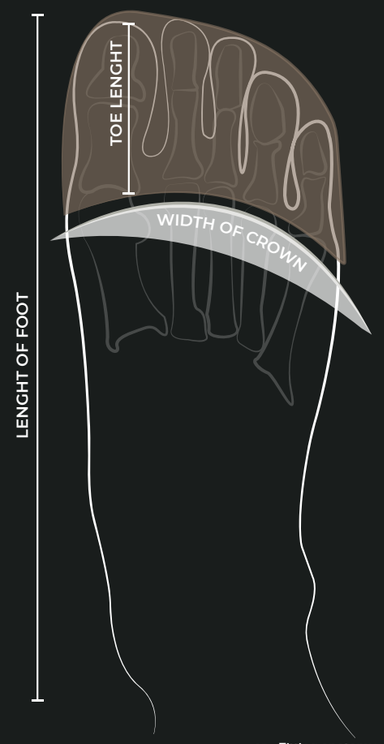
R25 Shank and sock fitted to length of feet !

CONCLUSION

It is established that the dancers care more about their aesthetic appeal rather than their ergonomic posture. To get a new pointe shoe accepted by the professional dancers it is important that the aesthetic aspects are fitting to the norm and culture of the industry.
To get a pointe shoe performance-ready, the shoe should fit the feets measurements of break-pointe, vamp height, width of crown and foot size.



94 Angles of platforms



95 Fitting anatomy

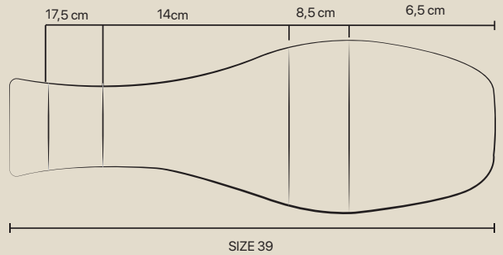
TEST OF BREAK POINTES - SIZE 39

Based on the interviews conducted at the RDB the team proceeded to figure out if there is any linkage between the size of the foot and the breakpoints. A test was conducted to investigate if breakpoints are able to be generalised to the foot size.

CONDUCTION OF TEST

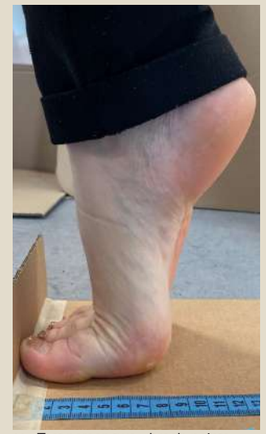
The team had created a cardboard template with a stop edge and a guideline on the cardboard to where they needed to put their feet. A measuring tape was placed at the top of the stop-edge to measure their foot length. The data consisted of 3 inputs; the foot size, the distance between stop-edge and the half-point mark, and thirdly the length from the tip of their toes to their arch-point. This was measured when the test persons were on half-point, and then a piece of tape was placed in the hollow of their arch. The participants were then instructed to go back to a normal position, providing the team with a measurable number for the arch-breakpoint.

The test was conducted on a total of 27 test persons. However, only 17 of the asked persons, were a true size 39 (24,7 cm (Shoe Size, 2018)) (see Appendix 24).



96 Break pointes measurements

97 Test person one - break-points



98 Test person two - break-points

CONCLUSION

It was concluded that breakpoints can be generalised and do depend on the size of the foot.

R26 Breakpoints fitted to dancers foot size !

THREE DIRECTION

The team evaluated different directions, that the current gained knowledge could potentially develop into (see Appendix 25). Three market directions were discussed to ensure that no obvious market potential was overlooked.

A MEASURING DEVICE

99 Measuring device direction

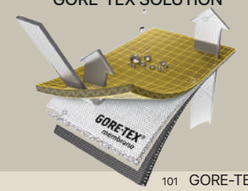
A device to measure how to achieve a PR pointe shoe. This is new market potential, as it is perceived as a blue ocean product. The prime market is manufacturers & brands such as Freed of London.

A PERFORMANCE-READY POINTE SHOE

100 Pointe shoe direction

To create a long-lasting PR pointe shoe. The main goal is to limit inconveniences and create a more reliable product for the companies and professional ballet dancers. It seems this is a potential gap on market.

GORE-TEX SOLUTION



101 GORE-TEX direction

The Gore-Tex solution is to create the internal part of a pointe shoe and sell it to many different pointe shoe brands thereby profiting off of the entire pointe shoe industry. However, there is no assurance that companies will adopt it.

CONCLUSION

The current knowledge can be adapted in all three directions, however, the team needs to find a gap in the market to truly choose a direction. The team acknowledges that the main objective has been to try to make an impact on the industry of ballet. The team is certain that the success of the product should not rely on a company or narrow-minded traditional individuals within the industry.

Make an impact on the industry +

DESIGN BREIF 2.0

CRITERIRA LIST

The team utilised the Kano Model based on user satisfaction and needs. It is divided into three categories Basic, Performance and Delighters; Basic is the users 'must haves', and Performance is 'More is better', which brings the user something new and better. Whereas Delighters is unexpected and a 'nice to have'. As chocolate on the pillow in hotel rooms (Verduyn, 2020).

	PERFORMANCE	BASIC	DELIGHTERS
BOX	• Support the toes when en pointe • Expand & compress with feet movement • Give dancer ground feeling	• Box vamp height fitted to the length of toes • Box width fitted to the length of the crown on feet • The angle of the platform: 10°	• Equalize load pressure • Limit inserts
SHANK	• Break-points fitted to dancer's foot size • Support arch en pointe • Support phalanges when going en pointe	• Shank fitted to the length of feet	
SOCK		• Sock fitted to the length of feet • Minimise friction on the platform	• Pre-sown darning
ALL	• Extent performance-ready zone with minimum of two days • Be performance-ready from new • Minimise rotation between pointe shoes • Uniform replicas • Ability to do roll through without doing any workarounds to the pointe shoe	• Withstand ten times a ballerinas weight • Follow aesthetic perception of the ballet industry • Must be breathable • Not deteriorate by sweat	• Not add more components to the bag

INTERACTION VISION

"The product will be **reliable** as your partner in crime, as **familiar** as your mother's perfume and feel as **prepared** as being in the front-rank position in a race, ready from the get-go."

A.

B.

C. 102 Interaction vision **(Pasman et al., 2011)**

PROJECT OVERVIEW

The team has figured out how to achieve the basic criteria to accomplish a correct fitting and a better understanding of what stage a performance-ready pointe shoe is. This is equivalent to a half deteriorated shoe (in the middle of its lifetime). Meaning the pointe shoe is pliable enough in certain areas to do a roll through, yet stiff in others to keep the dancer supported en pointe. These areas are defined by replicating the deformation points in the shank. However, it currently lacks the deformation points in the toe box to fully replicate it.

To achieve a **proof of concept** the team needs to be able to successfully replicate a performance-ready pointe shoe while understanding and conveying the parameters to achieve it. This way, ensuring that the process can be replicated on other dancers once the project ends.

TASK

03. / 8.

CONSTRUCT

CHAPTER SUMMARY

This chapter focuses on the principal and the material level of the value pyramid (p. 5), by further understanding the working principles of the shoe and creating and iterating mock-ups and testing them in real life. It further handles the composition of the components and their material choices, resulting in the final internal construction.

Detailing

103 Construction of Empire State Building, New York City 1925

MOCK UPS

After settling on a proof of concept the team proceeded with trying to replicate the characteristics of a performance-ready pointe shoe. Mock-ups of different materials were created to, for the first time, test their observed behaviour of them on a professional ballerina.

PLANNING OF MOCK-UPS

The team conducted a plan to hopefully test as many materials as possible and find some sort of principle or material properties that could potentially create the desired performance-ready pointe shoes (see Appendix 26). A visit to *Aalborg Gummivare fabrik* was conducted to get as many material samples as possible.
The team did have reference values of deformation on the shank (see p. 39), however, none on the toe box. The development of box mock-ups was therefore difficult to evaluate prior to the visit to the RDB.

The aim was to create an interchangeable system with one sock, several boxes and shanks that could be combined as like. Appendix 27, for a full overview of the mock-up development.

SHANKS

The shank measurements were based on our test-person Isabella´s current shank (retrieved from her old pointe shoe). The old shank had a slight s-curve as a default due to being moulded into the desired shape. The team tested out several bamboo shanks and tried to cast in hard silicone, however, the silicone was too toxic to work with. None of these solutions was therefore proceeded with.

POLYMER SHANK

The team proceeded to test other materials, such as a polymer shank. This broke during production and was unable to be thinned enough.

105 Polymer shank

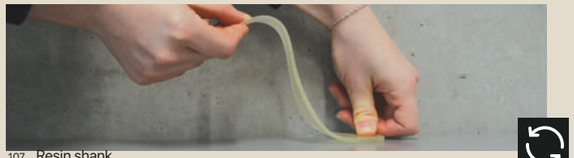
NYLON SHANK W. REINFORCEMENT

A nylon shank with fibre reinforcement was produced [S1]. This was too stiff, however, if iterated upon with some kind of bending in the breakpoint, this could have potential. A new iteration with a varying thickness was created [S5].

106 Nylon shank with fibre reinforcement

RESIN SHANK

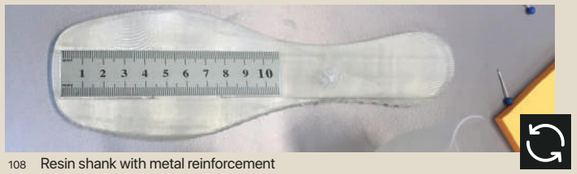
A resin shank with varying thickness was created. This was way too soft but could create the desired flexibility. New iterations on a resin shank with reinforcements was created to provide stiffness [S2 + S6].



107 Resin shank

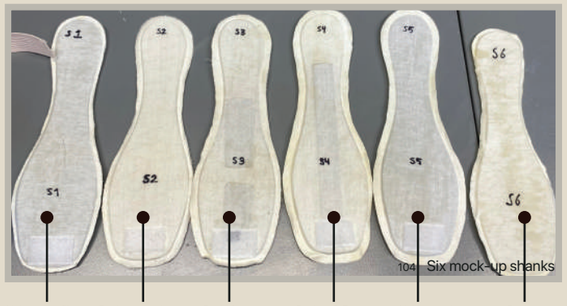
RESIN SHANK W. REINFORCEMENT

Two iterations with spring metal reinforcement were created to provide the shank with more support and stiffness [S3-S4].



108 Resin shank with metal reinforcement

FINAL SIX SHANKS



104 Six mock-up shanks

Nylon w. fiber reinforcement | Resin w. varying thickness | Resin 1 mm metal insert | Resin 0,5 mm metal insert | Nylon varying thickness | Resin one thickness

109 Resin shank with two metal reinforcement to create breakpoints

CONCLUSION

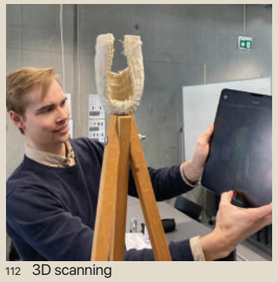
Six shank mock-ups were ready to bring to the RDB. All covered in canvas to distract the dancer from what is inside the shank and not judge it before trying.

BOXES

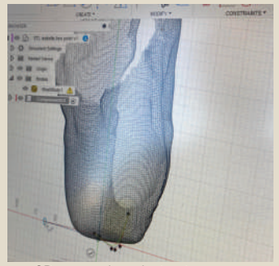
To achieve a correctly fitted toe box, the team utilised 3D scanning technologies, both on Isabella's foot (conducted during the last visit) and on her old toe box. This was part of the iteration process of creating the toe boxes.

3D PRINTED BOXES

110 Tree 3D printed mock-ups



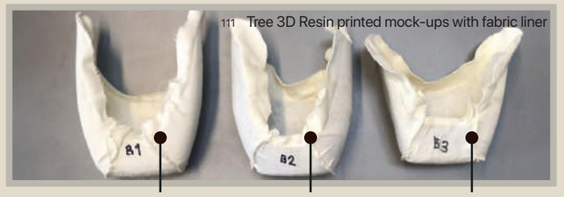
112 3D scanning



113 3D scanned mesh structure

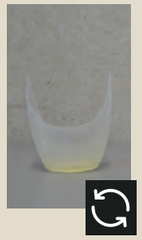
The team first iterated upon the shape through 3D software and tested the printes versions internally in the team, as one of the team-members has the same shoe size as the test person. Three resin mock-ups with varying thickness was brought to the RDB as well as a resin mock-up with nylon reinforcement. The benefits with resin is that is can be hard at the bottom and flexible at the top.

FINAL THREE BOXES

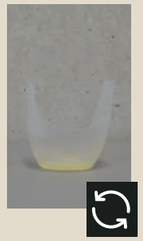


111 Tree 3D Resin printed mock-ups with fabric liner

Resin: asymmetrical box | Resin: Symmetrical box | Resin with nylon reinforcement

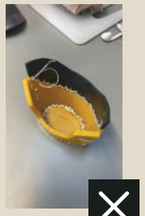


114 Symmetric Resin box



115 Asymmetric Resin box

116 Resin with nylon reinforcement



117 Frankenstein: silicone shores (A80-A90)

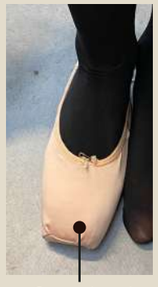
CONCLUSION

Three Box-mock-ups were brought to the RDB. Same as with the shanks, are all boxes covered with canvas.

SOCK

The sock holster was created using patterns retrieved from Isabella's old pointe shoe. The shoe fitted a team member, which was a big achievement for the team. The feet, however, change, especially if you dance on them most of the day. This was not taken into account.

118 Original Freed pointe shoe



119 Oure sock mock-up

120 Our sock mock-up

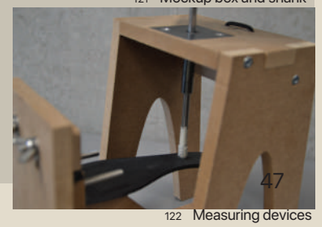
EVALUATION PRIOR TO VISIT

The team tested the deformation on all six shanks prior to going to the RDB. This was to be well prepared and have a pre-notion of how the test would go. The team also intended to cut all six shanks during the test, to that way appeal to the professional's needs for a 3/4 shank (see Appendix 28).

Velcro was placed on each box and shank piece to connect them during the testing, as they in reality act as a combined unit.

The team is aware that these mock-ups will not fulfil the user's requirements, but they will hopefully bring a better understanding of how to modify the design to accommodate it better and hopefully give the dancers something more tangible to evaluate on.

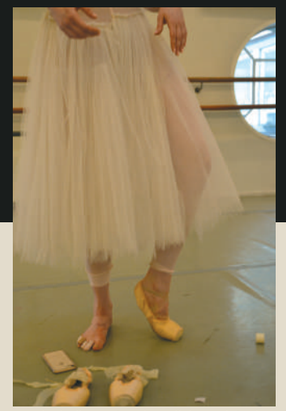
121 Mockup box and shank



122 Measuring devices

TEST AT RDB - 3RD VISIT

The team travelled to Copenhagen to once again do a testing session, this time with Corps dancer Isabella to give feedback on the mock-ups (see full testing scenario and feedback in Appendix 29). To evaluate how well the components were performing she tested the roll through (see ill. 123)



123 Isabella testing the roll through in the mock-ups

I29 The dancers do a roll through to test how pliable the shoe is

Ensure the sock can fit both prior and after a day full of dancing

SOCK

The sock part of the interchangeable system did to the teams misfortune, not work. It could unfortunately not fit around Isabella's swollen foot, from 7 hours of dancing. The heel part could simply not get around her heel. This resulted in the team using her old point shoe (that we had received earlier) to conduct the testing in. Shank had been removed, however, the box was extremely dead, leaving her with almost no support in the toe region.

BOX

The missing sock part, due to swollen feet, led the team to find another workaround to conduct the testing. Using her canvas shoe, it could provide some structure and stability to test the three boxes in. Without proper structure, it was difficult to fully test the functionality of the three boxes. It became apparent how important the support of a sufficient vamp height is and the impact of supporting wings in the shoe. Isabella emphasised that the two resin boxes were way too soft, providing her with no support (see ill. 124) The resin box with nylon reinforcement was too annoying and irritating for her to truly test the functionality, which led her to mention the importance of clean lines both internally and externally on the shoe. She liked the asymmetrical one, however, she does not like that it looked too lumpy, as if she had a bunion.

124 Test mock-ups box and shank

EVALUATION

Extremely dead box. The sock and wings are extremely important to help support the internal components.

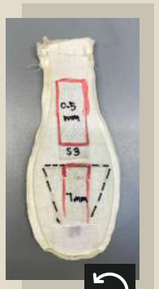
SHANK

All six shanks were tested both with a full shank and cut in 3/4. Isabella had a hard time describing how she felt using the different shanks, despite her being a hypersensitive professional. To accommodate this she decided to wear her Freed pointe shoe on the right foot (what she referred to as a performance-ready pointe shoe) and our test mock-up on the left. This helped her describe the difference and where she would prefer more support. One shank (S3 - resin w. two parts 0,5 spring metal reinforcement), she liked extremely well. It gave her flexibility to do a roll through and then support when en pointe. The only dislike was the crack in the s-curve (see ill. 125 B), she wants it as a natural curve like her other shoe (see ill. 125 A). Another concern was the lack of spring back time (a common problem with all shanks). She describes this feeling as the shank moving along with her foot, being pliable and moulded.

125 Three mock-ups A, B and C.

Her PR shank.

Our Shank inside



R27 Shank spring back time must follow foots movement !

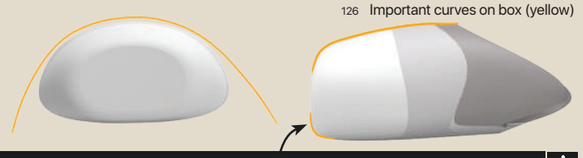
EVALUATION

Shank S3 (resin w. two parts 0,5 spring metal reinforcement) cut to 3/4 length was the best solution. Still needs alteration (see red drawing) However the line needs to become a smooth S-curve.

AESTHETICS

Isabella commented on the linework, which she was displeased with. She explained that the bottom curve on the box is very critical, as it has a functional purpose, by helping her to easily roll onto point.

126 Important curves on box (yellow)



R28 The bottom curve on the toe box should be an R5 curve !

CONCLUSION

The test left the team a bit deflated, as the test did not go as planned. However, after assessing the data it was back to high spirits. The team concluded that the available materials will not be able to perform the desired criteria. A new testing type needs to be applied. There is still a lack of data regarding the box, which needs to figure out how to achieve. The best news was that Isabella provided the team with a PR box. This shank is dead, luckily as this makes it unusable.

BOX-TEST IN LAB

During the last visit to Copenhagen, the team had received a performance-ready pointe shoe from their test person Isabella. This permitted the team to test the received box in a closed environment with the possibility of changing the force to receive measurable deformation points. All in the attempt of achieving performance-ready parameters of the box.

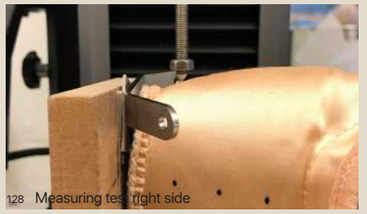
127 Tensile strenght tester setup

TEST SETUP

After the instruction of the *Instron tensile strength tester,* the team did a few test runs to find the correct range to apply normal force with and at what rate. This led the team to proceed with the first intended measuring points (see p. 37), being 9 different measuring points. Three one top and three on each side. Applying 50N on the first point of every side and 30N on points 2-3.

The measured data is in the tables below. (The values are all retrieved at a force of 30N.) Appendix 19 for full test setup, sources of error and the results.

RIGHT SIDE



128 Measuring test right side

	Point 1	Point 2	Point 3
RIGHT	d = 1,2	d = 1,15	d = 2,6
LEFT	d = 1,16	d = 1,18	d = 2,8

TOP

129 Measuring test top

	Point 1	Point 2	Point 3
RIGHT	d = 1,2	d = 1,5	d = 4,5
LEFT	d =	d = 2,6	d = 6,4

LEFT SIDE

130 Measuring test Left side

	Point 1	Point 2	Point 3
RIGHT	d = 1,3	d =	d = 2,45
LEFT	d = 1,3	d = 1,25	d = 2,1

COMBINED DATA

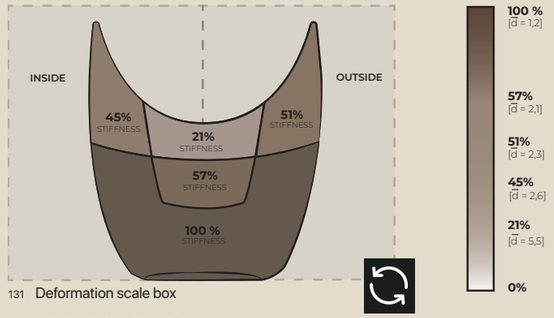
Following the test, all data was evaluated and combined. Two data points were unfortunately lost due to the program overriding existing data points (Top, point 1, left shoe & Left, point 2, right shoe). And without the opportunity to run the test again, the team had to work with the retrieved data.

By combining the data of the right and left shoes, it became apparent that a difference was seen in the inner and outer parts of the pointe shoe. The data was very similar on points 1-2, leaving point 3 with the main difference. After combining the data the team converted the deformation points into a percentage of material hardness. See ill. 131 for a graphical view of the difference in the box, depending on whether it is the inside (where the big toe is) or outside (where the pinky toe lies).

SOURCES OF ERROR

As this test setup was the first time trying the device it created a handful of sources of errors (see Appendix 19, problems during the test). The clamped fixture created an unlevelled surface for the pinpoint to hit, resulting in the force of the pin being pushed outwards rather than downwards. This led to the team cutting the arm midway in the test scenario. The clamp also resulted in a torque, that the team tried to reduce and secure with metal plates.

DEFORMATION SCALE



131 Deformation scale box

CONCLUSION

The retrieved data and the difference between the inside and outside of the shoe seem tangible, as the big toe adds more pressure to the toe than the pinky toes, which are mostly used to create balance. These measurements will become the reference for further investigation to create a PR pointe shoe. Next step will be to try to replicate the values in FEM and test what materials can recreate the desired deformation values. The team is aware that this single test scenario is a huge generalisation of how the majority of pointe shoes work. Further tests of several pointe shoes are needed to confirm if it is a generalized behaviour of a PR pointe shoe. However to achieve our proof of concept (see p. 44) this one measure is sufficient.

REPLICATION

After retrieving some measurable reference values both on the shank and on the box, the team proceeded to try to replicate these reference values in Finite Element Analysis (FEA*).

GEOMETRY OF BOX

Following the test on the *Instron tensile strength tester,* the team decided to dive intro knowledge on different materials and their properties. A study of eight polymeric materials was conducted. The polymer was chosen as they fit the initial material requirements the best (see Appendix 30 for the in-depth investigation). The eight materials are listed below:

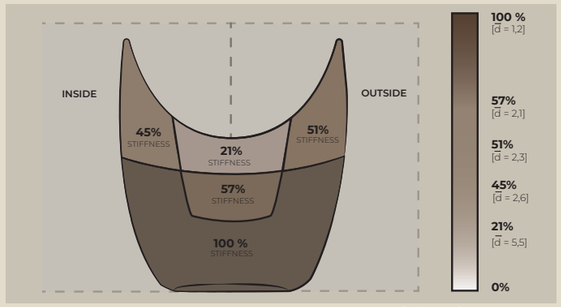
PA NYLON
HDPE High density polyethylene
POM
PEEK
TPO
ABS
PBT
PP Polypropylene

HDPE

HDPE is a thermoplastic known for its high abrasion to wear and resistance against water. It is produced in many shapes and forms by injection moulding (Plastindustrien, n.d. a).

PP

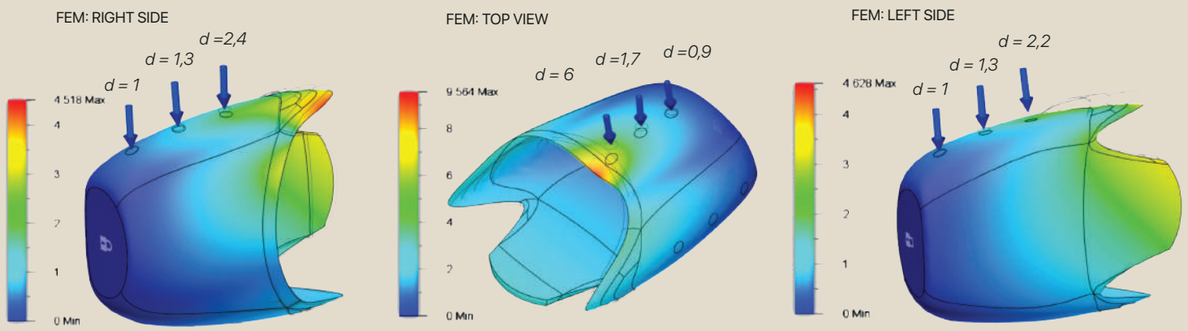
PP is a commonly used thermoplastic with good chemical resistance and can withstand high temperatures. It is widely used because of its strength and toughness (Plastindustrien, n.d. b).



132 Deformation scale box

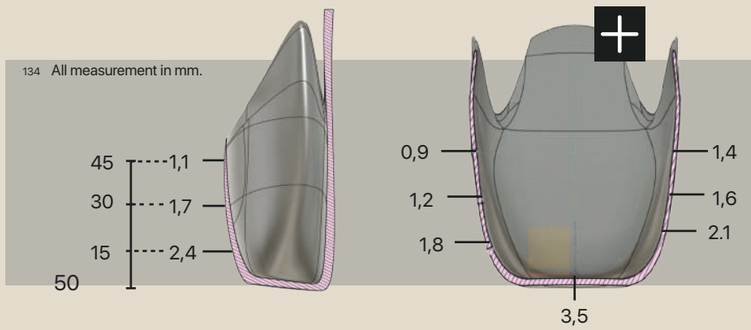
FEM ON HDPE BOX

Once settled on the best suitable material HDPE, the team proceeded to test the box construction in FEM to mimic the desired deformation points achieved in the lab. Through trial and error and a lot of iteration, the team finally settled on a wall thickness that enabled the desired deformation points (see Appendix 30).



133 FEM analysis on box, deformation points measured in mm

The FE analysis led to geometry and the noted the material thickness of the box component shown in ill. 134. These values should be able to reconstruct the desired deformations and therefore hopefully the desired functional aspects of the box component.



134 All measurement in mm.

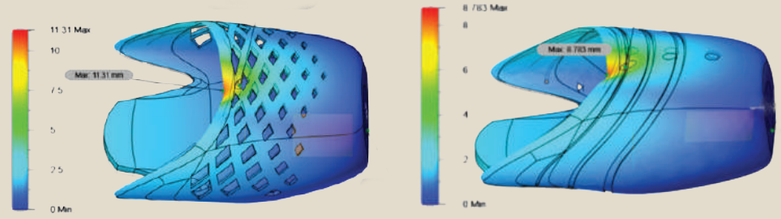
CONCLUSION

The FE analysis led to geometry and the noted the material thickness of the box component shown in ill. 134. These values should be able to reconstruct the desired deformations and therefore hopefully the desired functional aspects of the box component.

HDPE is used to create the box

BREATHABILITY

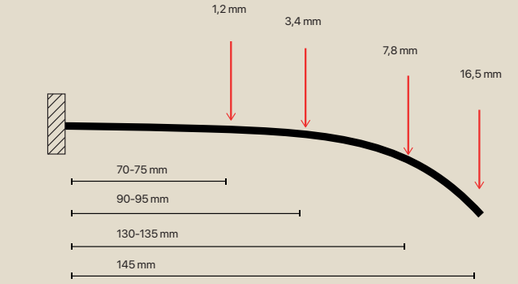
The team proceeded to further model ways to create wholes that can enable airflow through the construction (see Appendix 31 for reference products and testing). Several diamond-shaped cut-outs were tried as they would help with the expanding and contraction of the toe box. A kerfing solution was also tested, however, none of the solutions was chosen as they reduce the material strength and are difficult to produce.



135 FEM breathability

SHANK GEOMETRIES

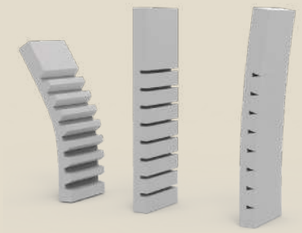
Based on the identified shank deformation found on p. 39 (see ill. 139, for an overview of deformation at 12 N force) and test of different shank mock-ups, did the team proceed to develop the shank geometries. The last mock-up (resin shank w. two parts 0,5 spring metal reinforcement) (see ill. 124 p. 48) had some good qualities with the flexible parts and the hard and supporting metal parts, however, the team is not trying to make the dancers stand on metal, which potentially could cut their feet. The team did instead try to look into other ways of creating this material duality.



139 Desired deformation points on shank

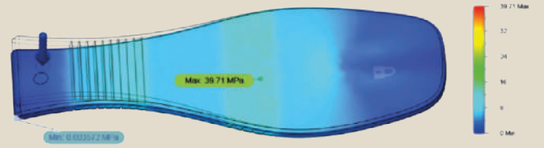
KERFING

By testing a kerfing solution on cardboard (see ill. 140) it became apparent that it could be a solution that could create the desired effect. Kerfing is a way of creating meticulous wholes in the material to make it more flexible. The beneficial thing about kerfing is that it can provide flexibility in one direction and stiffness in another, once the kerfing lines align on top of each other. By measuring the desired number of lines (see Appendix 32) the team quickly moved from cardboard to 3D.

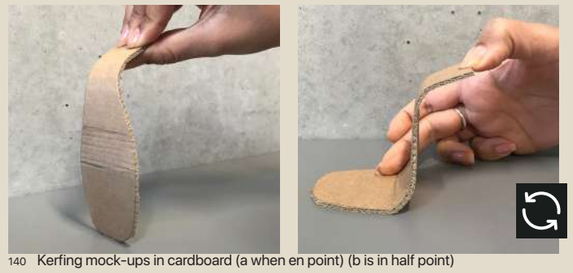


136 Kerfing principle (A, B & C)

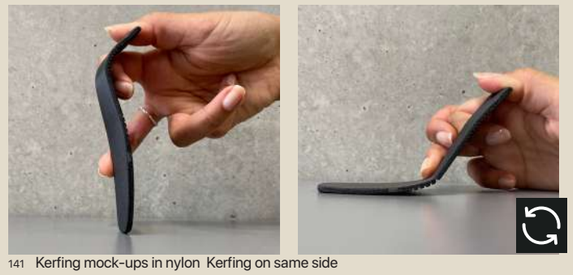
137 FEM on Nylon shank with kerfing



138 FEM on Nylon shank with kerfing



140 Kerfing mock-ups in cardboard (a when en point) (b is in half point)



141 Kerfing mock-ups in nylon Kerfing on same side

142 Kerfing mock-ups in nylon kerfing on different directions

CONCLUSION

The kerfing was tested out both in FEM in Nylon and printed in nylon. The problem however, is that nylon unfortunately is still too stiff, even with the kerfing. This led the team to proceed with other materials.

MILESTONE CONCEPT

The team presented their milestone concept "Sweetspot". This solution was to combine every component (shank, box & sock) into one solution as all three part contribute to the main functionality of the pointe shoe. This is necessary as the dancers are very hesitant towards new solutions and are not willing to adapt any seemingly new and innovative technologies.

Sweetspot is intended to be sold as a whole shoe, but will have innovative technology inside through our combined shank-box solution.

143 Sweetspot

Aim to innovate on the overall aesthetics

03 CONCRUCTION

INTERVIEW WITH POLYMER EXPERT

The team contacted polymer expert Eric Appel Jensen to get feedback on the construction, production and most importantly the materials in relation to the functionality.

COMMENTS ON CURRENT MATERIALS

Erik agreed on the choice of utilizing HDPE on the box. This was due to the performance of the material not being a brittle material and not creeping due to extensive loading. HDPE will never break but will deform over time This is due it to materials' viscoplastic elasticity behaviour (see ill. 144 for a cyclic load testing & ill. 145 for hysteresis loop evolution).
Appel warned the team against using HDPE it was supposed to be in touch with any functional surface, as it becomes very smooth and has a hard time creating friction. However, the intention has always been to hide all components, which then is not a problem. HDPE is further odourless and has an extremely good resistance to all types of chemicals, which results in liquids and essentially sweat. Erik states that the box will be hard to produce due to the complex geometry, it is a long draw depth and can be very problematic, it is possible but assistance is needed from the manufacturing department.

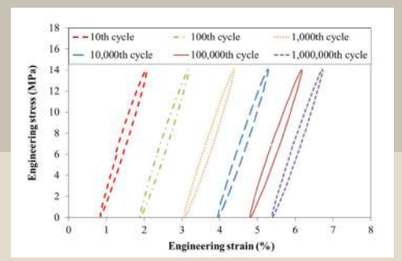
PC-ABS

Regarding the shank, he recommended using PC-ABS. He refers to this due to the spring back time of the material. It is not a brittle material. PC is hard to cast, which is why a mixture including ABS is beneficial. Nylon is not a good material to use as it absorbs moisture, which will not be beneficial in the scenario.

GLUE

Concerning how to join the two components in the desired solution Erik expresses no concern. "It is just about finding the right glue". HDPE however has a low surface tension, making other materials have difficulties adhering because they would need to have even lower surface tension.

144 HDPE: cyclic loading test (Qi et al., 2019)



145 HDPE: Hysteresis loop evolution of cyclic-loading (Qi et al., 2019)

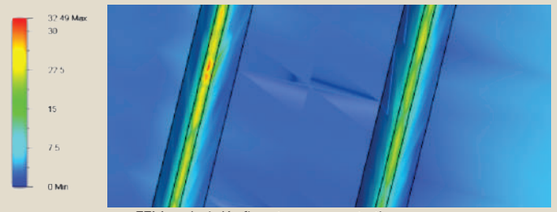
CONCLUSION

The team settled on utilizing the two recommended materials, PC-ABS and HDPE. The team later received sample materials to feel and properly identify the material properties.

Using HDPE for the box & PC-ABS for the shank

FURTHER SHANK ITERATION

Following the meeting with polymer expert Erik Appel Jensen, the team had new information to include to the development. New FEM analysises were created on the shank, now with the use of PC-ABS. This worked remarkably well regarding replicating the desired deformation values (see ill. 146). However it became apparent that the kerfing solution might create problems in the shank. Higher levels of stress were discovered in the kerfings which concerned the team (see ill. 147). These kerfing indents might result in weakening the solution, which resulted in the team investigating other solutions.



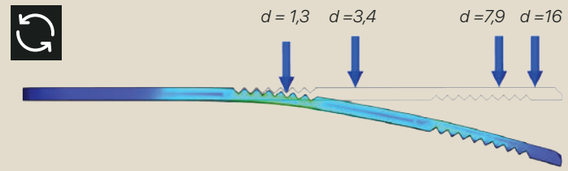
146 FEM analysis Kerfing stress concentration

OTHER SOLUTIONS

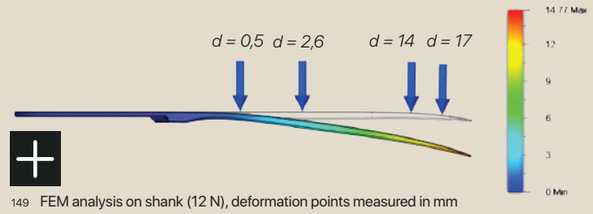
A 3 mm wall thickness shank was selected with gradient wall thickness; however the deformation points are yet not fully reached (ill. 149). The material behaviour is still unknown compared to the bounce-back time, stiffness and flexibility in two opposite directions. When utilizing a plain surface, the natural S-curve (see p. 39) is not achieved.

The S-curve could potentially be implemented in the production either by moulding the shank in an S-curve when produced or by post processing by heating the shank into the curve. However, this is a dilemma when the dancer is on flatfoot as the shank needs to go from straight into a S-curve when going from flat foot into half-pointe.

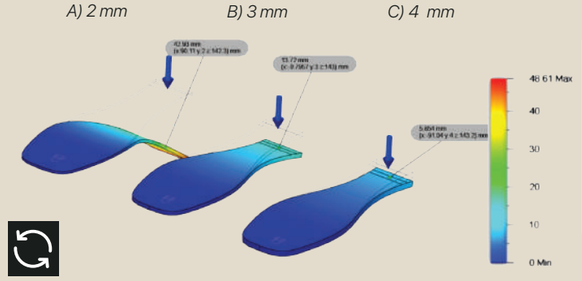
Utilizing Kerfing geometry allows the ability to get a natural S-curve with the movement of the feet between flatfoot and going en pointe. The team is not closing off with either of the two shanks as they both have properties that needs to be further elaborated through real life testing, yet they are the best two possible solutions through simulations.



147 FEM analysis on shank (12 N), deformation points measured in mm



149 FEM analysis on shank (12 N), deformation points measured in mm

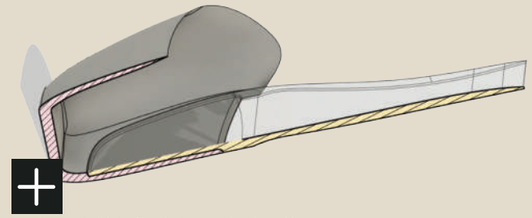


148 FEM analysis on shanks (A,B,C) (12 N), deformation points measured in mm

INTERFACES BETWEEN SHANK AND BOX

Several different interfaces were discovered through principles of product architecture and through the use of the Tjalve methodology (see Appendix 33). The choice fell on an integrated solution that could accommodate the difference in using two different materials (see ill. 150). Most of the found connections were very intricate and difficult to produce. The aim was the thinnest connection with the biggest surface area to ensure the glue would adhere best.

Following this, two materials HDPE and PC-ABS were investigated concerning their thermal expansion rate. HDPE expands approximately 10% more than PC-ABS, however, it is such a minimal expansion for both materials that a connection between them would not be impacted.



150 Integrated interface between shank and box

CONCLUSION

Following the FEM analysis on the PC-ABS kerfing, the team decided to investigate other ways to reach the deformation values without using kerfing which seemingly creates high-stress tensions. Kerfing seems to weaken the overall structure in both directions where placed. It also is a more expensive option and unfortunately, the team never reached the correct gathering of the kerfing to create stability (see ill. 148, C)

CONCLUSION

Following the established connection between the shank and the box, it is necessary to investigate how the combined unit will act in different scenarios and what aspects are the most vulnerable.

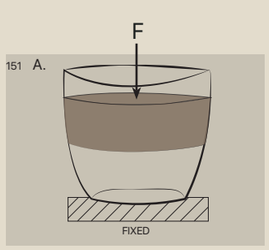
FEM - REAL SCENARIOS

Following the development of the box- and the shank geometries and the interface between the two, it was time to test the combined solution in a test setup. The team set up several test scenarios to replicate how the construction would act in the real world.

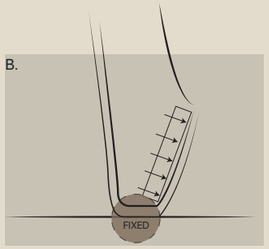
Remember that testing in FEM on materials that act like HDPE is extremely difficult. You need to test it in real life, to see how it behaves.

SCENARIO - EN POINT

The team set up two scenarios to mimic the force behaviour when a ballerina is dancing en point (see Appendix 30 & 34).
The first 1) When a uniform force is pushing directly down on the toe box (see ill. 151, A) When a dancer is leaning in her pointe shoe and force is distributed onto the vamp of the toe box (see ill. 151, B).

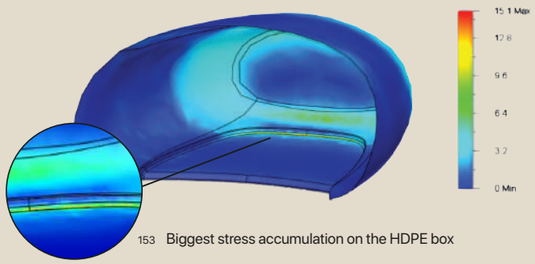


CASE 1:
COMPRESSION EN POINT



CASE 2:
LEANING EN POINT

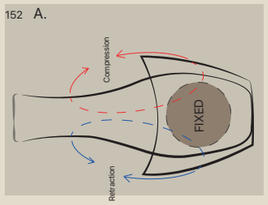
The two scenarios were quite similar in terms of stresses and safety factor. The biggest stress concentration was found in the interface connection between the shank and box (see ill. 153) The rest of the stresses were found in the lower part of the toe box (inner hollow of the toe box) and the bottom part of the toe box (see ill. 154).
The scenarios are quite simplified, and in reality is the scenario a combination of the two scenarios, to correctly approximate the behaviour of when dancing en pointe.



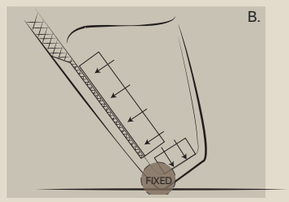
153 Biggest stress accumulation on the HDPE box

SCENARIOS - IN MOVEMENT

The team then proceeded to test out the behaviour when the ballerina is in a movement. These are instances like when on flat foot and twisting in the shoe, which create torque between the two glued materials (see, ill. 152, A) and on when half point (see ill. 152, B). Investigating these is essential as they could turn out to be critical for the construction.

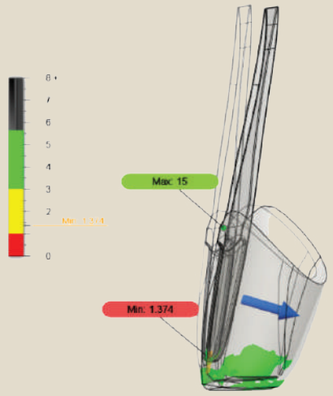


CASE 3:
FLAT FOOT AND TWISTING



CASE 4:
HALF POINT

The twisting scenario impacted the construction with stresses however, with a very high safety factor. The more interesting scenario is when on half pointe. This instance created stresses in the bottom part of the toe box and in the interface (the shank is removed to better see inside the toe box). The construction still had a high safety factor.



154 HDPE: Safety factor when en poine

CONCLUSION

The team will proceed to utilize the data from when the dancer is en point (Case 1 + 2) as these cases were exposed to the most impact. It also seems likely that the most impacted spot scenario will be en point, as the ballerinas roll onto point fewer times than when standing en point. With a high safety factor in the tested scenarios, the team decides that this testing setup is concluded. To ensure its success rate, testing will be necessary.

This leaves the current solution with one final box design and two potential shank designs. One with kerfing and one with varying thickness. The team concludes that the two shanks fulfil the intended deformation point and therefore should be to the desired performance-ready level. However, it is uncertain how the shanks will perform in a real life scenario, as it is more complex than an FEA can ever predict. One thing is to have the correct deformation points, another is how it feels during dancing. And having two shanks to test further will be beneficial. Testing if they actually have the desired stiffness's and hardness in the desired spots will be crucial for the further implementation.

TASK
04. / 8.

MARKET

CHAPTER SUMMARY

This chapter focuses on the spiritual and the contextual level of the value pyramid (p. 5), by understanding the market of the pointe shoes. This results in a strategic fit analysis to gain insights, find a positioning and obtain the best prerequisites for product launch. Hereby understanding which areas further development are needed.

Detailing

155 Bloch pointe shoes

BALLET IN NUMBERS

Following the development and detailing of how to achieve a performance-ready pointe shoe the team investigated the world of ballet in numbers. Through research and mapping, the team gathered an overview of the scope of the industry and potential gaps within the current market (see Appendix 35).

AMOUNT OF COMPANIES & DANCERS

All professional ballet dancers are, as previously mentioned, hired at a company. Companies are placed all over the world and often consist of a very global ensemble. The majority are placed in North America and Europe. The research showed that 419 established companies were found (Weinman, 2013, a). A company study showed that the biggest companies house between 100-5000 employees (but around 100 dancers pr. company)(Zippia, 2021). Combining this number with the established amount of companies leaves 49.000 professional ballet dancers. A study of demographics among professional dancers displays the gender difference as 77.8 % being female in the industry and 22.2% of male (Zippia, 2021). This leaves 38.122 dancers being professional ballerinas. Besides this number, there are still many dancers in other fields such as arts and movies. This might at first glimpse seem like a small number, nonetheless, comparing it to other sports the number seems much bigger. In NFL there are 32 teams and a total amount of 1,696 players ("Total Players in the NFL," 2017) and in basketball (NBA) 30 teams and a total of 450 professional basketball players in the USA (NBA, 2019).

419
COMPANIES

38.122
Professional
Ballerinas

1696
NFL players

450
NBA players

ECONOMY & SALARIES

Ballet companies are primarily non-profit organisations (Pointe, 2001), which therefore rely on external support, either from the government or through funding or private donations. Salaries vary throughout the world. In Europe and at RDB the customs are that a dancer is accepted into a company and then given a contract, spanning the dancer's entire career. Ending when the dancer is retired (at 40 years old) or when their body is no longer able to perform. In Denmark, a principal dancer earns 33.000 DKK, while a corpus dancer earns 27.000 DKK (Studentum, 2022). A principal dancer in the USA can earn from 33.000 DKK to 112.000 DKK a month (Loveland, 2018). According to Ask La Cour is ballet is the second most expensive education in Denmark and takes 15 years. It is estimated that a full education cost 120.000 USD and strikingly 24% of the combined costs are spent on 7 years worth of pointe shoes (Abrams, 2015). This indicates that ballet is elitist and is and only accessible to those who have the sufficient funds.

156 NYCB storage room

EXPENDITURE ON POINTE SHOES

Besides paying the staff at the company, are pointe shoes are the biggest expense. At the RDB each dancer is given 96 pairs each year (8*12). Multiplied with 67 ballerinas gives an estimate of 6.442 shoes each year (ca. 2.300 pointe shoes more than their financial manager explained). The cost of using a Freed pointe shoe per day is 400 DKK (if only using this shoe), however, if switching between the 8 pairs, the price will be 106.67 DKK pr day**. If our solution lasts a month (one Gaynor pair lasts 3 months), at a price of 1000 DKK/per, the cost will be 33.33 DKK per day. Though if given four pairs every second month (guessed estimate) the total price will be 66.67 DKK***. This results in 24 pairs of shoes for each dancer each year. A total of 1.608 pointe shoes a year for the RDB. Having a contract with 5 companies with the same size, this adds up to 8,040 pointe shoes per year. Despite this being a niche market the amount of shoes produced each year are quite substantial.

A Freed costs
400 DKK PER DAY

By rotating
(8 pairs a month)

106.76 DKK PER DAY**
(8 pairs * 400 DKK / 30 days)

Possible solution
33.33 DKK PER DAY

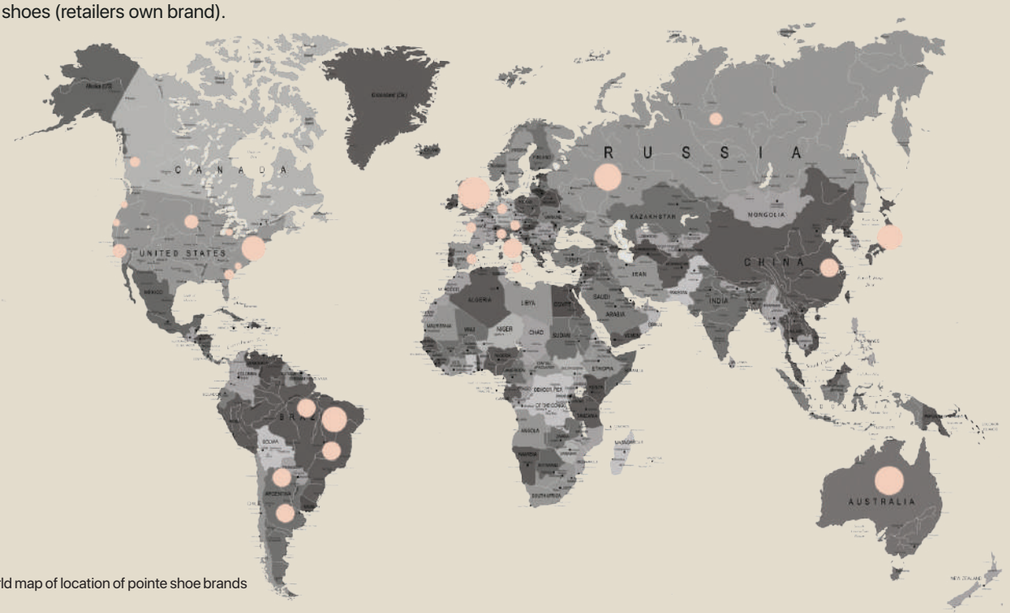
By rotating
(4 pairs every two months)

66.67 DKK PER DAY***
(4 pairs * 1000 DKK / 60 days)

POINTE SHOE BRANDS

The team investigated 80 pointe shoe brands (see Appendix 35), which at first seemed like a lot of brands considering the number of professional dancers in the world, but through further investigation, it became apparent that most of the 80 brands are actually white label pointe shoes (retailers own brand).

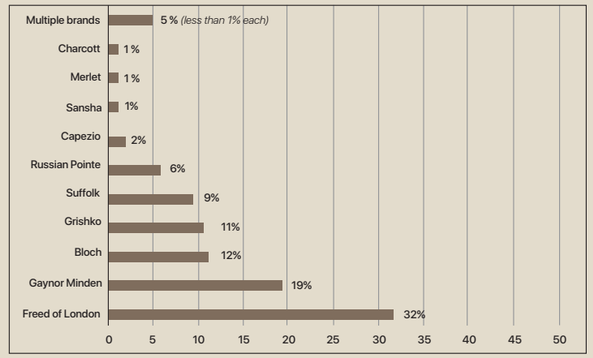
Underneath are the 30 most established brands, all mapped dependent on where in the world the brand is based. The bigger and more established brands are marked by bigger circles.



157 World map of location of pointe shoe brands

10 BIGGEST BRANDS

Following the analysis of the 30 brands, the team proceeded to analyse the 10 biggest brands (see Appendix 35) About half of these brands were established in the early 1900 and are still developing pointe shoes. The first point shoe brand was invented in 1910 - Italian Capezio (Kippen, 2013). Following the success of Capezio came Freed of London in 1929, who currently still dominates the pointe shoe market (Freed of London, 2021, b). In 1990 the first innovative pointe shoe brand Gaynor Minden was created. Now considered the most technologically advanced pointe shoe on the market today (Word, 2013). A study investigated the most used brands at several companies around the USA (Buckner, 2019), (see ill. 158). The distribution of brands shows that the US market is quite fragmented compared to the European market, where companies mostly buy from one manufacturer. Freeds however, are still the most used brand throughout the study.



158 Brand distribution of pointe shoes at USA companies (Buckner, 2019)

TRADITIONAL VS. INNOVATIVE BRANDS

Looking at the top 10 brands from the study, it is noticeable that there is a distinction between traditional and innovative brands (see ill. 159). Traditional, meaning utilising classical materials such as canvas, glue, burlap and satin. And innovative refers to trying to put new technology into the pointe shoes, often through the use of different materials than the classical ones, primarily polymers or other materials used in athletic shareware. But by investigating the current brand it becomes apparent that the world of ballet has had little to no change over the last 100 years. The only recent development was another thesis project of an industrial designer creating a 3D printed pointe shoe and a design student envisioned a pointe shoe created in collaboration with Nike (The pointe shop, 2021) (see Appendix 36). None of the concepts has made an impact in the industry, however, are highly talked about both online and throughout the interviews.

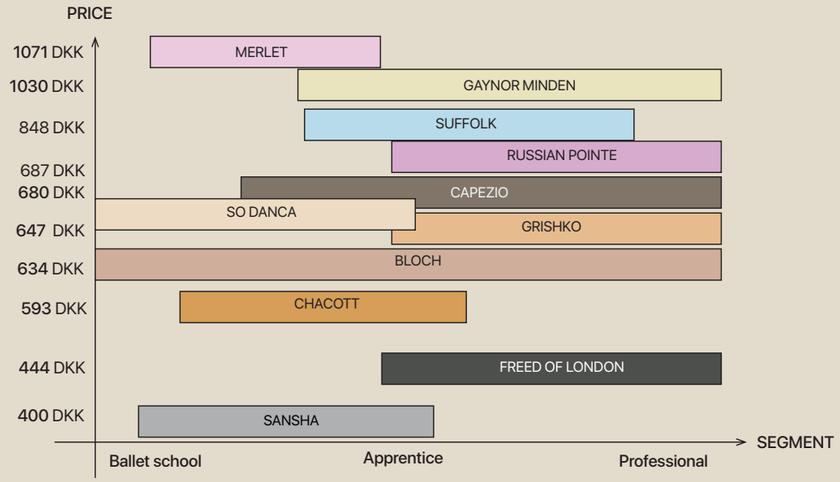
159 Traditional vs. innovative brands

TRADITIONAL	VS	INNOVATIVE
Freed of London		Gaynor Minden
Bloch		Merlet
Grishko		So Dancá
Capezio		
Sansha		
Chacott		
Suffolk		

Be an innovative brand

PRICES OF POINTE SHOES

With the use of systematic market segmentation, the team evaluated the 10 biggest brands according to segment and price. It became apparent that innovative brands are more expensive than traditional brands however, pay off in the long run. Despite there being 30 brands the industry is exposed to the same market form, being a differentiated oligopoly, with a few providers with differentiated products. The team did investigate the turnover of the 10 brands (see Appendix 35), however, these numbers are not representable, as many of the big brands (Capezio, Bloch, Sansha) also produce normal shoes and equipment and mainly profit from the sales of these.



160 Brand distribution of pointe shoes at companies (Buckner, 2019)

+ Pricematch the innovative brands

IDENTIFYING GAPS IN THE MARKET

To identify gaps in the market the team utilised the knowledge from the user insight and the analysed level of expertise (p. 26) to figure out our requirements for current pointe shoes and possible ways to improve the shoes and reach a new market potential. The levels Novice and Advanced beginner are excluded as both of these levels use stock shoes (see Appendix 37). It became apparent that the current pointe shoe does not meet the user needs and requirements needed at the level of expertise. Hereby enables the team to create a pointe shoe that reaches this market segment.

LEVEL	NEEDS / INSIGHTS	REQUIREMENTS	CURRENT MARKET	A POTENTIAL SOLUTION
EXPERT	The shoe needs to be performance-ready User need to have many performance-ready shoes (last longer)	Long-lasting performance-ready pointe shoes (trustful) Give lasting support		Last above 15.000 cycles of fatigue (see p. 60) Have more identical replicas Breathable pointe shoe (for swollen feet)
PROFICIENT	Working all day in a pointe shoe (12 + hours) Shoe breaks down - dancers change shoes every second hour A constant seeking of a performance-ready pointe shoe	A performance-ready pointe shoe Moulded box and shank Fit the dancer's flexibility level		Add breakpoints Integrated compression and expansion of the box from start (feels worn in from start)
COMPETENT	Need better fitted pointe shoes (as they are on point for 4+ hours) Need to look aesthetically beautiful on the feet (dancers are judged)	Fitted to the anatomy and flexibility of the dancers Look like an extension of the body (Follow the body lines, colour of body)	Personal fitting of the pointe shoes Coloured shoes	Help equalize the pressure (customized to individuals need) Difference between right and left shoe

161 What a pointe shoe should be able to do, depending on level of expertise

CONCLUSION

Working with professional dancers and creating a long-lasting performance-ready pointe shoe will fulfil the dancer's needs in a way no current pointe shoe does.

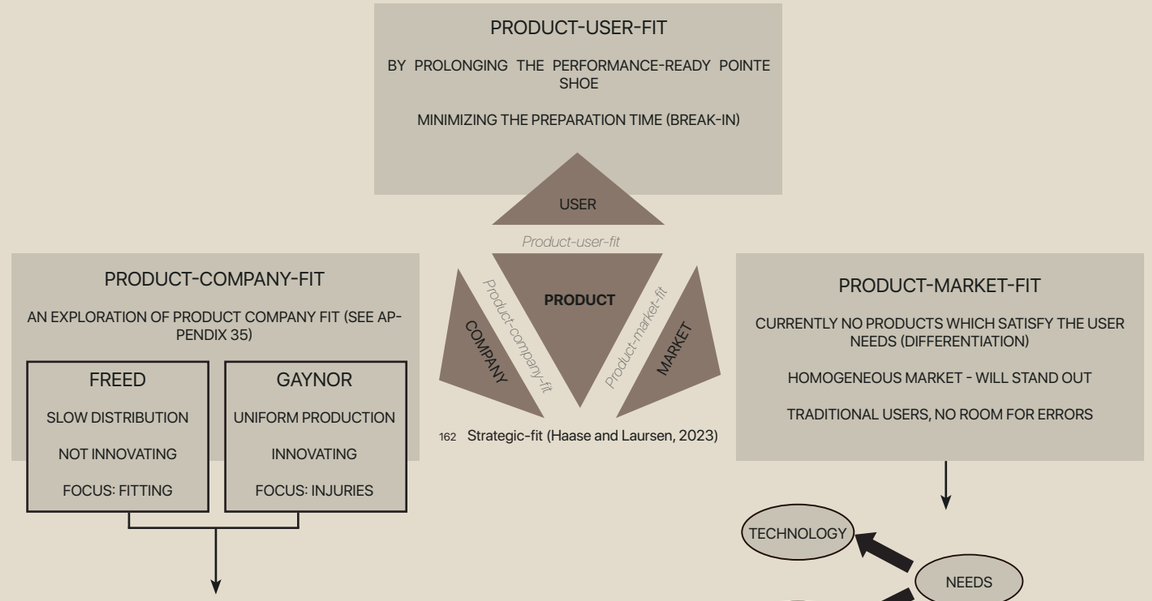
STRATEGIC FIT

As a part of the conceptual design stage and enforcing the product validity, the team turned to the strategic fit model to ensure that the product aligns with the resources that are available (Haase and Laursen, 2023).

THE STRATEGIC FIT MODEL

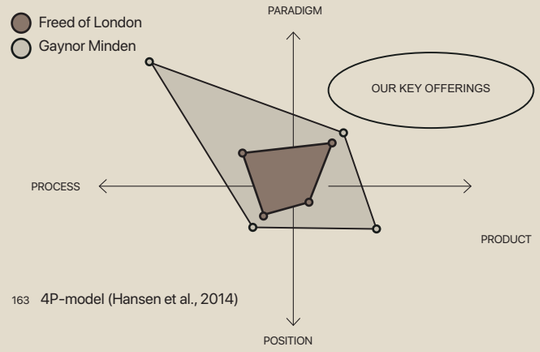
The strategic fit model is used to help companies overcome competitive challenges. The model is split up into Product-user-fit, Product-market-fit and Product-company fit and aim at helping the design align within these three categories and hereby receive a strategic-fit.

So far has the team has only dealt with the product-user-fit: developing based on their needs, aspirations and wishes (latent-needs). The two other categories will now be investigated to find a product-market & product-company fit (see Appendix 35).



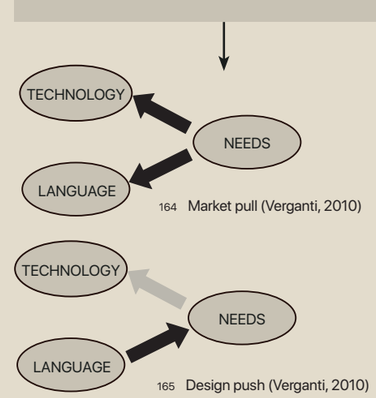
162 Strategic-fit (Haase and Laursen, 2023)

4P-MODEL



163 4P-model (Hansen et al., 2014)

Based on an evaluation of the two companies it became apparent that the team needs to pair up with Gaynor Minden. They utilise similar production methods and are an innovative brand - the scenario is a low risk for both parties. And the performance-ready pointe shoe will help with the Gaynor Minden's credibility.



164 Market pull (Verganti, 2010)

165 Design push (Verganti, 2010)

By utilizing the principles of Verganti (2010) it becomes apparent that currently the product is a market pull, where innovation tries to answer explicit and immediate customer need. However, to truly create radical design innovation, a design push must take place.

CONCLUSION

Based on the principles of a strategic fit, it is concluded that the team will need to work with Gaynor Minden as they are the best fit on the current market. The team also needs to tackle the language of the product to truly create product innovation and have a strong position on the market.

+ Strive for radical design innovation

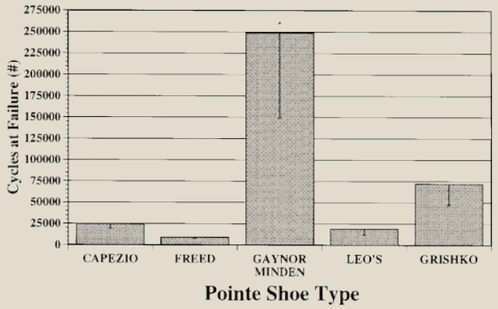
A PARTNERSHIP WITH GAYNOR MINDEN

As concluded through the strategic fit model, the best possible company to be working with would be Gaynor Minden. The team will now further investigate how a partnership with Gaynor Minden could develop.

A BRAND THAT LASTS

As previously stated, Gaynor Minden is one out of three innovative brands, but was however the first to truly branch into a new territory and succeed with it. The founder Eliza Minden have own ballet expertise and identified user needs from dancers hurting and designed to help create a pointe shoe that would be more supportive and help absorb shock better (balletomanehk, 2008). But while tackling the identified user needs the solution also tackled another common problem within the industry - overconsumption of pointe shoes.

While a Freed of London pointe shoe last an average of 8-9 hours (Buckner, 2019), the Gaynor shoes however, last three times as long (Dancewear, 2018). A comparative mechanical analysis of five pointe shoes evaluated Gaynor as the longest-lasting pointe shoe on the market (Cunningham et al., 1998). The Gaynor shoe withstood 250.000 cycles, where Freed withstood 15.000 cycles. And through the interviews it was told that Gaynors can last up to 3 months.



166 Five pointe shoes and their ability to withstand failure.

! R29 Last more than 15.000 cycles of fattigue

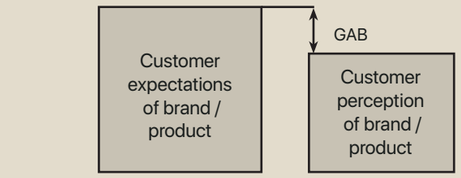
EQUIPPED FOR CHANGE

The aspect of lasting longer is also partially what frightens dancers of committing to Gaynor, as the added support in the shoe is synonymous with cheating. Exactly the same that Anna Pavlova (one of the most famous ballerinas through history) was accused of back in 1871 for darning her pointe shoe to give it more strength, something that now 151 years later has become a standard practice amongst dancers. Gaynor are therefore not afraid to stand out and push the artform in a healthier direction. They also gather thousands of professional ballerinas' testimonies to disregard of the bad reputation (Weinman, 2013, b).

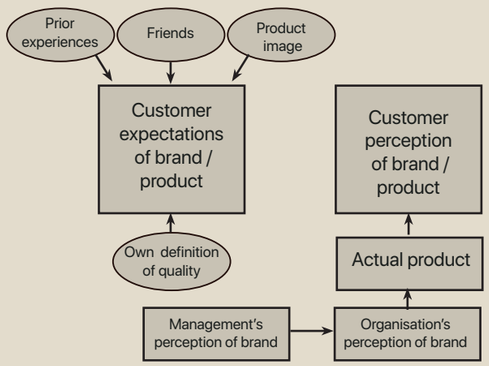
QUALITY GAPS

However, when investigating the brand further, the use of understanding the company's current customer gaps seemed appropriate (see Appendix 14)(Parasuraman et al., 1985). A gap is when customers' expectations are not met in terms of their actual perception when receiving a product (see ill. 168) And especially one major aspect keeps being discovered - the inability to do a roll through in the Gaynor pointe shoes. This is due to their toe box and shank being too hard and never reach the performance-ready spot or have the desired breakpoints. Another big gap is their current change in production setup. Moving from a outsourced production in the USA to their own factories in Eastern Europe. This change has created huge differences in the product, resulting in users not wanting their Europe-produced pointe shoe. This gap directly affects their core customer group, which is why it is valued as critical, especially since it can quickly influence friends or the product image.

So why is a partnership with Gaynor profitable for them? By partnering up with our solution Gaynor can benefit from the performance-ready aspect of the shoe, now creating the desired stiffness and flexibility to constantly be performance-ready. The solution can further help Gaynor cement them on the market as constantly seeking new innovation and change in the industry.



167 Quality domain, simplified (Parasuraman et al., 1985)



168 Quality domain, extended (Parasuraman et al., 1985)

CONCLUSION

Throughout this market investigation it became clear that besides the pointe shoe being a niche market there is nonetheless a comprehensive spending is on and destruction of pointe shoes each year. By partnering up with Gaynor Minden can both parties benefit from the collaboration, especially as Gaynor are using the same resources. The next step will be to investigate the outer exterior of the pointe shoe as it was concluded that a design push should be present to create radical design innovation.

TASK

05. / 8.

AESTHETICS

CHAPTER SUMMARY

This chapter focuses on the spiritual, the contextual, the principal and the material level, all four levels of the value pyramid (p. 5). The history and the traditions of ballet are investigated to help predict the future of ballet and pointe shoes. Further development are proceeded through sketching, mock-ups and testing. The chapter end in a final design brief.

Detailing

169 *Harry Styles, Pop icon*

TIMELINE OF BALLET

To truly comprehend a product, you must understand its history and origin, especially in the context of ballet which is synonymous with tradition. A timeline is conducted to understand the most crucial aspect of ballet and its influence on the industry today.

CLASSICAL BALLET
ROMANTIC BALLET
NEO- CLASSICAL BALLET
CONTEMPORARY BALLET

Renaissance period

15 & 16TH CENTURY

1581
Adapted into French culture by Catherine de´Medici

Ballet moves from palaces to stages

Baroque period

17TH CENTURY

Ballet originated from Italian **renaissance courts**

ITALIAN METHOD

1651
FRENCH METHOD

1661
First ballet school "Academie royale de danse" by King Louis XIV

Beauchamps invents "The 5 positions"

1737
RUSSIA METHOD

Female dancers starts to be accepted

1730s
Marie Camago invents the ballet slipper

1771
DANISH METHOD

Romanance period

18TH CENTURY

Modernism period

19TH CENTURY

1926
ENGLISH METHOD

1877
Tchaikovsky's music transforms ballet (Swan lake)

1832
Marie Taglioni is the first person to go on pointe

1937
AMERICAN METHOD

Balanchine brings Neo-classical ballet from Russia to USA

1950
One act ballet emerged

1970
Pointe shoes starts being painted in different skin colors

1990
Lauren Anderson is the 1st African-American ballerina to become a principal dancer in a major company.

Digitalism period

21TH CENTURY

2017
Pointe shoes are produced in more diverse skin colours

2020
Gender norms Men starts to wear pointe shoes

170 Timeline of ballet

TYPES OF BALLET STYLES

As Peter Brandenhoff introduced, are there three main types of ballet. Classical (romantic is also under classical), Neo-classical and contemporary. Each ballet style and its characteristics will now briefly be discussed.

171 Pas de deaux

CLASSICAL BALLETS

SWAN LAKE, CINDERELLA & THE NUTCRACKER

Classical ballet also referred to as the French method, is categorised by the classical techniques structured by Pierre Beauchamp's five positions. It is known for its pointe work, a turnout of the leg and high extensions. The dances are very precise in coordination with the music. Classical ballet has five elements that must be included:

1) It must tell a story – often a fairytale involving a boy/girl plot with a problem to be resolved by the end.
2) It must have costumes and scenery.
3) It must have music, and the music must go with the story (mainly classical).
4) It must have a "folk" or "character" dance.
5) The female dancers must wear pointe shoes and tutus ("classical ballet | Britannica," 2013).

172 Arabesque position in Giselle performance

ROMANTIC BALLET

GISELE & LA SYLPHIDE

All romantic ballets were produced in the 19th century and mark when ballerinas started to go on pointe to create the illusion of floating. After this, pointework became the norm for ballerinas. Big expressions, movement categorise the romantic era, and choreography turned into a story.
High leg extensions, precise movements and big turnouts (outwards rotation of the leg from the hip). Complicated sequences, and demanding steps (Pittsburgh Ballet Theatre, n.d.).

173 Famous posture form a Apollo performance

NEO-CLASSICAL

APOLLO, ROMEO & JULIET

Introduced by the Russian Sergei Diaghilev but made famous by his student George Balanchine, who expanded classical ballet into a new form. Balanchine gave ballet a new spin by mixing classical ballet with what later became a contemporary style. The style is performed in non-traditional costumes to highlight the story and characters. It values skills and techniques but manages to express the dance more rigidly than before.

174 Contemporary ballet

CONTEMPORARY

RAINBOW ROUND BY SHOULDER

Contemporary ballet is all about experimentation and creativity. Driven by the neo-classical movement, William Forsythe invented improvisation methods during the dance, which became the catalyst for the contemporary ballet style. It is a style that includes elements from classical ballet and modern dance. Not constructed to the rules- or the specific lines of classical ballet (Art factory international, 2018), it is described as a "plotless" ballet; without any storyline, the dance is held together by expressiveness, emotions and human endeavour and flexibility.

CONCLUSION

The ballet types have evolved throughout the years, especially in the last 70 years, where the style has become much freer, less bound by rules and more expressive and emotional.

THE EVOLUTION OF BALLET SHOES

Just as the ballet dance itself has evolved, ballet shoes also have. The expression of both the woman carrying the pointe shoes and their accessories will now be investigated.

175 Marie Camargo in high heels

In 1681 women were finally allowed to dance ballet. They danced in narrow, small heeled shoes in different colours and ornaments matching their decorated costumes. Their dresses were cut between ankle and knee to showcase their foot techniques. This, at the time, was considered vulgar, especially with their low cut necklines.

17th CENTURY

Both men and women wore high heels as this was the fashion in the aristocratic scene. Even king Louis XIV wore high heels. The shoes were made of silk.

178 High heeled ballet shoe

176 Marie Camargo

In 1730 made, Marie Camargo the first ballet slipper by removing the heels on the shoes. It allowed her to expand her movements and jumps. In 1790 invented, Charles Didelot a "flying machine" that lifted the dancer to give the illusion that the dancer was flying. Their dresses still resembled the dresses in the court, but now with lower necklines to showcase their chest.

18th CENTURY

Ballet dancers were at this time considered vulgar as they entertained the upper-class of society and often men. The ballet slipper was made in silk, colours and ornaments.

179 First flat pointe shoe

177 Marie Taglioni

1823 Marie Taglioni is the first person to go on pointe. The ballet slipper was changed into a square toe, leather sole and tied ribbons around her toes and ankle. The tutu entered the industry in the 1870s when the skirt became wider and above the knees to showcase their more complicated footwork. However, this made society suspect the dancers' were prostitutes.

19th CENTURY

Dancers started between 1870 - the 1890s to reinforce their toe boxes with newspaper and flour paste, allowing the dancer to do more steps and pirouettes on pointe. The pointe shoe continued to be narrow as it looked, then helped it look like a leg extension to enhance the floating effect. The slippers were made in satin fabrics matching the colour of the stockings.

180 Marie Taglionis favourite pointe shoe colour

181 Anna Pavlova

Anna Pavlova creates reinforcement in her pointe shoes due to unstable arches (between 1910-and 1930s) By adding a sole of leather and extra support in the toe box. She collaborated with Salvatore Capezio to launch the first pointe shoe brand. The pointe shoe was made of canvas and glue, with a small and narrow toe box and darning around the platform to make it round and more prominent.

19th CENTURY

Society started to dress more loose fitted dresses, showing the shoulders and legs to the knees. And later become much more practical. The tutu skirt is moved further up the legs and becomes wider. The pink colour is worn everywhere.

184 Anna Pavolas darned pointe shoe

182 Ballerina in tutu

In 1990 launches Gaynor Minden a new pointe shoe with a polymer core and shock absorbent foam to make it more springy and last longer. The bodice becomes skin-tight, and the tutu gets wider at a 90-degree angle to showcase the whole leg and enhance the long lines of the body. The preferred look of a pointe shoe is still narrow as it creates the illusion of dancing on the toes.

19th CENTURY

As ballet becomes more athletic, the dancer goes more en pointe, and the stages become bigger - the shoes become wider and give more stability. The big stage allows the dancers to have a wider platform without it not looking like they were en pointe. Companies start to colour their shoes to make them look like their skin colour.

185 Gaynor Minden pointe shoes

183 Maxfield Haynes dancing in pointe shoes

Society's recent re-examination of gender roles has made more pointe shoes accessible to all gender identities. To increase comfort, dancers use inserts to put inside their pointe shoes. The industry is seeing a flourish in insert products.

20th CENTURY

Pointe shoes start to be hidden with tights to mask their exterior and make them look like an extension of the body. In 2018 the largest brand Freed of London began to produce four different pointe shoe colours to make the shoe blend with more dancers' skin colours.

186 Pointe shoes covered by black tights

Sources: (Bata shoe museum, n.d.) (Guiheen, 2020) (Footalk, 2019) (Blakemore, 2018) (Looseleaf, 2007)

CONCLUSION

The ballet types have evolved throughout the years, especially in the last 70 years. The style has become much freer, less bound by rules and more expressive and emotional, still pushing boundaries as ballet has always been viewed as provocative.

- Honour tradition and old perception of dancing on toes
- Be an inclusive brand
- Proceed to acknowledge the provocative image

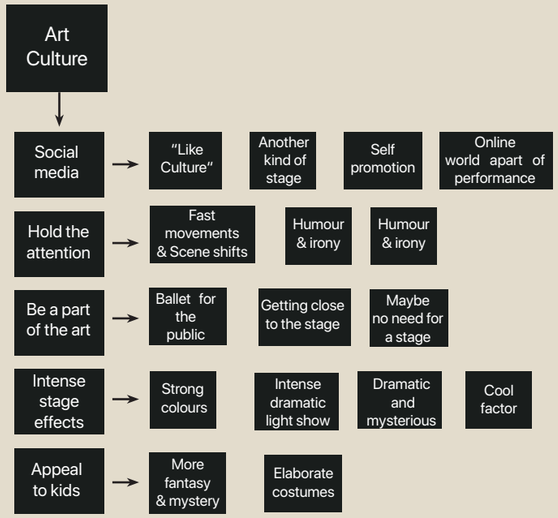
TRENDS AND TENDENCIES

Based on the investigation of both the history of ballet and the evolution of the pointe shoe the team proceeded to look into trends and tendencies to help envision the future of ballet and pointe shoes.

MEGATRENDS

To enter the world of trends and tendencies, the team highly relied on methods such as "Peers observing peers" and "trend analysis" (Lewrick et al., 2020) (see Appendix 38). The peers observing peers way is where observations on behaviour are listed, commented upon and interpreted. The insights are gathered and categorised into a trend-analysis board to visualise them and find megatrends.
The team evaluated that ballet is not in the direction of expanding into an elite sport, even though ballet competitions have become more popular. If ballet moved in a more athletic direction it would become more like gymnastics, and the distinction between the two lies in that ballet is an art form. Therefore, it is essential to look at what other aspects of the world of art and culture navigate within.

Therefore, the team investigated the world of art and culture to see what was popular in the segment and what appealed to the younger demographics that will become the future watchers of ballet.



187 Mapping of mega trends

NEXT STEP FOR BALLET

A mood-bard was created to showcase and highlight the intended criteria and direction for the future of ballet.

1 Quirky and humorous performances: Jerome Robbin's "The Concert" is a fun and humorous ballet where the audience laughs at the choreographed mistakes. The ballet is simple with no need for scenography, only accompanied by a piano. This one ballet could indicate a future genre of combining comedy with ballet.

2 The NYCB had a famous photoshoot with American Vogue, emphasising their body figures, musculature, strong posture and the official entrance into ballet, where the body's natural form is preferred, contradictory to what is the norm in Europe (slender body, p. 18).

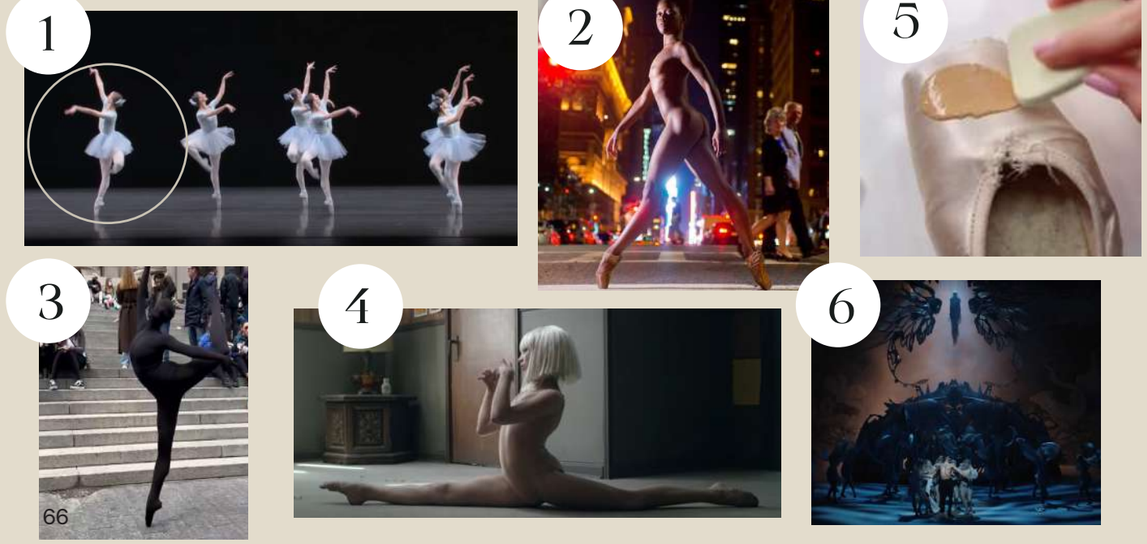
3 NY is the epicentre for propulsion. In NYC, ballet dancers start have started among people in public spaces. Trends and tendencies from NYCB take at least five years before arriving in Copenhagen. This dancer lets the dance speak for itself and refers to Kim Kardashians' fashion statement (Met Gala 2021).

4 Quirky and humorous performances: Singer Sia's music video Chandelier made headlines with dancer Maddie Ziegler's crazy, quirky and emotional character, expressing ballet differently from before.

5 "Pancaking*" is to put foundation on the pointe shoes to make it a skin colour. The foundation quickly deteriorates due to the sweat and wear and tear of dancing. More companies perform modern ballets and require darker ballerinas to have shoes that do not distort the lines.

6 Royal Danish Ballets' stenographic setup is dark, mysterious and intriguing. Designed by Anja Vang Kragh and Mia Stensgaard and reinterpreted by Nikolaj Hübbe. The play had massive success across the country, both among young and old.

! Fit all skincolours

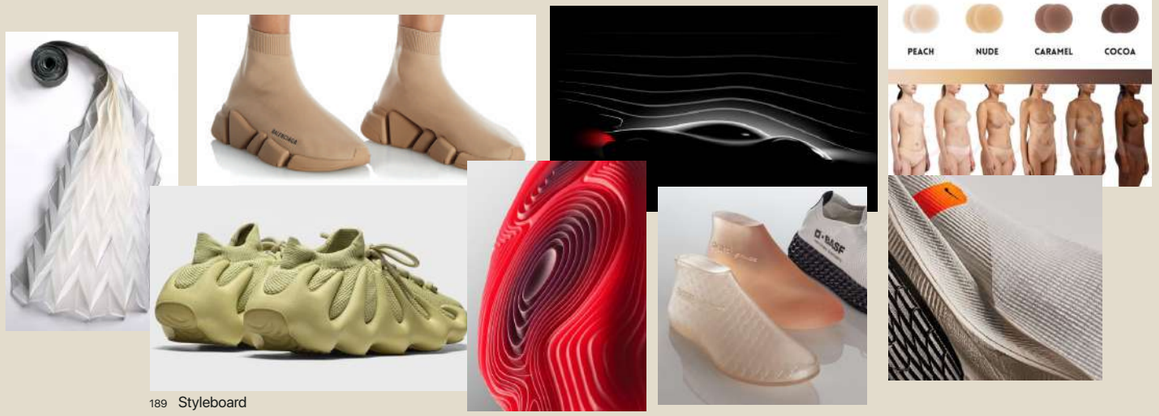


188 Mood board

STYLEBOARD

Based on the mood board for the future of ballet, the team started to wonder what a shoe should be able to express as the artform is being moved closer to the audience and becomes more seamless and a complete extension of the body.

The team created style boards to help the sketching process (see Appendix 39).

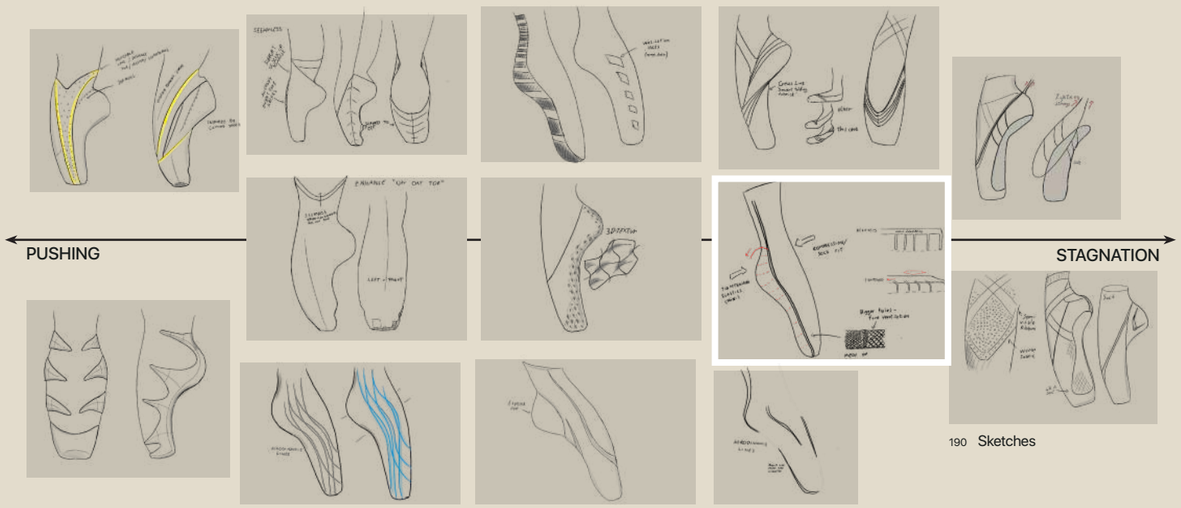


189 Styleboard

PERCEPTUAL MAPPING

Following the sketching round (Appendix 39), each concept was evaluated with the help of perceptual mapping (QuestionPro, 2021). This was to categorise how much the ideas push the industry vs stagnating.

The team decided on a simplified aesthetic to not push the industry too much but still create references to the classical shoe and their tradition to extend the lines of the body(see white highlighted box).

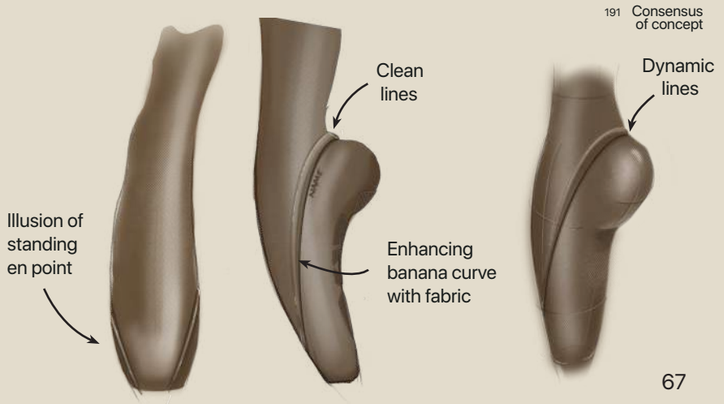


190 Sketches

COMMON UNDERSTANDING

The team created a visual understanding of where the team was heading and gave consensus among the members (see Appendix 39).
The aesthetic look of the pointe shoe should have an overall clean look, with no bumps and creases. It should generally look nice and neat as the audience moves closer to the dancer. Through dynamic lines, the team intends to help create illusions of emphasising standing en point while also creating a homage to the classical pointe shoe and highlighting the banana curve.

A smooth surface on sock-part +



191 Consensus of concept

TEST AND DEVELOPMENT

Following the common understanding of where the team was heading, the team relied on testing, sketching, and modelling to detail the shoe's exterior further.

SOCK TEST

As the team was set on evolving the currently preferred lines (Freeds) into a new concept, the use of stockings and an existing Freed of London shoe were used.
By covering a pointe shoe (with five layers), the team achieved a seamless look. However, it became apparent that every crease underneath the stocking was still noticeable. By taping an elastic band onto the pointe shoe, the team achieved the desired visual effect on the exterior. Several different placements of the elastic were tried (see Appendix 39), to figure out how to achieve the desired shadows bests. Adding a thick elastic onto the shoe created shadows that enhance the illusion that the dancer is on pointe.

192 Test with a pointe shoe with a stocking & elastics on top.

SUPPORT AND ELASTICS

Following the stocking test on the existing pointe shoe, the team tried testing developed components into a whole unit. The box and shank were inserted into a tennis sock. Through the testing, it became apparent that the components need support, both near the wings and to make the shank hug the foot's arch. The team proceeded with a low practical solution of taping the sock in different placements to create the desired support (see Appendix 39). Once the testing was complete, the team settled on having two places of support (see ill. 193), ensuring constant contact with the foot and sole (shank).

R30 Always contact between shank and feet !

193 Test of lacking support

194 Test of places to place support

FURTHER ELASTIC TEST

The team proceeded to create one whole unit. By creating a complete product architecture (see Appendix 40) of box, shank, sock and every internal patting, the team finally created one prototype that looked like a pointe shoe (see ill. 198, 199 & 200). The internal structure required nine components, including an inner sock to hold everything in place and create comfort for the user (more on this under production). But the team needed to make sure that the shoe would also sit correct (and feel as tight as possible) on the dancer while supporting the components where they needed to.

The team started to investigate products where the shoes needed tightening. Especially the knowledge of how a snowboard boot is tightened was knowledgeable, as the rider loses control if the shoes are not correctly tightened(see ill. 197, Blue is lower zone and brown is upper zone). The same tightening principle was added to the pointe shoe, and after a couple of adjustments, the correct placement of the channels (the placement of where the ribbons run) was in place. The team now needed to re-insure that the interaction with the product also made sense.

Elastics should not hang loose +

195 Capezio, fizzion shoe

196 Nike Offline pack

197 Burton Moto snowboard boot

198 Testing of elastics #1

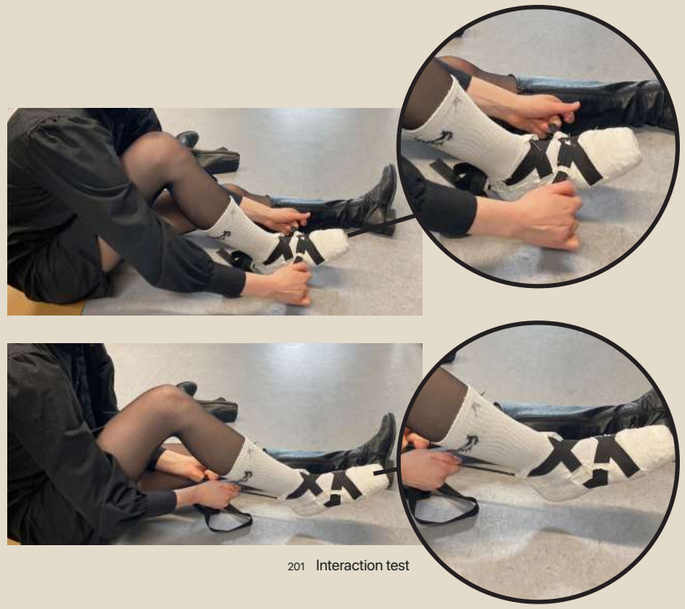
199 Testing of elastics #2

200 Testing of elastics #2

INTERACTION

Following the first construction of a combined prototype (see ill. 201), the team began testing the user interaction. This was especially getting in and out of the shoe and how to lock it correctly in place.

The prototype only tightened in the heal region, but it quickly became apparent that this did not draw the pointe shoe sufficiently near the toe box area. The team then decided to leave a piece of the elastics bare to allow the user to adjust the lower part of the pointe shoe, the same way the snowboard boot has two zones, an upper and a lower zone tighten. This change also helps the user easily pull the elastics the other way to get out of the pointe shoe. The overall product modality is very functional and enables the user to align the action to the reaction.



201 Interaction test

SECURING ELASTICS

The team further investigated ways to secure the elastics safely but settled on a tightening mechanism to keep the elastics from moving. The team also identified that this tightening mechanism should not be placed directly on the Achilles, as this will be annoyed during dancing. However, it should be placed a bit on the inside of the foot, where a small pocket is formed (between Achilles and the tibia bone, see ill. 202). The mechanism should have tactile or auditive stimuli to let the user know that the elastics are well secured. This is quite important as this will help the dancers not get a reduced salary (see p. 17).

202 Test of closing mechanism

WOVEN FABRICS

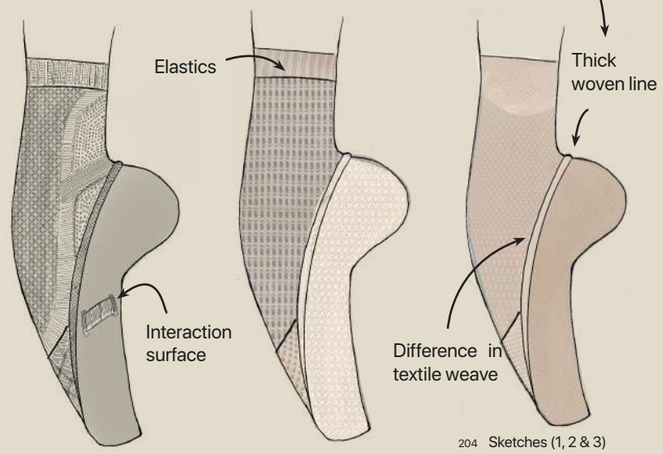
Following the interaction test, the team began looking into different weaving structures to help create zones within the product. A new sketching round was created. Especially breathability was important, as bigger holes in the construction can help with the overall ventilation of the shoe. The team also wanted the textiles to look as natural as possible, as they should not create too noticeable features, but more have a "skin finish", if possible. The big "vein" resembeling the classic pointe shoe will be created like a thick woven lining (see ill. 203, C) The team settled on the use of a bigger seamless elastic, as this would help the sock stay secured to the calf. By leaving the elastics bare (near the toe box, see 1st sketch), the team also created a visible feed-forward and affordance on the shoe and a deliberate break in the surface structure.

SOLE

The team also investigated different materials or anti-slip surfaces for the outer sole (see Appendix 41). However, based on the insight from Peter Brandenhoff that contemporary dancers more utilise socks to slide around on stage, the team settled on still allowing this movement pattern. However, this shoe also allows for the slide and then going on pointe, just as Peter hoped the future moves would look like (see Appendix 04).

Deselect the need for a sole & anti-friction ×

203 Different weaving patterns (A,B & C)



204 Sketches (1, 2 & 3)

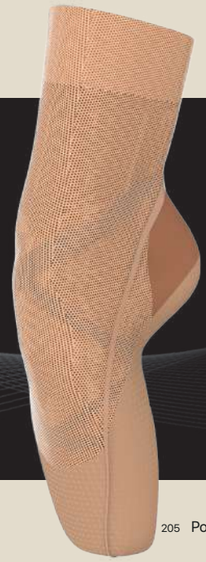
AESTHETIC DIRECTION

Following the performed analysis, test and synthesis processes, the team finally settled on an overall structure for the pointe shoe.

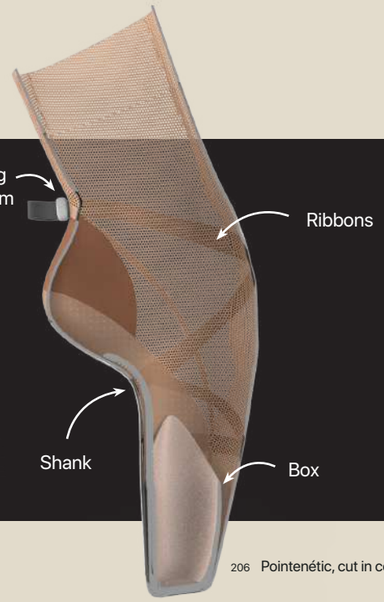
The Pointenétic pointe shoe was presented at the Milestone. The pointe shoe aims to try to push ballet into a natural, honest and inclusive aesthetic. The concept combines all aspects that have been processed so far from functionality, construction, and aesthetics.

Pointenétic Genétic

Prepared, Powerful, Precise, Poetic, Performance, Physical, Piquette, Pointe, Pas de Deux, Plie, Playful, Professional, Provocative, Practical, Popular, Proper, Priceless, Praiseworthy, Pleasant, Passionate, Permanent, Persuasive, Photographic, Positive, Promising, Public.



205 Pointenétic



206 Pointenétic, cut in construction

PERSONALIZATION

The team is further looking into how the ballerinas can personalise their pointe shoes. From the first visit, several potential aspects came to light (See Appendix 42).

1) The dancers write underneath their dead pointe shoes if they have had a memorable performance, just like badges on a scout uniform. This type of personal relation the team intends to highlight. It could be created by the texture of the woven fabric, allowing for further customisation with embroidery.

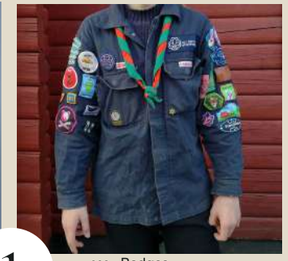
2) Each dancer writes their name on their pointe shoe to differentiate them from the other pointe shoes. The dancers also write left and right to tell the shoes apart. Even though the team's solution is not uniform, the team intends to have a woven R or L, as some tennis socks do.

3) The team quickly understood that darning was either completely loved (and had become a signature of some dancer's pointe shoes) or was hated entirely and more a chore. For this reason, the team intends that the darning can be optional. The darning can either be pre-sown in production or a personalisation aspect, as some dancers think it makes their pointe shoes last longer and gives more stability.

R31 Visual difference between right & left shoe !

Personalization of pointe shoe +

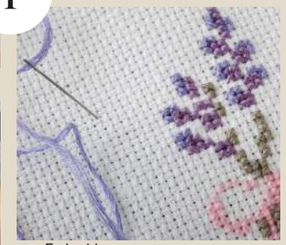
207 Memorable performance



208 Badges

1

209 Markings



210 Embroidery

2

211 Darning

3

212 Personalization, name

CONCLUSION

The team has developed the outer exterior of a pointe shoe that tries to contribute to the further involvement of the world of ballet. By pushing the aesthetic look and function, the team aims to make an impact and become one step closer to creating radical design innovation.

DESIGN BREIF 3.0

CRITERIRA LIST

The team utilised the Kano Model based on user satisfaction and needs. It is divided into three categories Basic, Performance and Delighters; Basic is the users 'must haves', and Performance is 'More is better', which brings the user something new and better. Whereas Delighters is unexpected and a 'nice to have'. As chocolate on the pillow in hotel rooms (Verduyn, 2020).

	PERFORMANCE	BASIC	DELIGHTERS
BOX	• Support the toes when en pointe • Expand & compress with feet movement • Give dancer ground feeling	• Box vamp height fitted to the length of toes • Box width fitted to the length of the crown on feet • Angle of the platform: 10° • R5 on the bottom-back curve of platform	• Equalise the load pressure • Limit inserts
SHANK	• Break-points fitted to dancer's foot size • Support phalanges when going en pointe • Always contact between shank and feet	• Shank fitted to the length of feet • Support arch when en pointe	
SOCK	• Secure all internal component to feet • Fit all skin colours	• **Sock fitted to the length of feet**	• **No wrinkles and creases on the surface** • **Personalisation of pointe shoe** • **Pre-sown darning**
ALL	• Last more than 15.000 cycles of fatigue • Be performance-ready from new • Minimise rotation between pointe shoes • Uniform replicas • A visual difference between right & left shoe • Price match the innovative brands	• Withstand ten times a ballerinas weight • Not deteriorate by sweat • Ability to do roll through without doing any workarounds to the pointe shoe • Follow aesthetic perception of the ballet industry	• Not add more components to the bag • Radical design innovation • An innovative brand profile • An inclusive brand • Must be breathable

PROJECT OVERVIEW

The team created Pointenétic, a pointe shoe that tries to renew both the inside and the outside of the pointe shoe construction. The outer exterior of Pointenétic aims to push the current aesthetic preferences and enhance the connection to inclusivity and functionality. The team has created a pointe shoe that replicates the desired values for a performance-ready pointe shoe by testing and developing the internal structure. It still needs to be tested and verified to evolve further and solidify the product. Partnering up with Gaynor Minden will evolve Pointenétic into yet another innovative push while staying competitive in the market. Precisely how will be further investigated, as the team intend to keep within a budget range of 800-1200 DKK., while still meeting functional requirements of the pointe shoe.

INTERACTION VISION

"The product will be **reliable** as your partner in crime, as **familiar** as your mother's perfume and feel as **prepared** as being in the front-rank position in a race, ready from the get-go."

TASK

06. / 8.

PRODUCTION

CHAPTER SUMMARY

This chapter focuses on the material level of the value pyramid (p. 5). It focuses directly on the with detailing, defining and synergy of the product components and the manufacturing process. A cost estimation is also developed.

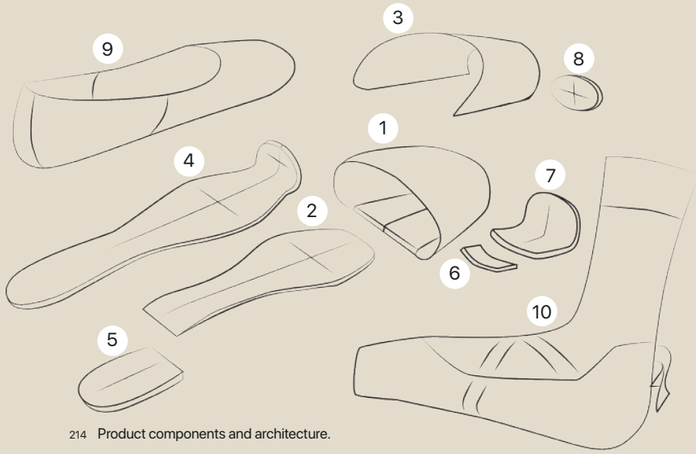
Detailing

213 Aluminium shoe sole mould

PRODUCT ARCHITECTURE AND MATERIALS

The productional aspect will now be investigated regarding the materials and production methods. Through a function-based modular product architecture, the team will accommodate different sizes and shapes.

The development of the first functional mock-up (see ill. 201, p. 69) led the team to create patterns of how Pointenétic internal construction would look. It consists of ten components listed below (see ill. 214). Materials will be explained, some inspired by Gaynor Minden's use of materials and production setup.



214 Product components and architecture.

BILL OF MATERIALS

1 Box (HDPE)
2 Shank (PC-ABS)
3 Box inner lining (1 mm EVA foam w. lining*)
4 Inner sole (2 mm EVA foam w. lining*)
5 Heel cushion (2 mm EVA foam)
6 Shock & noise absorbing pad (2 mm EVA foam)
7 Shock absorbing platform patch (1 mm foam w. lining*)
8 Toe pad (2 mm foam w. lining*)
9 Inner sock lining* (0,5 mm)
10 Woven outer sock (2 mm PET) w. elastic ribbons (25 mm) and lock lace

* Lining: *a PET, moisture wicking silver ion fabric.*

1-2 PLASTIC PARTS

The box and shank (parts 1 and 2) are plastic parts designed to have flexibility and stiffness in their functionality (see chapter 3). The materials chosen are HDPE and PC-ABS due to their resistance to sweat and easy production capabilities. Injection moulding makes it possible to create changing wall thickness, and high production volume, and keep replicas uniform (Thompson, 2007, 50-63).

3-8 FOAM PARTS

Part 3,4 & 8 are all parts made of EVA foam. The parts in contact with the foot (part 3, 4, 7 & 8) have an outer lining to create a smooth surface with the skin (see lining under textiles). The EVA foam is chosen as it creates a mouldable layer when exposed to heat. The foam great material memory capabilities, allowing the user to mould their feet inside the shoe when dancing (Thompson, 2017, 118-121). The specifically chosen EVA has antibacterial properties and are commonly used in insoles (dgyqeva, n.d.). Part 5 & 6 are made of shock-absorbing foam.

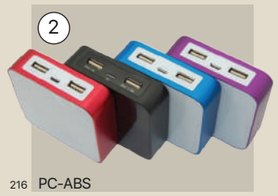
9-10 TEXTILE PARTS

Part 9 is made out of *moisture-wicking silver ion fabric*. The fabric is composed of PET fibres knitted into sheets. The function of the inner sock is to keep the plastic- and foam part snugs to the foot and create a rigid heel cap, therefore needing to be non-elastic. The fabric is chosen for its quick-drying and breathable properties, helping transport sweat away and reducing smell (Sportingtex, n.d.). Part 10 is also composed of PET textile, though in an elastic and durable blend. Being a high-performance textile with versatile applications, it is commonly used in shoes. PET do not contain BPA, phthalates or dioxins, ensuring that it is safe to have on the body for an extended time (Thompson, 2017, 152-163).

0 ASSEMBLY, GLUE

A special glue, the *Permabond TA4600* series, is needed to assemble the two plastic components (shank and box, see Appendix 43). The rest of the shoe is connected with glue, which is commonly used in shoe production.

215 HDPE caps



216 PC-ABS

217 EVA foam insole

218 Anti-bacterial EVA foam

219 Moisture wicking silver iron fabric

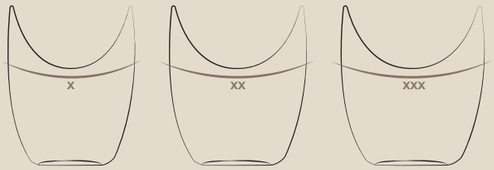
220 Fly-knit weave, PET integral knitting

CONCLUSION

The materials for the construction are chosen and the team will now proceed with the production of the ten parts.

PRODUCT VARIATIONS

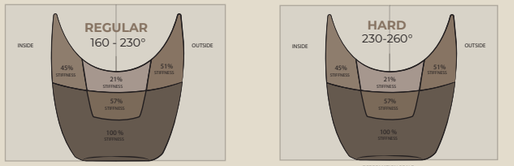
To properly fit a shoe to a dancer, variations are needed to accommodate different foot types. To accommodate this, shank and box will be constructed in various sizes. Pointenétic will range from size 35 to 42 and include half sizes, giving a combined number of 16 shoe sizes. The different variations and their reasoning are listed below.



221 Three widths of box in common notation (X, XX & XXX)

WIDTH OF THE BOX

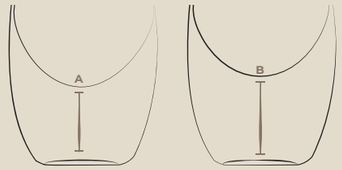
The box's width depends on the measured width between the phalanges and metatarsals (see p.42). All big pointe shoe brands carry three widths - resulting in the team believing all sizes can be accommodated in three width variations.



223 Regular and hard strength

RANGE OF THE STRENGTH

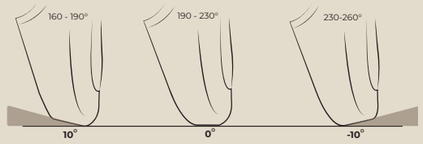
The stiffness of the box is dependent on the dancer's flexibility, and the support they feel they need. The difference is an increase in the wall thickness geometry, (see Appendix 19).



222 Two heights of the box (A, B)

HEIGHT OF THE BOX (VAMP-LENGTH)

The height of the vamp is dependent on the length of the toes and how flexible the dancer is. If they are really flexible, the dancers will need a higher vamp, so they do not knuckle over (see ill. 84, p. 41). The vamp variations result in two geometric changes to the part.



224 Flexibility in relation to platform angle

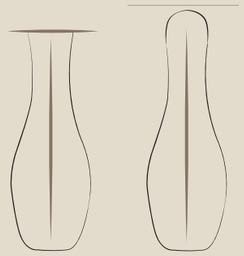
ANGLE ON PLATFORM

Dependent on the dancer's flexibility and aesthetic preference, most dancers want 10 degrees. This results in three geometrical changes to the box.

228 Eight full sizs (no half sizes)

SHANK SIZE

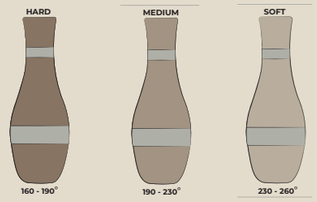
From previous studies, it is concluded that the breakpoints follow the sizes of the dancer's feet. (see p. 43) To minimise the number of shank length variations, the shank will not be produced in half sizes. Resulting in 8 different shank geometries.



230 Two shank lengths

3/4 OR FULL SHANK

The shank length depends on the dancer's preference. It is most common to have a 3/4 shank because it provides more stability when en pointe. However, dancers with injuries are required to wear a full shank, and so are dancers at the competent level. This also means a geometric variation of the part.



229 Three hardnesses

SHANK HARDNESS

The stiffness is dependent on the dancer's flexibility and the amount of support the dancer requires when en pointe. This variation will happen through a material variation. The hardness of the PC-ABS shank varies in hardness, created through a different blend of PC and ABS. The soft shank will have a higher amount of ABS and the hard one will have a mixture with more PC, to stiffen the shank (Liu & Yao, 2013).

CONCLUSION

The shank will be made in 16 different geometric variations, eight sizes and two different shank lengths. These 16 variations will be produced in three different hardnesses, resulting in 48 shank variations. This resulted in a total number of 36 box variations. However, if the team only produces one platform angle (10 degrees) the number will be lowered to 12 variations, significantly less.

PRODUCTION METHOD

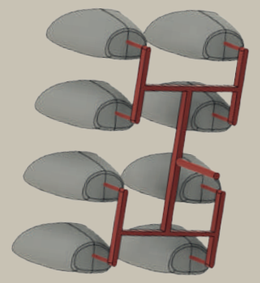
Having split the shoe into individual components, found their respective materials, and estimated the number of variations needed for a start-up scenario, the team will now investigate suitable production methods for each component.

INJECTION MOULDING

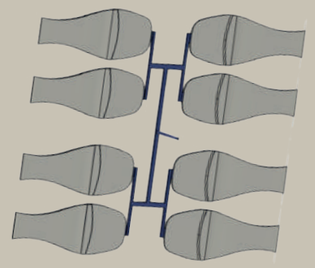
The box and shank are both produced in plastic materials. The box will have 36 different variations, the shank will have 16, and all variations will have the same interface to make them compatible across all variations.

Injection moulding allows for high volume production and can make the geometries for the component while using the chosen materials. The parts need to be manufactured by suppliers who have the experience to operate the machinery. The many variations of components and size of the intended production make for utilising multi-cavity injection moulding, as it is the most cost-effective setup in this scenario (see Appendix 44). This minimises the number of tools needed for production and optimises the cycle time per unit (see Appendix 45). This, however, requires a bigger machine, and more complex tooling with runner systems.

225 Multi cavity injection moulding tool setup.



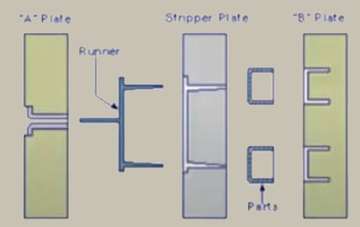
226 Multi-cavity runner system box tool



227 Multi-cavity runner system shank tool

INJECTION MOULDING, HDPE

The box part (part 1) is designed to be produced by injection moulding, fitting it with draft angles. HDPE is generally an easy material to injection mould; but its low shape stability and high thermal expansion rate can create challenges. A way to ensure material predictability is not to use colour and only use raw granule (Interview with Erik Appel). The thermal expansion means it shrinks when cooling down. This results in using a cold runner system (Starmould, 2021). The geometry and wall thickness of the component means that the material should flow from thick to thin (Erik Appel Jensen), resulting in the injection point, being positioned at the platform. The tool setup is a cold runner system with a stripper plate. Allowing the optimal injection rate (Mold technology, 2011). The draw depth of the component and a three plate mould setup, results in the need for a steel tool, allowing for a higher volume. The set-up for production would require three, eight cavity tools, valued at 250.000 DKK per tool, (see ill. 226),(see Appendix 44 & 45).

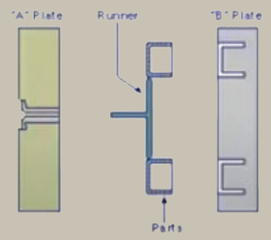


231 Tree plate cold runner system

INJECTION MOULDING, PC-ABS

The shank is a flat component, and has been fitted with draft angles to accommodate the production method. ABS is an easy material to mould; however, introducing PC makes it more complicated. This is because PC can introduce residual tension that can self trigger and damage the part when hardened. Manufacturers in Denmark and Europe know how to avoid this, but in Eastern Europe, probablynot (Erik Appel Jensen).

The injection moulding tool is a simple two-part multi-cavity set-up with a cold runner system, due to the flat geometry. The injection set-up has a flat gate at the tip of the part (Mold technology, 2011). The two plate mould and the limited draw depth allow the tool to be made in aluminium. This makes the tool cheaper to produce compared to steel. The production setup requires two eight cavity tools valued at 90.000 DKK per tool (Appendix 44 & 45).



232 Two plate cold rubber system

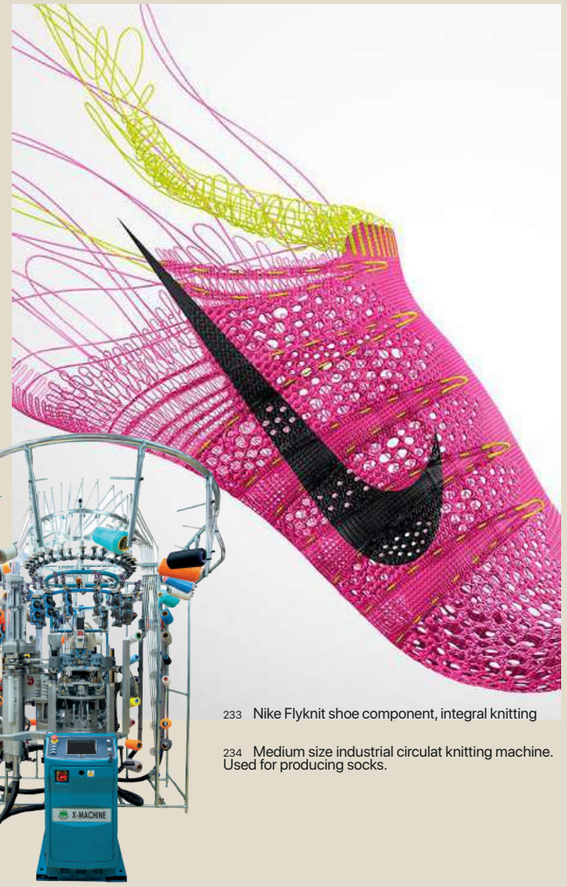
INTEGRAL KNITTING

The production method requires a large production setup of a circular knitting machine. The machine creates interlocking threads. These woven structures can be altered as wished because the yarn is not oriented in a specific direction and can vary according to the component's specification (chinahanma, 2021). This makes it possible to create a component consisting of different weave structures that vary, creating support and stiffness in one place through a tight knitting pattern and creating thin meshes in other places for elasticity and breathability. It can alter the design according to aesthetic preferences and colour variation in different areas; the possibilities are many.

The knitting is composed of countless spools of threats. This means that if wanting to create different colours in the weave or pre-made darning, it only requires changing programming and the spools of thread. A component like this, will be sourced at a subsupplier due to high machine cost and the need for experience and knowledge to operate the machine properly.

It is a very complicated knitting machine and a science in itself to use properly

– *Scott Lee Roberts*
Technical product manager at ECCO Shoes



233 Nike Flyknit shoe component, integral knitting

234 Medium size industrial circulat knitting machine. Used for producing socks.

CUTTING PATTERNS

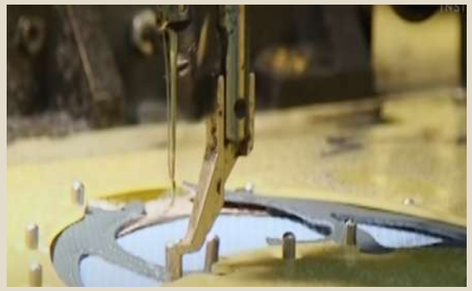
EVA foam and fabric lining are sourced from suppliers and come in sheets. The various components are cut out using a metal cutting template for stamping (see ill. 235, A), securing consistent component shapes and minimising the time spent peppering the parts for production. The difference in sizes is met by using different cutting templates (Business Insider, n.d.).

The components that need to be stitched together are laid out and flat-stitched together. More intricate stitching is performed manually. Flat stitching by machine (see ill. 235, B) allows for more durable and consistence stitching. In contrast, hand stitching (see ill. 235, C) allows to reach the intricate areas and make optional stitching or corrections. Both are widespread practices in high-volume shoe production (Business Insider, n.d.).

235 New balance production line steps, A .

The cutting mashing presses the template knife through the material, cutting out fabric and foam patterns.

B.



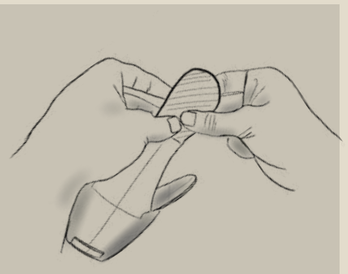
Flat stitching by machine is done on a template. Flat stitching is used because it does not create any overlapping threads and creates a durable connection.

C.

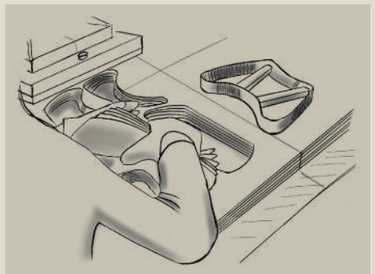
Hand stitching the more intricate areas where human guidance is needed.

ASSEMBLY SCENARIO

The assembly only focuses on the shoe assembly, not focusing on the manufacturing of the individual components.

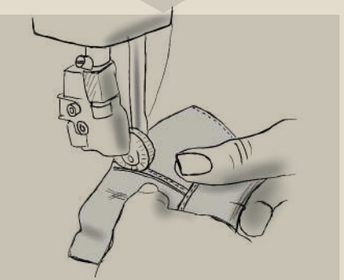


The stamped out foam components (parts 3-8) are glued to the box and shank assembly.

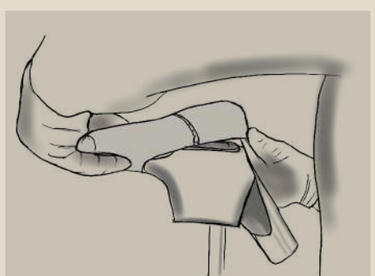


The foam, fabric and inner sock components are cut out using templates and a stamper (part 3-9).

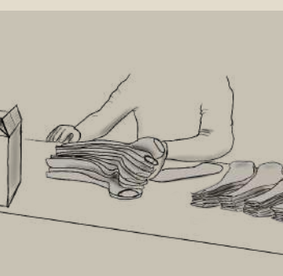
The shank and box (parts 1 and 2) are glued together.



The inner sock is sown together from the patterns, some automatically, others manually.

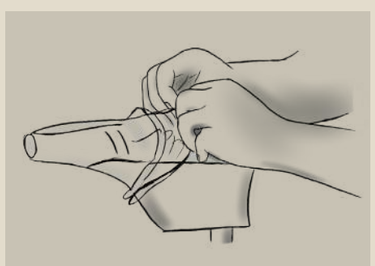


The cushioned sub-assembly of the box and shank are glued together with the inner sock (part 9), by using a last* to secure the construction.

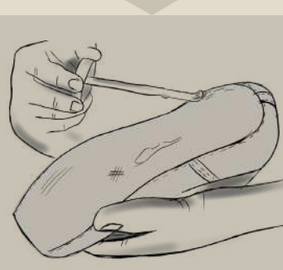


The outer sock (part 10) is unpacked from the subsupplier and prepared.

To secure all parts the final shoe is sown together at the seam lines. Name and other details are added.

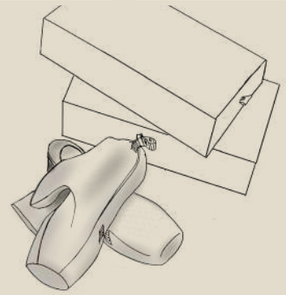


The outer woven sock (part 10) is rolled over the inner construction. The shoe is then sent to dry.



Glue is applied to the fabric lining and prepped for assembly with outer sock.

Both pairs are approved by a quality check and sent to the ballerina.



236 Assembly scenario

COST ESTIMATION

With the materials and production methods selected, the team figured out how much it cost to have the intended production set-up. Combining this with an estimated sale allows the team to evaluate a potential break-even and review if the product is profitable.

EXPENSES

Cost estimation has been performed by deconstructing the shoe and estimating each component's material price and potential tool cost. This, combined with a rough estimate of the time it takes to complete each task and the machine cycle times results in an overall assessment of the cost per shoe (see Appendix 45).

The production cost is a variable cost that will rise with the number of produced units. The start-up cost includes all machines, tools and rent and is a fixed one-time payment.

PART NO.	PART NAME	UNIT COST
1	BOX , HDPE (INJECTION MOULDING)	6,50 DKK
2	SHANK, PC-ABS (INJECTION MOULDING)	5,00 DKK
3	BOX INNER PADDING, 1 MM EVA FOAM W. LINING	1,92 DKK
4	INNER SOLE, 2 MM EVA FOAM W. LINING	2,49 DKK
5	HEEL CUSHION, 2 MM EVA FOAM	0,30 DKK
6	SHOCK ABSORPTION PAD, 2 MM EVA FOAM	0,07 DKK
7	PLATFORM PAD, 1 MM EVA FOAM	0,58 DKK
8	TOE PAD, 2 MM EVA FOAM W. LINING	0,19 DKK
9	INNER FABRIC SOCK	5,00 DKK
10	SOCK W. ELASTIC RIBBONS, PET (WOVEN)	30,00 DKK
Assembly	LABOUR COST	17,55 DKK
	TOTAL UNIT COST (VARIABLE)	**69,60 DKK**

237 Expected material cost, labour- and production price for each component.

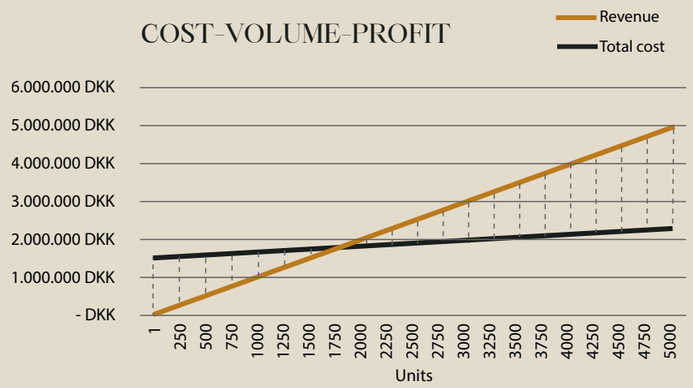
TOTAL COSTS

69,60 DKK	139,10 DKK	1.530.000 DKK
PER SHOE	PER PAIR	IN START-UP COST

BREAK-EVEN

A Cost-Volume-Profit calculation (CVP) is made based on the cost estimation and a set price of 1000 DKK, before tax, for one pair. The prices are based on a price and market positioning, which will be further explained in the next chapter. The calculations are based on the sales from the manufacturer directly to the customer (does not take retailer margins, and companies buying in bulk into consideration (see Appendix 45).

The CVP calculation shows the development of expenses and profits through the development of the number of sold pairs of shoes. The break-even point is estimated to be at **1800 pairs sold**. The break-even is when the company have paid off all debt and will start earning money.



238 Cost volume profit graph, intersection point is where break even is reached

CONCLUSION

All materials, production- and assembly methods have been chosen. The total cost for a start-up will cost 1.530.000 DKK. The break-even will be reached once a total number of 1800 pairs are sold. This is equivalent to reaching break even after one year and two months with RDB as a client. If having five companies of the same size, the number will change to 8.040 pairs sold and reach break-even in three month (this number is only pay-back time, excluding the development time) (Ulrich & Eppinger, 2019).

TASK

07. / 8.

IMPLEMENT

CHAPTER SUMMARY

This chapter focuses on the spiritual and the contextual level of the value pyramid (p. 5). Strategies for the launch of the product is developed and a viable business model for the product is creating. A vision for the usage and fitting scenario is constructed.

Detailing

239 Contemporary ballet dancer

00 IMPLEMENT

PARTNERSHIP

As concluded in the market chapter, the strategic fit will be achieved by partnering with the pointe shoe brand Gaynor Minden. The type of partnership will now be investigated, to minimise the risk scenario for the start up.

SHARK TANK

This partnership would make Gaynor Minden their prime investor, and allow Pointenétic to have full control of the company and direction to follow, whereas Gaynor would get a part of the income from each sale. The distribution and sales channels would be in Pointenétics company, resulting in a high start-up cost, as explained on p. 78 and in (Appendix 45).

It would be difficult selling the concept as there it is at the moment no more than a concept. And Gaynor could view the partnership as a high risk, as the brand sells to the same customer segment.

JOINT VENTURE

In this scenario, the team joins forces with a secondary company (Gaynor) and forms a new separate company. This is to distinguish the Gaynor Minden and the Pointenétic brand from one another and here both companies will bring something to the table. Pointenétic would deliver new innovation methods, the concept for the product and general development know-how. In comparison, Gaynor would bring production capacity, a strong supply-chain and general know-how in the business. In this case, we are splitting the risk with Gaynor. It is more an investment, if it succeed then Gaynor will have a big profit. If it fail, the Gaynor brand will not suffer.

UMBRELLA BRAND

In this case, Pointenétic would sell everything to Gaynor Minden and end up as a small brand under their umbrella. In this case, the product would be associated with the Gaynor brand. This method is usually used with brands that have positive equity. But it is hard for Pointenétic and Gaynor to make a valuation. This is valued based on factors. It can therefore be hard to value the "company" because it does not have any way to prove assets and liabilities. If the product was sold with a patent, it might be easier to justify the scale of the value. If selling the product, this should be done through royalties to get a piece of the cake.

CONCLUSION

A Joint venture with Gaynor Minden allows both brands to benefit of each individual capacity and knowledge while maintaining the brand values separated.

+ Doing a joint venture with Gaynor Minden

00 IMPLEMENT

BUISNESS MODEL

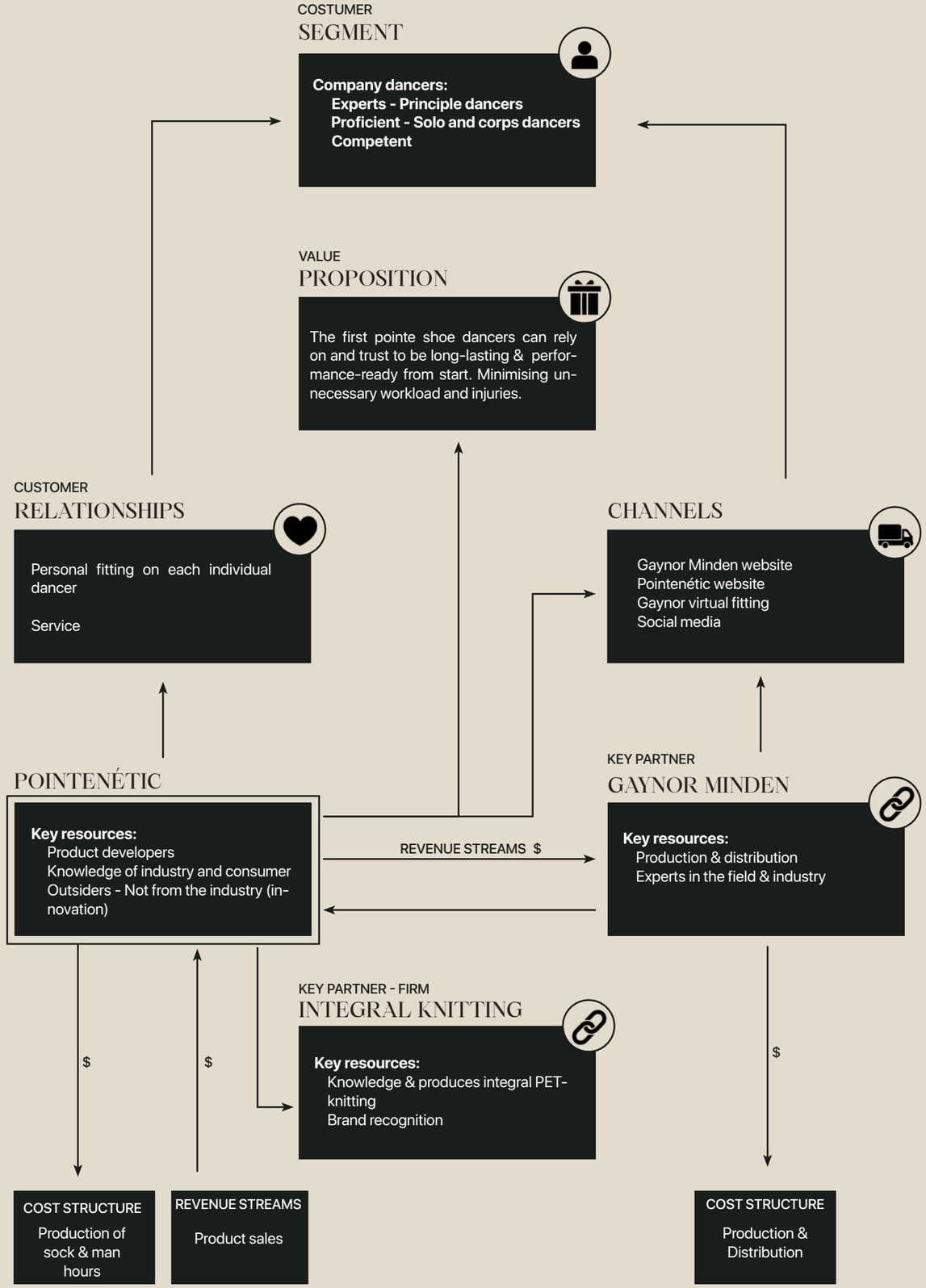
Using the Business Model Canvas (Osterwalder and Pigneur, 2010), a business case is created for Pointenétic, assuming a partnership with the pointe shoe brand Gaynor Minden utilising their key resources. Gaynor Minden is well established in the US, having the second biggest market share.

MARKET STRATEGY

Doing a Joint venture with Gaynor Minden would allow Gaynor to get better market share in Europe, as the introduction of Pointenétic aim to fit the conservative market. The team intends to create a more traditional pointe shoe with the shank-box combo (inner core) to help cement the Pointenétic brand on the market (more on this on p.82). Other brands, such as SóDanca and Merlét, are starting to catch up with Gaynor Minden by creating long-lasting pointe shoes with polymer inner cores. Gaynor, therefore, needs to overcome strategic challenges and partner with Pointenétic to sustain the Gaynor brands as being frontrunners of innovation in the ballet industry.

The prime customer segment is the professional dancers (principal, solo and corps dancers) working at a company. Pointenétics key resources are: knowing the ballet industry and consumers' latent needs and applying a value proposition by giving the dancers a reliable and performance-ready pointe shoe. This ensures that their most important tool is ready to go on stage when needed, without a whole day of preparation. Meanwhile also reduces possible injuries from wearing dead pointe shoes. Pointenétics key activities will mainly be in the product development and customer relation regarding personal fitting to the individual dancer where their needs can be, and customer service.

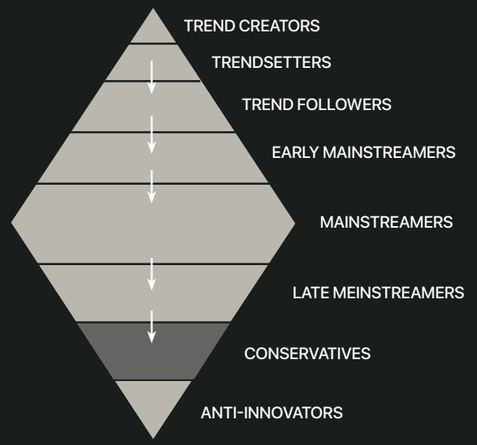
Gaynor Minden will be in charge of manufacturing and distribution as the same production methods are used for the inner cores (shank, box, foam combo). The sock will be outsourced to another firm that knows integral PET knitting as the sock differs from Gaynor Minden's material portfolio. Revenue streams will occur through product sales channels where Gaynor Minden will get transaction revenue from an agreement (negotiated). The largest volume of sales is expected to come from professional dancers organized trough companies such as the RDB, bought by the purchasing department. Channels such as Pointenétics' website and physical pointe shoe stores will also be used to reach the customer segment. Advertisement through professional ballet dancers being brand ambassadors promoting Pointenétic on social media platforms (Instagram, Tiktok, Reddit and Youtube) exposing it to the global market.



240 Business model (Osterwalder and Pigneur, 2010)

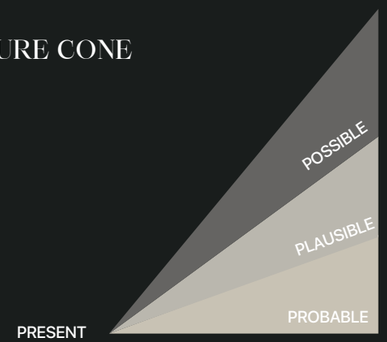
IMPLEMENTATION PLAN

The plan requires four primary phases; phase 1: the concept development, phase 2: joint venture with Gaynor Minden, phase 3: Manufacturing and launch of the traditional Pointenétic shoe, and phase 4: The second launch of the complete Pointenétic product (as in product report). The reason for two launches is that the customer segment is very conservative and takes long to adapt to the trends. The team aims to first innovate on the classical pointe shoe by inserting the inner core* (shank, box and foam combo) to make the trendsetters within the industry adapt the product. Slowly the trend trickles down and will be adapted by the segment, see ill. 241.



241 Trend predictions (Kongsholm and Frederiksen, 2019)

FUTURE CONE

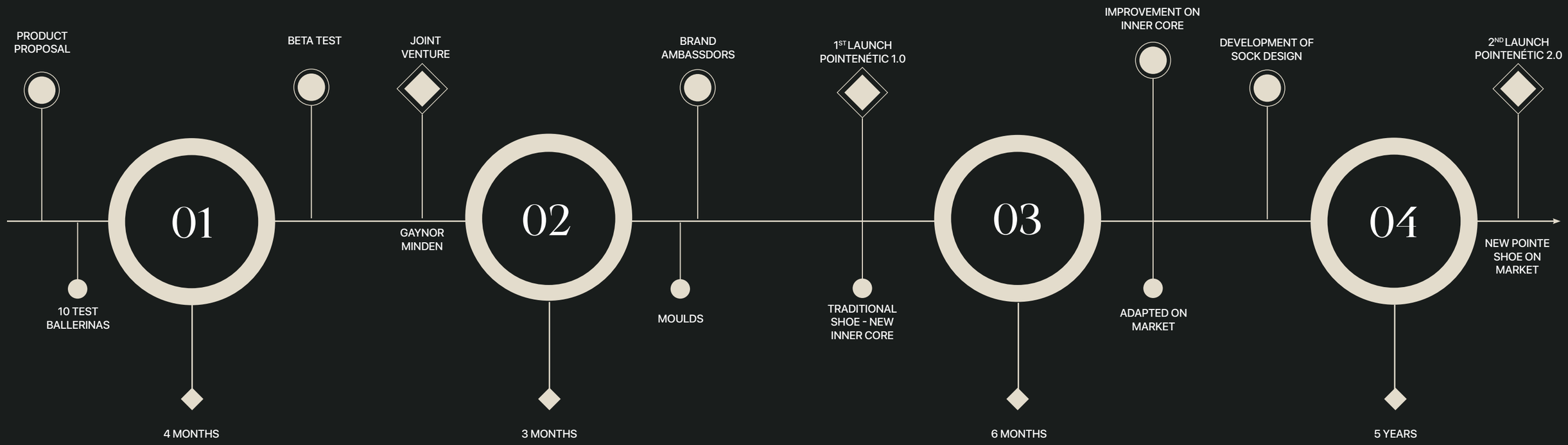


242 Future cone (Voros, 2018).

The possible future could be how pointe shoes will completely change in the future. Why have an inner and an outer part when the future could just be one part, not a shoe but more of an exo-skeleton-like product, truly enhancing the lines of the body.

The plausible future is the market entry of Pointenétic 2.0. The solution is very probable, but some aspects, such as the outer sock production and the extent and volume of the business plan, are still unknown.

The probable future is the invention and implementation of Pointenétic 1.0 (our inner core inserted into a traditional pointe shoe). This product will likely succeed as it fulfils the users' latent needs and still respects the tradition of the artform.



CONCEPT DEVELOPMENT

This phase intends to develop the inner core further and ensure its principle and that it works for more ballerinas. Therefore, a beta test is performed with the help of ten professional dancers with different feet and anatomies to ensure that the performance-ready principle works. A trial run of two weeks testing several pairs is necessary to get an honest review of its comfort, functionality and replication success.

JOINT VENTURE / DEVELOPMENT

This phase entails constructing a business plan and a contract with lawyers to establish partnership with Gaynor Minden where the inner core will be developed. The aim is to create a traditional outer sock with the preferred European lines (similar to Freed of London's) and have further ongoing tests.

MANUFACTURING / 1ST LAUNCH

This phase marks finalising the manufacturing process, where all moulds, materials and processes will be reviewed to get ready for launch. Prior to the launch, the team will partner up with professional ballerinas, who will become brand ambassadors and promote the pointe shoe and the brand. There is a big trickle-down effect within the world of ballet, ensuring that if Pointenétic reach prominent ballerinas, dancers on all levels below (expert/proficient) will start to follow the trendsetters and trend followers. The first launch also marks the first step of the future cone, the probable stage.

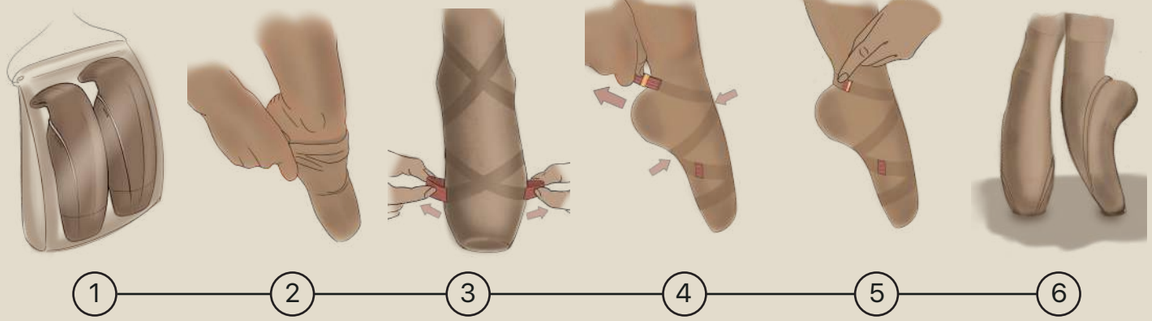
FINAL DEVELOPMENT / 2ND LAUNCH

The final stage of the implementation starts about five years after the first launch. By this point, the whole ballet world will have heard of a new performance-ready pointe shoe (since not much happens). It will be adapted on the market and be well adapted into ballerinas' shoe bags. Throughout these years, the development of the final sock and the true Pointenétic 2.0 shoe will have been tested and approved by loyal and demanding clients as well as iterated upon based on feedback. It will then be ready when the second ready to be launched as second wave. This step marks the beginning of the plausible future, and it is uncertain if this product will be adapted. However, the arguments for it being adapted are present. The plan of the future will be to follow the technology, expand to own factories, and continue innovating on the product.

243 Implementation plan

USAGE SCENARIO

A usage scenario is created based on testing (see Appendix 46) and interaction with the product. This is done to observe the reduced number of steps from receiving a pair of pointe shoes to wearing them on stage (see p. 16-17 for usage scenario for the existing product).



244 Usage scenario

1. The dancer receives the personalised Pointenétic 2.0 pointe shoes.
2. The dancer pulls the shoe on, just like a sock, all the way up the calf.
3. The dancer pulls in the elastics near the lower zone, tightening the pointe shoe around the box.
4. The elastics' upper zone is tightened and secured with a lace lock.
5. The ribbons are fastened in a slit on the side of the pointe shoe.
6. The dancer is ready to enter the stage with her new Pointenétic shoes.

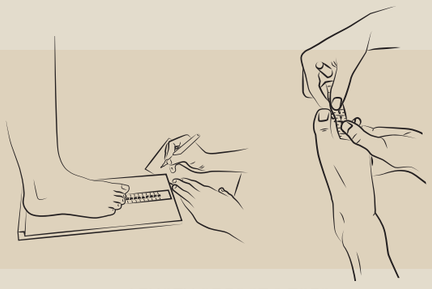
COMPARISON BETWEEN UASAGE SCENARIOS

POINTENÉTIC PREPARATION STEPS:
No prepararion steps, 2 minuettes of taking Pointenétic on

FREED OF LONDON PREPARATION STEPS:
8 preparation steps (two hours) + dancing in them a whole day. (see p. 16-17)

FITTING SCENARIO

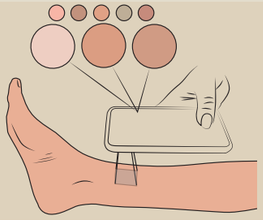
A fitting scenario is created to anticipate how the fitting process of Pointenétic is going to occur. The initial fitting will take place physically once a year. The ordering are proceeded by the company, and once fitted the data will remain in a dancer-spec-sheet. The company is always in a position to request a fitting consultation.



LENGTH OF FOOT & TOES

CROWN OF THE FOOT IS MEASURED

DANCER'S FLEXIBILITY IS MEASURED



SKIN COLOUR IS MEASURED
& SOFTWARE INTERPRETS IT

THE FEET ARE 3D SCANNED
FOR KNOWLEDGE ABOUT FOOT ANATOMY

THE DANCER RECEIVES THEIR POINTENÉTIC
SHOES 2 WEEKS AFTER FITTING

245 Fitting scenario

TASK

08. / 8.

EPILOUGE

CHAPTER SUMMARY

This chapter focuses on the spiritual level of the pyramid, while also evaluating the synergy between the achieved layers (p. 5). Final thoughts are displayed along with an evaluation of both the product- and process report.

246 Ballerina trapped in fabric

CONCLUSION

The project aimed to redesign the professional ballet dancers' most important tool and become a reliable, long-lasting performance-ready pointe shoe. A solution well desired in the world of an extreme sport.

During the first visit to the RDB, it was discovered that the dancers spent hours preparing all of their pointe shoes to make and keep several of them performance-ready. The combination of the current pointe shoe construction and its poor resistance to sweat results in an unreliable pointe shoe, as it deteriorates, creating an unpredictable lifetime.

The team learned how to define and achieve a performance-ready pointe shoe through measurements, tests, and simulations. Utilising this knowledge resulted in the ability to replicate the behaviour in other materials and prolong the lifetime of the pointe shoes. An outcome that is as close as simulations can get, but only real-life testing can conclude the success rate of the concept.

The aim was to push the conservative industry on its current aesthetic preferences and show that innovative products still can be beneficial while respecting the culture, traditions and expertise. It is further concluded that the notion of cheating is mainly used to honour older generations for their ability to withstand the pain, something synonymous with their expertise.

The result is that the Pointenétic shoes do not require two hours of preparation before using them; this is a reduction in 8 break-in steps and a day's worth of dancing. Pointenétic will break with the traditional handling time of the pointe shoes and create a reliable solution, similar to other extreme sports, ensuring that it is ready from the get-go.

REFLECTION

PRODUCT

The proof of principle of Pointenétics still needs further validation through physical tests, prototypes and comprehensive observations and interviews.

FUNCTION:
The functionality of the inner core of Pointenétic is highly dependent on material behaviour. The box and shank utilised in Pointenetic are only simulated through an FEA, implicating the uncertainties of the physical behaviour that has to be tested in a real-life scenario to validate the concept and discover further iterations. An elaborated test will be executed on the primary user, at the RDB after submission, with a functioning prototype developed in collaboration with Ecco.

The project ended with two possible directions for the shanks, as either solution could be utilised in the box. However, looking in retrospect the team wishes there were clearer indicators to proceed with one solution. However, the circumstances of testing with two solutions will give further insights into the following improvement and iterations of the product.

The project aimed to create a long-lasting performance-ready pointe shoe by reaching a fatigue level above 15.000 cycles. However, the simulation data was inconclusive and did not result in any deliberate findings, resulting in not knowing the extent of the long-lasting aspect of the product. But if evaluating Pointenétic to similar products, the product would be able to withstand high levels of fatigue.

USAGE:
Professional ballet dancers have developed habits of moulding and adjusting their pointe shoes to their individual needs. This leaves a lingering question of what adjustments will happen to Pointenétic following the adaption and implementation of the pointe shoes. Knowledge of these alterations and adjustments could be included in the following development of the pointe shoe to perhaps create intentional adjustment points, enabling the dancer to personalise the shoes further and ease the process of tailoring them. However, the general usage of pointe shoes is battling against old rituals and customs that can be hard to change the habit of.

AESTHETICS:
The aesthetic look of the pointe shoe is aimed at pushing the industry towards a new direction of combining more urban references with the traditional look and symbolic value. However, the knowledge of how they proceed after receiving a pair is uncertain. But the interviewees' eagerness to help improve the pointe shoe and their extensive knowledge of what new innovation there is within their field, indicate that there is an underlying search for something new and different. To proceed, the team aims at discussing the design with the gatekeeper of the Royal Danish Ballet, Nikolaj Hübbe, as he (and the shoe manager) are ultimately the ones deciding what is allowed within the walls of the company.

PROCESS

Following the first visit to the RDB, the team had gained insight into the industry and the culture and left with a heightened level of interest in the project, as the obtained knowledge confirmed and broadened the perspective of the solution field. This, however, led to difficulties as a lack of limitations clouded the team's vision for an extensive period of time, resulting in the team not being able to separate aspects from one another. This added a level of complexity to the development as conveying the knowledge to others was generally troublesome and unclear.

PROTOTYPING
The lack of sufficient prototyping capacity and access to materials turned out to be one of the biggest hindrances in the project as it created uncertainties as concepts could not be evaluated properly based on its functional and physical behaviour. This barrier resulted in opting for modelling and simulation. An acceptable method that gives an understanding of the components' demeanour, but unsatisfactory as a computer can never simulate how the impact is supposed to feel on and for the dancer.

NAVIGATION
The lack of knowledge about ballet created an alluring and attracting environment leading the team down a path of wanting to uncover and decoding the underlying mechanisms of the historic art form. The project has proven to push the team out of their comfort zone by aiming for a paradigm shift and working with footwear highly dependent on the physics and anatomy of the body. This results in the process constantly alternating between the four levels of abstraction to align the levels and the output.

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100 Pointe shoe direction: https://www.liveabout.com/how-long-do-pointe-shoes-last-1006799
101 GORE-TEX direction: https://theskimonster.com/blog/posts/waterproof-breathable-membranes-guide/
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C: file:///C:/Users/aisha/OneDrive%20-%20Aalborg%20Universitet/Msc04%20-%20Master%20Thesis/Rapport/Process%20report/02%20Functionality/design%20brief/thomson-and-thompson.htm#
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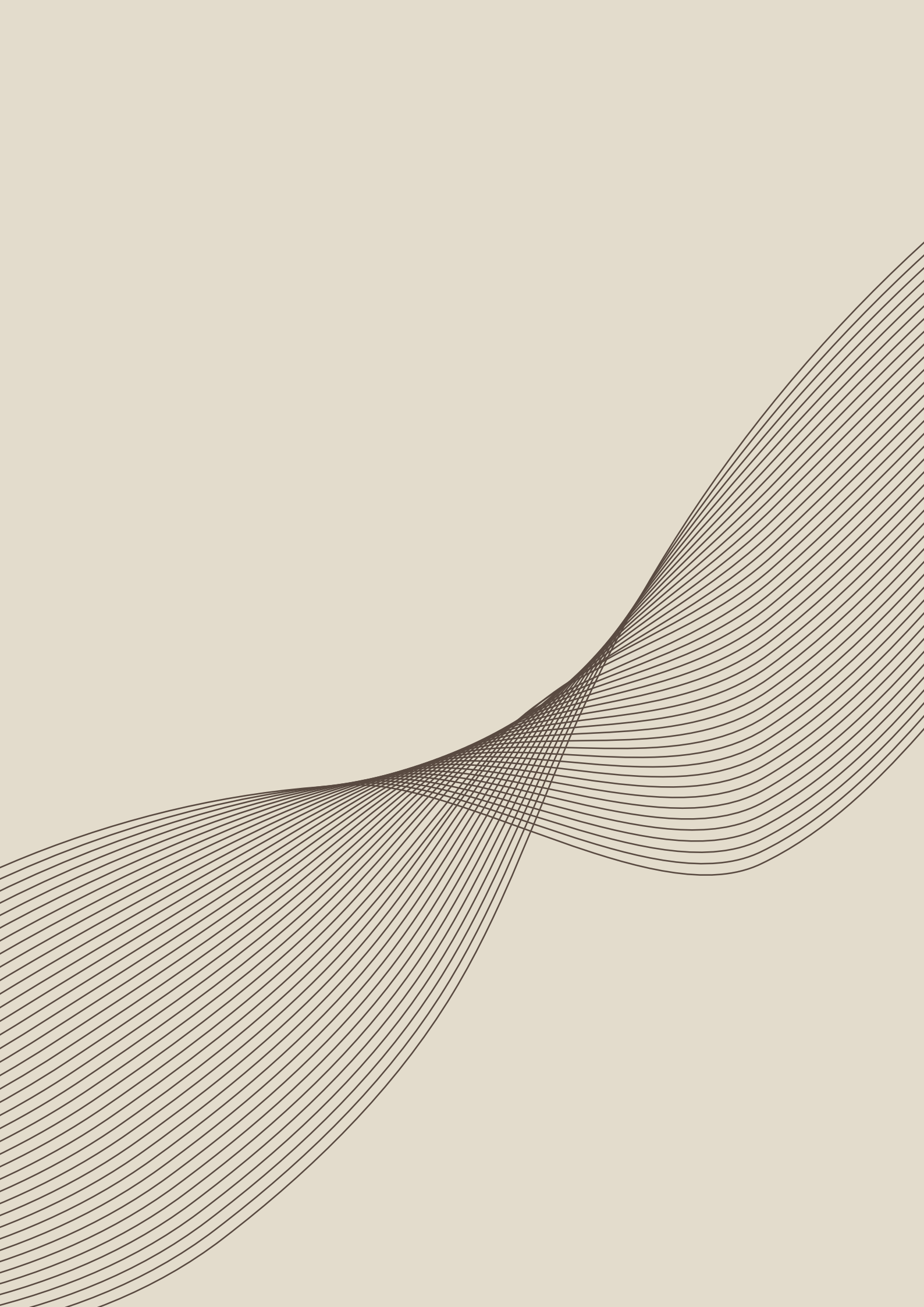
128 Measuring test right side : Own illustration
129 Measuring test top: Own illustration
130 Measuring test Left side: Own illustration
131 Deformation scale box: Own illustration
132 Deformation scale box: Own illustration
133 FEM analysis on box, deformation points measured in mm: Own illustration
134 All measurement in mm.: Own illustration
135 FEM breathability: Own illustration
136 Kerfing principle (A, B & C): Own illustration
137 FEM on Nylon shank with kerfing: Own illustration
138 FEM on Nylon shank with kerfing: Own illustration
139 Desired deformation points on shank: Own illustration
140 Kerfing mock-ups in cardboard (a when en point) (b is in half point): Own illustration
141 Kerfing mock-ups in nylon Kerfing on same side : Own illustration
142 Kerfing mock-ups in nylon kerfing on different directions: Own illustration
143 Sweetspot: Own illustration
144 HDPE: cyclic loading test (Qi et al., 2019)
145 HDPE: Hysteresis loop evolution of cyclic-loading (Qi et al., 2019)
146 FEM analysis Kerfing stress concentration: Own illustration
147 FEM analysis on shank (12 N), deformation points measured in mm: Own illustration
148 FEM analysis on shanks (A,B,C) (12 N), deformation points measured in mm: Own illustration
149 FEM analysis on shank (12 N), deformation points measured in mm: Own illustration
150 Integrated interface between shank and box: Own illustration
151 A. : Own illustration
152 A.: Own illustration
153 Biggest stress accumulation on the HDPE box : Own illustration
154 HDPE: Safety factor when en poine: Own illustration
155 Bloch pointe shoes: http://www.dance1redondo.com/wp-content/uploads/2017/11/iris-prima-052.jpg
156 NYCB storage room: https://www.huffpost.com/entry/the-nutcracker_n_4460978
157 World map of location of pointe shoe brands: Own illustration
158 Brand distribution of pointe shoes at USA companies (Buckner, 2019)
159 Traditional vs. innovative brands: Own illustration
160 Brand distribution of pointe shoes at companies (Buckner, 2019)
161 What a pointe shoe should be able to do, depending on level of expertise): Own illustration
162 Strategic-fit (Haase and Laursen, 2023)
163 4P-model (Hansen et al., 2014)
164 Market pull (Verganti, 2010)
165 Design push (Verganti, 2010)
166 Five poitnte sheos and their ability to withstand failure. (Cunningham et al., 1998)
167 Quality domain, simplified (Parasuraman et al., 1985)
168 Quality domain, extended (Parasuraman et al., 1985)
169 Harry Styles, Pop icon: https://www.google.com/search?q=harry+styles+ballet&sxsrf=ALiCzsZgIeCUs7_k15ZIUlCb5yg2ih1HTw:1652858462686&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiG2KDMwej3AhVOR_EDHQWdCi8Q_AUoAXoECAEQAw&biw=1536&bih=753&dpr=2.5#imgrc=2gqPiYMSFXbC5M
170 Timeline of ballet: https://pl.pinterest.com/pin/484137028678095679/
Cathrines castle: https://en.wikipedia.org/wiki/Catherine_de%27_Medici%27s_court_festivals
Different colors shoes: https://www.pinterest.dk/pin/544513411197662951/
George balanchine: https://balletcenter.nyu.edu/the-wall-street-journal-a-balanchine-muse-revives-a-rare-work-august-24-2016/
Lauren Anderson: https://www.coomerballet.com/events
Louis the 5th: https://medium.com/@maejacoloaguilar/ballet-the-louis-dance-69842f1f461e
Burton boots: https://www.burton.com/dk/en/p/mens-burton-moto-snowboard-boot/W22-104361.html
171 Pas de deaux : https://www.miamidadecountyauditorium.org/event/cuban-classical-ballet-2018-annual-gala-season-premiere-auroras-wedding/
172 Arabesque position in Giselle performance: https://balletaustin.medium.com/giselle-a-truly-romantic-ballet-f9ef0a2b51e8
173 Famous posture form a Apollo performance: https://www.theguardian.com/stage/2021/jun/06/royal-ballet-balanchine-and-robbins-review-vadim-muntagirovs-apollo-is-simply-divine
174 Contemporary ballet: https://www.timeout.com/newyork/dance/complexions-contemporary-ballet-11
175 Marie Camargo in high heels (Footalk, 2019)
176 Marie Camargo Guiheen, 2020)
177 Marie Taglioni Guiheen, 2020)
178 High heeled ballet shoe (Looseleaf, 2007)
179 First flat pointe shoe (Looseleaf, 2007)
180 Marie Taglionis favourite pointe shoe colour (Blakemore, 2018)
181 Anna Pavlova (Blakemore, 2018)
182 Ballerina in tutu(Bata shoe museum, n.d.)
183 Maxfield Haynes dancing in pointe shoes
184 Anna Pavolas darned pointe shoe((Looseleaf, 2007)
185 Gaynor Minden pointe shoes(Bata shoe museum, n.d.)
186 Pointe shoes covered by black tights (Blakemore, 2018)
187 Mapping of mega trends: Own illustration
188 Mood board:
Sock: https://www.amazon.com/Pro-Mountain-Cushion-Athletic-Sneakers/dp/B07BRR59DY
Weird shoe, adidas, grøn: https://www.seprun.com/product/39808
Capezio fizzon: https://www.danzetc.ca/us/fizzion.html
Folded paper: https://www.pinterest.dk/pin/559783428658098577/
Darning, personalisation: https://www.google.com/search?q=darning+-pointe+shoes&sxsrf=ALiCzsYErPQlrZR8JF55826WFBeMcQx-lA:1652903162962&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiX-oCP6On3AhUki8MKHSSgCNEQ_AUoAXoECAEQAw&biw=1536&bih=696&dpr=2.5#imgrc=-JQo2ny3rqEDWM
Nike, thick wein https://www.pinterest.dk/pin/2814818504854927/
189 Styleboard:
Nike puffy shoe: https://www.sizeofficial.dk/product/gr-nike-offline-pack/387510_sizedk/?istCompanyId=7ad73ab1-dfd2-4fa5-8996-2d05e82b1dc3&istFeedId=ef0fac1d-4db4-47c6-a7cc-27a2608c1205&istItemId=pqwtrmiwt&istBid=t&gclid=Cj0KCQjwspKUBhCvARIsAB2lYuueCXP38dGA0idDieUfwP4xKggnoRubDS_oEa5jSWux-5i6vtgOWk24aAtf2EALw_wcB&gclsrc=aw.ds
190 Sketches: Own illustration
191- 194 Consensus of concept: Own illustration
195-198 Capezio, fizzion shoe: Weird shoe, adidas, grøn: https://www.seprun.com/product/39808
Capezio fizzon: https://www.danzetc.ca/us/fizzion.html
199-202 Testing of elastics Own illustration
203 Different weaving patterns (A,B & C) https://www.pinterest.dk/pin/2814818504854927/
204 Sketches (1, 2 & 3): Own illustration
205-206 Own illustration
207- 212 Memorable performance:
https://www.google.com/search?q=darning+pointe+shoes&sxsrf=ALiCzsYErPQlrZR8JF55826WFBeMcQx-lA:1652903162962&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiX-oCP6On3AhUki8MKHSSgCNEQ_AUoAXoECAEQAw&biw=1536&bih=696&dpr=2.5#imgrc=-JQo2ny3rqEDWM
213 Aluminium shoe sole mould xxx
214 Product components and architecture. : Own illustration
215 HDPE caps
216 PC-ABS: https://www.e3s-conferences.org/articles/e3sconf/pdf/2020/39/e3sconf_ewre2020_02111.pdf
217 EVA foam insole: https://dgyqeva.com/products/anti-bacterial-material-eva-foam-sheet-for-insole-with-puching-hole-137
219 Moisture wicking silver iron fabric: https://www.sportingtex.com/quick-dry-fabric
218 Anti-bacterial EVA foam
220 Fly-knit weave, PET integral knittinghttps://runrepeat.com/nike-flyknit-racer
221-232 Own illustrations
233 Nike Flyknit shoe component, integral knitting
234 Medium size industrial circulat knitting machine. Used for producing socks.
https://www.kidzo.fr/products.aspx?cname=nike+flyknit+material&cid=15&xi=4&xc=23&pr=68.99
235 New balance production line steps, (Business Insider, n.d.).
236 -238 Own illustration
239 Contemporary ballet dancer:
https://as1.ftcdn.net/v2/jpg/00/66/01/94/1000_F_66019440_TFKv5xkN4BVrbX-3MZc71QrKGmoXjfHry.jpg?fbclid=IwAR3ClEdVYfo_JS77rLWfPMBSUd_UdVfn-cefb-PxsqQlXYluxzHpzZgSt6FY
240 Business model (Osterwalder and Pigneur, 2010)
241 Trend predictions (Kongsholm and Frederiksen, 2019)
242 Future cone (Voros, 2018).
243-245 Own illustration
246 Ballerina trapped in fabric, Adobe stock



THE

TECHNICAL DRAWINGS

Title:	PERFORMANCE READY POINTE SHOE
Theme:	BALLET POINTE SHOES
Project period:	01.02.2022 - 25.05.2022
Main supervisor:	LINDA NHU LAURSEN
Co-supervisor:	BRIAN LAU VERNDAL BAK
Pages:	15

DISCLAIMER

The technical drawings are constructed on the parts made for a single pointe shoe in a size that fits the primary test person.

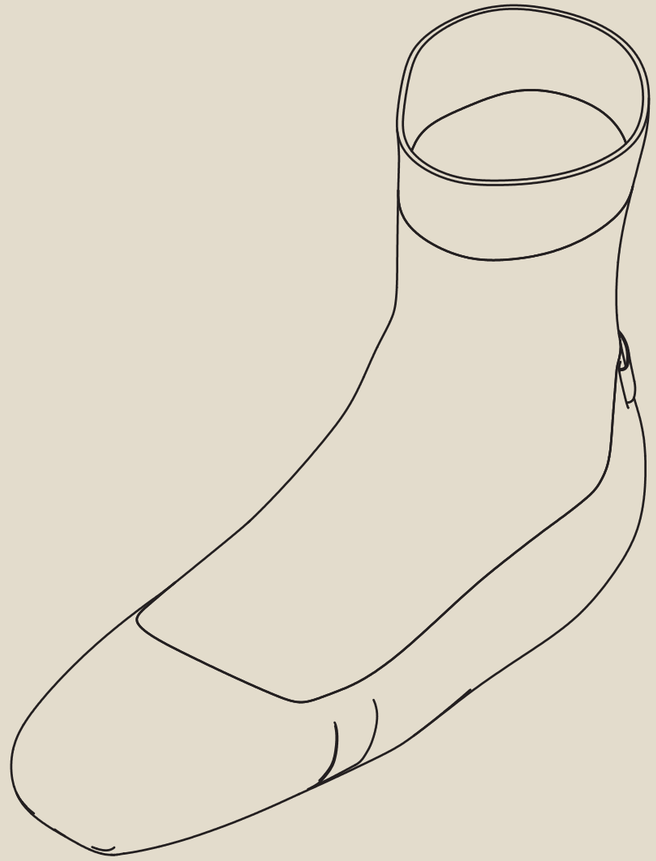
OVERVIEW:

1 Bill of materials
2 Exploded view
4-7 Drawings part 1-8
8 Sub-assembly part 9
9-11 Sow pattens
12 Sow guide
13 Sub-assembly part 10
14 Knitting chart
15 Detail drawings

TECHNICAL DRAWINGS
AALBORG UNIVERSITY / SPRING 2022
INDUSTRIAL DESIGN / MSC04 ID3

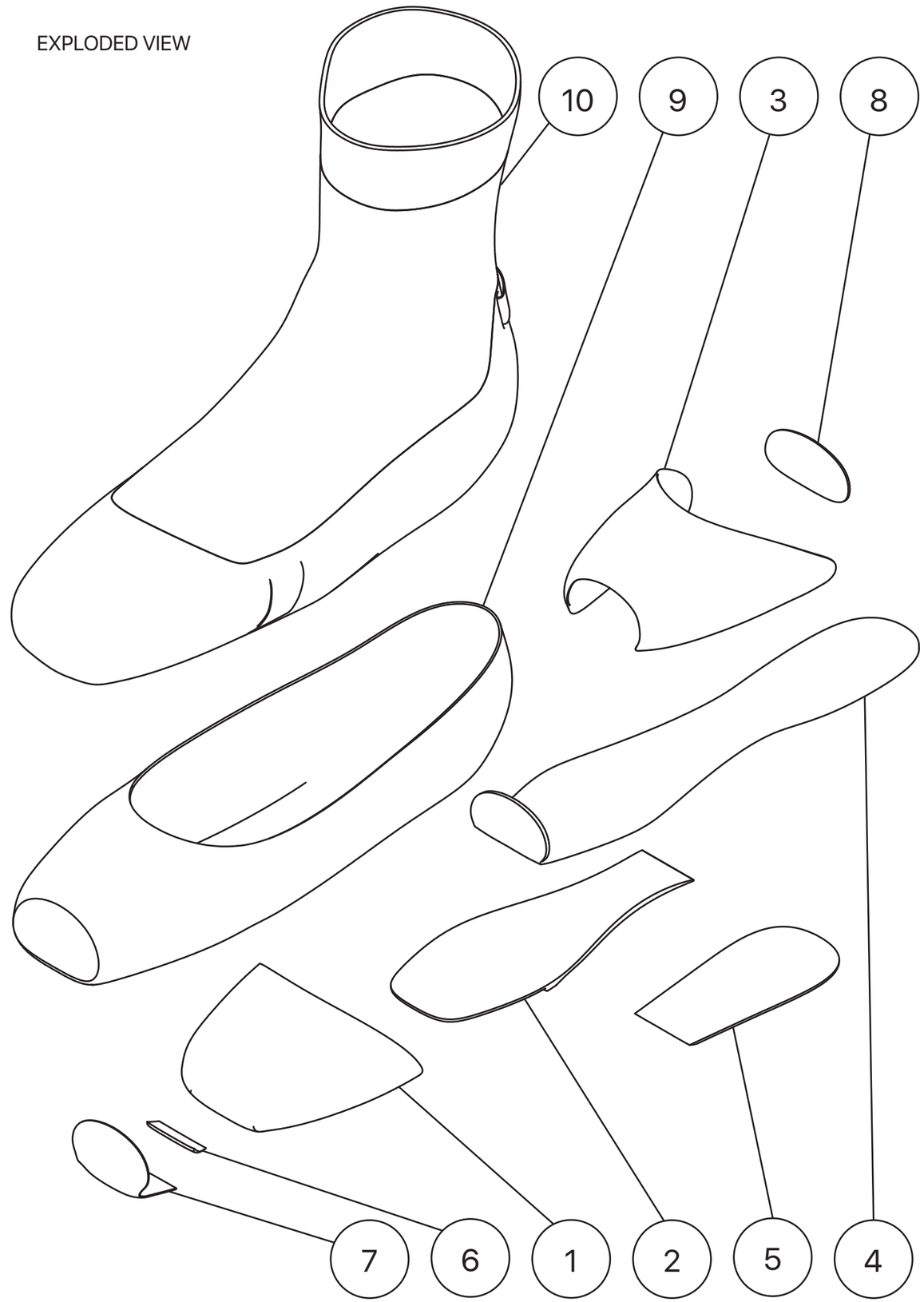
AISHA SUSANNE HJORTH NIELSEN
JULIE RIISBERG MIKKELSEN
JOHANNES BAARRIS HANSEN

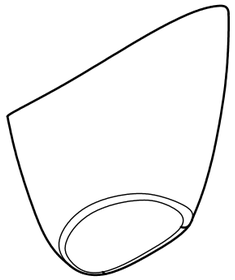
OVERVIEW

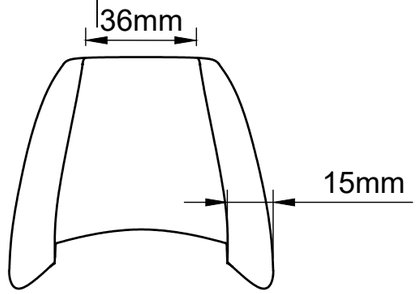


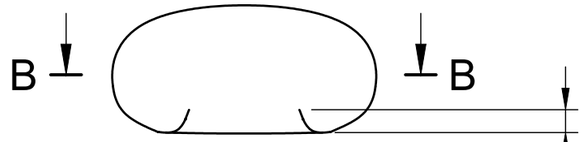
PART NO.	PART NAME	MATERIALS	QUANTITY
1	BOX (WIDTH: XXX)	HDPE	1
2	SHANK (SIZE: UK 5 1/2 OR EU 37)	PC-ABS	1
3	BOX INNER PADDING	1 MM EVA FOAM W. LINING	1
4	INNER SOLE	2 MM EVA FOAM W. LINING	1
5	HEEL CUSHION	2 MM EVA FOAM	1
6	SHOCK ABSORPTION PAD	2 MM EVA FOAM	1
7	PLATFORM PAD	1 MM EVA FOAM	1
8	TOE PAD	2 MM EVA FOAM W. LINING	1
9	INNER FABRIC SOCK SUB-ASSEMBLY	MOISTURE WICKING SILVER IRON FABRIC	1
10	SOCK SUB-ASSEMBLY	PET (WOVEN), ELASTIC RIBBONS AND LACE LOCK	1

EXPLODED VIEW

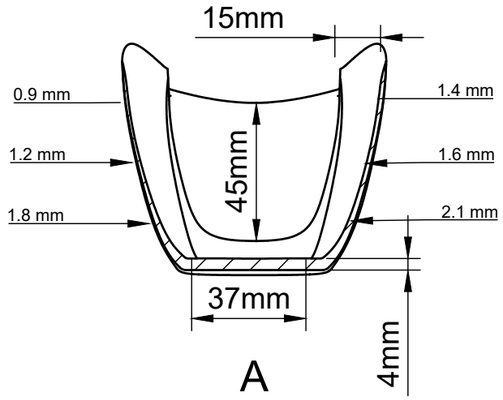




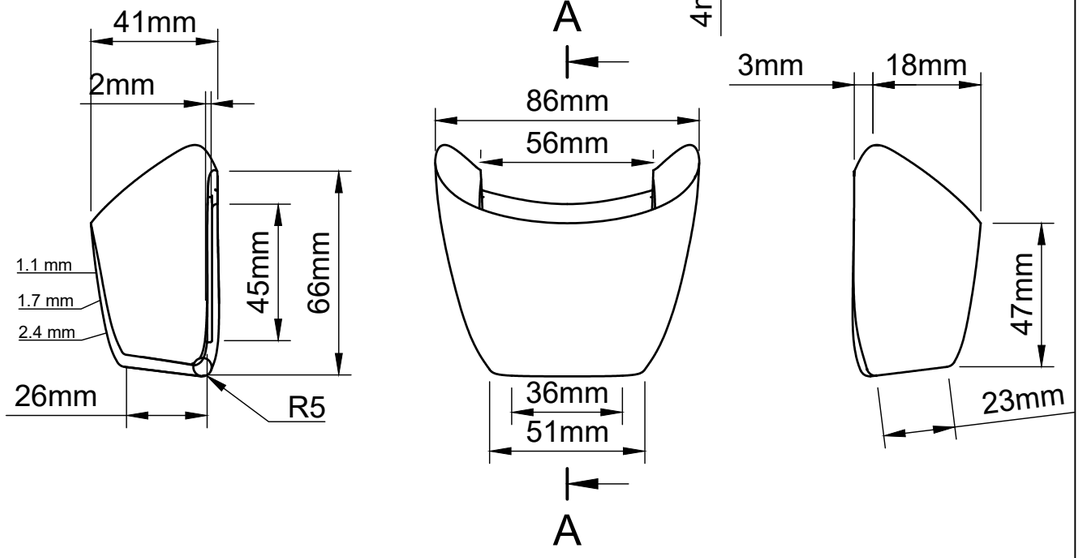




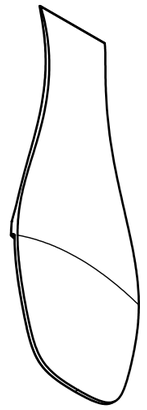
B-B (1:2)

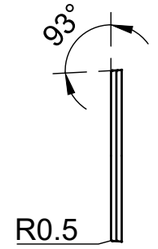


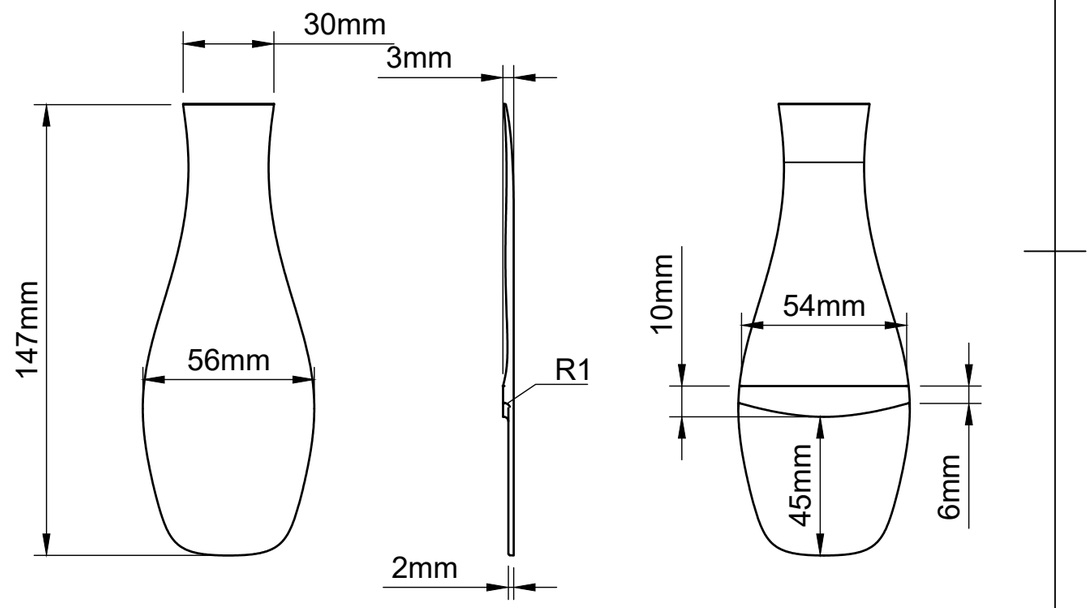
A-A (1:2)



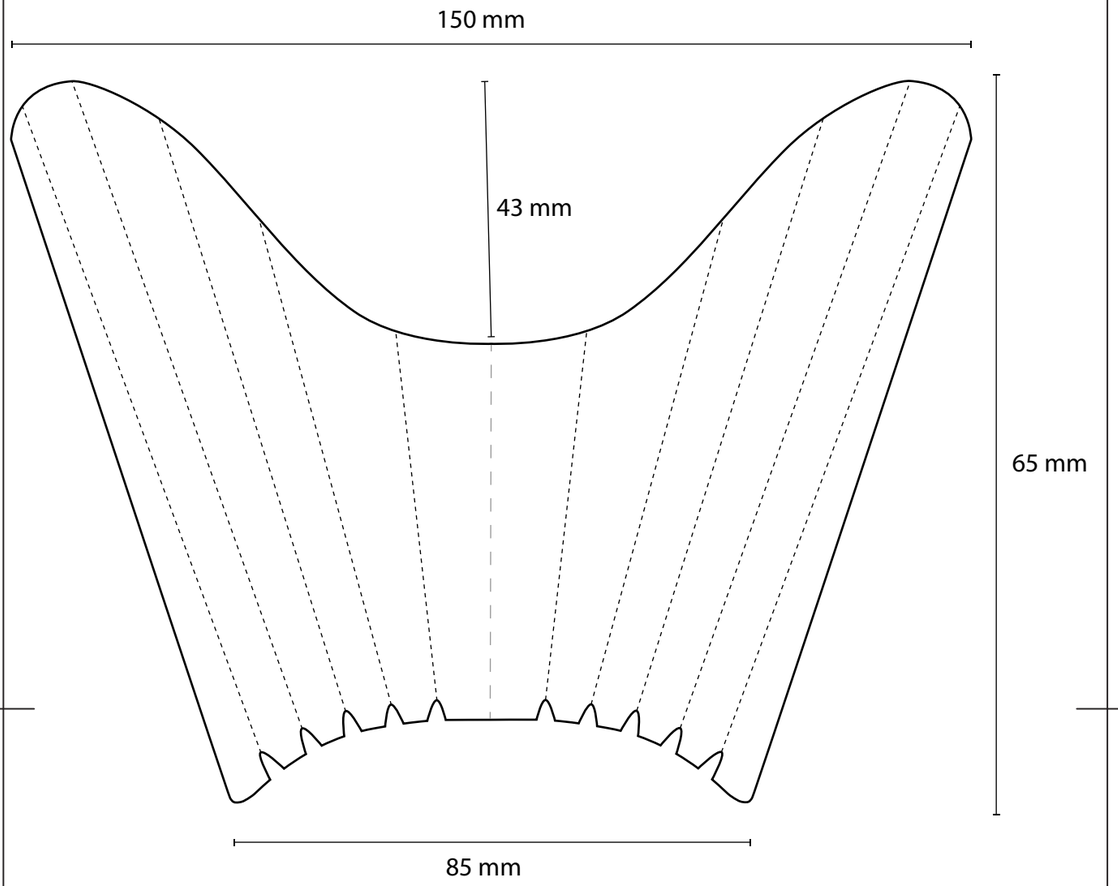
Author: MSc04 ID 03	Date: 23-05 2022	Part number: 1
Production method: Injection moulding	Material: HDPE	Part name: Box (Right side foot) (Width: XXX)
Sheet size: A4	Unit: mm	Standard: ISO / Scale: 1:2







Author: MSc04 ID 03	Date: 23-05-2022	Part number: 2
Production method: Injection moulding	Material: PC-ABS	Part name: Shank 3/4 (Size: UK 5 1/2 or EU: 37)
Sheet size: A4	Unit: mm	Standard: ISO / Scale: 1:2

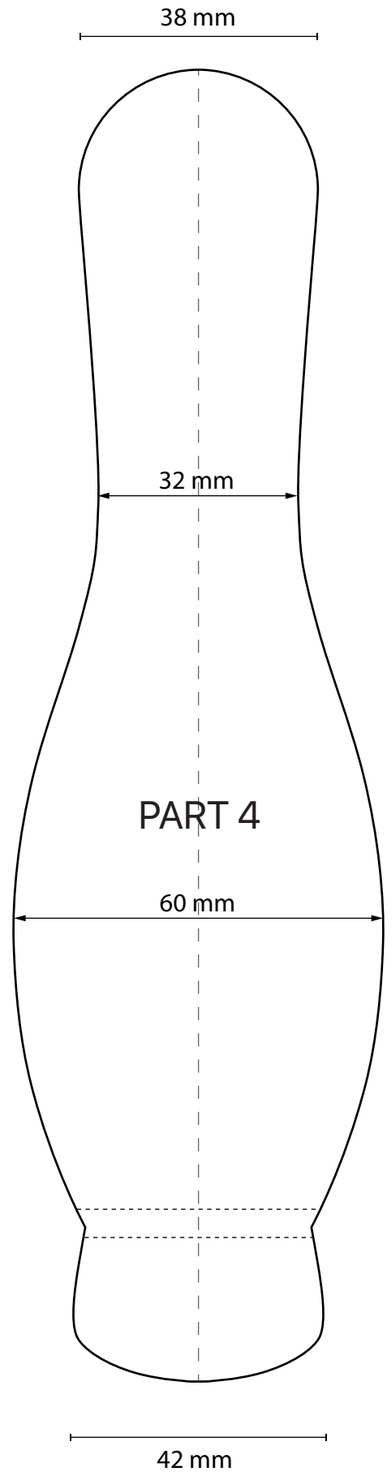


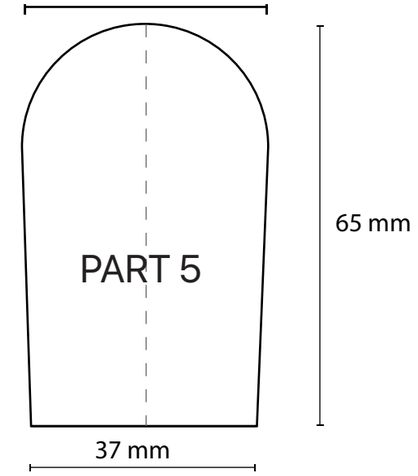
Cut line

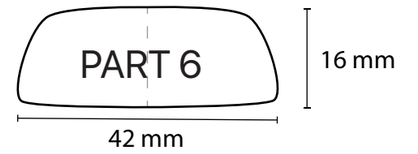
Bend line

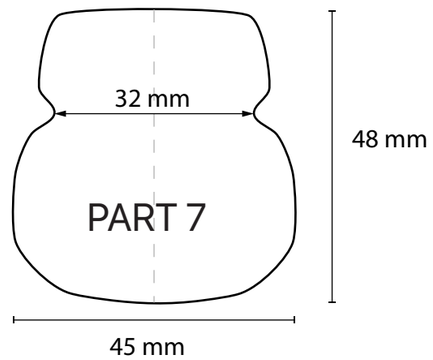
Symmetry line

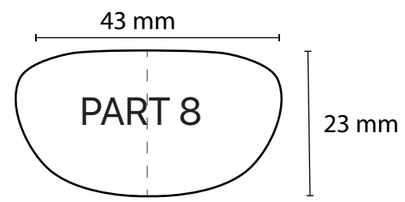
Author: MSc04 ID 03		Date: 23-05 2022	Part number: 3
Production method:		Material: EVA FOAM W. LINING	Part name: BOX INNER PADDING
Sheet size: A4	Unit: mm	Standard: ISO	Scale: 1:1





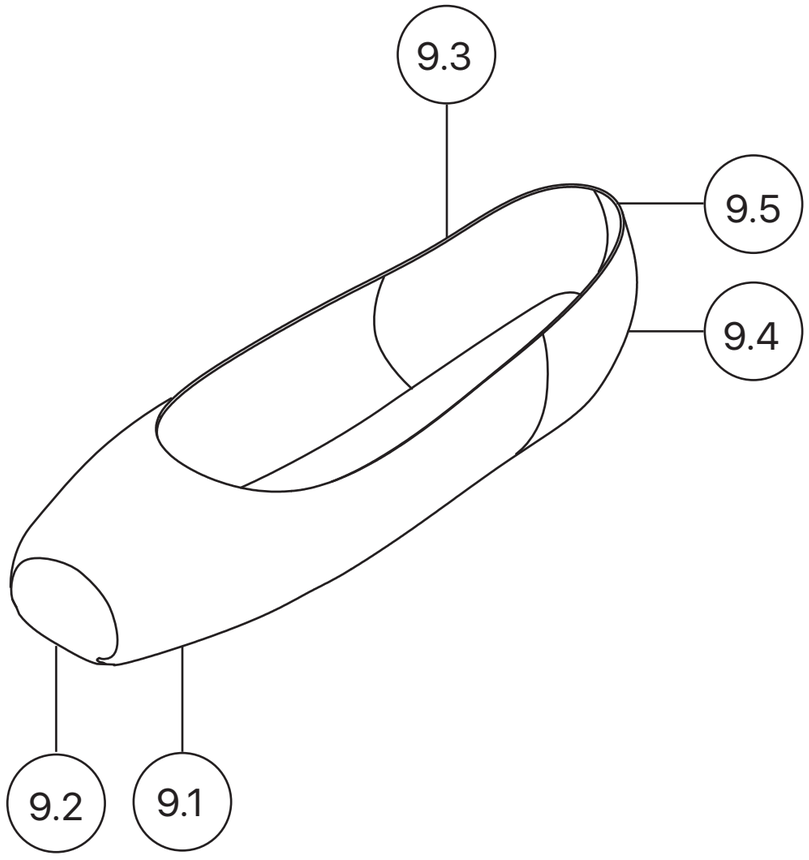






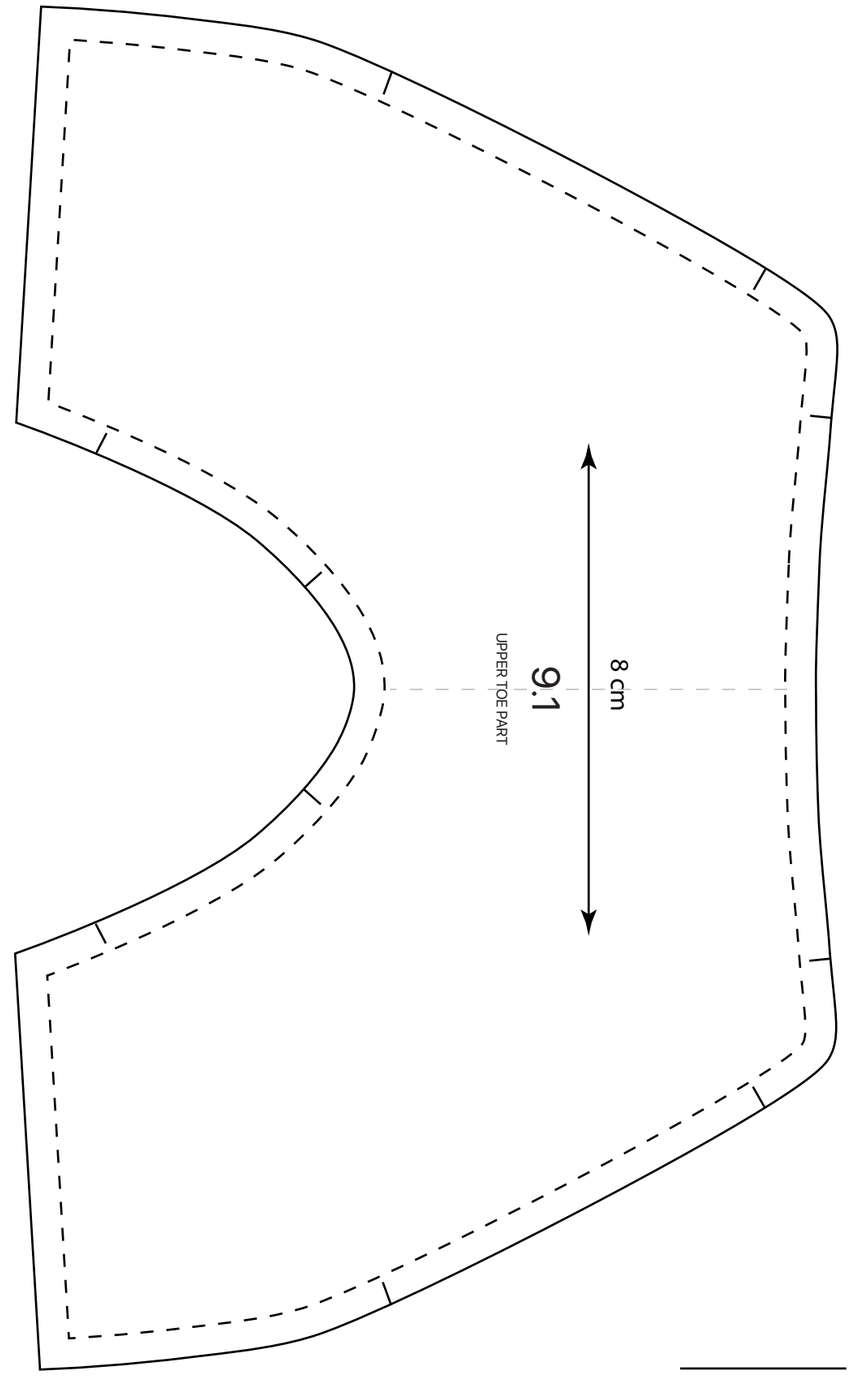
Author: MSc04 ID 03		Date: 23-05-2022	Part number: 4-8
Production method:		Material: EVA FOAM W. LINING	Part name: 4 INNER SOLE, 5 HEEL CUSHION, 6 SHOCK ABSORPTION PAD, 7 PLATFORM PAD, 8 TOE PAD
Sheet size: A4	Unit: mm	Standard: ISO	Scale: 1:1

CANVAS SOCK, part 9
SUBASSEMBLY



PART NO.	PART NAME	MATERIALS	QUANTITY
9.1	UPPER TOE PART	MOISTURE WICKING SILVER IRON FABRIC	1
9.2	SOLE PLATFORM PART	MOISTURE WICKING SILVER IRON FABRIC	1
9.3	HEEL RIGHT SIDE	MOISTURE WICKING SILVER IRON FABRIC	1
9.4	HEEL LEFT SIDE	MOISTURE WICKING SILVER IRON FABRIC	1
9.5	HEEL STRAP	MOISTURE WICKING SILVER IRON FABRIC	1

SOW PATTERNS, PART 9.1
1:1 with 5 mm seam allowance

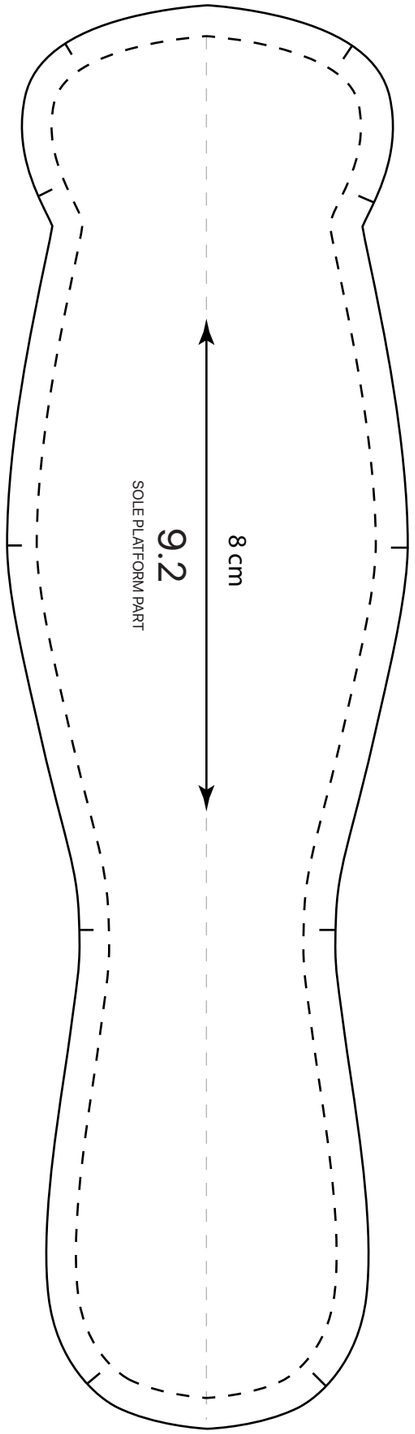


Cut line

Seam allowance

Symmetic line

SOW PATTERNS, PART 9.2
1:1 with 5 mm seam allowance

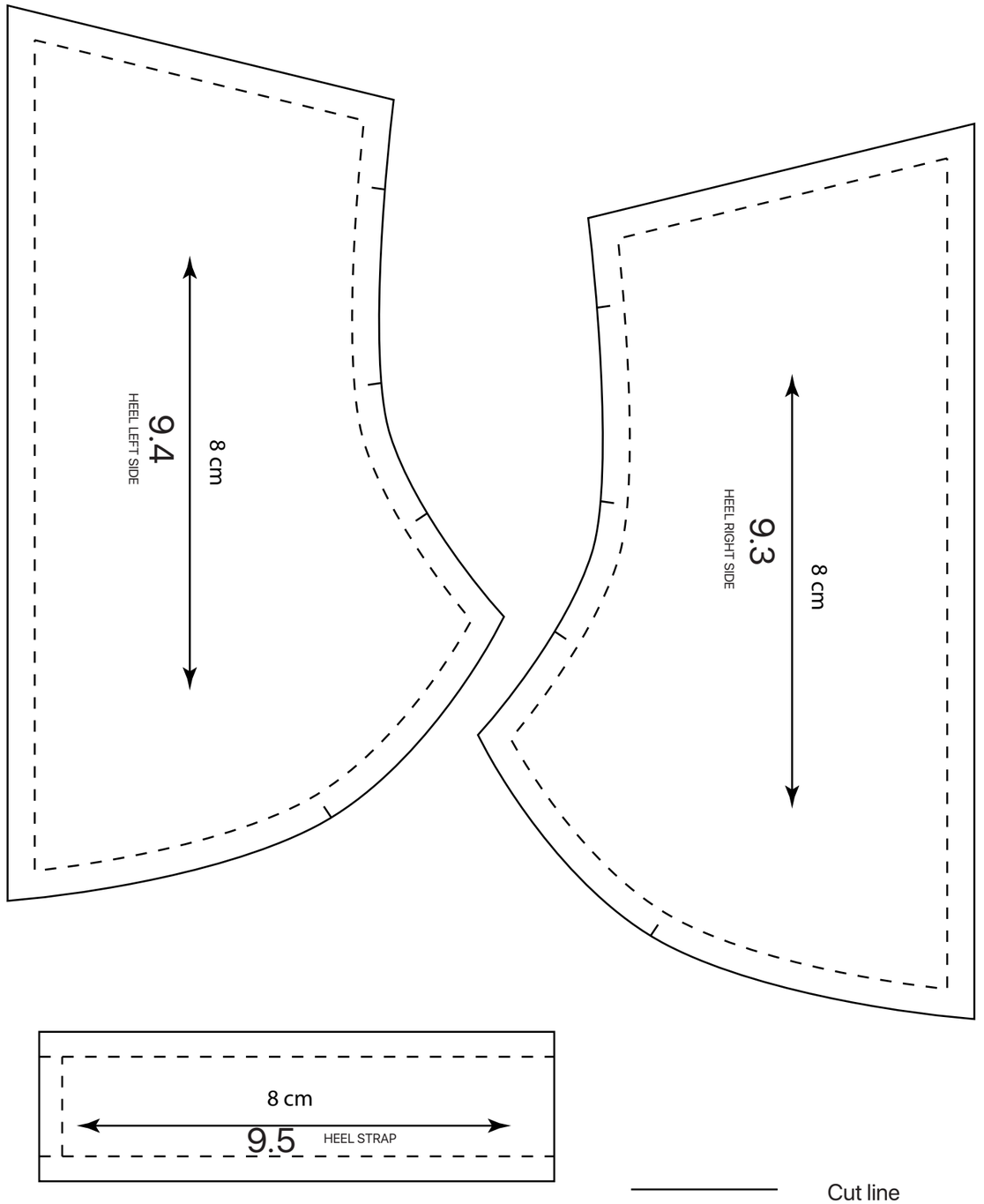


Cut line

Seam allowance

Symmetic line

SOW PATTERNS, PART 9.3 - 9.5
1:1 with 5 mm seam allowance



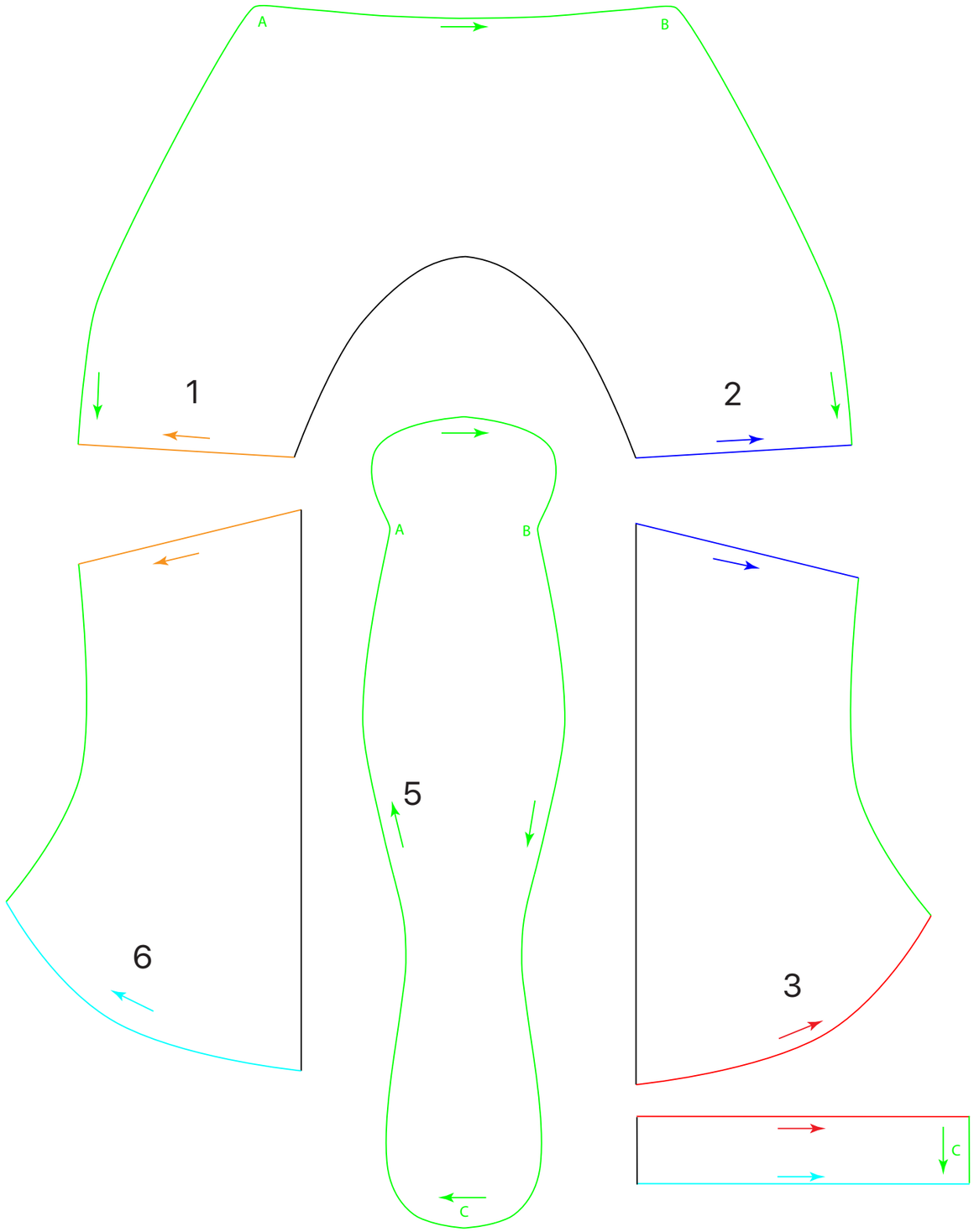
Cut line

Seam allowance

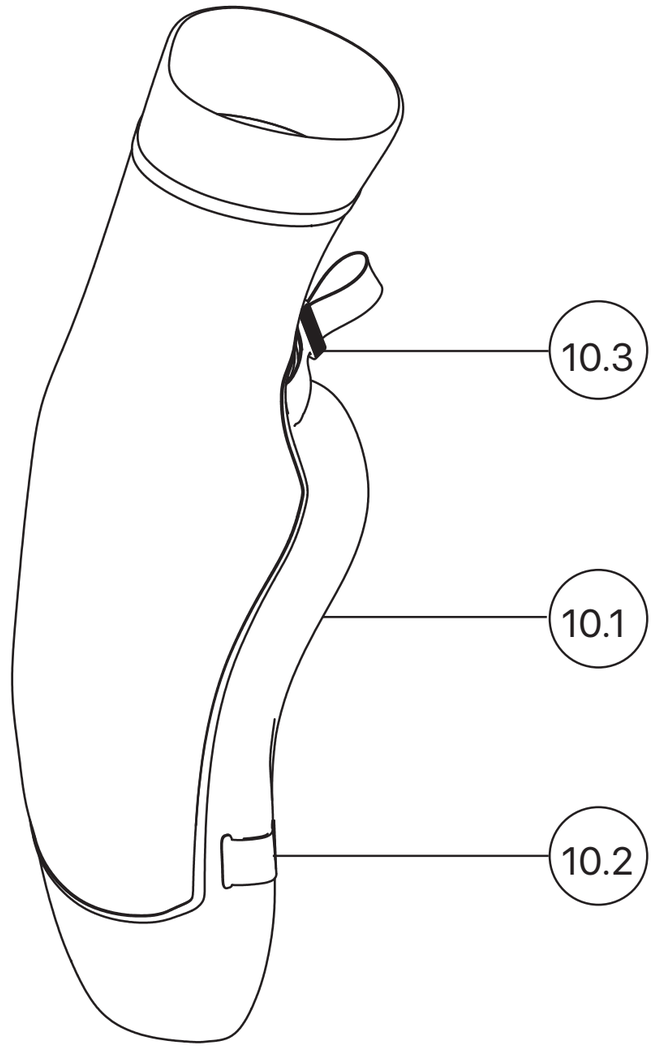
Symmetic line

SOW GUIDE

The order of opperation. Seam connection along with corner allignment points (the letters).



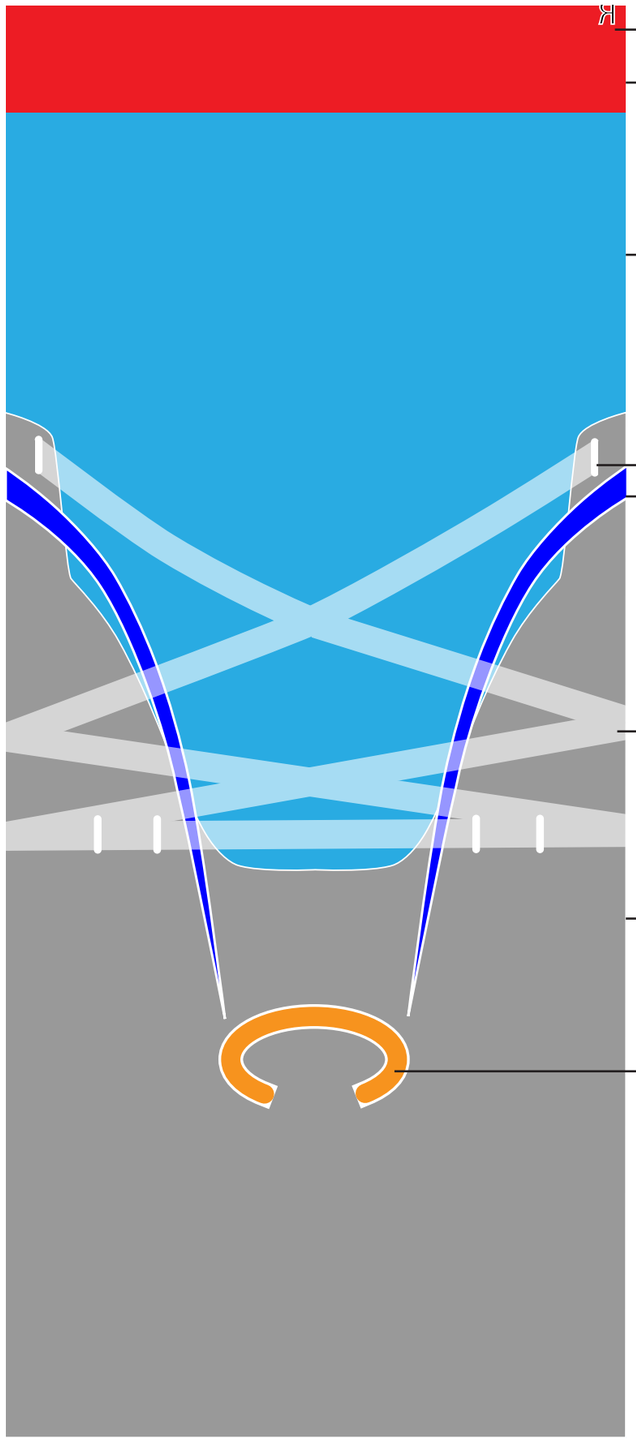
WOVEN SOCK, part 10
SUBASSEMBLY

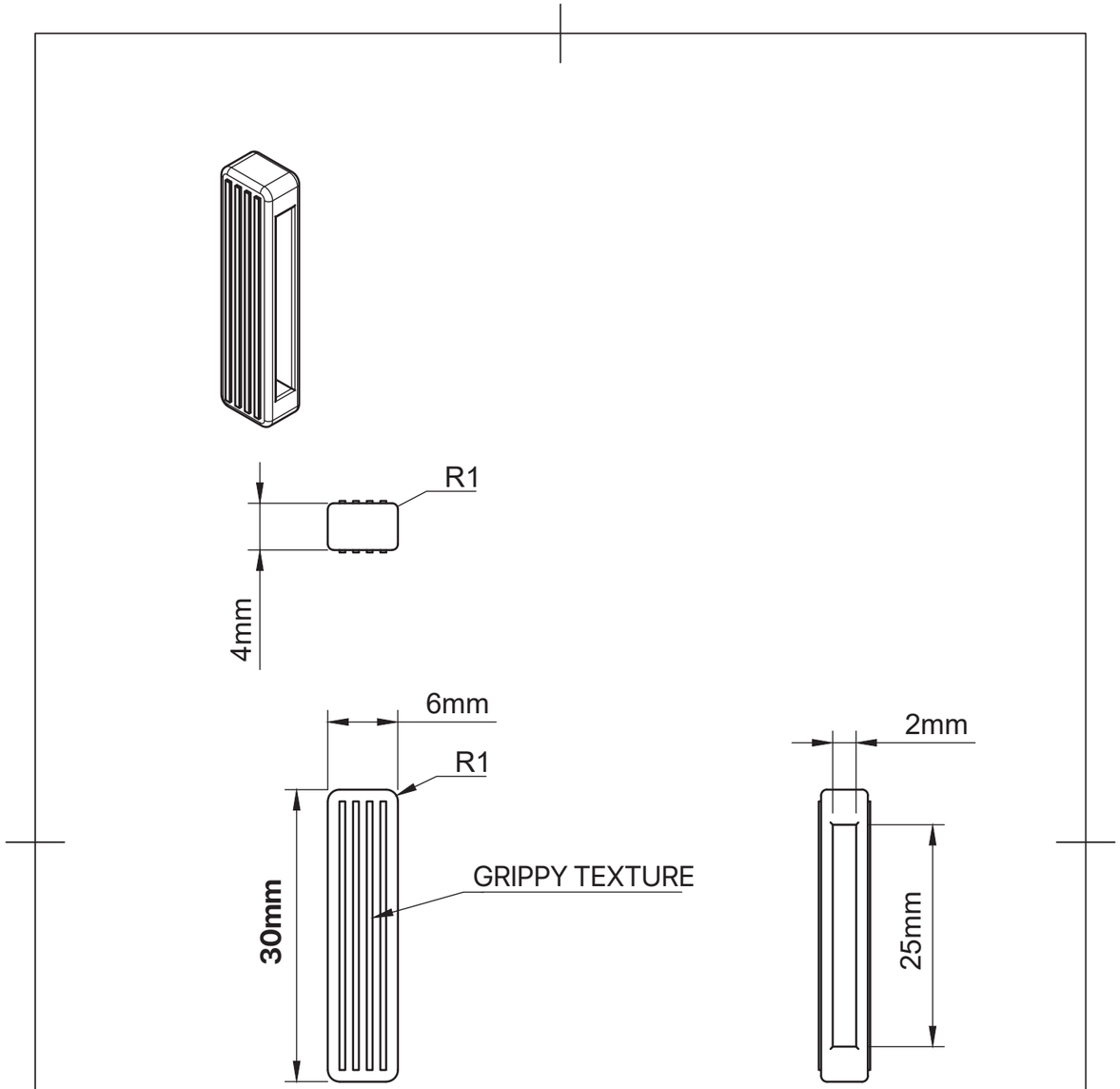


PART NO.	PART NAME	MATERIALS	QUANTITY
10.1	SOCK	PET THREAT	1
10.2	ELASTIC RIBBONS	25 MM FLAT ELASTIC	1 M
10.3	LOCK LOCK	PLASTIC (SUB-SUPPLIER)	1

PLAITING GRAPH

The plaiting graph will be transformed in to a em-graph, programming the circular knitting machine.





Guiding drawing, describing the part and form that is required

Author: MSC04 ID 3		Date: 23-05 2022	Part number: 10.3
Production method:		Material:	Part name: LOCK LACE
Sheet size: A4	Unit: mm	Standard: ISO	Scale: 1:1