lucallian

Innovation in the Traditional Equestrian Field For a New Level of Anatomically Tailored Harm-Free Saddle Fit for Riders and Horses

Imprint

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Lucallian is a team project and equestrian innovation that delivers a health-centered and technologically advanced solution for the saddle fitting process and saddle design. The smartphone application utilizes AR scanning and measuring technology, enabling riders to autonomously complete the advanced fitting process and order a customized saddle based on the individual biomechanics of the rider and the horse.

By incorporating individual measurements into a physical product, Lucallian creates an anatomically personalized saddle tree and padding system for both the rider and the horse to achieve a perfect and harm-free fit.

Keywords: AR technologies, customisation, autonomous saddle fitting, innovative saddle design, health-centered design, animal-care, equestrian equipment, anatomically custom-build.

Table of Contents

Partner & External Mentors 8
Areas of Focus& Work 9
1 Introduction 10
2 Research 12
Definitions 13
2.1 Background & Context 14
2.1.1 Saddle: Design & Fit 14
2.1.2 Generic & Customised Saddles 15
2.1.3 Innovations in Equine Industry 16
2.2 Desk Research 17
2.2.1 Equine Anatomy Relative to Measurements & Saddle Fit 17
2.2.2 Fit-Related Differences in female's & Male's pelvis biomechanics 18
2.3 Related Work 20
2.3.1 Saddle fitting & measurement systems 20
2.3.2 Equine Data Collecting Projects 20
2.3.3 Saddle Design & Fitting 22
2.3.4 Conclusion 23
2.4 Research Question & Hypothesis 24
2.5 Methodology 25
2.6 Motivation & Contribution 26
2.7 Chapter Overview 26
3 Concept 28
3.1 Field Research 29
3.1.1 Interviews 29
3.1.2 Cultural Relevance 30
3.1.3 Visiting Rancho: Casti 31
3.1.4 Visiting Saddlery: Equinomic 34
3.2 Problem Statement 36
3.3 Concept 37
4 Project Development 38
4.1 Service & Application Ideation 40
4.1.1 Persona 40
4.1.2 User Journey 41
4.2 Experiments with Scanning & MeasuremWent Technologies 42
4.2.1 Testing AR and Scanning Applications 42
4.2.2 Scanning of a Horse: Lidar Technology 43
4.2.3 Scanning of a Person: Lidar Technology 46
4.2.4 NeRF Technology 46
4.2.5 Scanning of a Person: AlterEgo Software 47
4.2.6 Conclusion on Chosen Method 49

4.3 Comprehensive Measurement System 50
50
4.3.1 Defining Necessary Rider Measurements 51
4.3.2 How to measure 52
53
4.3.3 Rider Parameters: Manual Input 53
55
4.3.4 Horse Measurements: Scanning & Photo Method 55
4.3.5 How to measure 57
57
4.3.6 Application of Designed Measurement System 57
4.3.7 Prove of Concept Prototype: Clay Molding 58
4.4 Application Development 60
4.4.1 Defining Functionality 62
4.4.2 Information Architecture 64
4.4.3 User Flow 68
4.4.4 Design 68
4.4.5 Results 70
4.4.6 Usertesting 72
4.5 Saddle Tree Design 74
4.5.1 Lucallian's Approach to Saddle Tree 76
4.5.2 Anatomically Customised Saddle Fit for a Horse 78
79
4.5.3 Gender Specific Saddle design 80
4.5.4 Manufacturing 82
5 Conclusion 83
5.1 Ethical Question 83
5.2 Learnings 83
5.3 Contribution 84
5.4 Next Steps 84
6 Bibliography, References & Figures 84
6.1 Books 84
6.2 Web Artcicles 84
6.3 Reseacrh Papers 86
6.3 Video
6.4 Applications
6.5 Companies
6.6 Figures
Appendix

Partner & External Mentor

Lucallian is a collaborative effort between myself and my partner, Kaitlynn Harrison, a student from the Industrial Design Department at Zurich University of the Arts. Our shared passion for the Equestrian world and horses brought us together and motivated us to work on this project. Kaitlynn, having an extensive experience in horse riding, identified a gap in the equestrian equipment development that sparked our interest.

We were fortunate to to receive support by Fjord, Accenture Song, that kindly offered us their mentorship throughout project. We were particularly grateful to Jordane Vernet, a Service Designer at Accenture Song, who served as our external mentor. Jordane's expertise and knowledge in the field guided us at every stage of the process. She provided us with valuable insights, helped us refine and validate our concept, and steered us in the right direction.

Areas of Focus & Work

Throughout the duration of the thesis project, Kaitlynn and I collaborated closely, both being involved in each aspect of the project, ranging from branding to product design decisions. The current thesis was primarily authored by me, the sections written by Kaitlynn are indicated accordingly. Due to our constant collaboration, I will refer to "us" in the remaining work.

As an interaction designer, my focus revolved around several key aspects:

—Designing the measurement system for both riders and horses (defining exact necessary measurements and translation into a saddle design)

—Developing a mobile application that utilizes the developed measurement system

—Defining gender-specific saddle design adjustments: Recognizing

—Participating in developing a saddle tree concept that innovates on harm-free fit.

1 Introduction

A riding saddle is an integral part of equestrian sports and activities. Being an essential medium connecting two living beings, riders, and horses, a saddle is a key factor in their safety, health, and comfort. A properly fitted saddle will ensure a secure and harm-free ride for both sides, while an ill-fitting saddle can lead to pain, discomfort, and even injury. In order to achieve a comfortable saddle fit, a saddle should be tailored to the individual anatomy of the rider and the horse.

Generic saddles pose challenges as they are mass-produced and often hinder the horse's flexibility and anatomy. Customized saddles are available but are becoming less common and have limitations in customization. Measurements from both the horse and rider are often not considered in a saddle fitting process, and the process itself is time-consuming and costly.

We believe that contemporary technology with its extraordinary qualities has the potential of making a fitting and customization process more precise and simpler. The current thesis explores the potential of applying technologies in the traditional saddle fitting and design and aims to create a comprehensive measurement system and application, along with concepts of innovative saddle design, that would result in a service delivering a harm-free anatomically tailored saddle.

Research 2

Definitions

Saddle: A saddle is a seat-like structure designed to be placed on the back of a horse or other riding animals

Saddle fit: Saddle fit refers to the proper alignment and adjustment of a saddle on a horse's back

Horsetech: Horsetech is a term that typically refers to the application of technology and scientific knowledge in the field of horse care and management

Equine: The term equine relates to horses, encompassing the study, care, and management of horses

Lidar: Lidar stands for "Light Detection and Ranging." It is a remote sensing technology that uses laser light to measure distances and create detailed 3D maps or models of the surrounding environment

Saddle fitting: Saddle fitting is the process of selecting and adjusting a saddle to ensure proper fit and comfort for both the horse and rider

NeRF (Neural Radiance Fields): A novel approach that uses neural networks to represent complex 3D scenes and objects. It combines computer vision and deep learning techniques to generate highly realistic and detailed renderings

Background & Context

2.1

Saddle: Design & Fit

2.1.1 A saddle serves a number of crucial functions for both a rider and a horse. It insures a safe and comfortable seat, even weight distribution across the horse's back, support for proper posture and balance, and freedom of movement inside the saddle and for a horse. Each part of a saddle has its own purpose and function:

The tree of the saddle is a supportive structure located inside the saddle and usually is made of wood and/or steel *(Fig. 3)*. It supports the saddle, gives it shape, and is designed to distribute the rider's weight on a horse's back. The fit of a saddle tree is the first and the most important factor in the saddle fit process.

The gullet in a saddle design refers to the channel that runs down the center of the saddle, which allows clearance for the horse's spine *(Fig. 2)*. It is the space between the two panels of the saddle that rest on the horse's back. At the head of the tree, the gullet is essentially an upside-down, V-shaped piece of steel that fits over the withers of the horse. A narrow gullet may cause pressure on the spine, while a wide gullet may not provide enough support and stability *(The Horse and Stable, 2022.)*.

The pommel in saddle design refers to the front part of the saddle that rises above the seat and helps to secure the rider's position *(Fig. 1)*. The primary function of the pommel is to provide stability and support for the rider's upper body, particularly during faster or more challenging riding *(The Horse and Stable, 2022.)*.

The panels of the saddle are the side pieces that provide cushioning for the horse's back *(Fig. 1)*. They are typically designed with a curved shape that mimics the contour of the horse's back and helps distribute the weight of the rider evenly. Well-padded panels also provide some shock absorption, reducing the impact of the rider rising and falling *(The Horse and Stable, 2022.)*.

The twist is the narrowest part of the seat, where the rider sits. It is located in-between pommel and wider seat *(Fig. 1) (The Horse and Stable, 2022)*. This part serves as the main contact point between a rider's top of the inner thigh and groin and the saddle. Twist plays a crucial role in a fit for a rider. Especially for women, for whom too wide and high twist that would be optimal for men is not a comfortable fit.

The seat is where the rider positions themselves. The level of cushioning and the seat's depth in comparison to the pommel and cantle vary according to the saddle's intended use

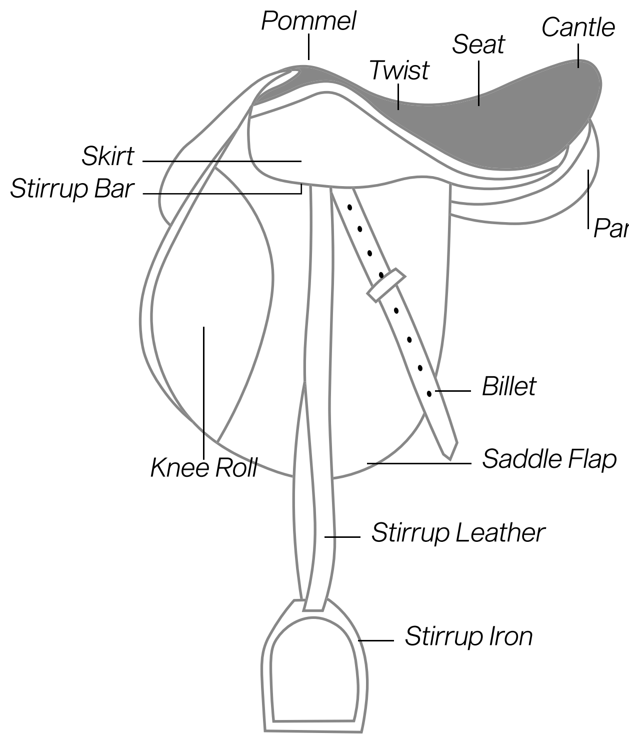
(Fig. 1).

Flaps are large pieces of leather that lay over the billets and serve the rider's legs' protection from movements and friction. The flaps of a saddle can affect the rider's position and the way the saddle interacts with the horse's body. Flaps that are too

insecure position, while flaps that are too thick or flexible may cause pressure points or lack support *(Fig. 1)*.

A girth is a piece of equipment used to keep the saddle in place on the horse's back. It is a strap that goes under the horse's belly and is attached to the saddle on either side. The girth is used to distribute the pressure of the saddle evenly across the horse's back and prevent the saddle from slipping or moving while the horse is in motion.

Stirrups are a component of a horse saddle that allows the rider to place their feet and provide support and balance while riding. They consist of a pair of loops that hang from the saddle's tree and are connected to the stirrup leathers *(Fig. 1)*. *(The Horse and Stable, 2022)*.



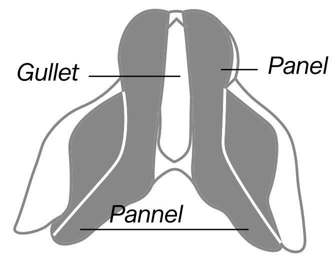


Fig.1-2

Saddle tree

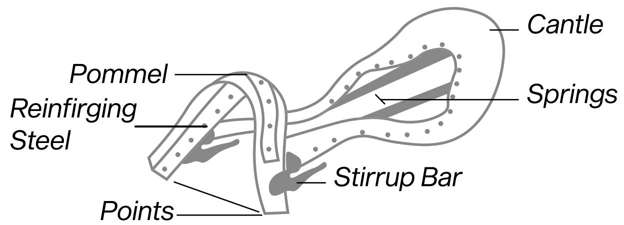


Fig.3

Generic & Customised Saddles

2.1.2 Saddles fall into two categories depending on the method of production: generic and customized saddles.

Generic saddles are pre-made and designed to fit a wide range of horses and riders. They are typically less expensive and available in tack shops and online stores. While generic saddles can be a good option for some riders, they may not always provide the best fit for the horse and rider, which can result in discomfort and even injury. Finding the best-fitting saddle is one of the challenges faced by riders, particularly if they are unable to test it out on their horse.

Customized saddles are designed to fit the unique anatomy and biomechanics of both the horse and the rider. They are typically more expensive. A saddle that is custom-made can help to improve riding balance and stability, weight distribution and reduce the risk of injuries. Also, such saddles can prevent body distortions

Though, through our research, we discovered that there is a serious limit to the customisation performed in saddleries. Not all saddle makers obtain necessary measurements from both horse and rider, failing to consider the horse's movement and gender-specific design solutions based on the rider's pelvis type. The process is time-consuming and costly, requiring multiple visits to the rider's location.

In reality, both saddle choices are not truly customised, to start with, they are not specifically built in the first place for a unique anatomy of horse or a rider. Both choices are rarely gender specific.

The choice of generic saddles is influenced by factors such as the time-consuming and costly fitting process, the declining availability of customized saddles, and the lack of standardized methods among saddle makers for fitting and customization. This uncertainty makes it challenging for riders to determine the level of customization in a saddle.

Saddle readjustments are often sent to saddle makers or manufacturers, with riders sometimes opting for a new saddle instead. Self-adjustments by riders are limited to padding changes, but not all riders are knowledgeable in correct adjustments. This process requires additional time and payment.

Innovations in Equine Industry

2.1.3 The equestrian industry is mostly traditional and manual nowadays. There are many factors that caused Equestrian equipment to almost save its original shape.

Some of those factors include the notion of historical prestige associated with certain brands, regardless of the effectiveness or comfort for the horse. Additionally, riders who achieve success and gain popularity often receive support from saddle manufacturers, leading to their opinions and preferences driving innovations in the industry *(Natural Horseman Saddles, 2021).*

Horsetech, being a young niche, can be categorized as equine-related technology, including equipment for riders and horses. Horsetech collaborates with a wide range of other sectors, such as sports-HCI (Human Computer Interaction), leisure and training technology, and IoT (Internet of Things) *(Berggren, 2018).*

Desk Research

2.2

Equine Anatomy Relative to Measurements & Saddle Fit

2.2.1 A saddle should be located on the saddle support area. It includes the withers, thoracic region, and lumbar region. A well-fitted saddle should distribute the rider's weight evenly. The saddle support area at the back of the horse is located at the 18th vertebra *(Fig.2)*, which is the last one connected to the ribs. The strength required for the horse to carry weight comes from the intermingled muscles and ligaments in the ribs. Beyond the last rib, there are lumbar vertebrae with fragile horizontal transverse processes. These vertebrae are unable to bear any weight, so the surrounding muscles tense up to protect them.

The withers, which are the uppermost thoracic vertebrae. It marks the place where the saddle gullet plate should be located *(Fig.4)*. The withers of the horse are known as the highest point of these spinous processes.

Scapula, its rotation and location are incredibly important as a well-fitted saddle should not interfere with the scapula's movement *(Fig.4) (Ruddock, 2016)*. The fragile cartilage located on top of the scapula can be easily harmed between the sturdy scapula bone and the tightly girthed steel or wooden tree of a saddle. Once the cartilage is damaged, it cannot regenerate, and the harm is irreversible.

The nuchal ligament system serves to link all the vertebrae together and functions as a suspension bridge for the skeleton *(Fig.4)*. In case the saddle does not provide enough space for the ligament, it will be unable to carry out its duty, which may lead to physical harm to the horse.

Longissimus muscle runs from the neck to the sacrum and its function is to facilitate movement rather than bearing weight. Tense back muscles can cause physical harm to the horse, as well as spooking and various other behavioral and training problems.

The fascia in the saddle support area plays an important role in distributing the weight of the rider and the saddle over a larger surface area. When the fascia is healthy and functioning properly, it helps to maintain the shape and structure of the saddle support area and allows the horse to move freely and comfortably *(Ruddock, 2016).*

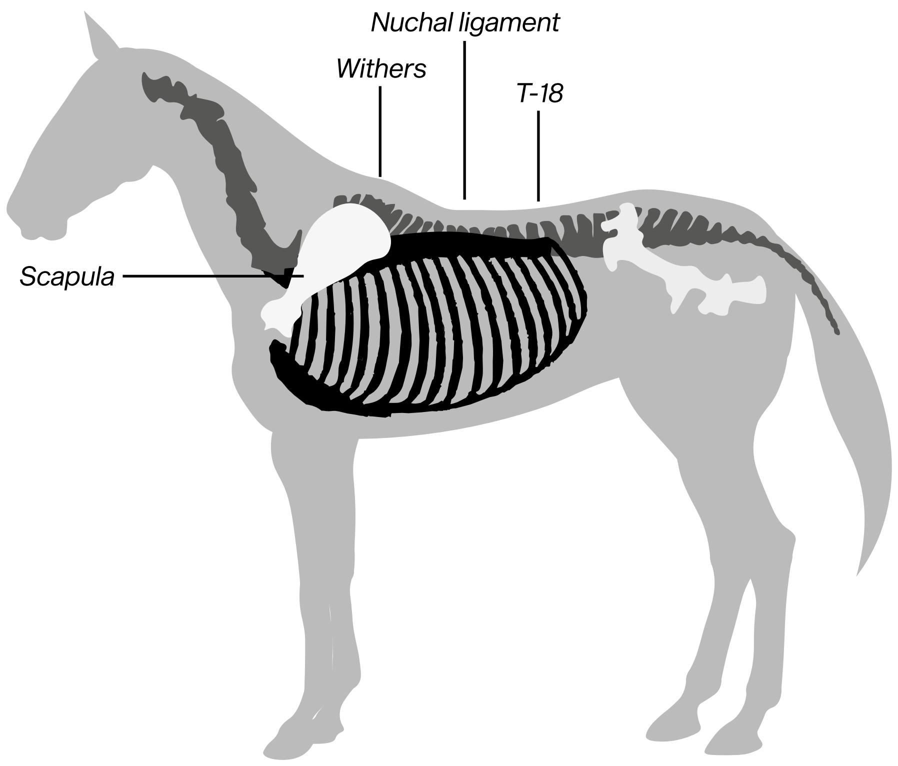


Fig.4

Fit-Related Differences in Female's & Male's Pelvis Biomechanics

2.2.2 Despite the fact that the number of female riders continuously increases, there is still a lack of female-friendly equipment.

Major differences of male and female biomechanics lies in the pelvis structure *(Fig. 5).* The female pelvis is wider and shallower than the male pelvis and also normally tilted forward. The male pelvis, on the other hand, is narrower and deeper, with a smaller pelvic inlet and outlet. Generally, male pelvis is optimized for stability and support of the upper body and locomotion.

For females, the wider pelvis and more anteriorly rotated position can make it more challenging to maWintain a stable balance while riding, as the center of mass is shifted further forward compared to males.

For males, more posteriorly rotated position can make it easier to maintain balance while riding, as the center of mass is shifted slightly further back compared to females. This factor should be taken into account in a saddle tree's curvature design.

Female riders have three points of contact with a saddle, while male riders have two. This impacts the weight distribution and balance of a rider. These parameters should impact the shape of the saddle twist and the support the saddle provides for female riders at the lower back.

Due to the difference in hip muscle location, male riders have more space between the upper inner thighs, so they prefer wider fenders. At the same time, female riders have less space and would prefer narrower fenders to accommodate the shape of their legs.

prefer wider fenders. At the same time, female riders have less space and would prefer narrower fenders to accommodate the shape of their legs.

The leg skeleton is also different for males and females: a male's lower leg is usually longer than the upper leg. Males feel more comfortable when the stirrup bars are positioned more in front. For females, the ratio is the opposite. Consequently, it is more ergonomic to have stirrups closer to the middle of the saddle.

Bad fit saddle deforms women's bodies like Chinese feet. But it also badly impacts a horse. When a female rides with a male saddle, it can cause all the weight to be concentrated on one point on the horse's back, leading to poor weight distribution *(HorseClass, 2015).*

Female pelvis

Male pelvis

Fig.5

Saddle fitting & measurement systems

2.3.1

Horseshape Laser *(Schleese, 2017)*

Similar to our vision, the laser captures a complete 3D image of the horse's back shape to help with saddle customization or custom fitting before being sent to the customer. The device can read the three-dimensional contour of the horse's back and send that information back to the main computer for analysis. It works best when a fully customized saddle is being constructed to fit a specific horse's back, but the horse owner can also choose to have a "cutout" form of the shape, enabling comparisons of changing conformation over time.

We would like to note that all data is in the hands of the manufacturer, and the whole process has to tighten eighty-eight screws. Afterward, he has to put input each number into a form on the EQUIscan website. Finally, a user will receive a PDF with a 3D model of the back of the horse, a model of the device on the top, and a "heat map" of the pressure distribution. The measurements are taken in a stationary position to minimize any movement from the horse.

The Topographer by EQUIScan
(EQUIscan, 2023)

As we consider EQUIscan one of the main players in the field it was important for us to understand their process. We organized an interview with the EQUIscan team at the SPOGA-2023 expo.

EQUIscan aims to capture a horse's back shape and curvature. The EquiScan Topographer *(Fig.6)* is a set of eleven independently movable sectioned arms that are placed across the back of the horse, each arm has mechanical numbers that are representing the angle data on each point of the surface. EQUIscan team informed us that only professional saddle makers or doctors can use the Topographer.

After placing the device on the horses's back loosely the user

Although the outcomes are good, it is a very time-consuming process. Another problem is the actual use of device: mostly saddlemakers put it above the saddle and checking the fit in this way *(Fig. 6)*. So there are no direct implementation of the measurements in to a saddle design. As users' data is stored on the EQUIscan website they can compare measurements from previous years.

Fig.6

The EASY-CHANGE Fit Solution
(EASY CHANGE)

The EASY-CHANGE Fit Solution is a set of tools that allows a user to custom fit their saddles. The Gullet Gauges is a tool to help a user to select the correct size gullet to fit their horse *(Fig.7)*.

A user can also use the gullet gauge to monitor any changes in a horse's muscle every three to six months. After placing it loosely on withers of a horse a user should adjust the device to fit withers angle and then write down the measurements and check with a current saddle if any adjustments are needed.

Fig.7-8

Equine Data Collecting Projects

2.3.2

Piavita *(Piavita, 2021)*

Piavita is a Swiss company that offers a portable and non-invasive monitoring system for horses. Their device, which consists of a sensor unit and a smartphone app, captures real-time data on vital signs such as heart rate, respiratory rate, body temperature, and blood pressure. The device can be attached to the horse's halter or girth, allowing for easy and wireless monitoring. It provides a graphical representation of the data and sends alerts if any readings deviate from pre-set parameters *(Fig.8)*.

The collected data can be stored and shared with veterinarians and other healthcare professionals, aiding in diagnosis and treatment. Piavita's technology aims to improve the efficiency, accuracy, and accessibility of veterinary care for horse owners, trainers, and veterinarians. However, one drawback is the requirement for the horse to wear a special belt with an attached sensor.

Alogo *(Alogo)*

Alogo Analysis is a Swiss tech company specializing in equestrian analytics tools for measuring the performance of horses and riders. Their system includes the "Alogo" mobile app and the equine sensor "Move PRO," which is attached to the horse's girth. The sensor collects data on the horse's movement, and this information is transmitted to the mobile app for analysis. The app provides detailed insights into the horse's gait, stride, speed, and other performance metrics.

Of particular interest is the data on longitudinal and lateral balance and straightness, which can help riders maintain a balanced position and avoid uneven weight distribution. Inspired by Alogo, we considered integrating sensors directly into the saddle, eliminating the need for a separate device and providing more convenience for riders to gather data on their horse's health and performance.

We found the Alogo application as one of the most advanced mobile applications in the equine industry, offering user-friendly feedback in a compact and straightforward manner.

Saddle Design & Fitting

2.3.3

Schleese *(Schleese, 2022)*

Schleese has earned a strong reputation for its exceptional “Saddlefit 4 Life” philosophy program, which is rooted in its comprehensive understanding of the anatomy and biomechanics of both horses and riders. The company uses multiple devices and professional saddle fitters to ensure that all parameters are taken into account. Schleese considers the horse’s conformation, musculature, and movement, as well as the rider’s position and individual measurements and requirements. By the end of the program, Schleese either defines the best-fitting saddle or offers a customer the option to order a customized saddle.

Apart from their considerate approach to saddle fitting, Schleese is also a pioneer in gender-specific saddles. They were one of the first companies and remain one of the few that offer a truly anatomically tailored saddle design for females.

Schleese was a big source of inspiration for our project. We would like to implement such a detail-oriented and holistic approach to the customization and fitting process, as well as design saddles that are tailored to the biomechanics of different genders at a structural level.

We would like to note that all data is in the hands of the manufacturer, and the whole process requires professionals.

Conclusion

2.3.4

After examining and testing different projects and applications, we came to the conclusion that there is no project that closely resembles the concept we have envisioned, so we focused on specific parts of different projects that would resonate with our concept.

Alogo serves as an example of a well-designed and user-friendly mobile application in the equestrian industry. We would like to achieve the same quality of implementation and clarity of feedback.

Regarding the procedure and system of saddle fit and measurements, we are inspired by the Schleese reference and their holistic approach, and attention to detail. Also, for the direction of saddle design, we would again situate our project close to Schleese saddles as their philosophy resonates with our approach.

We also came across a few applications like “Horseshape” *(Horseshape, 2011)* that promise to take a precise scan of a horse and document its back at the time of measurement. Unfortunately, after testing them out, we concluded that most of them were not working properly or at all.

We identified a trend among most of the saddle-fitting devices we looked at: they were mainly used to check if the already made saddle would fit the horse and to determine what adjustments could be made. Additionally, most of the devices just provide an outlook on a horse’s back, but not ready-to-implement measuremnets.

Research Question & Hypothesis

2.4

In the current thesis, we focus on the topic of health-centered anatomically tailored saddle fit process that could be completed autonomously by riders. Additionally, we researched the specific and possible implementation of gender-specific health-centered saddle design. For this, we have phrased the following research question:

- How can we create a simplistic, accessible, and comprehensive saddle-fitting application that could enable riders to perform the fitting process autonomously and order a customized saddle?
- How can we design a holistic measurement system that would capture and record all necessary measurements and parameters of a rider and a horse in order to generate ready-to-implement results for a saddle design?
- How can we design a saddle system that would be gender-specific and health-centered for a rider and harm-free for a horse?

We hypothesize that with the use of technologies, the complex process of saddle fitting can be simplified and deliver more precise results. We believe that with a clear understanding of benefits, riders would like to use a simplistic tool to achieve a highly customized saddle fit. Our ultimate goal is to develop a comprehensive service comprising a mobile application, an integrated measurement and fitting system, and personalized saddle design.

Methodology

2.5

We proceeded with several methodologies aimed at helping us gain a deeper understanding of the subject matter and gathering the necessary knowledge on saddle design and fit. We felt that very specific knowledge base is required to be able to innovate the process. Within our user-centric approach we had to profoundly understand our end users to define their real needs and expectations.

User Interviews

We decided to use the interview methodology to gain more in-depth knowledge of our end users and the status quo. We conducted interviews with horse owners, riders, saddle makers, software developers and others on scanning technologies to gather their insights and experience to have a comprehensive picture of each aspect of the service.

Expert Interviews

In order to understand the status quo of the saddle fitting process, we interviewed experts in a saddle craft, saddle makers. We also visited one of the saddleries to get a deeper understanding of the process.

Cultural Relevance

To gain a better understanding of the current state of innovations in the field, we attended the most influential events in the equestrian industry. By talking with professionals and examining projects and products on the spot, we were able to build a perspective on the direction we would like to pursue.

Field tour, examination & learning

By visiting a saddlery, we were able to situate our understanding of the saddle fitting and production process. The visit provided us with valuable insights into which parts of our knowledge and hypotheses were true and which were not. Without a doubt, the visit and experience working with a saddle maker were one of the most insightful methods we employed. This has been a great help in helping us shape our approach to the project and develop a product that is both innovative and practical.

Experiments & Prototypes

We aimed to investigate concepts and technology and validate it through experiments and prototypes. This process allowed us to go forward and iterate, whether they were fast or more intricate advancements. On the one hand, working with horses in the field gave us a firsthand understanding of what the scanning procedure might be like. We used the results as a major source of inspiration and as the foundation for developing additional prototypes. We were able to validate our gender-specific strategy by working with clay molding.

Motivation & Contribution

2.6 Our primary focus lies in finding a solution to an issue that impacts both human and, in our case, animal health. We believe the solution to the identified problems can have a profound positive impact. Additionally, our motivation comes from our own riding experiences and connection with horses developed through this practice.

Regarding our intended contribution, we aim to design a more convenient, fast, and accessible way for the saddle fitting process. We hope to create a user-friendly process that would break existing expectations in the traditional field.

We hope to generate more interest in health-centered and research-based design and to provide a product that takes into account the well-being of both riders and horses equally. We hope that our project will inspire more ideas for implementing innovations in the equestrian field and pushing traditional boundaries and expectations.

Chapter Overview

2.7 The first part of the current thesis was initially research-oriented and then changed to a collaborative and experimental process. Firstly, we conducted field research, which included observations and interviews, attending events, and conducting fieldwork at the rancho.

Through field research, we gained expertise and knowledge on saddle fitting and design processes, which shaped and added to our first prototypes. In the third stage of our thesis development, we continued prototyping and experimenting to validate the defined concept. During this process, we realized that we needed to iterate on our target user group and narrow down our focus for the final exhibition, as the project's scope was too broad for a Bachelor's work.

Concept 3

Field Research

3.1

Interviews

3.1.1

Firstly, we would like to thank all our interview partners for sharing their knowledge and experience with us. Their input ultimately shaped and enhanced our project. In this chapter we give a short overview of the interviews contexts. *Full interview findings can be found in the appendix.*

Jessica Wohlwend, a saddlemaker, emphasized the importance of precise measurements for both riders and horses. She discussed the need for observing horses in both stationary and walking positions, in her practice she relied on visual judgment rather than data. She mentioned importance of providing riders with comprehensive information about the saddle.

Sabrina Casti, a ranch owner and rider, shared her experience with customized saddles and the challenges of fitting saddles to multiple horses. She found the idea of a DIY padding system helpful but raised concerns about riders' ability to make appropriate adjustments. Sabrina expressed the desire for an application to have multiple profiles for each horse and suggested measuring the horse's temperature as well.

Jordane Vernet, a hobby rider, stressed the importance of prioritizing functionality over appearance when customizing saddles. She highlighted the need for accurate measurements of both the rider and the horse, as in her experience a saddle maker did not take any measuremnets of both. Jordane also mentioned the benefits of having feedback on the saddle's fit and the possibility of measuring the horse's temperature.

Stella Trümpi, a professional rider and horse owner, shared with us absoulutely different from hobby riders experience. In her case, she changed saddles every three years. She emphasized the need for proper customised fit as in her experience it helped to heal her back pain.

Pietro Zullo,cofounder of AlterEgo *(AlterEgo, 2023)*, AR technologies specialist, provided insights into creating models of riders and horses for measurements. He discussed the options of using AlterEgo models or Lidar scans for rider measurements and suggested Lidar as the most precise technology for measuring horses.

Verena Ziegler, the founder and CEO of Open Dress *(Open Dress)*, shared her expertise in utilizing NeRF technology for body scanning. She discussed the advantages of NeRF in creating accurate horse and rider models based on photos or videos.

Overall, the interviews highlighted the importance of precise measurements, the challenges of fitting saddles to different horses, the need for rider and horse feedback, and the potential of advanced technologies like NeRF for saddle fitting applications.

Cultural Relevance

3.2

With the aim of gaining a comprehensive perspective on the equestrian industry and the current state of equestrian innovations, we decided to visit the SPOGA 2023 expo and the White Turf Races.

SPOGA 2023 expo

The SPOGA Horse 2023 Expo focuses on showcasing the latest innovations, trends, and products in the equestrian industry. It prioritizes animal welfare, sustainability, and technology to promote ethical and responsible practices.

During the expo, we had the opportunity to interview the team behind EQUIscan, a leading company in saddle fitting systems. We thoroughly examined their product and discussed their methodology, and the details can be found in the "Related projects: EQUIscan" section of the paper.

At the SPOGA 2023 expo, we discovered Schleese Saddles, a mammoth company that specializes in a gender-based approach to saddle fit. We discovered that their product closely aligns with our own concept. They became our inspiration and source of knowledge for this thesis.

Throughout our research, we identified approximately ten innovative projects in the equestrian industry. While we observed a lack of implementation of new ideas in the sector, we were motivated to continue our work, recognizing the ample room for improvement and innovation. Several companies inspired us to pursue our idea of incorporating sensors into a saddle, as we deemed it both useful and practical. However, it is worth noting that, in our opinion, saddles witnessed the least amount of innovation compared to other products in the industry.

The White Turf Races

The White Turf races are an annual event held in St. Moritz, Switzerland that features horse racing on a frozen lake. We decided to visit this event as it would be beneficial to talk with different professional riders and ask about their saddle fit experience. We also aimed to get a sense of how horse riders would react to our innovative idea, understand their level of trust in technology, and collect possible suggestions *(Fig.9)*.

The event provided informative insights into the riding and treatment of professional horses, causing us to reflect on ethical questions. Firstly, we became aware about the retirement process for these animals and the duration of their racing careers. It became evident that there is a lack of legal regulations at this level to ensure the well-being of these animals.

Secondly, the event shed light on potential target groups that we had not previously considered, specifically riding schools. We were pleased to discover that one of the school owners expressed interest in our product idea, prompting us to reassess our persona.

Lastly, we discovered that many professional riders experience back pain due to intense competition and training. Furthermore, they replace their saddles every two to four years, more frequently than the average rider. Similarly, their horses are changed every four to five years to prevent overexhaustion.

Fig.9

Fig.10

Visiting Rancho: Casti

3.3

We concluded that field testing our concept is the crucial next step. During an interview with rider Sabrina Casti, she graciously invited us to her family ranch to interact with her horses. This proved to be informative and practical for our project (Fig.10).

At the ranch, we conducted our first horse scans using Lidar technologies *(see Development Chapter)*. This trial revealed the need for implementation instructions in the service to avoid issues. For example, scanning horses in stables was inconvenient, and we determined a minimum area of five to five meters was necessary. Another challenge was the horses' movement. They found it difficult to remain still, requiring a second person to keep them calm during scanning.

To capture the horse's back movement, we realized users needed to lunge the horse and record it from both sides. We also attempted to film the horse's movement from the bareback position, which provided valuable insights into shoulder movement and asymmetry.

A significant observation was the interdependence of rider and horse habits and behaviors. Sabrina explained that "rider and horse take each other's weakness." For example, a right-handed rider may unintentionally block the horse's right side during riding, leading to stiffness. Considering this, we decided to incorporate this factor into our design.

We observed a significant size difference between the warm-blood horse Tomara and the cold-blood racing horse Fou. Show-jumping horses are about one and a half times larger than racing horses due to their increased musculature. Their backs exhibited distinct curvatures and gullets, making it impossible to fit them into the same saddle.

Sabrina mentioned using a single saddle for her four horses due to budget constraints, except for Fou, who requires a custom saddle due to his unique back anatomy.

To optimize the scanning process and ensure accurate data capture, we identified key factors that needed consideration. Clear and comprehensive instructions for users were crucial, including proper phone positioning. It was important to conduct scans in well-lit areas with minimal distractions. Additionally, having a second person to help keep the horse calm and still during scanning proved beneficial.

Fig.11

** Fou, our selected horse model for design of a saddle tree*

Fig.12

** Closeup of Fou's angled back*

Fig.13

** Results of scanning a horse Flur*

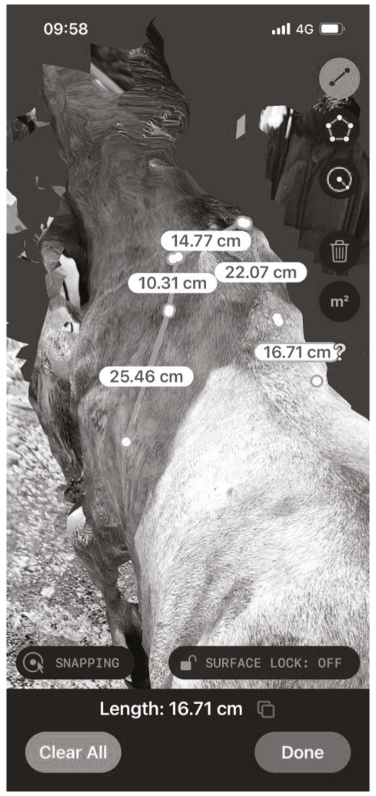


Fig.14

** Obtaining measuremnets from Fou's 3D model in the 3D Scanner App (2021)*

Visiting Saddlery: Equinomic

3.4

During our visit to Equinomic, a Swiss custom saddle production firm, we learned that their main customers are hobby riders. They outsource the production of saddle trees, which enables them to offer a product that can be customized to a certain extent. Equinomic shared that most saddleries have only five variations of a saddle tree and select the best match when an order is placed. Despite experimenting with materials like plastic, Equinomic decided to stick with the traditional wooden structure as it best suited their needs.

Here are the key points from Equinomic's process:

Measurement process

Equinomic's saddle production process begins with on-site measurements of the horse and rider. The rider's height, weight, trouser size, and upper thigh length are measured to determine the saddle panel length. The horse's height and body measurements are taken using a moldable rod tool, including withers, spine curvature, mid-back structure, and the location of the last rib. The saddler asks the rider to lunge the horse at different gates and test a sample saddle to observe shoulder movement. Modern breeding trends require higher saddle tree gullets to accommodate extreme horse movements. Equinomic finds EQUIscan useful only for Western saddles, and notes that modern horses' sensitivity is a crucial factor in achieving a proper saddle fit.Another important point is that Equinomic finds the EQUIscan system useful only for a Western saddle type.

Injuries Impacting Saddle Design

We asked Equinomic about saddle design-related injuries that a rider or a horse can have; they provided us with the following inputs:

1.Riders' hip joint problems: A narrow seat can be beneficial for riders with hip joint issues. This can reduce the pressure on the hips, which is particularly important for riders spending long periods in the saddle.

2.Riders' back problems: Riders with back issues may require a wider seat to provide enough space without causing discomfort.

3.Riders' tailbone injury: Individuals with tailbone issues may require a hole in the seat of the saddle to reduce pressure on this area.

4.Horse's kissing spines: Saddles can be designed to remove pressure from the point on a horse's back where kissing spines occur.

Rider preferences

Another important input was that riders' preferences may vary regarding the cantle, seat size, depth of seat or flatness of a seat, and saddle flaps shape.

Production process

After obtaining measurements the saddler can partially modify the saddle tree depending on the horse's body measurements by cutting away from the tree. For the rider's holding structure, Equinomic uses strong woven polyester straps, with the straps placed differently depending on the user's gender. In a woman's saddle tree, the vertically placed straps are wider than in a man's saddle tree because of the structure of the hip bones. Next, Equinomic adds padding.

Conclusion

Equinomic's insights have been invaluable, and we appreciate their contributions. To enhance our measurement system, we will incorporate some of their methods:

1.Requesting a video of a lunging horse without a saddle to assess back shape and movement.

2.Requesting a video of a lunging saddled horse with a rider to analyze balance and symmetry during riding.

3.To better accommodate individual horse and rider needs, we will introduce a new "Injuries & Anatomical Irregularities" and "Fit Preferences" pags for greater saddle fit flexibility.

4.Equinomic emphasized that saddle curvature is the key factor in proper saddle fit. However, our visit highlighted the challenge of achieving optimal fit with custom saddles. We remain dedicated to addressing this issue and ensuring the best possible fit for each horse.

Fig.15

Fig.16

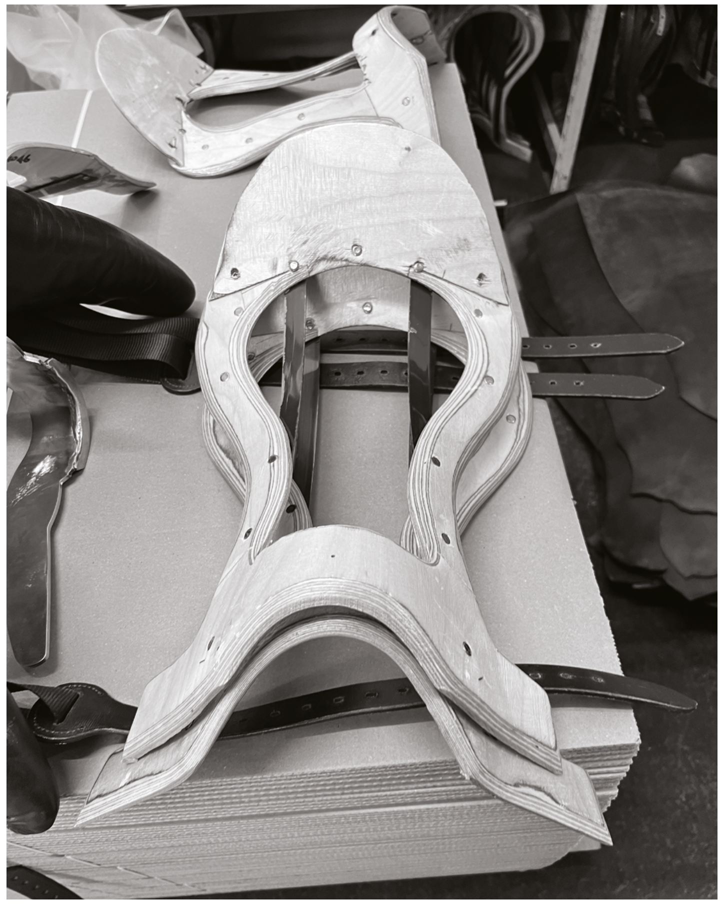


Fig.17

Problem Statement

3.2

- Customized saddles often lack consideration of all important fit parameters and exhibit inconsistency in fitting approaches and measurements among saddle makers.
- Existing saddle-fitting devices mainly focus on horses and lack ready-to-use measurements for saddle design, limiting accessibility and increasing costs. Also, we observed a disregard for the flexibility and body changes of horses during the measurement process.
- There is a lack of devices to take precise riders' measurements.
- Research on horse anatomy is not consistently incorporated into design decisions.
- Gender differences in rider biomechanics are often overlooked in saddle design, resulting in back pain and health issues for female riders and limited saddle options compared to male riders.

Concept

3.3

We approach our Bachelor thesis from a service design perspective and plan to deliver a concept of service for equestrians who need a customized fit solution. By the end of our project, we aim to have a developed service concept with designed core parts as a result.

Our first objective is to define a comprehensive measurement set for both the rider and horse's anatomical parameters.

Our second objective is to develop a user-centered smartphone application for saddle fitting that incorporates a comprehensive measurement system and guides users through the fitting process. The application will leverage scan and measurement technology, collecting users' data and seamlessly transferring it to the saddle tree design. Utilizing their smartphones, riders will independently input their own and their horse's parameters through a scanning process. The user-centric approach of our application aims to streamline the saddle fitting process and provide riders with a comfortable experience.

Our third objective is to design a concept of a saddle tree that would incorporate measurements of our rider and horse models' measurements. We aim to design a system that would be fitting to mass production. To achieve this, we plan to combine generic components that would be mass-produced with customized components that would be personalized. The design will utilize gender-specific solutions and an adjustable system that allows for a long product life cycle. These features will ensure a comfortable and tailored fit for female riders while considering their unique anatomical characteristics.

4

Project Development

Road Map

As our service incorporates several aspects, we aim to develop each of them in the following sequence.

Firstly, we aim to define the service value proposition and user journey to further specify the application functions.

Afterward, we design a comprehensive measurement and fitting system based on our findings, which will be utilized by the mobile application.

This step will be followed by experiments with different scanning technologies to determine the usability of the scanning process and the most suitable fitting method to be implemented in the concept of mobile application.

Consequently, we will work on the architecture and design of the application.

The final step is the development of the saddle tree structure, which will be based on our findings and goals.

Service & Application Ideation

4.1

Persona

4.1.1 Our first step was the finalization of the interviews and findings in order to set the number of personas that would represent the types of our target audience. Our user group was divided into two main categories: professional riders and hobby riders.

Professional rider

The professional rider persona, represented by Mia, emphasizes the importance of a perfectly fitting saddle to enhance performance and maintain the health of both rider and horse. Mia, an experienced show-jumping competitor, values familiarity with a specific saddle type due to time constraints between competitions. Her motivation lies in a well-tailored and health-centered fit, considering the frequent changes in horses she rides. Mia replaces saddles more frequently than hobby riders and requires durability and ease of cleaning. Her horse, Fou, is a thoroughbred with specific anatomical needs. A customized saddle is necessary to accommodate Fou's angled back and ensure proper weight distribution, preventing any negative impact on his back's condition. Customization is crucial for both Mia and Fu to optimize their performance and well-being in the show-jumping discipline.

Hobby rider

The hobby rider persona, represented by Emma, seeks an anatomically tailored saddle to address back pain and improve posture. Emma prioritizes her horse's health and desires an ergonomically tailored saddle specifically designed for Tomara, her Dutch warmblood horse. Tomara's larger size makes a generic saddle unsuitable. Emma, although not highly tech-savvy, is open to new opportunities. Her motivation stems from the well-being of both herself and Tomara. Unlike Mia, Emma has used the same saddle for approximately ten years. Emma's core need is a saddle that supports her posture, alleviates back pain, and provides a customized fit for Tomara. By fulfilling these needs, Emma aims to enhance her riding experience and ensure the comfort and health of her beloved horse.

Impact on the final product

Creating personas helped us to identify which ideas were essential and which were not relevant for our user types. For example, "performance feedback" was deemed unnecessary, while "balance feedback" was identified as valuable for both user types' goal of a harm-free riding experience.

Considering the varying familiarity with technology among our personas, we prioritized creating an easy-to-use tool for riders unfamiliar with scanning technologies.

During development, we discovered that our main audience would be hobby riders above thirty-five years old, as they have a greater concern for long-term health conditions and prioritize health-centered equipment for themselves and their horses. These insights shaped our assumptions and influenced our approach moving forward.

User Journey

4.1.2 The next step was to create a User Journey that illustrates the experience and interaction of a customer with our service. The User Journey was designed for the professional riders' user type, and it takes the user through all the stages of engagement with our service, from initial awareness to post-purchase behavior. The User Journey is presented in figure.

Results

We discovered that health issues were the primary motivation for users to order a Lucallian saddle. Additionally, we recognized that users had concerns about technology unfamiliarity and a lack of trust in the traditional equestrian industry.

Furthermore, we identified that users need to feel supported during the process, and the interface and flow should be easy to understand to gain trust. We also identified that clear expectations, instructions, and introductions to the process are essential for users to continue with the ordering process via the application.

By defining user actions and touchpoints with the service, we established functions the application should provide. We identified the main user's frustrations, such as fear of the unknown, not fully understanding service functionality, lack of trust, the length of the scanning process, unfamiliarity with methodology, and concern about the product's quality.

However, opportunities were identified to solve each pain point and prevent a dissatisfactory user experience. Overall, the User Journey helped us to better understand our user's needs, behaviors, and pain points, as well as identify opportunities for improving the user experience.

Experiments with Scanning & Measurement Technologies

4.2 The measurements method prototype was focused on testing technologies that would enable precise scanning of a rider and a horse to extract all necessary measurements from the further generated 3D model and implement them into a saddle tree design.

Testing AR and Scanning Applications

4.2.1 Through trial and error, we conducted scans on objects of various sizes, ranging from a pen to a human. We tested several applications including Polycam *(Polycam - LiDAR & 3D Scanner, 2020)*, 3D Scanner App *(3D Scanner App, 2021)*, Scandy Pro *(Scandy Pro, 2021)*, Luma AI *(Luma AI, 2022)* and Scanniverse *(Scanniverse, 2022)*. Our conclusion was that Luma, which utilizes NeRF technologies, yielded the best results for scanning a person. However, the process itself was both lengthy and complex, making it unsuitable for our goal of finding an easy-to-use method.

For instance, Polycam performed better when scanning small objects, whereas 3D Scanner App excelled at scanning larger ones. After thoroughly researching the available applications, we determined that 3D Scanner App provided the optimal results for scanning large objects. This software application leverages the camera on a mobile device to capture and generate 3D models of real-world objects. The app operates by capturing a series of photos of the object from different angles and utilizing advanced algorithms to construct a 3D model based on the visual data gathered from those images. It should be noted that the app employs Lidar technology, necessitating the scanned object to remain stationary while slowly moving the phone underneath and above it in order to create a robust 3D model *(Written by Kaitlynn).*

Scanning of a Horse: Lidar Technology

4.2.2 We concluded that testing our concept and idea in the field is the next essential step to take. During an interview with rider Sabrina Casti, she kindly invited us to visit her family ranch and interact with her horses. It turned out to be very informative and practical fieldwork for our project.

In the first field measurement prototype, we used Lidar scanning technology. To begin with, we started the process by selecting one of the horses Flur, a racing horse with a slim and fit body, and scanning him in his stable. We positioned him in the middle of the stable, with one person holding him still while the other scanned him using the 3D Scanner App. This process took several attempts as the horse kept moving his legs and head, which we knew to expect. We focused on scanning the most important areas, such as the breast, stomach, withers, and back. Scanning a horse in a stable was not convenient and we concluded that at least a 5*5 m area was required *(Written by Kaitlynn).*

To generate a 3D model, we recorded a video and extracted individual images that were then stitched together. To ensure accuracy, we captured as much data as possible, resulting in approximately 400 pictures. However, the software utilized only every fifth image from the sequence.

To capture the movement of the horse's back, we experimented with various methods, including lunging the horse and recording it from both sides. Additionally, we attempted to capture the wither movement and asymmetry by taking videos from the top and the back of the bareback horse.

We also tried out to make a video from the back of the bareback horse. It was informative as it allowed us to see clear shoulder movement and asymmetry.

An important observation we made was regarding the interdependence of the habits and behaviors of riders and horses. Sabrina explained this by stating that "rider and horse take each other's weakness." For instance, if a rider is right-handed, it may lead to the horse being blocked on the right side during riding, resulting in stiffness on that side. The movement of the withers and asymmetry in the shoulders can be captured by a video taken from a side of the horse. Considering this, we have decided to incorporate this factor in our saddle tree design and application *(Fig.12).*

Results

The scanning process is not intuitive and familiar for most of the "non-techy" people to which our target audience relates. Even for those of us who have experience with scanning applications, we found it challenging to get an accurate and complete model of the horse's body. It took us about 10 minutes to scan just one horse with 3D Scanner App, and during that time, we had to stay fully focused and move slowly we had to stay fully focused and move slowly around the horse to ensure that we captured every part *(Fig. 18-20)*.

Fig.18 3D model of our horse model obtained through 3D Scanner App*

(3D Scanner App, 2021) adn processes in other programms

Fig.19

** Closeup of Fou's angled back*

Fig.20

** Closeup of Fou's angled back*

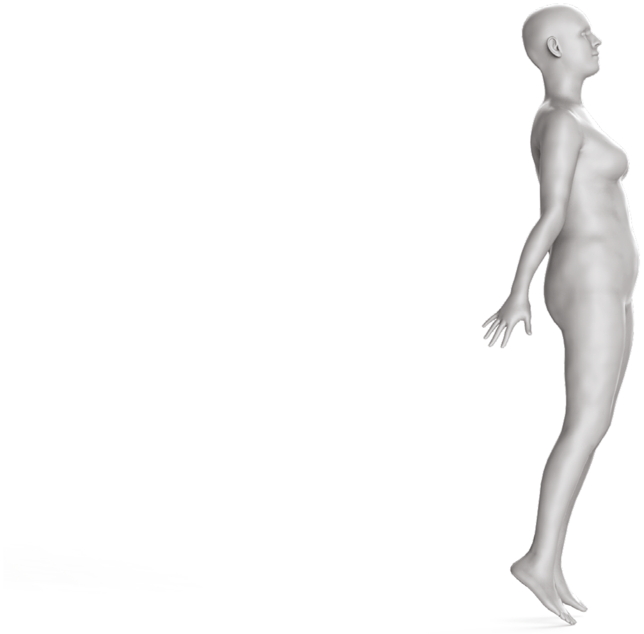


Fig.21

** 3D model of our rider model, generated by AlterEgo (AlterEgo)*

Fig.22

** 3D model of our rider model, generated by AlterEgo (AlterEgo)*

Instructions needed to be implemented in the application to address issues such as the need for a minimum area of 5x5 meters and the challenge of keeping the horse still during scanning, requiring a second person to keep it calm.

Scanning a horse's body presents difficulties compared to smaller objects. The size of the horse itself poses a challenge, and its complex structure, including going under the legs and above the spine, adds to the complexity. The horse's mobility and natural movements further complicate the process.

Despite some imperfect scans, measurements were extracted from the models, allowing us to measure body parts on the 3D model. The horse named Fou was selected for the saddle tree design due to his uniquely angled back, requiring a custom-made saddle to fit his individual anatomy.

While the application provided some measurements for the tailored saddle tree design, it was not possible to obtain the angles of the withers *(Fig. 12-13).*

Scanning of a Person: Lidar Technology

4.2.3 To create a 3D model of a person, we utilized the same application called 3D Scanner App that we previously used to generate 3D models of horses.

The person scanned wore tight-fitting clothes and remained stationary, as instructed by the application. However, when we generated the 3D model of the person, we noticed that the quality of the model was not as good as in the case with horses. Unlike the results we obtained with the horses, the model of the person appeared to be of lower quality, with some details missing or appearing distorted.

To try and improve the quality of the model, we repeated the scanning process several times. Despite our efforts, the 3D model of the person still did not meet our expectations in terms of quality and accuracy *(Fig.14).*

NeRF Technology

4.2.4 The next technology we tested was NeRF, which stands for Neural Radiance Fields. We were kindly offered help by Verena Ziegler and OpenDress *(OpenDress, n.d.)* to help us to generate our first NeRF model of a horse. NeRF is used in 3D computer graphics for rendering photorealistic images of complex 3D scenes. Unlike traditional 3D rendering techniques that use polygons to approximate the surfaces of objects, NeRF represents objects as a continuous function that maps 3D space to RGB values and “completes” the model with Artificial Intelligence.

For NeRF technology to perform optimally objects should remain stationary, and there should be sufficient lighting in the scene to capture the material's details accurately.

Experiments with Scanning & Measurement Technologies

To create a model using NeRF technology, a user must provide a reference dimension to the program to accurately measure the object. For instance, in the case of a horse, the height of the horse from the ground to the withers is a common reference point. Once the input reference is provided, NeRF generates a raw point cloud that contains all the measurements of the model.

In this particular example, the input material used to create the model was a video extracted from a 3D Scanner App. However, the video was taken at a close distance and was not ideal for creating a NeRF model. We received a generated raw point cloud which already has all the measurements in the model.

Despite this limitation, the resulting model was still highly precise and detailed, indicating the tremendous potential of NeRF technology. The model consisted of a point cloud with all the measurements included in the points *(Fig.23).*

Scanning of a Person: AlterEgo Software

4.2.5 AlterEgo is startup from ETH *(AlterEgo, 2023)* that utilises software that creates a 3D model based on a single image. The only data from a user needed is height and weight. The software functions based on a trained model that recognises body parts and creates a 3D model of the user. AlterEgo engineers shared that we can use photo from the front and back perspectives of the user to get most precise results *(Fig.21-22).*

Fig.23

Conclusion on Chosen Method

4.2.6

Throughout the testing phase, we explored various technologies such as NeRF (Luma, OpenDress), Lidar (Polycam, 3D Scanner App), and AlterEgo Software to determine the most user-friendly options to scan a rider and a horse. Our priority was to ensure a quick scanning process for users, and thus we defined following technologies we plan to use in the application:

For obtaining the rider's measurements, we utilize AlterEgo Software, which, in our case, requires two photos taken from front and back vertical perspectives.

For obtaining the horse's measurements, our future development plans involve utilizing NeRF technologies. However, for our Bachelor's work, we relied on the model created by Lidar in the 3D Scanner App.

To gather data on the horse's movements and flexibility, we request users to provide a video of the horse lunging. This video footage will be utilized to gather visual data for saddle design, as well as to generate 3D models in motion using NeRF technologies.

Comprehensive Measurement System

4.3

Defining Necessary Rider Measurements

4.3.1 After conducting desk and field research, we gathered enough data and knowledge to develop our own measurement system for achieving an anatomically tailored fit. The table below *(Fig. 15)* explains the required measurements and how they inform saddle design.

Measurement	*Influence on Saddle Design*	*Saddle Design Adjustments*
Pelvis width	Seat width should accommodate different widths. Pelvis volume impacts space occupied by the pelvis.	Impact on seat width. Larger pelvis volume may require longer saddle tree for sufficient room and support. Larger seat size requires flatter curve, while smaller size requires more pronounced curve.
Pelvic	Saddle should compensate for pelvic tilt and support the lower back.	Adjust saddle tilt angle to compensate for rider's tilt and support lower back. Forward-tilting pelvis requires flatter curve, backward-tilting pelvis requires more pronounced curve.
Balancing axes	Seat width should be defined by seat bone width.	Ensure the seat is centered over the balancing axes of a rider based on their gender.
Seat bones width	Seat bone width should be considered to adjust the seat width.	Adjust seat width to accommodate narrower or wider seat bones.
Ratio of femur bones length to lower leg	Stirrup location should accommodate different ratios and maintain rider's balance. Longer femur bones impact saddle length.	Adjust stirrup bar location and length. Varying femur bone length affects thigh bone angle, impacting required saddle tree length.
Lower leg	Stirrup bars should accommodate different leg lengths.	Adjust the angle and position of the stirrup bars to accommodate shorter legs and longer legs.
Upper inner thigh	Saddle panels should accommodate inner thigh form and muscle locations.	Adjust panel form to fit upper inner thigh shape and saddle panel length.
Balance & Tilt while seating	Saddle padding should compensate for tilt.	Tilting to the left would require more padding on the left side, and the opposite for tilting to the right.

Fig.15

Comprehensive Measuremnet System

How to measure

4.3.2 After determining the exact measurements of a rider, the next challenge was to find the most user-friendly way to gather these measurements from a scan or photo of the rider. The methods identified for obtaining the needed data were grouped into several categories:

Front photo:

—A front picture of the rider with legs shoulder-distance apart captures the shape of the upper inner thigh and helps determine inseam length.

—Pelvic width & volume. The circumference of the pelvis should be measured at its widest point while keeping the measuring line parallel to the floor.

—Length of Femur Bone and Lower Leg.

—Inseam Length

Back photo:

—Volume of the potential seat and approximation of seat bones location.

—Seat bones: Seat bone width is probably one of the most challenging measurements to make as it has different distances while standing and sitting. One innovative way to measure is developed by WTB Fit Right System *(Fit Right Systen - WTB., (n.d.)),* which calculates sit bone measurement based on individual biometrics, such as wrist width and riding position. However, since developing an exact system like the WTB Fit Right System would take several months,

Video of a rider sitting on a saddled horse from the back:

—Balance and tilt while seating: Obtaining data on the balance and tilt of a user while sitting on a saddled horse is essential. We aim to extract a photo from a photo from the back perspective out of the recording a user will take.

Video of a rider sitting on a saddled horse from the profile:

—Balancing axes: The balancing axes of a user should be defined while in a seated position on a saddled horse. The same picture used for pelvic tilt would provide data on the balancing axes of a user.

—Femur bone length/Lower leg length/Ratio of femur bone length to lower leg lengt.

Rider Parameters: Manual Input

4.3.3 In addition to the data obtained through 3D scanning and other measurement methods, there are several parameters that require direct manual input from the rider for saddle design:

1.Hip-bone structure: This information helps determine whether a female-specific or male-specific saddle design is needed, considering the biomechanical differences between genders.

2.Trouser size: Serving as a reference point, trouser size helps validate the accuracy of other measurements. It can also provide insights into the volume of the rider's pelvis, influencing the appropriate saddle size and shape.

3.Height: Rider height impacts saddle design by affecting how they sit and distribute their weight. Taller riders typically have longer legs, requiring a saddle with a longer and wider seat area to accommodate their leg length and provide adequate support. The pommel and cantle may also need to be adjusted for balance in specific riding disciplines.

4.Weight: Rider weight directly impacts the thickness of the saddle's steel structure. Weight distribution, particularly for taller riders, may affect the placement of stirrup bars and the shape of the panels, which distribute weight onto the horse's back.

5.Injuries and anatomical irregularities: This information will allow us to adjust saddle design to a particular rider's needs.

6.Preferred activity/discipline: Different equestrian disciplines have varying requirements for saddle design, including seat shape, flap length, and stirrup bar position. Understanding the rider's preferred activity helps tailor the saddle to their specific needs.

7.Preferred riding position: While the ideal riding position is balanced and centered, some riders may face challenges due to health conditions. For these individuals, a saddle with additional support and stability features, such as a deeper seat or larger knee roll, may be necessary.

Horse Measurements: Scanning & Photo Method

4.3.4 To ensure a customised and harm-free saddle fit, it is essential that the saddle tree, which is the most impactful part of a saddle design, fits securely and comfortably on the horse's back. To achieve this, we have defined the following essential horse measurements that need to be taken. These measurements are required for each particular part of the saddle tree, and we have collected them in the table below *(Fig.16)*.

Saddle Tree Length

Measurement	*Implementing in Saddle Tree*
Back Length: distance from withers until the T-18 rib	The length of a saddle tree should not exceed Saddle Support Area. The end of a saddle tree should be located 5-7.5 cm down from the spine as the tree doesn't contact the horse's back in the middle.
Shoulder Blade Position	The saddle tree should begin behind the horse's shoulder blade to allow for unrestricted movement. Consider the location of the shoulder blade when designing the length of the saddle tree.
Shoulder Angle: The shoulder movement furthest point	A horse with a more upright shoulder angle may require a shorter tree to allow for proper shoulder movement. The horse's scapula (shoulder blade) rotates about 45 degrees during movement.

Gullet Plate Width & Shape (Front of the gullet)

Measurement	*Implementing in Saddle Tree*
Withers: angle, slope length	Narrow withers require a narrower and more pointed pommel, while wider withers require a wider and flatter pommel. The shape of the front of the gullet should follow the shape of the withers plus an additional 4-5 cm of clearance for movement.

Saddle Tree Points

Measurement	*Implementing in Saddle Tree*
The angle of the scapula	Tree point should mimic the angle of the scapula to allow for unrestricted movement while in motion.
Position and rotation of scapula (shoulder blade)	The points should be positioned behind the horse's scapulae (shoulder blades) to allow for freedom of movement and prevent interference.
Withers	Narrow withers require a narrower and more pointed pommel, while wider withers require a wider and flatter pommel. The shape of the front of the gullet should follow the shape of the withers plus an additional 4-5 cm of clearance for movement.

Fig.16

Gullet width

Measurement	*Implementing in Saddle Tree*
Width of the horse's spine	The gullet needs to be wide enough to avoid any pressure on the spine.
Shape of the back (spinal curve)	A flatter-backed horse needs a wider gullet for clearance and pressure prevention, while a more curved or narrow-backed horse requires a wider gullet to avoid pinching.
Nuchal ligament	The nuchal ligament influences the saddle gullet. A well-developed ligament requires a wider gullet, while a less developed ligament needs a narrower one.

The curvature of the tree

Measurement	*Implementing in Saddle Tree*
Back length	Shorter-backed horses need a flatter curve in the saddle tree, while longer-backed horses require more curvature along their spine.
Withers	The front part of the saddle should mimic the withers shape and leave some clearance for it.
Back shape & The back (swing) line of the horse	The curvature of the horse's back shape & back profile of the horse defines the curvature of the saddle tree.

Fig.16

How to measure

4.3.5 After defining the necessary measurements for fitting a saddle to a horse, the next challenge was determining how to obtain these measurements through a scan, photo or video of the horse. To simplify the process, we categorized the measurements based on the method used to obtain them and identified three main ways to collect the data:

A video around a still horse would allow us to generate a 3D model of a horse with the following measurements included:

—Back Length: distance from withers until the T-18 rib

—Withers' angle, slope length

—The angle of the scapula

—Shoulder asymmetry

—Back shape & The back (swing) line

A video of horse lunging provide the following measurements:

—Shoulder Blade Position & Movement

—Shoulder Angle: The shoulder movement furthest point

—Back shape & The back (swing) line flexibility

A video of a rider on a saddled horse provide the following measurements:

—Interference of a shoulder blade with a current saddle

—Horses's behaviour while saddled up

Videos of the horse in motion offer valuable insights into how the horse's back and shoulders move naturally, including change in their body shape during movement.

Application of Designed Measurement System

4.3.6 After defining needed measurements from a rider and a horse and the chosen technologies we combined our findings and extracted the necessary data from a 3D model of Dzhuliia generated by AlterEgo software and 3D model of Fou generated by 3D Scanner App.

Prove of Concept Prototype: Clay Molding

4.3.7 To validate our measurements and be sure that saddle tree model created in CAD would fit Fou's, our horse model, owned by Sabrina Casty, Saddle Support Area we made a cut out of his back out of the polystyrene foam, which was sculpted by cutting away materials with a hot-rod and sanding machine. We used measurements obtained through Lidar scan to create this model of his back.

Afterward, we sculpted a 1:1 saddle tree model of out clay representing its' volume. Dzhuliia was used as the model for the saddle tree body, and a warm clay negative form of her sitting on top of the horse's back was obtained. The final results matched with measurements we took of Dzhuliia via AlterEgo software and provided us with proof about specifics of a female-built saddle. We defined that twist has to be flatter and narrower and a cut out in this area needed in order to avoid pressure and fit to her pubic pubic symphysis *(Fig.24-26)*.

Fig.24

Fig.25

Fig.26

Application Development

4.4

Defining Application Functionality

4.4.1 The Lucallian application serves several purposes and use cases related to saddle fitting and riding experience & horse well-being monitoring. These include:

1.Ordering a custom saddle: The application performs a “tailor tool” task by collecting data on both the rider and the horse. It takes precise measurements to create a customized saddle that fits the rider and the horse perfectly.

2.Maintaining saddle fit: The application enables riders to rescan and recheck the current saddle fit regularly. It ensures that the saddle continues to fit the rider and the horse comfortably and correctly over time.

3.Guiding saddle fit adjustments: The application provides riders with a guide on the process of padding adjustments and information on how these adjustments impact the fit of the saddle. This helps riders to make informed decisions about how to adjust the saddle for optimal fit and comfort.

4.Horse well-being monitoring: The application provides necessary health data of the horse that is crucial for monitoring its well-being. It helps riders to keep track of their horse’s health and detect any issues early.

5.Balance feedback: The application provides riders with feedback on their balance and riding posture. It helps riders to prevent any harm to both sides by providing real-time feedback on their posture and balance while riding.

Information Architecture

4.4.2 During the app design process, we focused on the information architecture of the user interface. We decided to start with a brief overview screen that answers the questions: “For Whom?”, “Why?”, and “How?” to introduce users to the app. To manage multiple horses and saddles, we included a clear indicator of the active horse profile in the top left bar, and the saddle sensor’s status in the top right bar.

The app’s navigation bar, located at the bottom, consists of four sections: “Saddle,” “Feedback,” “Profile,” and “About.” The main screen is the “Saddle” page, where users can initiate saddle orders. We added a “Progress” page to allow users to revisit and revise their orders.

screen is the “Saddle” page, where users can initiate saddle orders. We added a “Progress” page to allow users to revisit and revise their orders.

Ordering a saddle involves four parts: rider’s parameters and scan, horse’s parameters and scan, rider on a horse scan, and customization. The “Progress” page shows a visual stepper with estimated completion times for each step. It also indicates if a step is completed or needs redoing.

The “Saddle” page includes sections for “Adjustment guide” and “About the saddle,” providing detailed information and allowing users to adjust padding and rescan for fit.

The “Feedback” page is divided into “Balance” and “Health data” sections. Users can view current data and access detailed feedback and analysis over time.

The “Balance” page shows balance feedback and tracks the ride to identify areas of imbalance. The “Health data” page displays essential health indicators and offers the option to download data history.

The “Profile” page includes sections for “Rider profile,” “Barn,” and “Settings,” where users can review and edit parameters, access 3D models, and log out.

In the “Barn” section, users can review and edit horse parameters and measurements, access the horse’s 3D model, and view comprehensive feedback history for the selected horse.

Our goal was to create a simple and accessible information architecture, emphasizing saddle ordering and essential balance and health feedback monitoring.We aimed to layout the information architecture of the application in a simple and accessible way so that riders could focus on the main functions that our service provides: ordering a saddle and monitoring essential feedback on balance & health.

User Flow

4.4.3 In the design process, we created a user flow *(Fig. 27)* for the app, considering interruptions and potential time consumption. Users begin by creating their profiles, providing saddle-related data and marking any saddle-fit-related injuries or anatomical irregularities. The horse profile is created in a similar manner.

On the main “Saddle” page, users can initiate the saddle ordering process. They are guided to the “Progress” page, which outlines the steps and estimated time. We broke down the process of taking measurements into nine steps. Although the steps can be completed in any order, we suggest a starting point.

The first steps involves manual input of rider’s parameters & data, the second step requires rider to take two pictures of himself, from front and back perspectives. Following step requires manual data of horse saddle related parameters. Afterwards, the user is asked take a video around the horse that

stands still. Then, he repeats the process by taking video of the horse lunging to the right and to the left.

Ordering a saddle involves scanning the rider and the horse. The rider scanning process requires three photos, and an overview of the measurements is provided on the 3D model. The horse scanning process follows a similar layout, with guiding lines and an overview of the measurements on the 3D horse model. Anatomical irregularities or injuries of the horse are inputted after the scanning process, allowing users to mark them directly on the 3D horse scan. Afterwards, application generates a 3D model of the horse and allows the user to mark any injuries or anatomical irregularities that the horse has.

The last step is fit & customisation. There the user can review the generated saddle model and customise some parts of it. The application offers “recommended” parameters and allow user to regulate them within ergonomically fitting range. Additionally, a user can choose a color of the saddle.

After the process is finished the user can look at status of his saddle on the “Saddle” page.

After ordering a saddle, users can track the production and delivery timeline on the “Order” page. It displays estimated production time, delivery date, and updates on the order status. Shipment tracking and customer support contact are also available on this page.

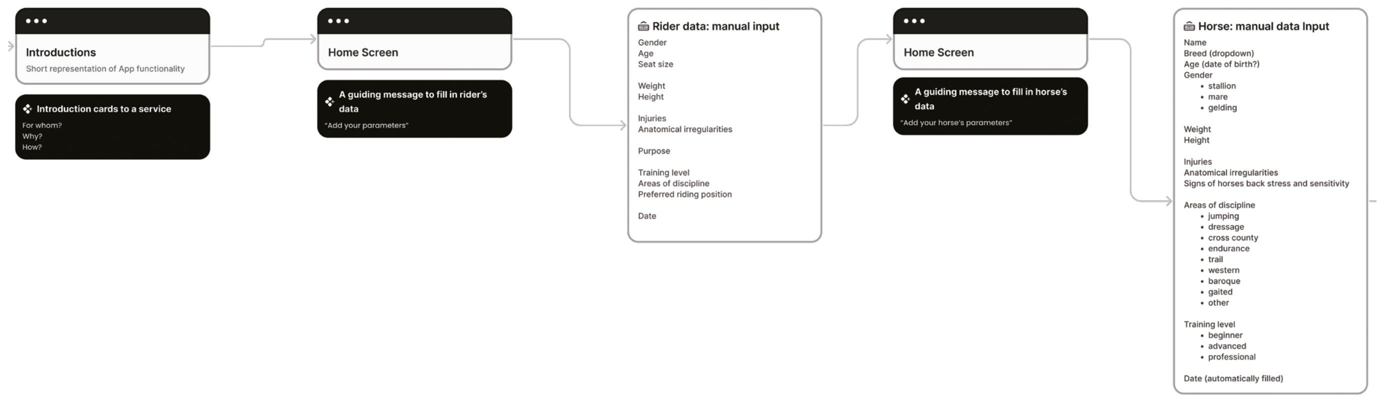


Fig.27

Design

4.4.4 Style

We have defined our brand leading style as retro-futurism. We appreciate the idea of merging elements of nostalgia and futuristic imaginings as it aligns with our service goal. Our aim is to create a distinct visual language that is both familiar, minimalist, bauhouqse, tech inspired for our equestrian target goroup. Our design incorporates elements from the 1920s to the 1970s, including sleek lines, bold colors, metallic shapes, and neumorphic elements. Through this fusion, we seek to inspire wonder and speculation about what the future may hold.

To achieve this, we have combined visions of obsolete technology with futuristic concepts. This blending of the old and the new produces a visually striking contrast that ignites the imagination. As an example, we have designed a dial for customization screens *(Fig. 39-40)* that exemplifies this approach.

We defined our vision of retro-futuristic application design by combining neumorphic elements, mostly used for navigating and interactive elements with flat ones.

In defining our vision for retro-futuristic application design, we have combined neumorphic elements, primarily used for navigation and interactive features, with flat ones.

Branding colors

Our primary color is off-white (F3F3F3). We tried to find a color combination that would complement our highlight or secondary color, resulting in a unique combination *(Fig.28)*.

We aimed to create a feeling of familiarity for equestrians by using the orange (FF4000) as our secondary colour. We decided to opt for a bright tone to emphasize the innovative approach of our product philosophy *(Fig.28)*.

The tertiary colors are black (00000) which create contrast. Black represents elegance. Additionally, these colors are easy to work with in the application's user interface *(Fig.28)*.

Application Development

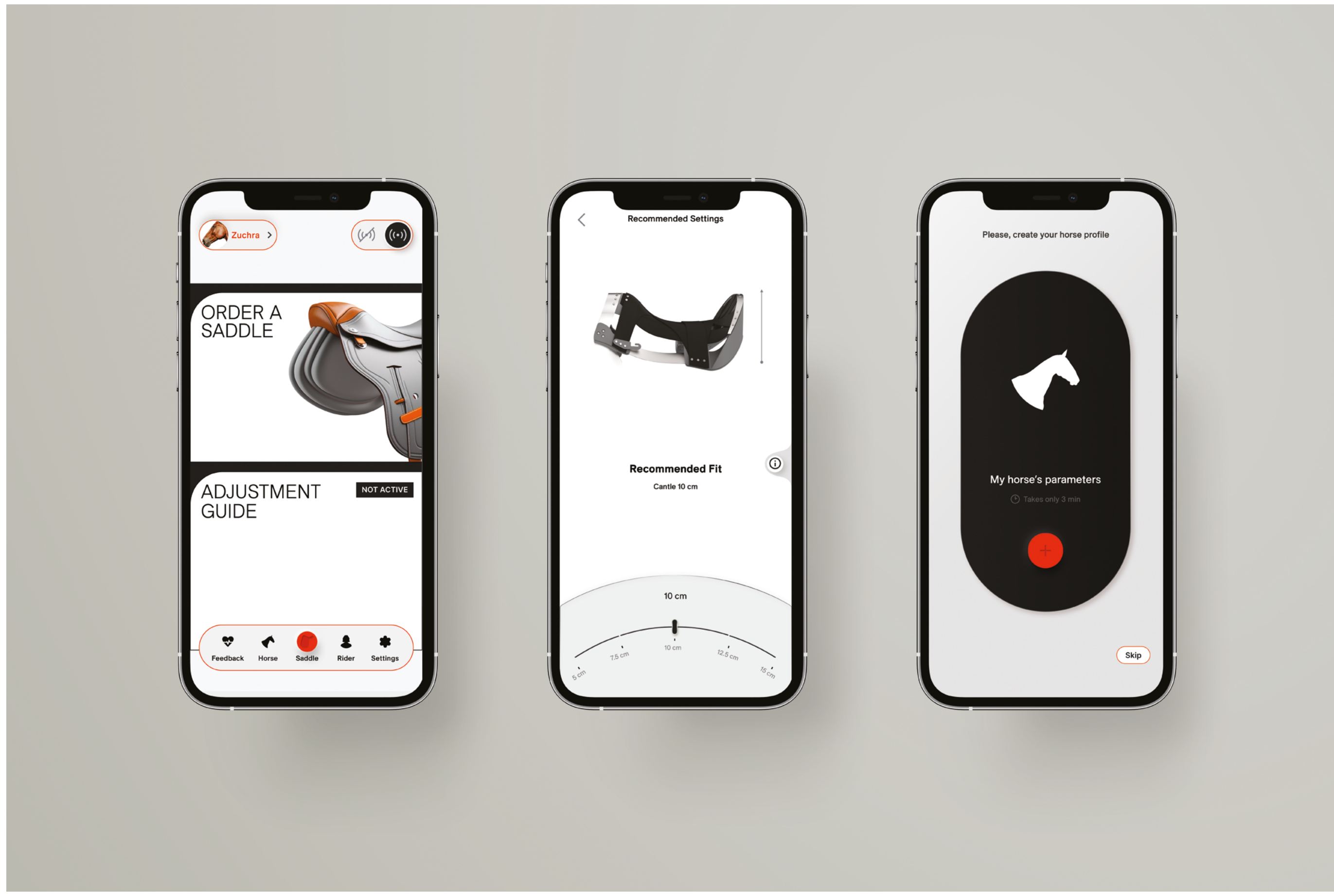
Color Palette

Fig.28

Logo

Fig.29

Fig.30



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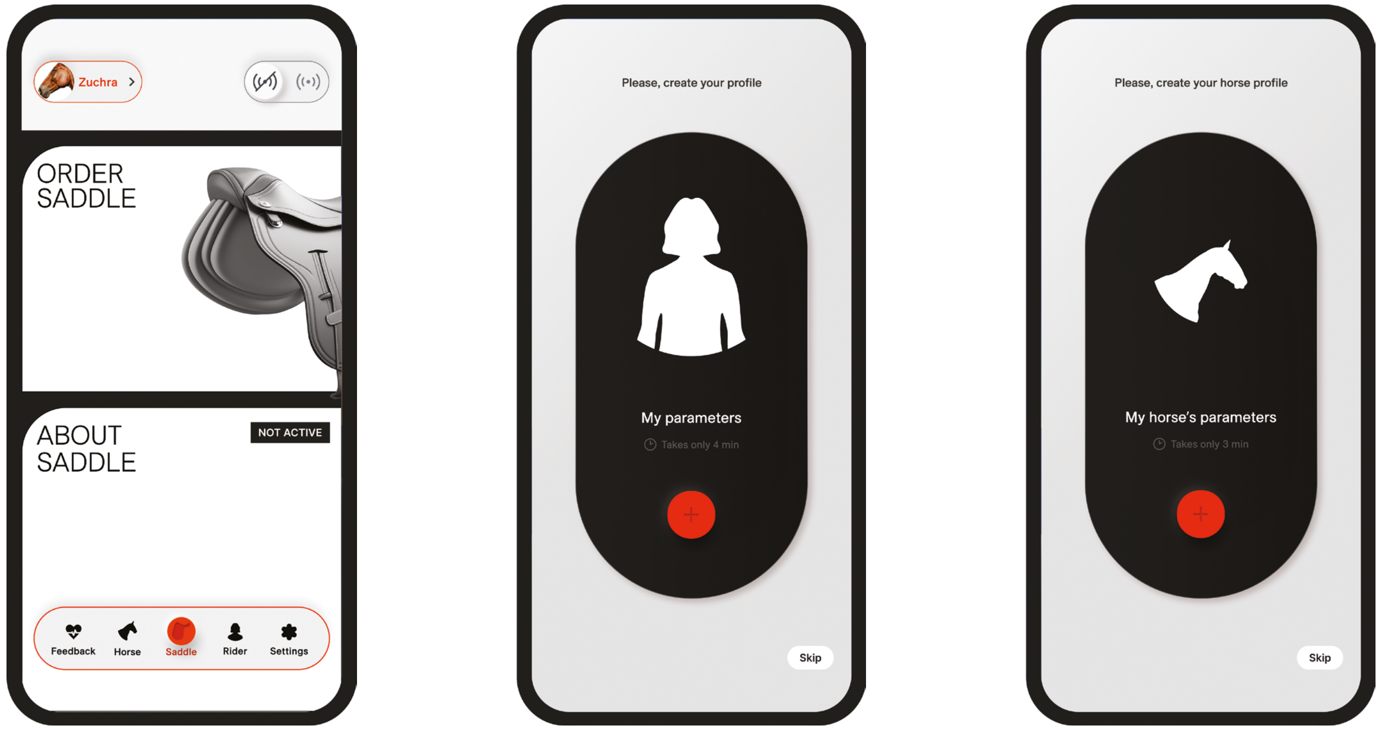


Fig.34

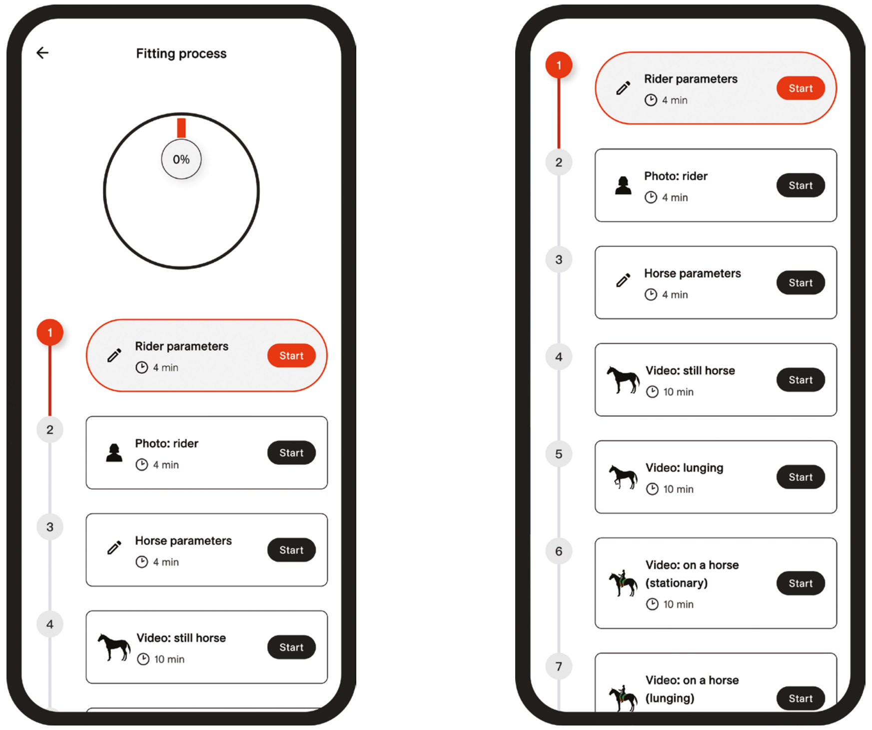


Fig.35

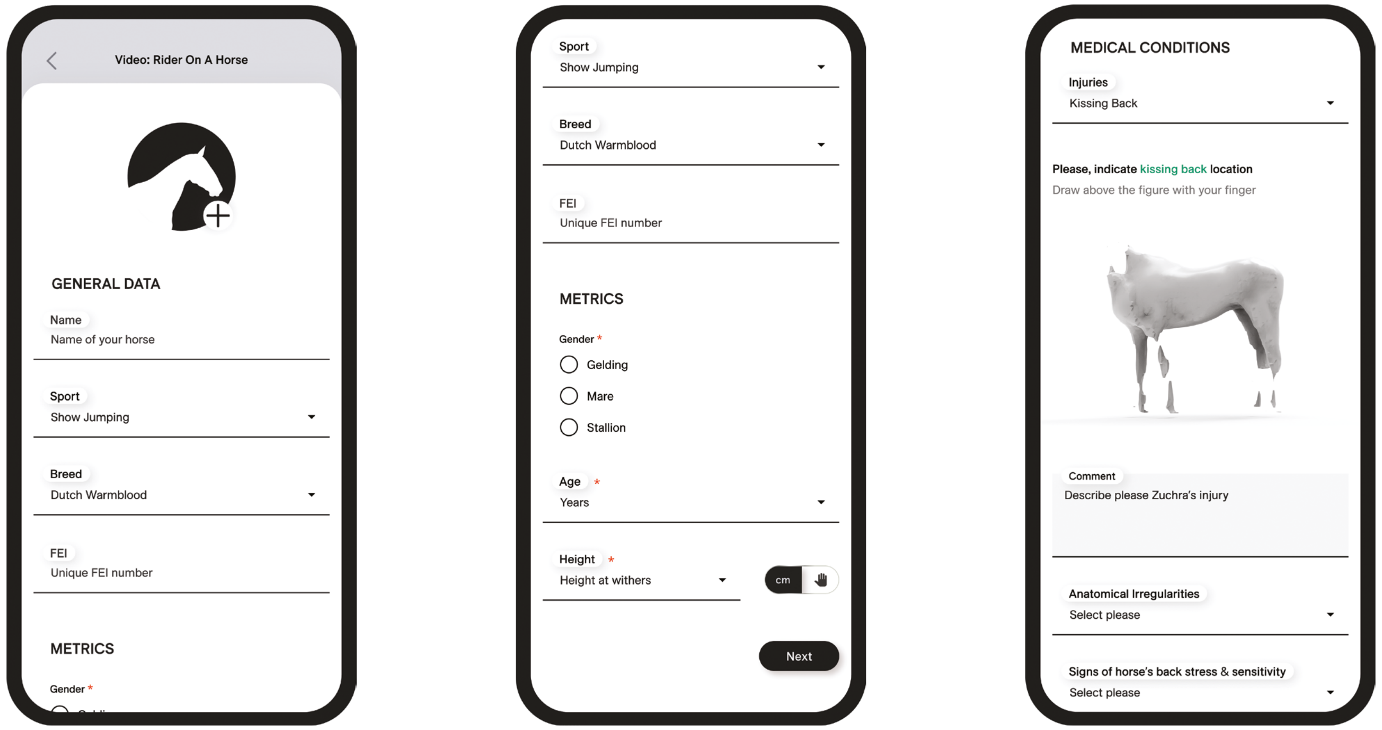


Fig.36

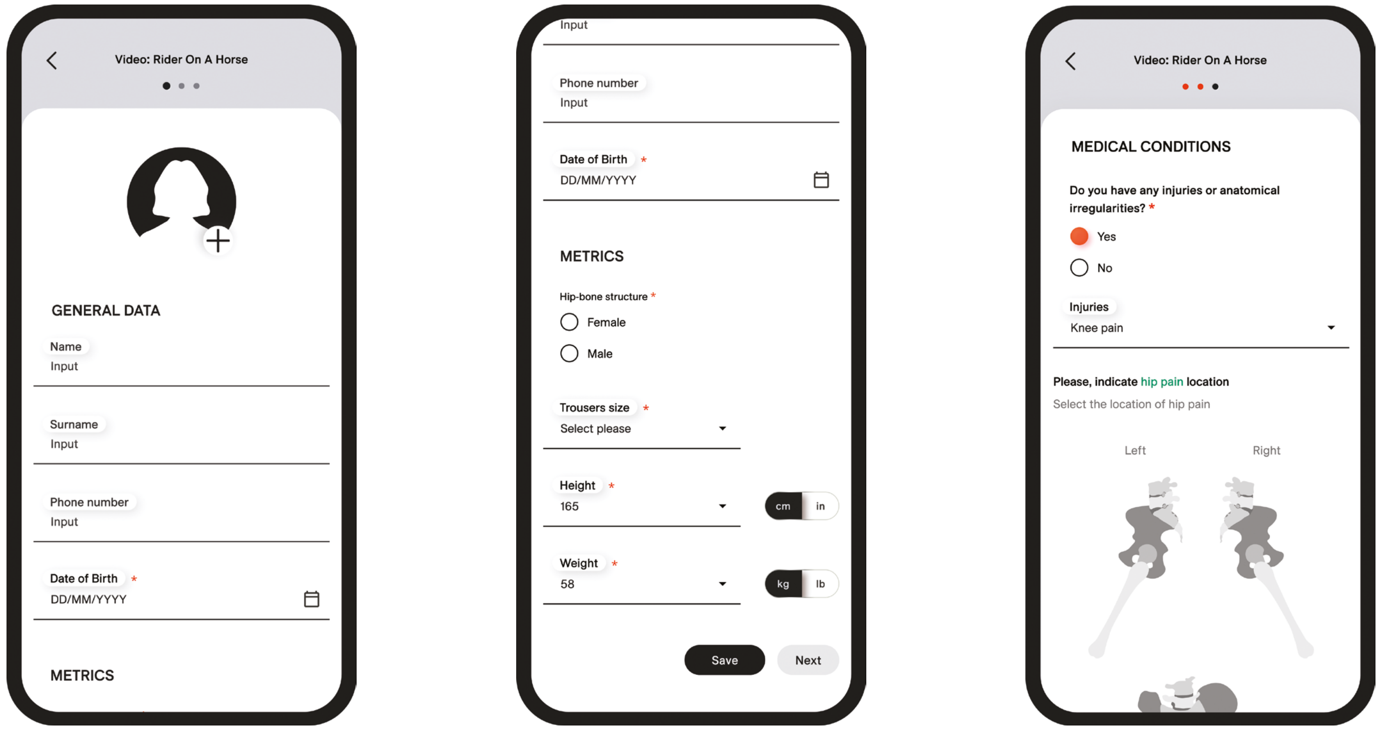


Fig.37

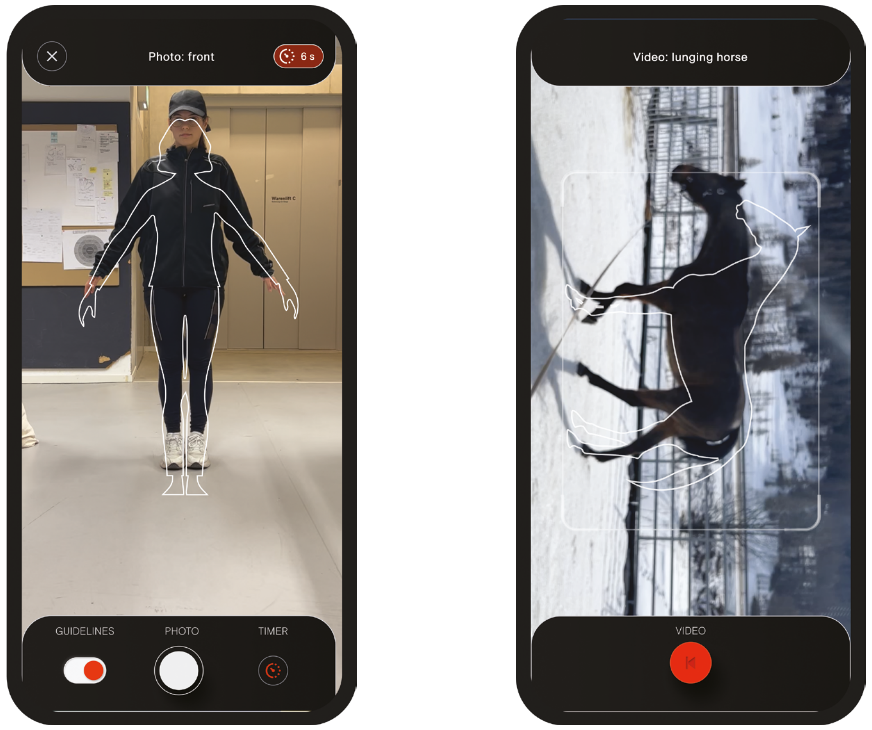


Fig.38

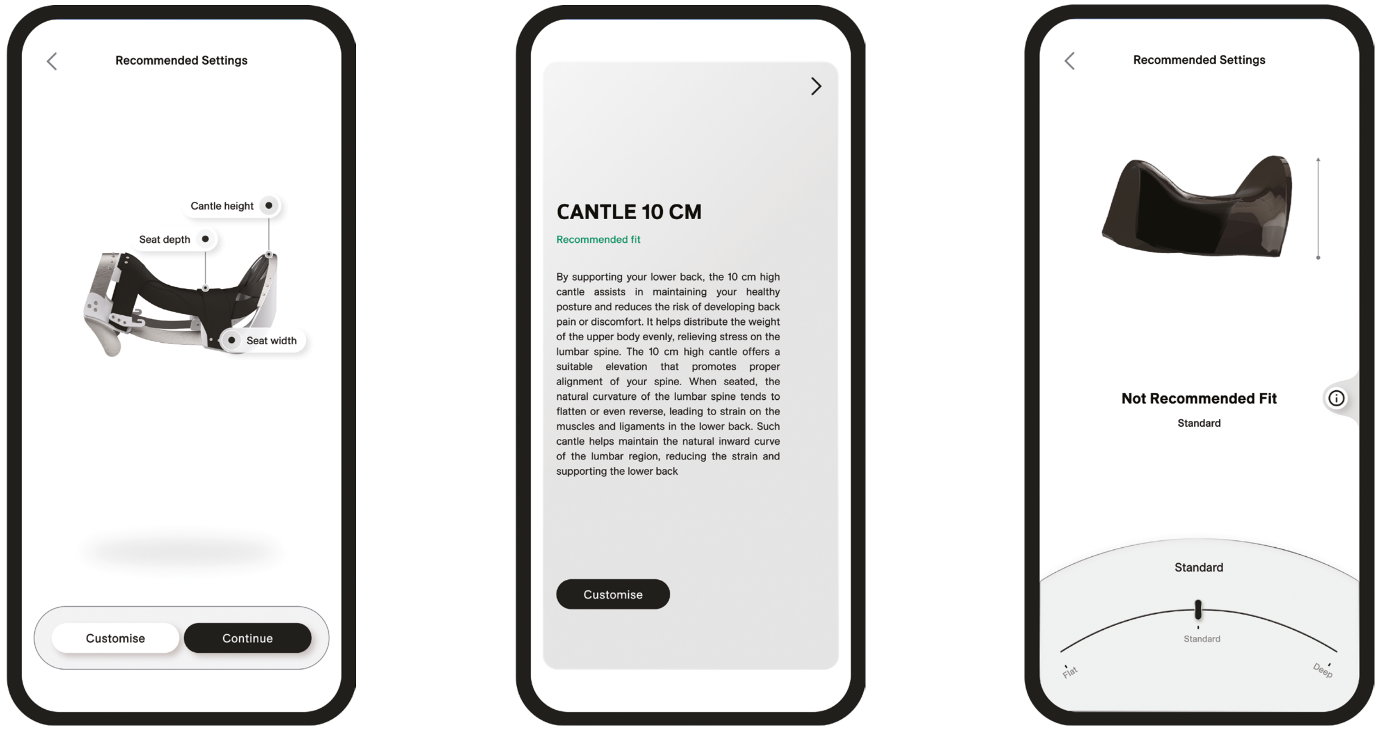


Fig.39

Fig.40

Usertesting

4.4.6 We conducted a user test with two participants, Christian, a twenty-five-year-old horse rider, and Fayçal, a twenty-three-year-old professional rider, to assess their understanding of our designed flow. Initially, both participants took some time to grasp the concept as it was new to them. We tested the second version of our prototype with both riders.

Christian had no difficulties navigating the saddle ordering process. However, he raised concerns about riders knowing the height of their horse from the ground to the withers (a reference point for technology). But he also did not come up with other measurements that could be used as a reference point for technologies. Christian was particularly interested in the "Feedback" page and mentioned that we would like to have such data after riding *(Fig.31)*

Fayçal showed significant interest in customization, with a particular focus on the dial designed for the customization screen. He provided feedback regarding the lack of intuitiveness when dragging the information button and suggested replacing it with a simple tap *(Fig.32-33).*

Both Fayçal and Christian found the progress screen easy and self-explanatory.

During the user test, we encountered three constraints. Firstly, we were unable to fully test the prototype in a field setting at a ranch, which we had initially intended. Secondly, the prototype being on Figma prevented us from testing the photo and video functions directly (although we simulated them). Lastly, we faced challenges in finding available female riders for the user test at that time.

Image

To test our saddle tree on Fou's back we went to Rennverein Zürich. We noticed a decline in the curvature of both the saddle tree and his back. However, we realized that as his back was quite asymmetrical, padding was supposed to correct this condition, while the saddle tree should maintain equal measurements on both sides. Moving forward, we plan to test the saddle tree with the designed paddings.

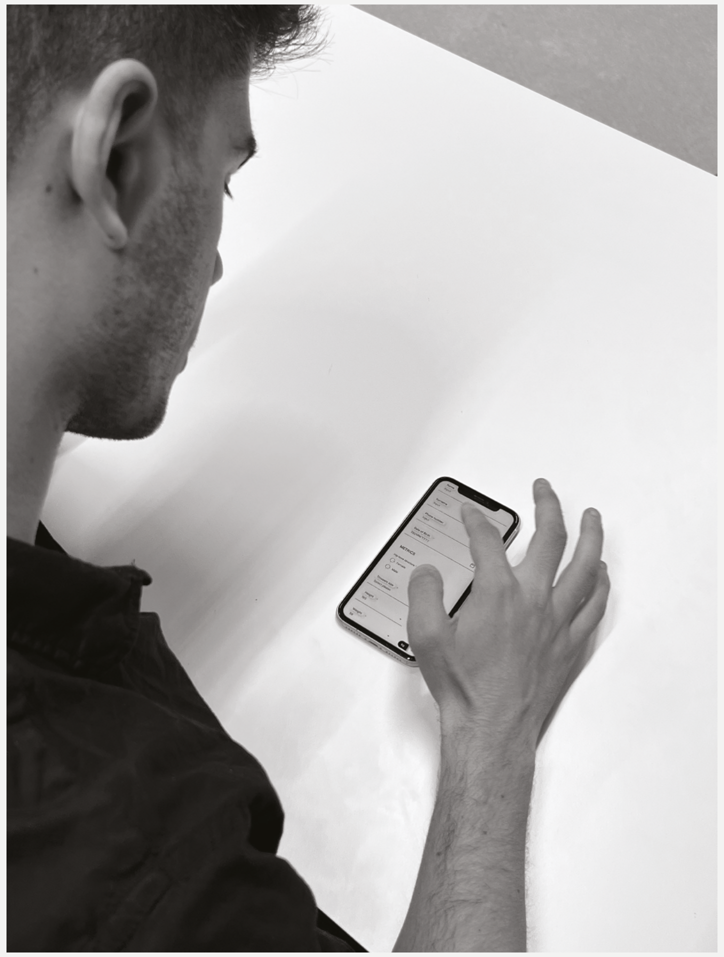
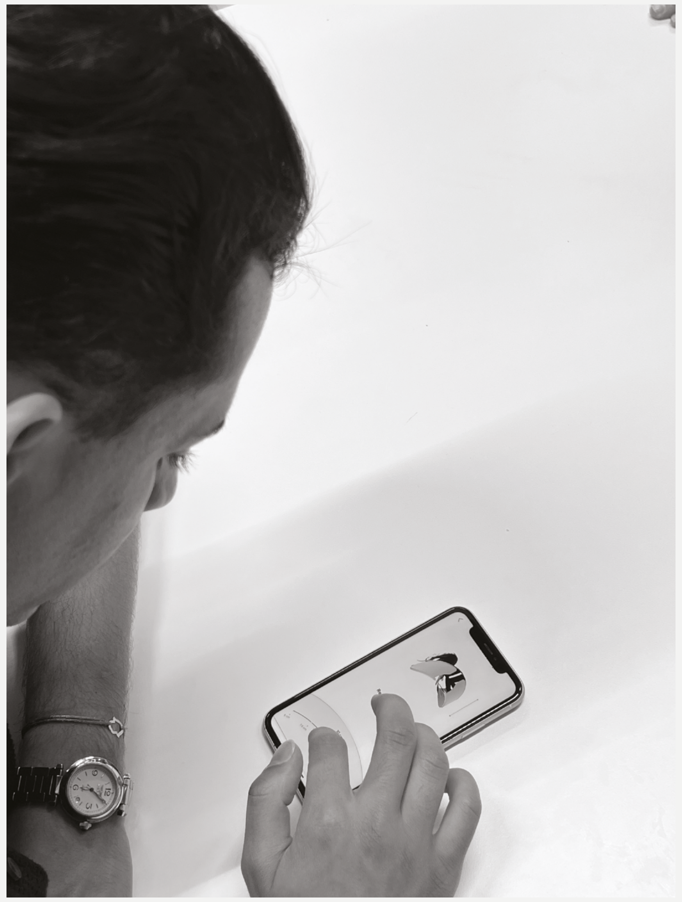


Fig.31

Fig.32



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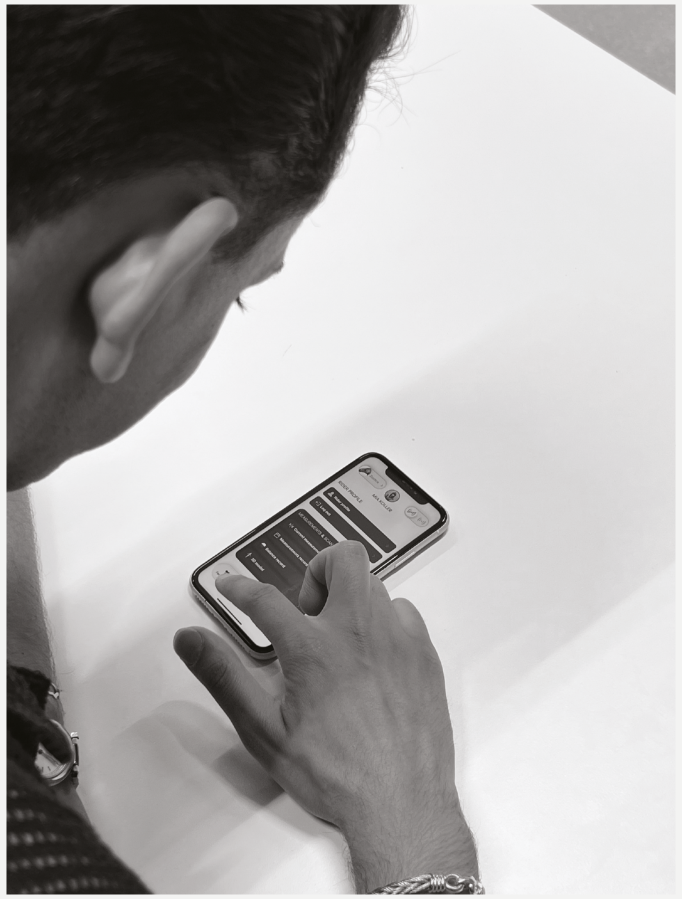


Saddle Tree Design

4.5

Lucallian's Approach to Saddle Tree Design

4.5.1 Our saddle design is anatomically tailored to Fou, one of the horses we scanned with Lidar, and Dzhuliia, a female rider *(25 y.o.).* We focused on creating a dynamic system that would adapt both to the horse's and rider's measurements. For that, we designed an innovative FlexFit system, which includes a FlexFit Tree *(Fig. 42)* system that is designed based on unique Fou's measurements, FlexBody *(Fig.43)*, and 3D CellPad *(Fig. 41)* systems that are designed for unique parameters of Dzhuliia. Our design incorporated harm-free, anatomically tailored, and gender-specific concepts.

The FlexFit Tree and AdaptPad are integral components of a saddle. The FlexFit Tree provides an adaptive fit between the horse and rider and consists of the 3D CellPad, FlexBody, and FlexTree. The 3D CellPad offers an anatomically cushioned and shock-absorbent structure through 3D printing and a Heterogeneous Lattice structure. The FlexBody, made of plastic parts and polyester belts, varies in shape based on the rider's hip bone structure, with visible differences between male and female designs. The FlexTree, comprising eleven pieces, including the gullet and Flex-Steel Struts, achieves weight distribution and flexibility. The AdaptPad is customizable with a padded cover made of sustainable leather and compartments for different types of cushioning materials such as gel pads, memory foam, and harder foam. Its configuration depends on the sport type and the rider's inseam length.

Our innovation lies within designing two separate systems for a saddle tree to be able to compromise less on the health of both sides, which is the case with many traditional saddles. Both systems are easy to manufacture and at the same time customize for different measurement sets.

Another aspect we innovated on is equal weight distribution achieved by 3D CelPad which is designed to compensate rider's tilt in any direction (defined by measurements taken). Additionally, the Flex Tree is designed to distribute the rider's weight on the sides of the horse's back and sides of withers. The bearing structure does not interfere with the horse's spine and shoulder movement. *(Written by Kaitlynn)*

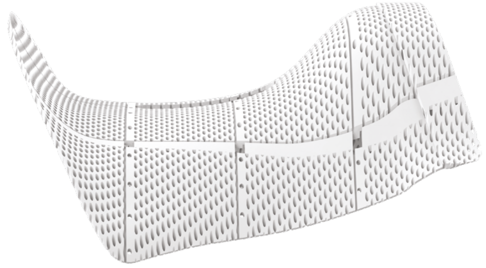


Fig.41

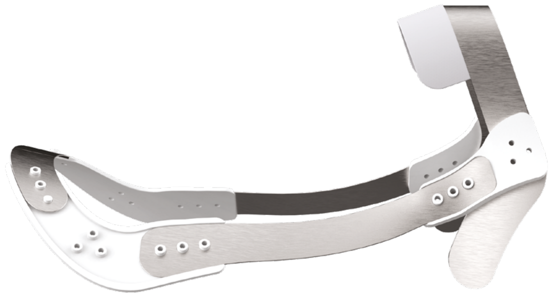


Fig.42

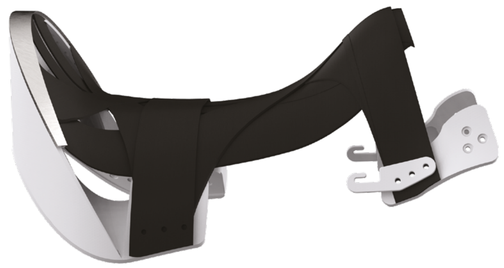


Fig.43

Anatomically Customised Saddle Fit for a Horse

4.5.2 The FlexTree was meticulously designed in CAD, taking into account the unique parameters of Fou's 3D model obtained through Lidar using the 3D Scanner App. This enabled us to create a saddle tree that perfectly fits his angled back.

With a length of 55 cm, the saddle tree is fitted precisely within Fou's Saddle Support Area, ensuring it does not extend beyond the T-18 rib.

Considering Fou's asymmetrical spine and shoulders, we tailored the FlexTree to accommodate his larger shoulder. The points of the saddle tree are positioned facing backwards and shaped in a way that allows unhindered movement of his shoulders.

Furthermore, the curvature of the FlexTree is specifically designed to match Fou's curvature and unique shape, providing optimal comfort and support.

To ensure a proper fit, the gullet of the FlexTree is shaped to conform to Fou's withers and slope shape. It provides a clearance of 5.5 cm, preventing any discomfort or pinching in the withers area.

Saddle Tree Design

Fig.44

Gender-Specific Saddle Design

4.5.3 As Dzhuliia modeled for a saddle tree design, we constructed a female-specific saddle tree. The seat width is 28 cm and wider than the general to accommodate Dzhuliia's pelvis volume.

The FlexBody has a narrower and flatter twist to accommodate the shape of Dzhuliia's upper inner thighs and to allow space for the third point of contact, which is pubic symphysis. Additionally, there is a cutout area in the location of the pubic symphysis in order to avoid pressure and discomfort. This would allow the rider to easier achieve a balanced position and not feel pain at the third point of contact.

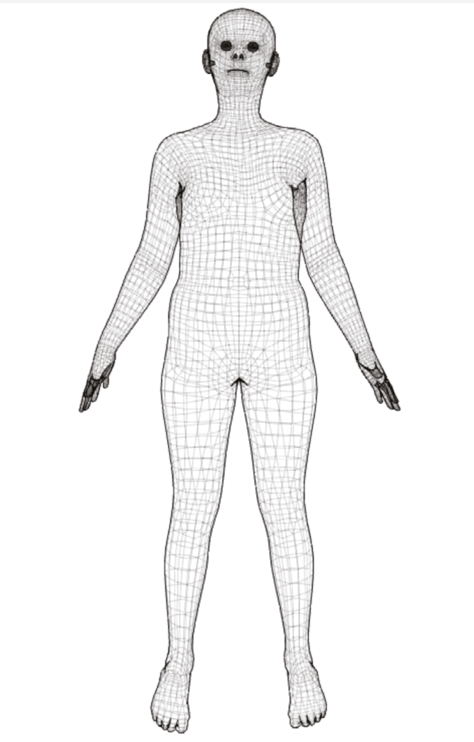
The cantle of the FlexBody is 15 cm and higher than general in order to compensate for her spinal tilt.

The Deering which holds a stirrup bar has the option to be extended in order to locate stirrup bars closer to the center of the saddle. That will allow Dzhullia to keep her posture balanced as her upper leg to lower leg length ratio is not equal and her upper leg is longer.

To correct her posture and aid in relief for her lower back we designed a lattice-based 3D CellPad concept based on Dzhuliia's 3D model, that has a thinner lattice under the seat bones area. Under the seat bones, the pad has a thicker homogenized lattice and provides more shock absorption, whereas in the areas of the thighs it is thinner to accommodate to Dzhuliia's upper inner thighs shape.

On the Flex Tree, the thickness of the bars that are made out of a long flex steel is 2mm and is based on Dzhuliia's weight (58 kg). Such thickness will provide a solid enough saddle tree structure that still can conform to the horse's back. The short flex-steel bars are also 2mm and their length is flexible and accommodated to the hip size of Dzhuliia.

Fig.45



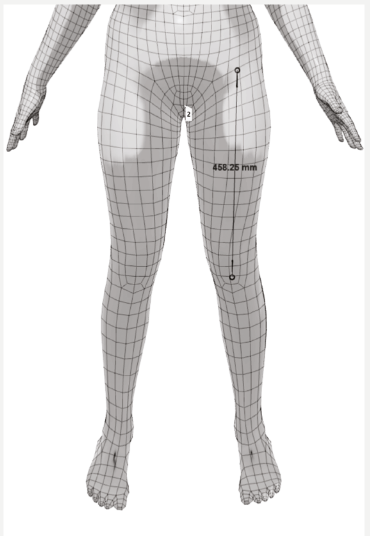


Fig.46

Saddle Tree Design

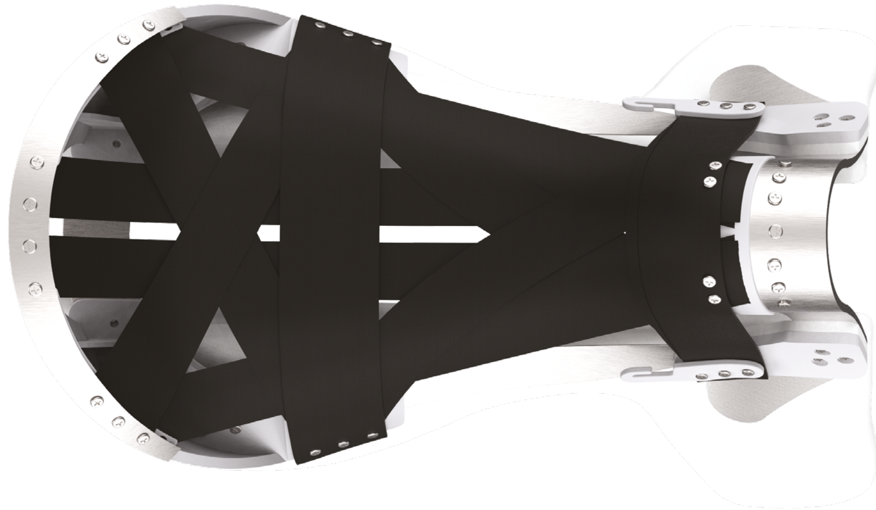


Fig.47

Manufacturing concept

5.5.4 The FlexFit system is designed for simplistic, minimal manufacturing. The system is designed to be customizable enough to be general: translating to parts of optimum size to accompany changes in length genuinely.

Firstly, the 3DCellPad is designed to be fitted and manufactured for a 3D resin printer for mass production: that would come in several sizes XS, S, M, L, and XL. It is made up of 16 individual pieces that are combined together with pop rivets in order to hold its form.

Secondly, the FlexBody has comprised 5 parts: 2 mirrored mass-produced plastic molds: the Front Connecting Strut (connection gullet point and connects the flex steel parts) and the Cantal Connecting Strut (the weight baring and balancing structures of the tree that also has 5 choosable cantal heights: 5, 7.5, 10, 12.5 and 15 cm) between these structures there are polyester belts that are individually strung and cut depending of the width and hight of the structure and where the hip bones are placed individually. The FlexBody gains structure when connected to the FlexTree.

Thirdly, the FlexTree system is the load-baring support that is designed to fit the horse's back and is made into 9 Pieces. The laser-cut 5mm thick steel gullet (that is bent into the shape of the withers and has a minimum of 4.5 cm of clearance (this can be very high depending on the horse) with the measurements received from the 3D models' data), the laser-cut 2mm thick flex-steel twist strut (measurements received from the 3D models' data) and the laser-cut 2mm back width strut (measurements received from the 3D models' data) that is designed to be able to be easily manufactured in very in length. *(Written by Kaitlynn)*

Saddle Tree Design

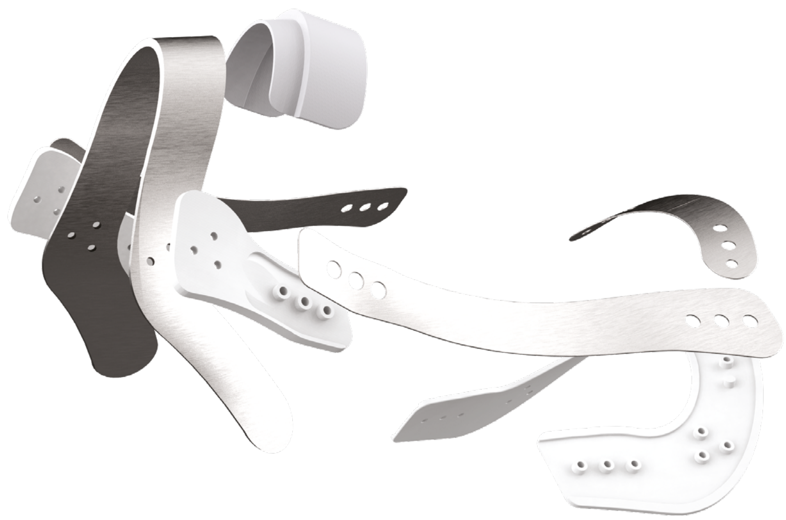


Fig.48

5 Conclusion

5.1 In this final chapter, we conclude our project and highlight key development points. Our research focused on customization and health-centered design, with the goal of creating a comprehensive service for custom saddle fit. Initially, we explored health-centered saddle fit for horses and discovered the impact of rider balance on horses, as well as the harmful effects of saddles on riders' health. After we identified a gap in the industry for female-specific equipment, we decided to make gender-specific design another aspect of our overall design philosophy.

Initially, we targeted both professional and hobby equestrians, but we discovered significant differences in their motivations and goals. As a result, we shifted our focus to hobby riders who have a strong bond with their horses and may experience health issues due to horse riding. Our process involved exploring various aspects simultaneously, including the current saddle fitting process, essential measurements for horse and rider, the rider's saddle selection process, technological implementation, and innovating saddle tree design and manufacturing components. We debated whether to develop a mobile application or a website for the fitting process, ultimately choosing a mobile application to enable riders to use and engage with our product during every ride.

During the early stages of our research, we began developing the application and creating initial sketches of the saddle tree. We had to consider manufacturing constraints and iterated on our ideas by considering realistic production costs, material choices, and manufacturing aspects.

Through fieldwork and interviews, we continuously refined our concept based on the insights and knowledge we gained. We paid particular attention to the scanning process to ensure it would be user-friendly for our non-tech target audience.

As we progressed with the application development, we recognized the importance of establishing a reliable and fact-based measurement system. This was crucial to ensure that our product design aligned with anatomical specifications. To accomplish this, we extensively researched and explored various supporting technologies to find the most suitable solution for our service.

Designing a medium that facilitates the interaction between two living beings, the horse and the rider, presented us with a genuine challenge and a significant responsibility. However, it also gave us an advantage as we approached saddle design with fresh perspectives, unburdened by the industry's traditional constraints. The design has the potential to either enhance the relationship and experience between riders and horses or contribute to the creation of harmful equipment. We emphasized a fact-based design approach and maintained honest self-assessment throughout, with the goal of creating a genuinely useful and health-centered product.

Ethical Question

5.2 Throughout our project, we recognized the importance of addressing the needs of both riders and horses. As animals cannot communicate directly, we felt a strong sense of responsibility to advocate for their well-being throughout the design process.

Our research led us to confront ethical dilemmas within the professional horse riding industry, particularly in events like the White Turf Races. We believe that legal intervention is necessary to protect animals and enforce regulations regarding their care, performance age, and retirement.

To ensure the safety of horses, we conducted extensive research on their anatomy, specifically focusing on how saddles can potentially harm them. We implemented measures to mitigate these risks, but we acknowledge that there is still room for improvement.

We firmly believe that the involvement of medical professionals and veterinarians is crucial in this design process to avoid any potentially harmful decisions. Their expertise and insights

Learnings

5.3 Working on Lucallian was a pure joy and excitement for our tandem interdisciplinary project. As we approached the project with both sincere interest and passion for horses and the equestrian field. We were internally driven to achieve the results we envisioned in the beginning. It enabled us as designers to approach the thesis from a very motivated perspective.

Our work has provided us with valuable practical experience and knowledge that has significantly enhanced our skills and confidence as interaction and industrial designers.

Working on such an extensive project allowed us to deepen our knowledge of user experience design and the implementation of design methods into practice. Specifically, we found the most insightful working with our target group representatives and fieldwork. It was astounding to see what raw and creative ideas resulted from simple tests or interviews with each of our participants.

Our Bachelor project enabled us to properly perform various approaches and tools that were introduced to us at the Zurich University of the Arts and gain inner confidence in our knowledge.

Contribution

5.4 While the equestrian field is often perceived as a low-tech, traditional industry, seemingly untouched by technological innovations; we firmly believe that there is room for technology to enhance various aspects of horse riding and equipment. We believe that our thesis introduces the concept of the Lucallian service and serves as a compelling example for fellow equestrians, innovators, and designers to explore the potential for innovation within the field.

The well-being of the horse often gets overlooked while performing as many in the equestrian industry think about solo the rider's comfort and less so the horse. Lucallian's core concept is derived from the well-being of both horse and rider.

We hope to inspire the industry to think beyond traditional approaches and consider how advancements in technology, design, and user experience can positively impact the equestrian industry.

Our research brings attention to the overlooked changes in modern horses' back sensitivity and shoulder flexibility. By bridging the gap between traditional practices and modern equine anatomy by understanding, we promote evidence-based approaches to the welfare of horses. We also emphasize the importance of a health-centered approach in equestrian equipment design and raise awareness among riders about the significance of proper fitting for both their own comfort and their horses' well-being.

During our visits to ranches and White TURF races, we had a motivating exchange with horse owners, riders, and riding school owners. After presenting our service concept, we received positive feedback on our project and multiple requests to test it out, and even wishes to buy our product for themselves. We promised that we will reach out to them when the project turns into a startup.

Through the implementation of an anatomy-based design approach, we aim to revolutionize the industry's standards by making female-built saddles as readily available as male-based ones. By our example, we aim to prevent female riders from experiencing posture distortion caused by ill-fitting saddles. While also offering a myriad of customization possibilities for both men and women

We see our project as a framework for working on products that involve the welfare of both animals and humans.

Next Steps

5.5

After graduating, Kaitlynn and I plan to transform our thesis into a startup. During the process, we received interest in our project from companies like Accenture Song, known for helping businesses overcome challenges and drive innovation, and Seaver, which focuses on embedding technology to monitor the health of horses and companions of riders.

During thesis development, we identified exciting and promising ideas that we will implement in later stages of project development. Firstly, we aim to integrate balance sensors into the saddle to monitor riders' posture and balance during riding. We see this as one of the main factors for ensuring harm-free riding. The Lucallian mobile application will provide feedback on each riding session, notifying users of any imbalanced posture and suggesting adjustments.

We also aim to include health data sensors in our saddle design, focusing on key indicators such as heart rate, respiratory rate, blood pressure, and temperature. While similar projects like Piavita exist, which often produce separate hardware, we need to conduct testing to determine the feasibility of directly implementing sensors in the saddle due to potential pressure during riding.

Additionally, we introduced the concept of a DIY Adjustment padding system, which includes color coding on the pads to guide users, as well as a mobile adjustment guide in the Lucallian application that allows users to rescan their horse and receive guidance on adjustments. Many of our interview partners found this idea very useful, as horses' bodies change over time.

Also, we plan on manufacturing our saddle out of locally sourced second-hand leather. The saddle posed would be designed in a part-based system to be sourced from second-hand leather offcuts because most sourced offcuts are recut in sections leaving smaller pieces at the end of their use.

An essential future step involves conducting further user testing of the application on the ranch and saddle model with padding. As we were only able to test the final saddle tree model once on our model horse, Fou, without padding, more precise feedback is needed.

In summary, our future steps include integrating balance sensors and health data sensors into the saddle design, exploring the concept of a DIY Adjustment padding system, and conducting thorough user testing to refine our application, and designing a hole saddle modeavoid any potentially harmful decisions. Their expertise and insights can contribute greatly to ensuring the well-being and safety of animals.

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Appendix

Interview Findings

Jessica Wohlwend, saddlemaker

Our first interview partner was Jessica Wohlwend, a saddle maker, who worked in the past for Equinomic Saddlery, located in Wigoltingen, Switzerland. (link) Jessica worked primarily on English saddles. Jessica mentioned that in Switzerland around fifty percents of saddles are customized, which is much higher than in other countries. Here are some valuable outtakes for our service:

Measurements

Jessica shared her approach to measuring both riders and horses. For riders, she focuses on trousers size, hip width, and femur bone length. When measuring horses, she takes pictures from the deepest point of the back in both directions to estimate the swing line, followed by a separate measurement of the back line.

Jessica stressed the importance of measuring horses in both stationary and walking positions. She relies only on her visual judgment to assess the horse's musculature and character without recording any data. Observing a horse's neck movement is also crucial to determine its range of motion.

During measurements, it is essential for the horse to feel and behave naturally to avoid distorting its back shape. Identifying the rider's dominant side helps check posture balance. Jessica advised considering that a horse's body shape can change significantly over time as certain body parts take longer to grow.

Service

We identified that it is crucial to provide a rider with full information on a saddle after purchasing, as it can be used afterward in case of readjustments or selling. The provided information should include details such as the specific horse and rider for whom the saddle was made, as well as the saddle's parameters and the materials used in its construction.

Sabrina Casti, rancho owner, rider

Sabrina Casti, a former professional rider, has a family history of owning and training horses. At present, her family owns four horses at their "Casti" ranch, St. Moritz, Switzerland. Horses are named Fou, Flur, Toni, and Tomara. Fou is an ex-racehorse, while Flur and Toni are presently competing in races. Tomara is an ex-showjumper.

Experience with a customized saddle

Sabrina ordered a customized saddle for Fo only once, as he has a specific back shape, which is very angled and narrow. The customized saddle was tailored only to Fo's parameters, not hers. She mentioned that a saddler would need two to three appointments, which is a lot of time and money. She emphasized that in her experience, the customization process was focused only on fit for the horse, and it was the only criteria for the final result.

In her experience, saddlemakers did not look at a rider on a horse. They asked about the rider's height and weight and measured the length of her legs. Furthermore, they looked at the horse in movement without a rider on the horse, to see how the old saddle moved on the back. They made the horse walk and lunge. Saddlemakers used EQUIscan, but she did not have a particular opinion on that.

Currently, she has one saddle for all her horses. To accommodate it to each of them, she uses a lot of padding. In her opinion, it is very expensive to allow a customized saddle for each horse. Sabrina defined a normal lifetime of a saddle as fifteen-twenty years.

Health problems:Sabrina had back problems caused by riding. She said that many horses also have back problems, which, in her opinion, can be solved by a customized saddles.

About the DIY Padding System:

Sabrina found the idea of a DIY padding system very helpful, as it would allow riders to adjust the padding themselves. However, the concern is that riders may not always know how these adjustments would impact the fit of the saddle.

Regarding the Application:

In her opinion, to build trust in new technologies, a saddle maker should provide support throughout the initial stages of launching. Sabrina also expressed the desire for the application to have the feature of multiple profiles, allowing her to create separate profiles for each of her horses.

Jordane Vernet, hobby rider

Vernet Jordane, our mentor from Accenture, has an extensive background in horse riding, with twenty-five years of experience and participation in horse jumping competitions.

Experience with a Customized Saddle

Jordane previously had a customized saddle, which became unusable when she changed horses. She noticed that saddlemakers often prioritize the aesthetic appeal of the saddle rather than considering the horse's parameters or the rider's. She advised us to prioritize functionality over appearance.

During the fitting process, the saddlemakers measured the length from her knee to seat bone and her hip width. However, they did not take any measurements from her horse initially. They only assessed the fit of the saddle on her horse at the end. Jordane also emphasized the importance of measuring the horse's girth and the size of its back.

Health problems

Jordane experienced back problems specifically in her lower back. However, changing the saddle resolved the issue.

Saddle Adjustments

Jordane never had to make any adjustments to her customized saddle. She found the concept of cushion adaptability and a DIY perfect fit to be useful.

Saddle Feedback Data

According to Jordane, having feedback on the saddle's fit would be beneficial. Additionally, she suggested that measuring the horse's temperature could be helpful as it is sometimes overlooked.

Stella Trümpi, professional rider, horse owner

Stella is an active professional show-jumper who participates in competitions and owns several horses.

About Saddles

Stella believes saddles aren't harmful to horses and primarily serve the rider's preferred riding style. However, ensuring a proper fit is crucial. She changes saddles every 2-4 years in show-jumping due to their reduced durability. Stella maintains two saddles, one for smaller and one for larger horses based on shoulder size.

Health Problems

While back problems are common among riders, Stella isn't certain if they solely result from ill-fitting saddles. Seeking advice, she obtained a specific saddle recommended by a veterinarian. In her experience, horses, especially in dressage, often encounter back problems. While riders may feel comfortable, horses might not, leading to pad adjustments. Stella attributes these issues to muscular rather than bone-related problems.

Customized Saddles

Stella's experience with customized saddles was mixed. One custom saddle created discomfort during jumping, creating too much distance and hindering contact with her horse.

Horses

Stella shared that she changes horses every four to five years, and in her experience, their bodies change a lot since they keep growing.

Stella, as a professional rider, had a completely different experience from the interviewed hobby riders. This shows us that the two categories have very different needs.

Appendix

Interview Findings

Pietro Zullo, cofounder of AlterEgo, AR technologies specialist

Pietro Zullo developed the software for the “AlterEgo” service (link), which creates a 3D model of a person based on two photos for the online clothes fitting process.

Rider measurements & scan

Pietro concluded that we have two options for creating a model of a rider to extrapolate measurements:

- If we only need measurements, we could use one of the AlterEgo models. This would require the user to provide us with one picture or a series of pictures, and input their height as a reference point.
- If we need more details, then the Lidar scan is the most precise option. The user should rotate in the same place (with an error rate of 2-5%).

Pietro recommended showing the user what a “good model” should look like, which could be done with a video or picture of the expected result.

Horse measurements

Pietro assumed that a Lidar scan is the most precise technology for measuring a horse. Unfortunately, he did not have enough knowledge to advise us on NeRF technologies and evaluate their impact.

Verena Ziegler, founder and CEO of Open Dress

Verena Ziegler is the founder and CEO of Open Dress, an application that scans, captures, and leverages actual 3D body data of real consumers to define and match sizes and sewing patterns, making made-to-measure scalable. OpenDress utilizes NeRF technologies. (Link)

Horse measurements

- Verena shared with us that, in her opinion, Lidar technology is better to utilize for smaller objects and is not a good fit for a scan of bodies either, as it focuses on straight surfaces.
- In her opinion, NeRF technology has an advantage in this case. Based on photos from different angles or one video, NeRF can create a point cloud-based model of a horse that would have all measurements. In this case, a user would need to provide the application with a “ground truth” measurement, such as the height of the horse, for example. One of the necessary conditions is that the camera should be stable.

Rider measurements

- Verena also shared with us that the same approach could be applied to perform a scan for a rider.

After the interview, Verena kindly offered us to try the NeRF technologies her company works with. We provided her with some materials from Sabrina Casti’s horses, and Verena and her team created an example of a NeRF model of Tomara for us. (The process and results are in the ...)