



EXPLORING MODULARITY IN PHYSICAL THERAPY: THE DEVELOPMENT OF A NOVEL MODULAR TOOL

Master of Industrial Design
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EXPLORING MODULARITY IN PHYSICAL THERAPY: THE DEVELOPMENT OF A NOVEL MODULAR TOOL

A Master's Project by

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My MID Peeps for allowing me to be my authentic self during our time together, the late nights in studio, delirious laughter, and lifetime friendships.

My Friends & Family for standing by my side through my entire academic career.

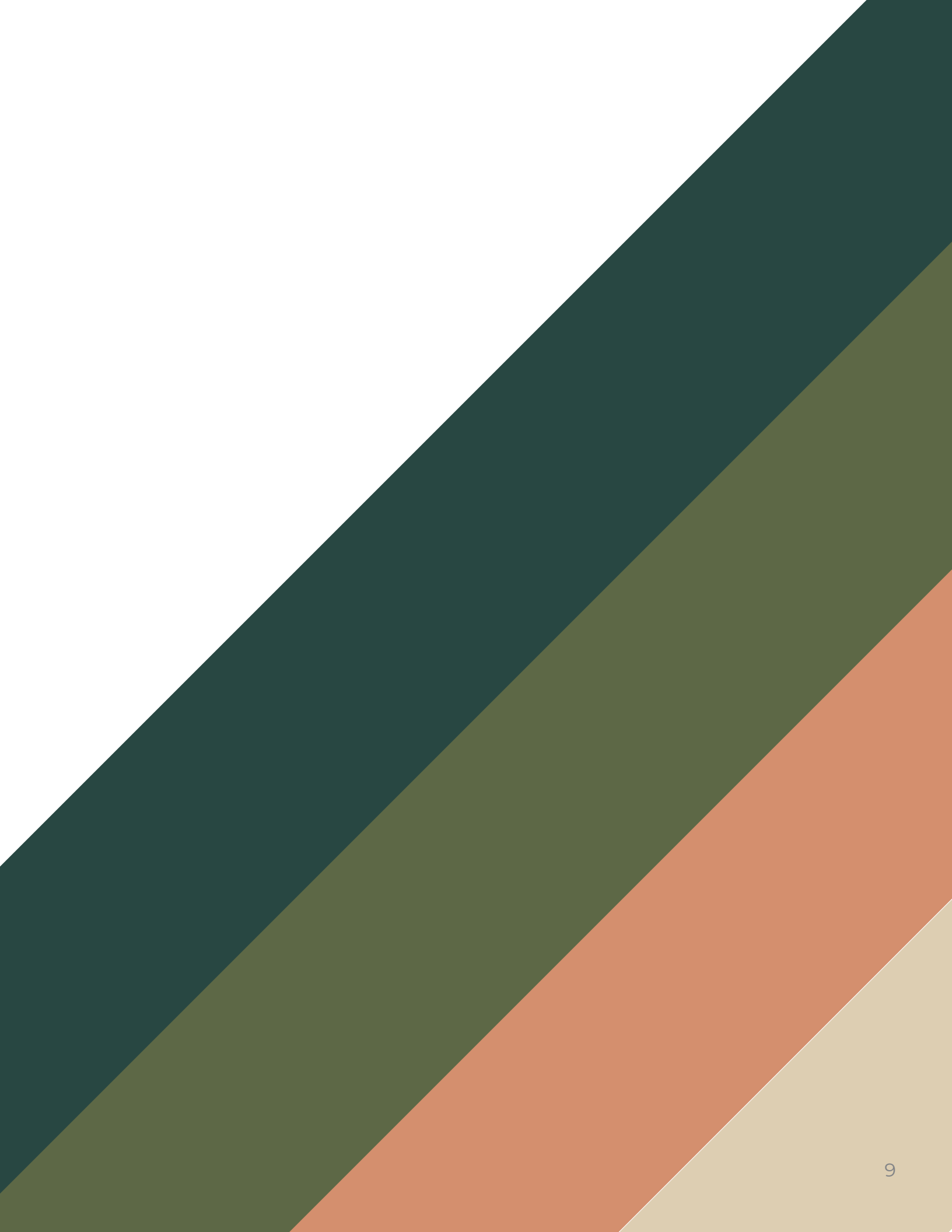
David Peters for always supporting my adventures, following me to a new city, and forever believing in me.

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PART 01

INTRODUCTION



ABSTRACT

The aim of this project was to answer the question: Is modularity valuable in a physical therapy setting? Physical therapy happens in a myriad of ways. Numerous tools, interventions, and methods exist to improve health and well-being. Instead of drugs or surgery, physical therapy aims to improve the health of an individual through methods such as manual therapy, functional training, functional control, exercise regimens, etc. The utilization of multiple tools, interventions, and methods creates a variety of different prescriptive avenues for any person to take. Exploring these aspects, this research set out to enhance and customize an aspect of the physical therapy experience with a novel design. Through ethnographic research and semi-structured interviews, the role of modularity in the physical therapy recovery setting was evaluated. The insights provided by the interviews and observations yielded findings which indicated there was indeed value in modularity within the physical therapy recovery space. This project presents a novel modular recovery system comprised of several parts which can be customized by a person in countless ways.

DESIGN PROCESS

01

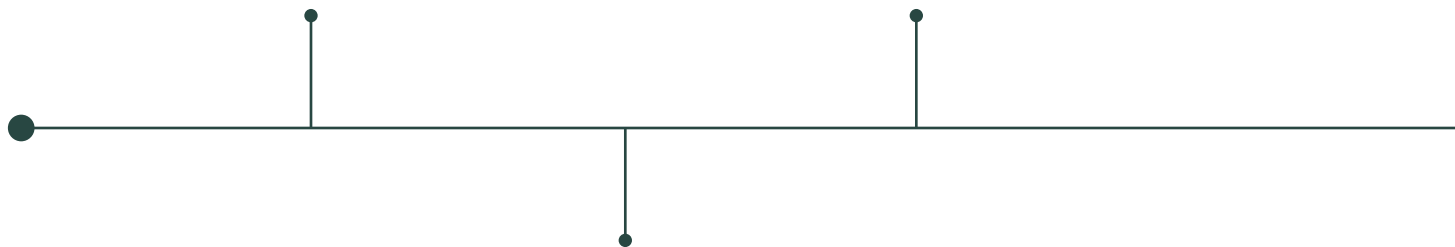
LITERATURE REVIEW

A comprehensive look at existing technology and methodologies was conducted. This gave insight into current trends being utilized.

03

RESEARCH SYNTHESIS

Research insights were compiled into equipment categories and opportunities for improvement were identified.



02

RESEARCH: ETHNOGRAPHY

Initial interviews were conducted with subject matter experts such as physical therapists and trainers to learn about their processes and procedures.

05 PROTOTYPING + ITERATION

Multiple rounds of physical prototypes were created. Participatory design was used by implementing feedback from users in each iteration.

07 RESULTS + LOOKING FORWARD

The brand development was explored and “minimis” was born. The results of the project are reflected on as well as the potential future state.

04 DESIGN IDEATION

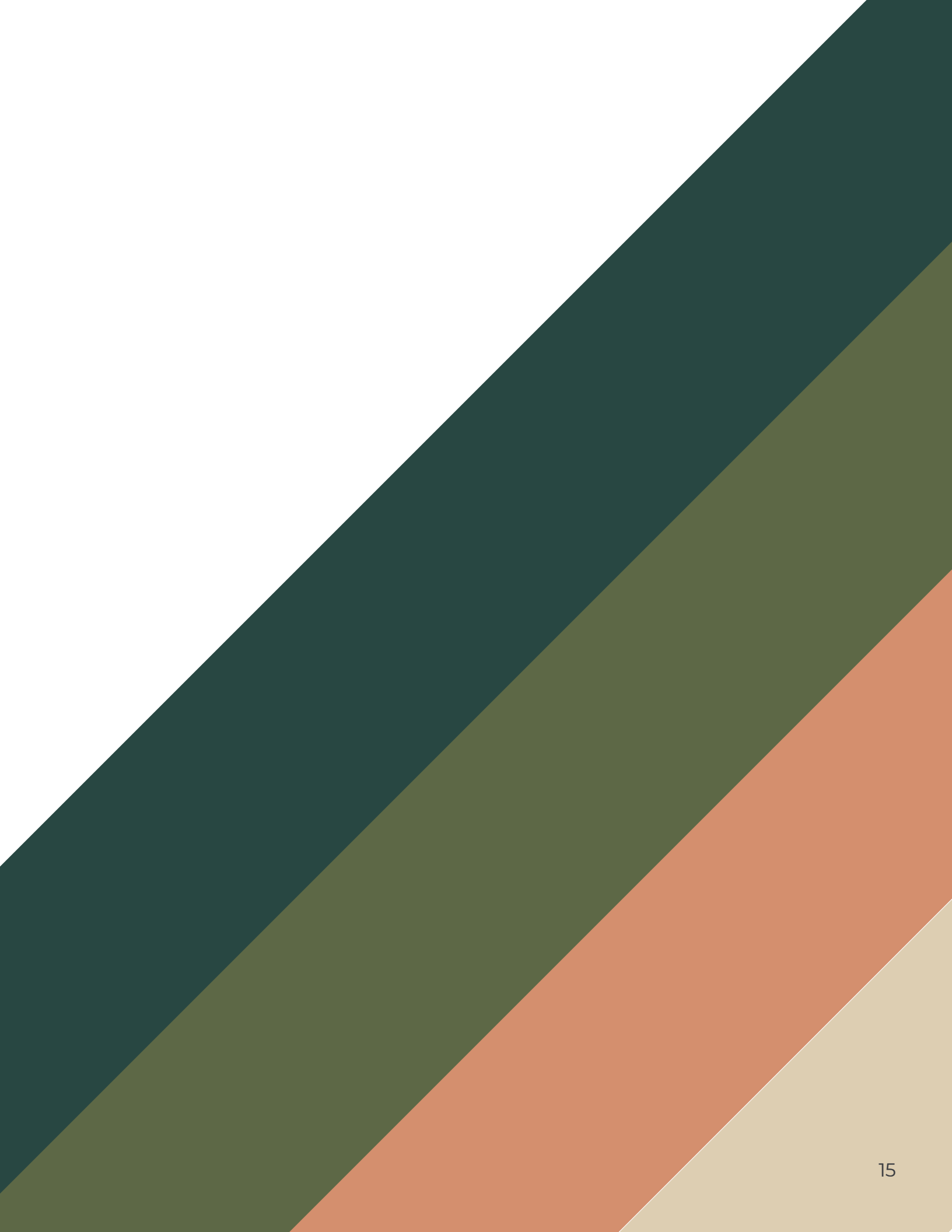
Design Criteria were established and initial ideation began. Design ideation began with rough and quick sketches in 2D.

06 BUILD: FINAL

A final prototype was constructed and taken to experts for a final round of feedback on the design.

PART 02

BACKGROUND



Injuries in Athletics

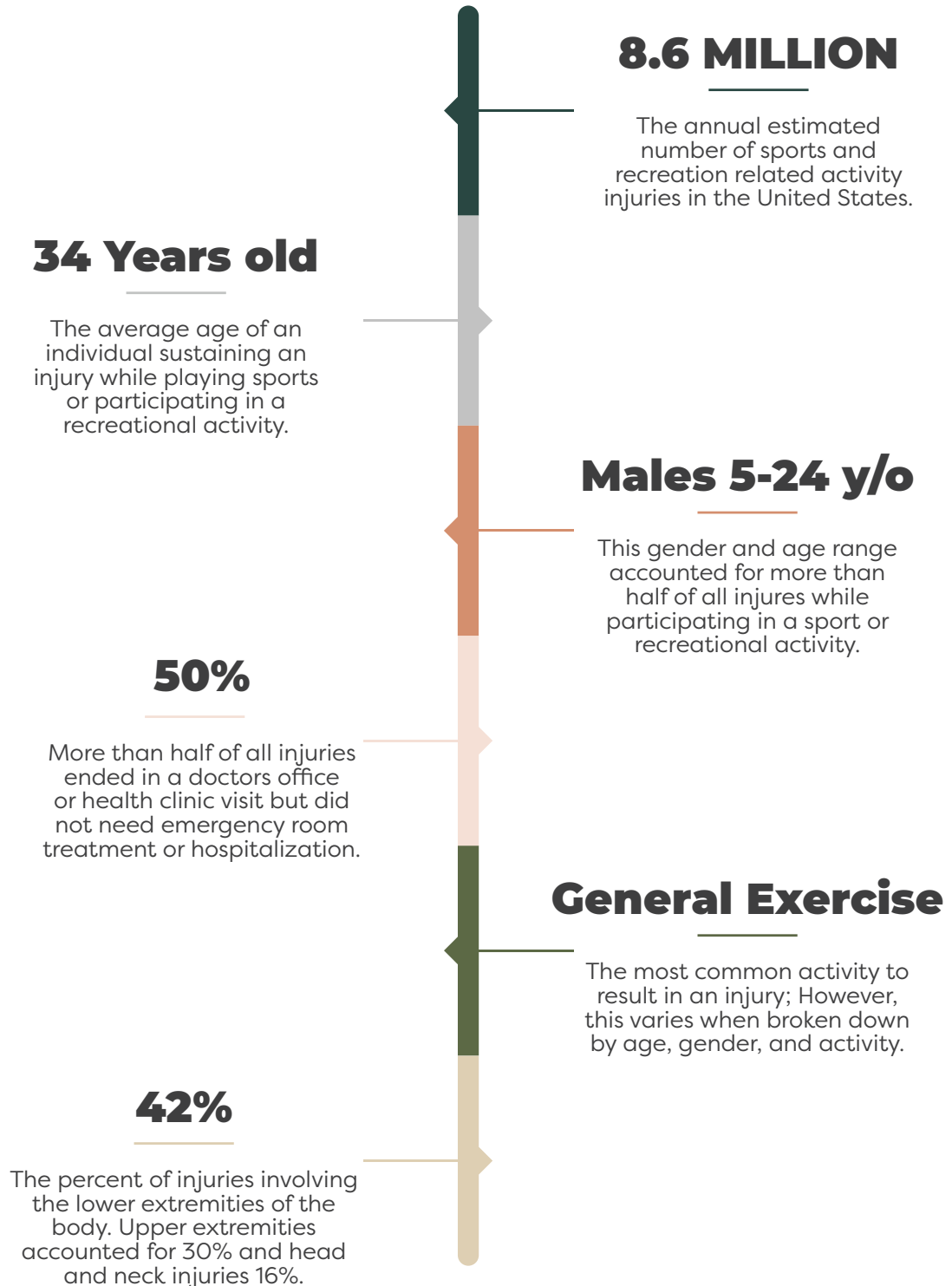
Sports and recreational activities are big business in the United States and globally. In North America alone, revenue from the sports market topped \$83 Billion showing a steady increase the past ten years. Globally, the number is even larger coming in at a whopping \$500B (Gough, 2019). Knowing this, an enormous amount of people participate globally in various sports ranging from personal independent running to professional football. A common theme among all sports are **INJURIES**.

These injuries vary in metrics such as injury risks, injury rates, and injury odds (Hopkins, Marshall, h, & Hume, 2007). Contact sports such as football have more recorded injuries than non-contact sports like swimming (Zachary Y. Kerr, et al., 2015). An important fact to note when speaking of sports injuries is the lack of standardization of reporting an injury or trauma. No one common conceptual basis for reporting exists but there are proposed methods being evaluated (Toomas, et al., 2014). Therefore, it is extremely difficult to estimate a “total injury” rate. Often, a singular sport will be examined and broken down by injury rate along with qualifying factors such as age or gender. Important to the research is the fact there are injuries in every sport and in general exercise.

The National Health Statistics report participated in face to face interviews in order to gain a better understanding of injuries in sports and recreational activities. Their study concluded there are approximately 8.6 million injuries annually with an average age of 34.1 years. Males are the most likely to incur an injury. Over 50% of the injuries needed a doctors visit but did not require a visit to the emergency room. Perhaps not surprisingly the most common activity related to injuries was “general exercise.” (Chen, Ph.D., Hedegaard, M.D., & Sheu, Ph.D., 2016).

One way to address an injury or trauma is to participate in a physical therapy based setting. Physical therapy (PT) is defined as: “one of the allied health professions that, by using evidence-based kinesiology, exercise prescription, health education, mobilization, electrical and physical agents, treats acute or chronic pain, movement and physical impairments resulting from injury, trauma or illness typically of musculoskeletal, cardiovascular, respiratory, neurological and endocrinological origins” (Physical Therapy, n.d.) Participation in physical therapy can be both preventative and reactive in nature to physical injuries or traumas. For this study, physical therapists, trainers and athletes were invited to provide feedback and insight into common injury recovery methods, interventions, and therapies.

Statistics



Physical Therapy Interventions

After seeing the statistic of 8.6 million people being injured each year, the exploration of how those injuries are dealt with became a key question in the initial research. For the purpose of this project, a variety of intervention methods were examined to understand the landscape of what physical therapy entails. Recovery methods, interventions, and processes were documented to reveal potential areas for opportunity. The breakdown of intervention methods

can be seen on the following pages. By no means is this an all inclusive list. The physical therapy world constantly evolves and introduces new techniques, technologies, and methods.

However, opportunity spaces needed to be explored. Certain gaps in the market became apparent as the research went on. In particular, the need for a smaller footprint modular recovery system. This fills a need expressed by experts for a practical solution.

PHYSICAL THERAPISTS PROVIDE TWO GENERAL TYPES OF INTERVENTIONS:

1

PATIENT OR CLIENT / INSTRUCTION OR EDUCATION

This particular type of intervention entails teaching the patients or clients (or their significant others or caregivers) how to optimize functions of specific tasks of care.

2

INTERVENTIONS TO ACHIEVE PATIENT/CLIENT GOALS AND EXPECTED OUTCOME

This type of intervention begins with an evaluation of a particular situation. A diagnosis and plan are then formulated with a goal or expected outcome. The physical therapist will routinely re-evaluate this plan and adjust needs, goals, and expected outcomes as needed - including frequency of care.

Intervention Methods

A

AIRWAY CLEARING TECHNIQUES

B

AID WITH ASSISTIVE PRODUCTS AND TECHNOLOGIES

C

FUNCTIONAL CONTROL (STABILITY AND MOBILITY)

- Balance training
- Developmental activities training
- Gait and locomotion training
 - Developmental activities training
 - Gait training on various terrains and dual task
 - Implement and device training
 - Perceptual training
 - Standardized, programmatic, and complementary exercise approaches
 - Manual and power mobility training
- Motor function (motor control and motor learning) training or retraining
- Neuromuscular education or reeducation
- Perceptual training
- Sensory training or retraining
- Skeletal alignment/posture training
 - Body mechanics and postural stabilization
 - Body mechanics training
 - Postural control training
 - Postural stabilization activities
 - Posture awareness training
- Standardized, programmatic, and complementary exercise approaches
- Vestibular training, including canolith repositioning/habitation exercises

Intervention Methods

D

FUNCTIONAL TRAINING

- Activities of daily living (ADL) training for self-care
- Instrumental activities of daily living (IADL) training for domestic life
- IADL training for work (job/school/place)
- IADL training for community/social/civic life
 - Injury prevention or reduction during integration or reintegration into community /social/civic/life
 - INJURY PREVENTION WITH THE USE OF DEVICES AND EQUIPMENT
 - Postural support and integrity
 - Safety awareness training

E

INTEGUMENTARY REPAIR AND PROTECTION

E

MANUAL THERAPY

“Skilled hand movements and skilled passive movements of joints and soft tissue and are intended to improve tissue extensibility; increase range of motion; induce relaxation; mobilize or manipulate soft tissue and joints; modulate pain; and reduce soft tissue swelling, inflammation, or restriction.”

- Manual lymphatic drainage
- Manual traction
- MASSAGE
 - Connective tissue massage
 - Therapeutic massage
- MOBILIZATION/MANIPULATION
 - Dry needling
 - SOFT TISSUE
 - Spinal and peripheral joints
 - Neural tissue mobilization
- PASSIVE RANGE OF MOTION

F**THERAPEUTIC TECHNOLOGIES**

“Comprised of procedures and devices using various forms of energy and the use of force (eg, approximation, compression, distraction) to assist muscle force production and contraction; decrease unwanted muscle activity; improve circulation and increase the rate of healing of open wounds and soft tissue; eliminate soft tissue swelling, inflammation, or restriction; modulate or decrease pain; increase range of motion and maintain strength after injury or surgery; stabilize an area that requires temporary support; and assist in functional training.”

- Athermal agents
- Biofeedback
- Compression therapies
 - Compression bandaging, garments, taping, vasopneumatic compression devices
- Cryotherapy
 - Cold packs, ice massage, Vapocoolant spray
- Electrical stimulation
 - Electrical muscle stimulation (EMS)
 - Electrical stimulation for tissue repair (ESTR)
 - Functional electrical stimulation (FES)
 - High-voltage pulsed current (HVPC)
 - Neuromuscular electrical stimulation (NMES)
 - Transcutaneous electrical nerve stimulation (TENS)
- Electrotherapeutic delivery of medications
 - Iontophoresis
- Gravity-assisted compression devices
 - Standing frame
 - Tilt table
- Hydrotherapy
 - Contrast baths, pools, whirlpool tanks
- Light agents
 - Infrared
 - Laser
 - Ultraviolet
- Mechanical motion devices
 - Continuous passive motion (CPM)
 - Sound agents
 - Ultrasound
- Thermotherapy
 - Dry heat, hot packs, paraffin baths
- Traction devices
 - Intermittent, positional, sustained

Intervention Methods

G

THERAPEUTIC EXERCISES

- Aerobic/endurance exercises
- Coordination/agility exercises
- Developmental activities training
- Flexibility exercises
- Neurodevelopmental training
- Relaxation techniques
- Strengthening exercises
- Vestibular training



A Lightforce therapy laser observed in a physical therapy office

Moving forward

After outlining the largest sectors of physical therapy interventions, it became apparent there was need for a smaller footprint massaging system. Because space was often limited and in demand at physical therapy offices, gyms, and “on the go,” the idea for a modular system needed to be explored.

Would a smaller modular system hold value in these spaces? Spoiler alert - the research showed it did indeed present value. These spaces are often overrun by tools and items for therapy. The opportunity to provide a modular system having limited parts, which provides a large variety of configurations was apparent.

The initial exploration of tools and methods needed a deeper dive. Therefore, recovery methods were explored more in depth by turning to the current research available. This was done in order to identify potential opportunity areas in the field of recovery.

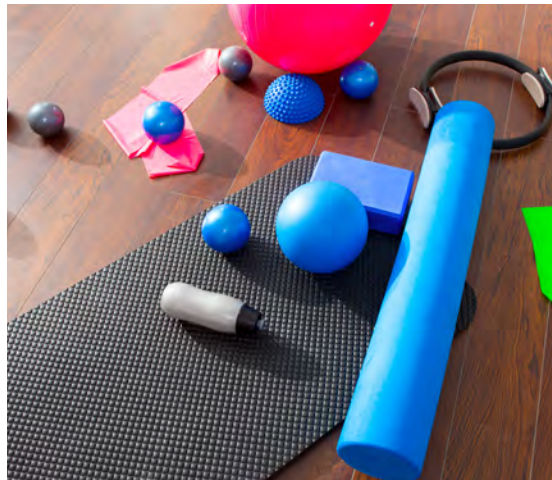
For this project, a deep dive into recovery methods involving massage, soft tissue interventions and mobility interventions were primarily explored. These were explored because of their intersection with exercise and injuries. Often, these particular methods are seen not only in physical therapy offices, but in gyms and training facilities. Specifically, manual therapy and therapeutic technologies were examined more in depth.

Although there are thousands of products on the market today, this project explores where those products fall short. Products today often serve a singular purpose. Instead, a solution of variable parts and pieces should be made to serve a variety of purposes in regard to recovery.

Recovery Methods Research

Numerous studies have set forth to determine the most effective recovery technique for muscles, particularly in athletics; however, a clearly effective method has not been established and often particular modalities are not widely accepted as a post-exercise therapeutic methods (Brummitt, 2008; Cheatham, Kolber, Cain, & Lee, 2015; Tiidus, 1997). A variety of recovery methods such as cryotherapy, thermotherapy, ultrasound, stretching, muscle contractions, cupping, taping, percussive movements, and massage have been evaluated (Cheung, Hume, & Maxwell, 2003). Unfortunately, the studies have produced varied results with no clear conclusion on effectiveness. Massage, in particular, has been studied a multitude of ways to determine if it is an effective pre-exercise or recovery strategy (Schroeder & Best, 2015). Again, the research returned varied results with no clear consensus of the effectiveness of massage physiologically (Crane et al., 2012). One consistent result however is the

positive trend of perceived effectiveness by the participant for recovery, performance, and range of motion (ROM) (Cheatham et al., 2015; Moraska, 2005).



Many techniques for administering massage exist. Massage can be administered by a professional or self-facilitated using a variety of methods, tools, or devices (Moraska, 2005). Massage is utilized for muscle recovery, injury prevention, and maximizing physical performance. Similar to Swedish massage, athletic massages employ a set of movements to achieve reduced

Research

soreness, increased physiological recovery, and perceived recovery. These movements are effleurage, petrissage, tapotement, friction and vibration (B. J. Hemmings, 2001). The movements are designed to stimulate blood flow to a specific area in an attempt to flush out unwanted substances residing in the muscles, elongate and relax the muscles to become more fluid, and/or prepare them for maximal output if utilized before exercise as to decrease chance of injury. Nevertheless, numerous research studies have yet to confirm in mass the benefits of sports massage from a physiological standpoint. Massage as a treatment for muscle soreness is not universally accepted (Jay et al., 2014).

Research varies greatly regarding massage due to a lack of standardized protocols in research methodologies. For instance, when researching massage numerous controls differ between studies. These controls include varied hands on massage time, time of intervention, differing skill levels of the person performing massage, consistency in massage, nutrition, water intake, and outside factors of everyday living to name a few (B. J. Hemmings, 2001). Massages in some studies were as short a minute or as long as 30 minutes in duration and performed immediately before, immediately after, or a defined amount of time post exercise (Halperin,

Aboodarda, Button, Andersen, & Behm, 2014). With time differences as vast as these, results varied greatly between the research studies. Several studies induced delayed onset muscle soreness (DOMS) and then integrated an intervention, such as massage, to measure outcomes of perceived pain of DOMS. Overall, massage appears to alleviate the feeling of DOMS either physiologically or psychologically (Beardsley & Škarabot, 2015; Cheung et al., 2003). As someone who personally trains, DOMS is not always the same. Different days, meals, and movements all contribute to the subjective pain felt by DOMS. Therefore, some of these studies have an inherent flaw of subjectivity of the person's everyday use and nutrition contributing to recovery. Results of these studies do indicate however the ability of massage to increase range of motion and flexibility (Beardsley & Škarabot, 2015; SPORTS, 2005).

With differing results on whether massage physiologically helps with muscle ignition or recovery, there is promising data showing a positive correlation to **PERCEIVED** recovery (B. Hemmings, Smith, Graydon, & Dyson, 2000; B. J. Hemmings, 2001). The studies reveal people who participated in massage either

Research

before or after exercise have a lower level of perceived soreness (Jay et al., 2014). Arroyo-Morales et al. (2008) found “post-exercise massage can generate well-being, a sense of calm, a reduction in anxiety, and an improvement in mood and perceived relaxation and recovery.” Although massage might not show strong physiological changes in recovery research, these findings provide a conclusion about the overall psychological benefits in athletes of their perceived recovery and abilities.

The perception of an athlete’s recovery via massage becomes an interesting area of study. In recent years, massage rollers, stick rollers, and foam rollers have become more popular for individuals of almost any age or ability (Schroeder & Best, 2015). As the usage of massage rollers has increased multiple studies have set out to explore their muscle release advantage: self-myofascial release (SMR or SMFR). Defined as when a person self-applies pressure to muscle and fascia (usually with a foam roller, massage roller, or similar) SMR helps enhance myofascial mobility (Cheatham et al., 2015). These techniques alleviate the effects of fascia restrictions which typically lead to a decrease

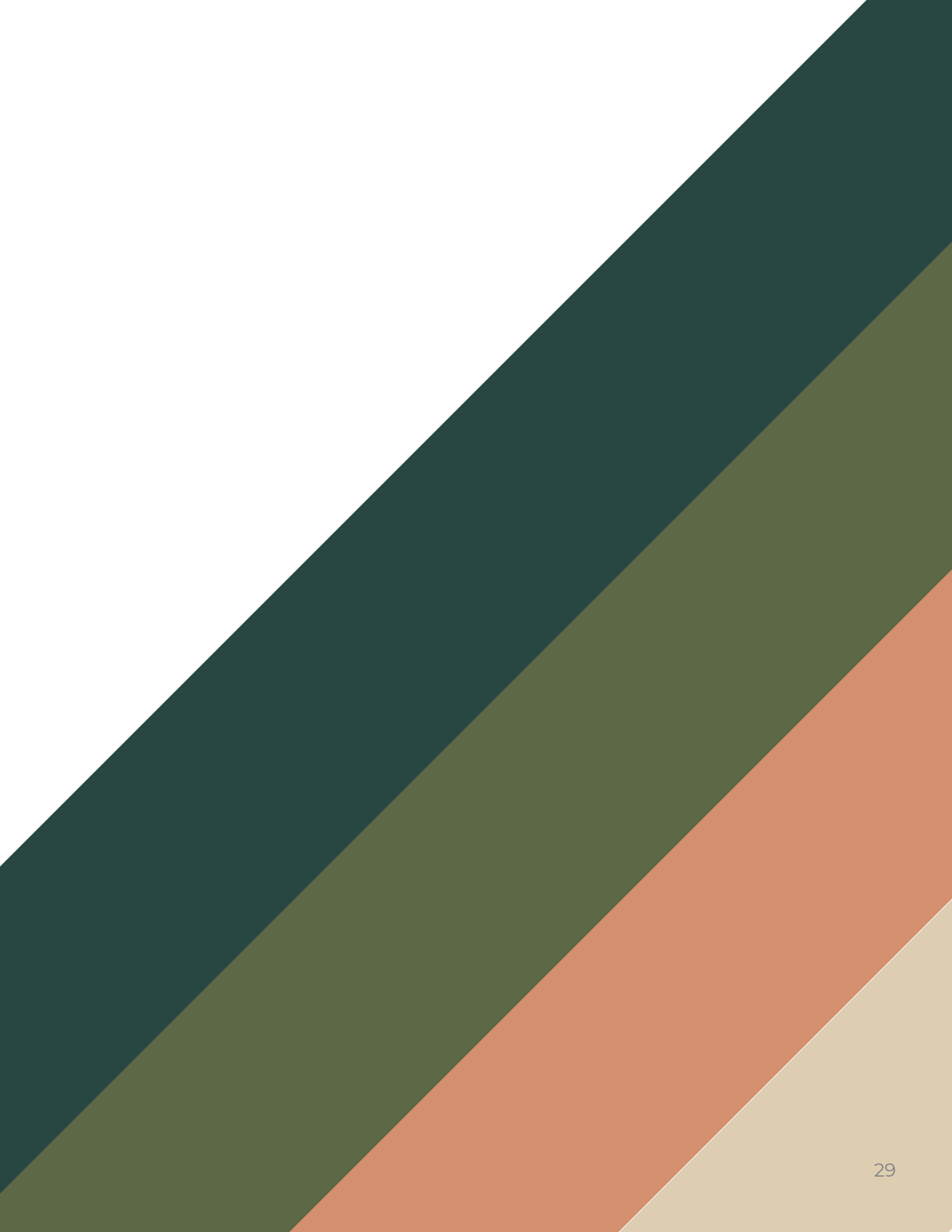
in flexibility, strength, endurance, motor coordination and physical pain (Sullivan, Silvey, Button, & Behm, 2013). One key advantage of self-rolling is the cost effectiveness. Since a therapist is not needed, a person can perform these movements on their own at a time convenient to them. Similar to traditional massage, SMR research shows “no consensus regarding the exact mechanism or mechanisms by which SMR leads to these effects” (Beardsley & Škarabot, 2015). However, Schroeder and Best (2015) found SMR appears to have a “positive effect on range of motion and soreness/fatigue following exercise, but further study is needed to define the optimal parameters (timing and duration of use) to aid in performance and recovery.” Standardized recovery massage protocol, evidence based programs, and treatment programs have yet to be established but could greatly contribute to the overall knowledge of the field (Brummitt, 2008). Therefore, ample room exists to explore the effectiveness of intervention methods pertaining to recovery and the possible methods to employ SMR. Muscle recovery, physical performance, and injury prevention remain central to all design opportunities.

Now what?

This initial primary research of recovery methods revealed a large set of methods, tools, and interventions. Obviously, an initial question still remains: what is the best tool for recovery? The literature provided a great basis to take to the field and conduct ethnographic research. Gyms and physical therapy offices were visited in order to observe first hand the particular tools, methods and interventions available to the stakeholders. This drove the subsequent project research.

PART 03

OBSERVE



Ethnographic Discovery

Gyms and physical therapy offices were visited in order to gain a better understanding of the tools used for recovery. Every gym and physical therapy office visited contained various ad hoc solutions. These solutions ranged in fidelity greatly. Observed among all sites, one configuration of items consistently appeared at every single site - “The Peanut.” Two lacrosse balls taped together to form a figure deemed “The Peanut.” The ad hoc functionality of the mobility gadget peaked a research interest.

Diving deeper into the configuration and creation of the tool, it was discovered the peanut was used to roll out multiple muscle groups but most often utilized to loosen the back muscles. The two lacrosse ball spheres create the perfect curvature and divot to release the muscles around the spine without damaging the spinal vertebrae.

In addition to this tool, numerous other ad hoc solutions were observed. These tools were created using items such as PVC pipes, yoga mats, lacrosse balls, and duct tape.



“The Peanut” consists of two lacrosse balls taped together to form a roller with a depression in the middle to account for the spine.

Ad Hoc Solutions Observed



An ad hoc solution to roll out back muscles whereby the user pulls the “tail” up to control the movement - lacrosse ball and duct tape.



An ad hoc solution of a large PVC pipe with a yoga mat duct taped to the outer surface of the pipe.



A mobility bin full of items used to mobilize in a gym environment. It was observed some tools were commercial products and some were ad hoc solutions.



An ad hoc solution of a large PVC pipe with piping taped in the center and the ends to create a firm roller with spinal separation in the center of the roller.

Exploring Locations

A total of 10 locations were explored and observed. Gyms and physical therapy offices were the main research locations. These were chosen because of their access to recovery solutions and tools to explore - both commercial and ad hoc solutions/tools/interventions.

5 GYMS

Five gyms were visited in order to conduct primary research to catalogue the recovery methods, interventions, and tools used by people.

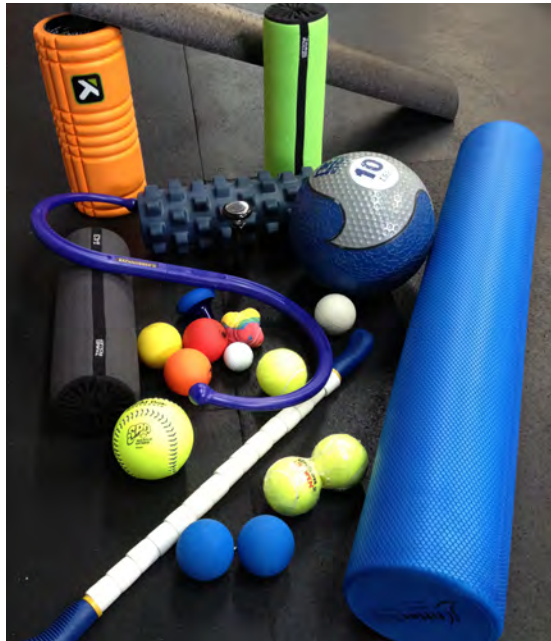


5 PHYSICAL THERAPY OFFICES

Five physical therapy offices were visited to observe any potential trace measures or ad hoc behaviors. In addition, information was collected on the methods therapists use along with the repository of tools.



Equipment observed



Above, a hodgepodge of mobility tools were observed. Various size balls and equipment serve to improve the mobility and recovery of people.



Seen above, Grafton Technique blades were observed. These are used for the Grafton Technique of vigorously massaging over muscles.



A Theragun was observed in a physical therapy office. This is a tool used for percussive massage.



Various types of tapes are shown above. These are used for stretching and manipulating muscles.

Expert Interviews

Around of in-person expert interviews was conducted to understand the current state of knowledge in physical therapy and recovery methods. A total of seven physical therapists, trainers, and persons involved with recovery methods were initially interviewed. The interviews were up to an hour long and took place at various gyms and physical therapy offices.

Being at the places of interest was important because of the vast number of tools, methods, and items utilized for their jobs. Interviews were designed to further the understanding of modularity and how people mobilize in the recovery setting at the advice of a professional. These interviews were not qualitative in nature but rather conducted in order to inform the next phase of the design process.

An interview guide was used to begin the conversation but the style was semi-structured in nature to allow for an organic conversational flow. The experts were initially asked about their level of experience and time frame in the field of athletics and recovery.

The interviews were designed to reveal the methods of how experts evaluate and recommend treatments in conjunction with recovery tools they use and recommend.

To be considered an expert in the qualification process the person must be actively involved in recovery methods for at least two years, 18 years of age, physically located in the United States, and fluent in English.

The purpose of this research study was to understand if modularity presents value in a physical therapy setting by understanding the most commonly used interventions in a recovery setting.

Certain personal and readily identifiable information was removed and replaced with generic phrases or descriptors in order to adhere to the signed participant documentation.

Internal Review Board approval was sought, gained, and consent of the expert was obtained prior to the interview process. The interview guides can be found in the appendix section of this book.

”

*Sometimes it's
hard to select the
right items you
need to mobilize
because there
are so many.*

Key Expert Insights

1 MOBILITY BALLS ARE ESSENTIAL FOR RECOVERY

A mobility ball is the single most used item in any gym or physical therapy office in regard to recovery methods and mobilization techniques. Balls, bands, and rollers were the most common items.

2 MINIMAL ITEMS ARE IDEAL IN THE GYM AND FOR TRAVELING

A minimal set of items configurable in a variety of ways could provide value to athletes, trainers, physical therapists, and others involved in recovery methods.

3 INSTRUCTIONS ARE WELCOMED FOR REFERRAL

With all the equipment available, having a resource to refer back to is key in methods of recovery. Knowing not only the correct way but additional ways to use tools are welcomed.

4 APPEARANCE AND COLOR DO MATTER

Branding and color choices make a difference in the tools people are willing to pick up and use. Even with recommendations some users will not use aggressively colored/branded items.

Expert Summary

After speaking with the experts in the field, certain insights and themes became apparent. In actuality, often the most effective therapies and tools are the most basic. The most common items found and utilized were items such as balls of all differing sizes and textures, rollers, and bands for stretching. Often the more elaborate and complicated systems go underutilized. Items such as the Theragun and laser recovery were specifically noted by multiple experts to satisfy client requests (perceived recovery) rather than actual recovery. Meaning, the experts do not really believe these methods of recovery work but rather use them solely to appease clients.

Feedback heard multiple times was the need for minimal items if the physical therapist or trainer was going to be traveling to an event or patient. Being able to use a tool for a variety of interventions was voiced multiple times.

In addition to this feedback, the experts revealed the need for instructions.

Since they often do continuing education reiteration of methods was “always welcome.” Therefore, the design should incorporate some sort of instructional piece or a cheat sheet on how it should be used. The recovery world is a vast ocean of products and methods. Instructions make the items more accessible to not only the experts but to anyone such as athletes who will also be using them.

Many experts also voiced an opinion on look and feel. Branding and color choices are important in the sea of available products. Outlandish bold colors and patterns were often voiced as a barrier for use. An effort should be made to make the color palette of the product as neutral as possible while also being inviting.

Finally, numerous experts voiced their desire for some sort of enclosure/ case if a future design were to occur. Due to the volume of items they have experts prefer a product to be self contained.

What are the current solutions on the market MISSING?

A variable participatory modeling method was utilized to inform the next phase of the design process - Velcro Modeling. This was used in order to gain insights into how an expert would configure pieces in an “ideal world.” This hoped to answer the question of: WHAT ARE THE CURRENT SOLUTIONS ON THE MARKET NOT PROVIDING?

A kit of parts was put together to learn more about how people would create mobility tools given simply the pieces instead of the whole object. The kit consisted of lacrosse balls, Styrofoam spheres, wooden shapes,

different diameters of wooden dowels, masking tape, hook and latch dots as well as a variety of various resistance bands used in athletics.

Each participant was tasked with configuring an ideal model(s) of what they believed to be a valuable mobility tool. By utilizing the pieces available to them, the participants configured a variety of tools. The process was aimed at fostering the creativity of the experts who use mobilization daily in a tangible manner. The low-fidelity prototypes allowed for rapid ideation of the models can be seen in the following pages.

Athletic Rubber Bands



Wooden Shapes



Lacrosse Balls



Styrofoam Spheres



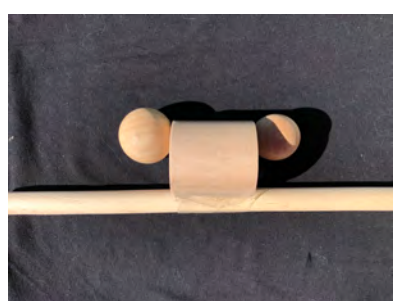
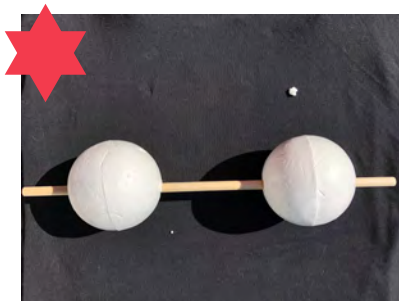
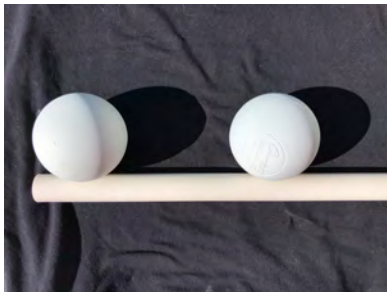
Velcro Dots



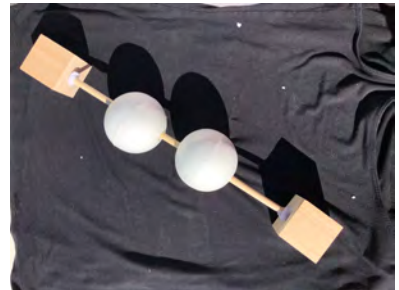
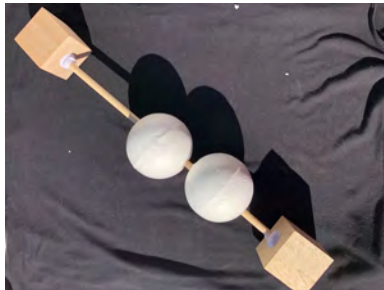
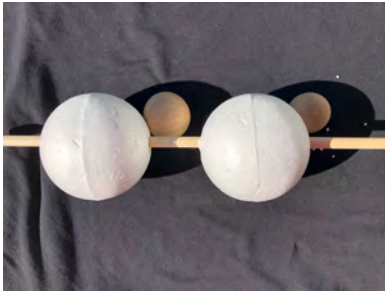
Participant Models

Seen below are some of the models provided by participants. Indicated by a ★, these are the most common configurations done by multiple participants.

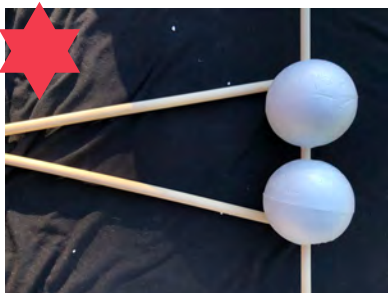
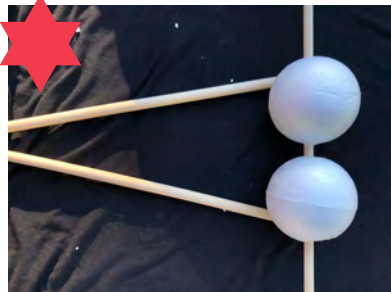
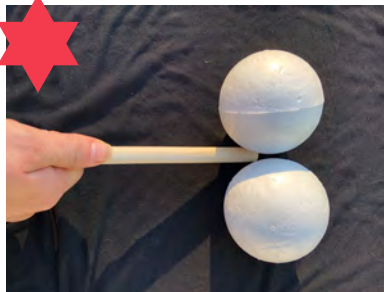
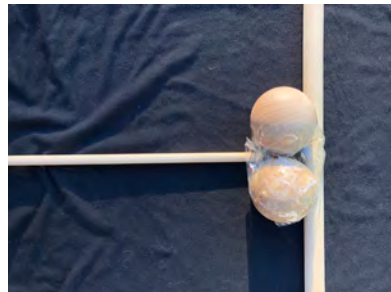
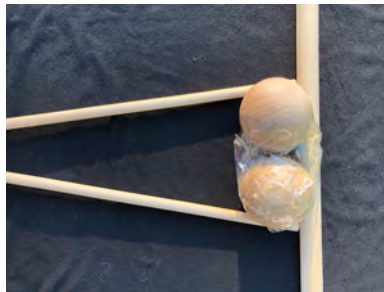
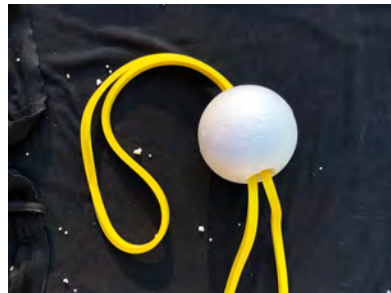
It was interesting to see patterns emerge of participants gravitating toward the two large spheres on a central rod. This was by far the most common configuration. In addition, various tips were used on the end of a rod/dowel. When prompted, participants said this was because of their need for pressure or trigger point work on the body (to release sore or tight muscles).



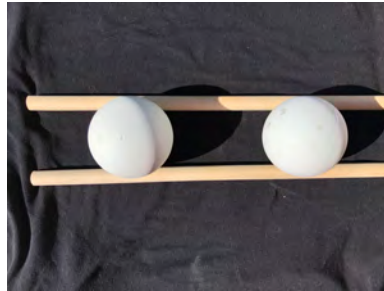
Models



Participant Models



Models



”

Lots of mobility tools in gyms involve duct tape and random objects - kinda similar to this.

Participant Model Takeaways

A total of 18 participants took part in the participant modeling session. The session took place in a gym and a physical therapy office. The modeling revealed the desire for modularity of the main rolling pin. Multiple participants offered the same configurations and these duplicate photos were not shown.

This style of creative toolkit, Velcro Modeling, was ideal because of the ability to utilize the physical elements of the design while employing participatory modeling. This gave the participants the ability to creatively construct configurations. The generative methodology employed here allowed for numerous designs to be engendered. Taking all of these into account, certain themes

began to arise. The centrality and versatility of main dowel rod became increasingly apparent. By fostering the innovation and creativity of the participants, the process gave insight into how the next phase of design should focus on modularity.

The Velcro modeling revealed the market today lacks in adequate modularity products. **Options to configure tools in a variety of ways to suffice a participant need was a major opportunity.**

The subsequent ideation was cognizant of the design criteria while also taking into consideration the participant modeling. The goal was to create modularity with defined pieces.

Takeaways

The Good

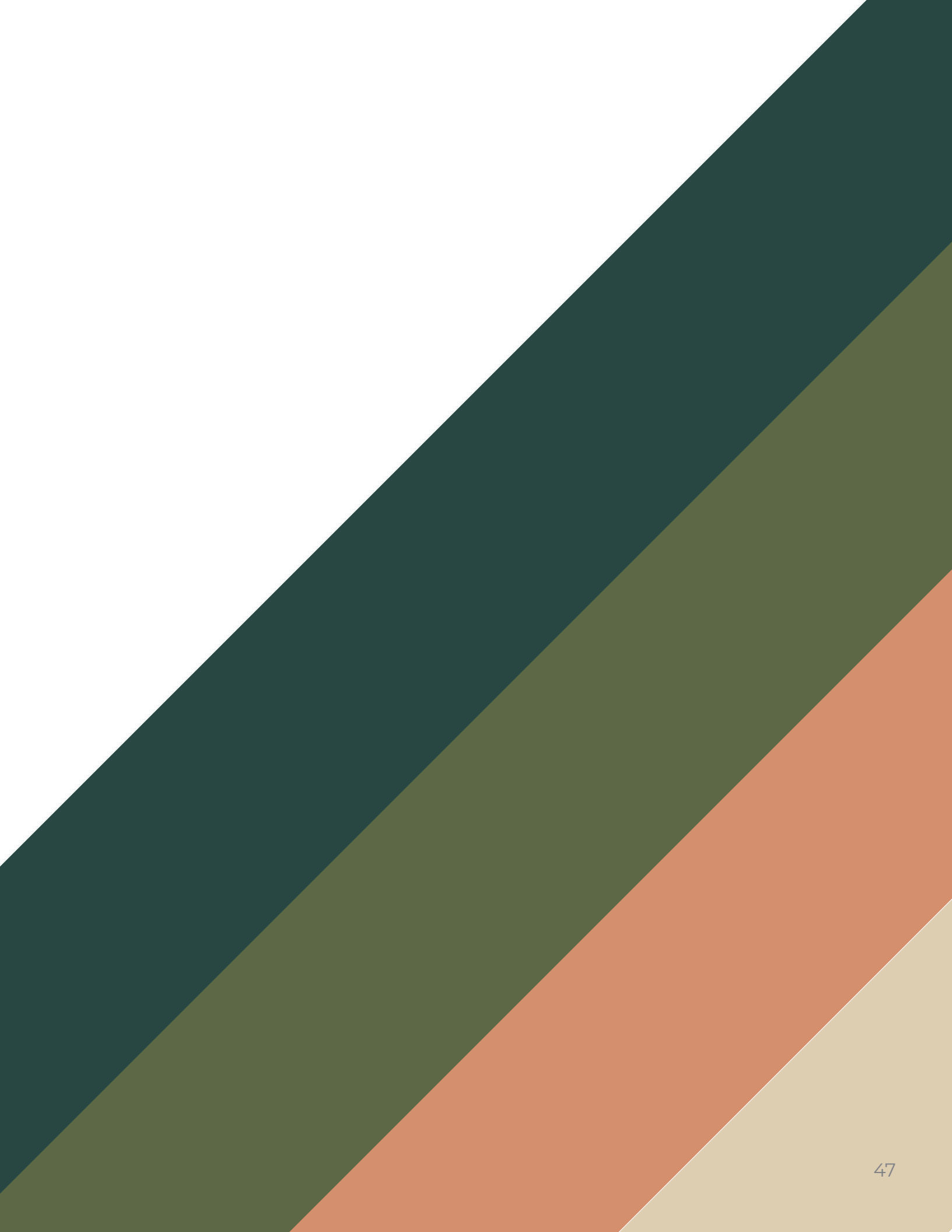
- 1 People loved the idea of configuring objects in a multitude of ways
- 2 A substantial amount of pieces were used by the participants
- 3 Individual pieces were configured in a variety of ways indicating the need for modularity of certain pieces
- 4 The main dowel rod and the “peanut” configuration appeared consistently
- 5 The need for a dowel end with multiple tips/attachment pieces was observed for trigger point type therapies

The Opportunity

- 1 People want the least possible amount of objects
- 2 People want to be able to configure the items in a variety of ways
- 3 Some participants voiced certain objects served no purpose in the kit and perhaps needed to be removed
- 4 People sometimes felt overwhelmed by the amount of pieces displayed in the kit
- 5 Participants took a bit of time to get settled into a creative mindset
- 6 Packing tape was cumbersome to work with at times

PART 04

INTERPRET



Affinity Mapping

After the initial ethnographic research was complete, affinity mapping was used to categorize the majority of the pieces of equipment and items observed at physical therapy offices and gyms. While researching, numerous different solutions were observed. Both ad-hoc and commercial solutions were being employed by athletes, trainers, and physical therapists to achieve individual mobility goals and betterment.

These observations led to the visualization of an affinity map to identify a potential design opportunity space. Because so many different solutions exist, a visual representation of the categories was helpful in defining the next step. This allowed the observation of the types of tools people were primarily creating ad hoc solutions for to fit their needs.

This mapping was used to categorize all the qualitative data collected from site visits. Initially, post-it notes were used to look at the categories and this data was then digitized using Miro.com for cleanliness sake and visibility.

Three major categories were created for the equipment and technique places. Nine subcategories were then created to further subdivide the equipment and techniques. The categories were formed around the use of the equipment or technique. Finally, the specific items or techniques were listed (seen on the next page in yellow). These comprised the majority of the information collected. It should be noted each office had hundreds of pieces of equipment and tools. Therefore, pieces observed multiple times were placed into the categories. Seen in green, there were two aspects of products noted if they provided additional therapy using heat or vibrations. A valuable aspect identified through affinity mapping is the possibility of modularity presenting value in these spaces.

Seen on the following page, is a small fraction of the overall tools used in the physical therapy market. Interesting, a question of tools or items serving multiple purposes came up. The concept of modularity was again reiterated.

Affinity Mapping

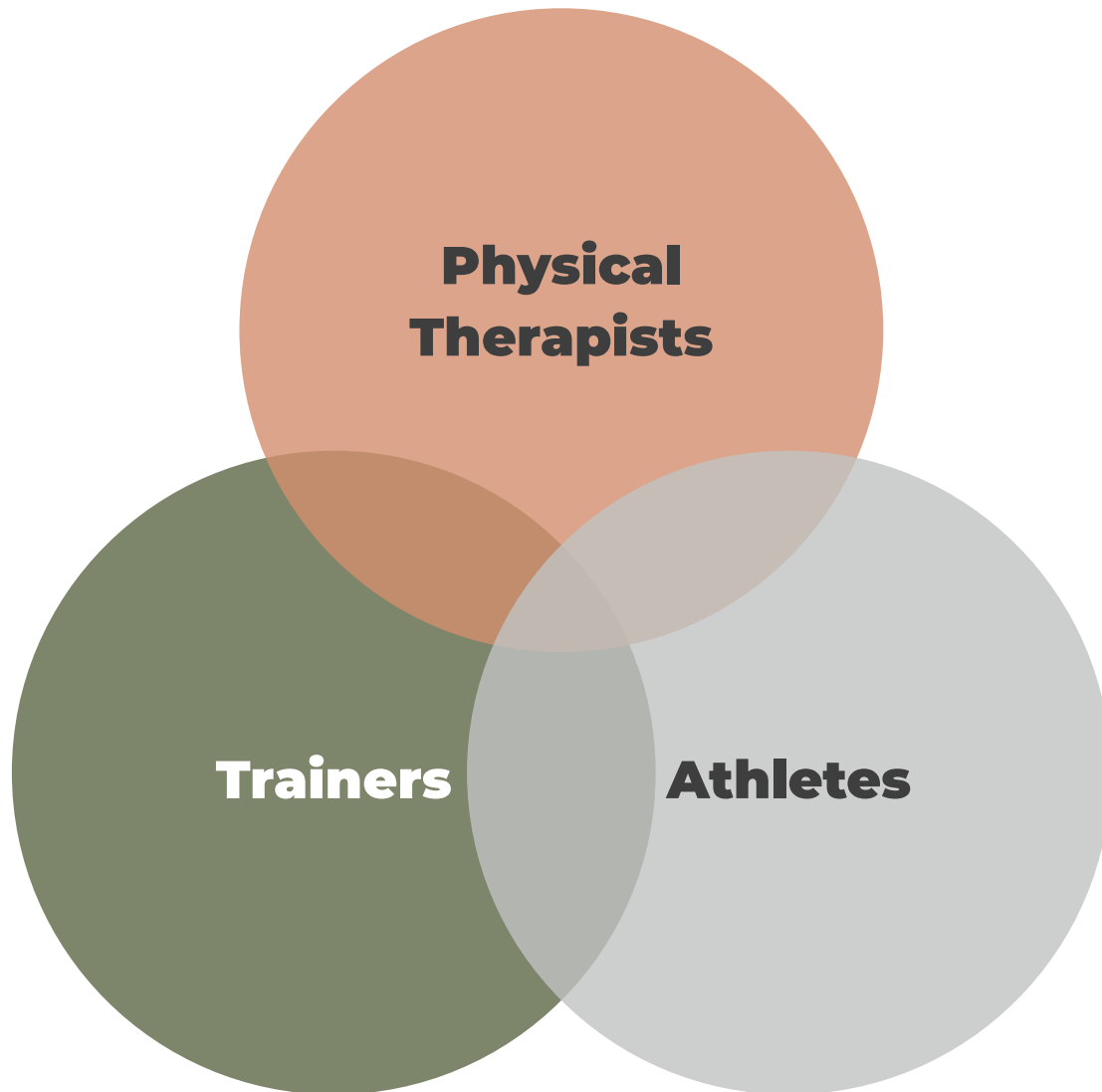


These ad hoc tools, seen with a red box around them, were an opportunity space to provide a solution. Coupled with modularity, there was a design space where pieces could serve multiple purposes. The affinity mapping helped identify exactly what equipment should be included and further explored.



*The pink boxes represent the category of overarching equipment.
The orange boxes represent the categories of specific equipment types.
The yellow boxes are used to categorize all the different pieces of particular equipment.
The green boxes represent particular capabilities of certain mobility equipment.*

Stakeholder Analysis



v

Stakeholders

1 Physical Therapists

A physical therapist is a person who holds a certification in physical therapy and is currently involved in providing physical therapy to patrons. Therapists help patients in recovery by either administering physical interventions themselves or providing a set of recommendations for the patient to perform on their own. These techniques range in a variety of methods, tools, and interventions.

2 Trainers

Trainers are persons who hold a training certification. These trainers often help people with mobility and recovery issues by recommending certain movements/products. They also often partake in these activities themselves. This category includes people such as personal trainers, CrossFit trainers (L1/L2/L3), and collegiate trainers to simply name a few.

3 Athletes

For the purpose of this research an athlete is defined as any person who is participating in and sort of physical movement whether professionally or recreationally. These persons benefit from interventions in their recovery methods if they participate.

Design Criteria

Design Criteria were created after the expert interviews, observations, and spaces were evaluated. In order to satisfy the needs of key stakeholders, numerous considerations were taken into account and the criteria was distilled from initial research.

The criteria works on a scale consisting of Must Have features, Should Have features and Nice to Have features. These criteria will eventually determine the features of the final prototypes and designs.



1

SMALLEST POSSIBLE FOOTPRINT

The novel design should be designed in the smallest possible footprint. The prototype should be cognizant of both the space in various gyms and physical therapy offices as well as consideration for traveling with the kits to offsites.

2

MORE CONFIGURATIONS THAN PIECES

The kit should contain the minimal amount of pieces to achieve the stated goal. The value should come from the configurations of said pieces in a variety of ways; therefore, the pieces should configure in more ways than pieces.

3

AT LEAST EIGHT DIFFERENT CONFIGURATIONS

At minimum, the pieces should configure into eight different arrangements. Each configuration should be unique in nature and not repeated.

4

DESIGNED TO RESIDE IN A GYM OR PT OFFICE

This kit will be designed to be placed in gyms and physical therapy offices. Overall space should be considered and an overall aesthetic should be considered.

5

HAS A CASE OR CONTAINMENT SYSTEM

Ideally, the modular kit should be self contained. The kit should have either a carrying case or containment system of some sort. This shall add value in a ease of traveling with the pieces if needed.

6

POSSIBLE ATTACHMENT TO A ROGUE RIG

Possibly the kit should contain a piece to attach a mobility piece to a rig or similar structure (even something so simple as a pole or upright structure). Thus, the kit could be utilized in the gym or on the go.

What's out there now?

As a design direction began to take shape a competitive landscape was necessary. Although research had been conducted throughout the project on recovery tools, now a closer look at modular systems and similar concepts was warranted. The following tools represent semi modular concepts in the market.

1

RADROLLER "ALL IN KIT" \$140.00

Designed as an "all in one kit" the RadRoller set includes "Roller Original, Rounds, Block, Rod and Helix." It does not have a total self containment system. Touts 100+ uses and travel friendly design. Has no modular parts other than massage stick able to run through the center of the Helix.



This system does not have a total containment piece, nor do the parts provide modular solutions. The pieces interacting together are the main massage stick can be run through the Helix for massage as well as the spheres can be left in the block. Otherwise, this was simply a variety of pieces sold together.

Benchmarking

2 KNOTTY ROLLER KICKSTARTER \$99.00

Designed as muscle recovery kit. However, there are no modular pieces. The kit includes a roller, strap, massage stick, a smooth ball, and a textured smaller ball. Touts 200+ uses and travel friendly design.

The main difference between the novel design presented in this project vs. the Knotty Roller is the modular capabilities of the pieces. Here the pieces are nested within a roller but cannot be combined to form additional recovery tools.

• 6 MUSCLE RECOVERY TOOLS •
• 1 FOAM ROLLER •



Although this might seem like the final design of this project at first glance it is not. This kit does indeed provide a similar solution to containment because they both are used as foam rollers. However, this kit lacks in parts and pieces. There are two balls and a massaging stick. These parts do not interact in any way.

What's currently available?

3 **ROGUE BATTLESTAR 2.0** **\$260.00**

The Rogue MobilityWOD BattleStar 2.0 is a “precision massaging roller” system. It is designed to be used either in the cradle or with the handles. The handles are designed to easily slip on and off of the main rod. The main draw for customers is the different diameter rollers and the “precision” they offer. This is an expensive option for a roller.



The BattleStar is a roller series to be used in the cradle or with the handles. This kit is modular in the sense of the rollers can be interchanged. However, it can only be used as a massaging stick. There are no other modularity aspects to the BattleStar. Therefore, it lacks in providing solutions to pressure point issues and other mobility needs.

Benchmarking

4

TRIGGERPOINT STK FUSION \$69.99

The TriggerPoint STK Fusion Handheld Massage Roller is representative of the interchangeable massage roller sticks on the market. The system can be used on the cradle or by putting the handles on the main rod. However, the pieces on the rod are not held in place. There are many numerous small washers which fit between the pieces and are easily lost. In addition, Includes 5 “component parts” to configure in a variety of ways.



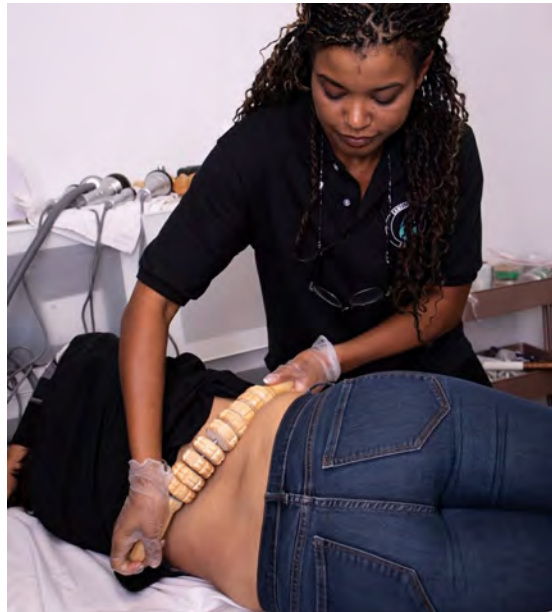
This product does provide a sense of modularity. The central pieces on the main rod can be interchanged to provide a variety of configurations. Although this system at first glance does not look like it has many parts, the rollers must have spacers in between each piece to work properly. Therefore, the 5 component parts must be accompanied by the small (easily lost) washers. It lacks in a containment system to ensure no pieces are lost as well as lacking in a way to lock the pieces into place. Finally, it lacks in any sort of pressure point pieces.

Wooden Therapy Options

1

Wood Therapy Tools \$285.00

Wooden therapy is a massage technique simply using wooden tools. This set, seen to the right and below, offers the same advantages as a similar massage roller stick but is made of wood. It comes with two large rollers, suction cup, cellulite mushroom, and a contouring board.



Unlike the proposed solution from this project, these wooden pieces are not modular. Each piece serves a specific purpose. They cannot be changed or modified. The wooden pieces are used for a singular purpose. The kit seen above does not have a containment case either.

Benchmarking

2

SculptICE Wood Therapy Tools **\$300.00**

SculptICE wooden therapy tools come in a variety of colors and assortments. This particular kit includes: a smooth roller, an engraved roller, a cubed roller, a breast swiss cup, a medium swiss cup, a medium swiss cup with roller, a cylinder, a mushroom, and a contouring table. Each piece is made of cedar wood and then is stained and painted.



Similar to the wooden therapy tools to the left, these tools all serve a singular purpose. Unlike the proposed solution, none of these pieces are modular or serve a variety of solutions. Therefore, it is different from the proposed kit because of its lack of versatility. In addition, the SculptICE kit has no container to easily transport.

The Market Opportunity

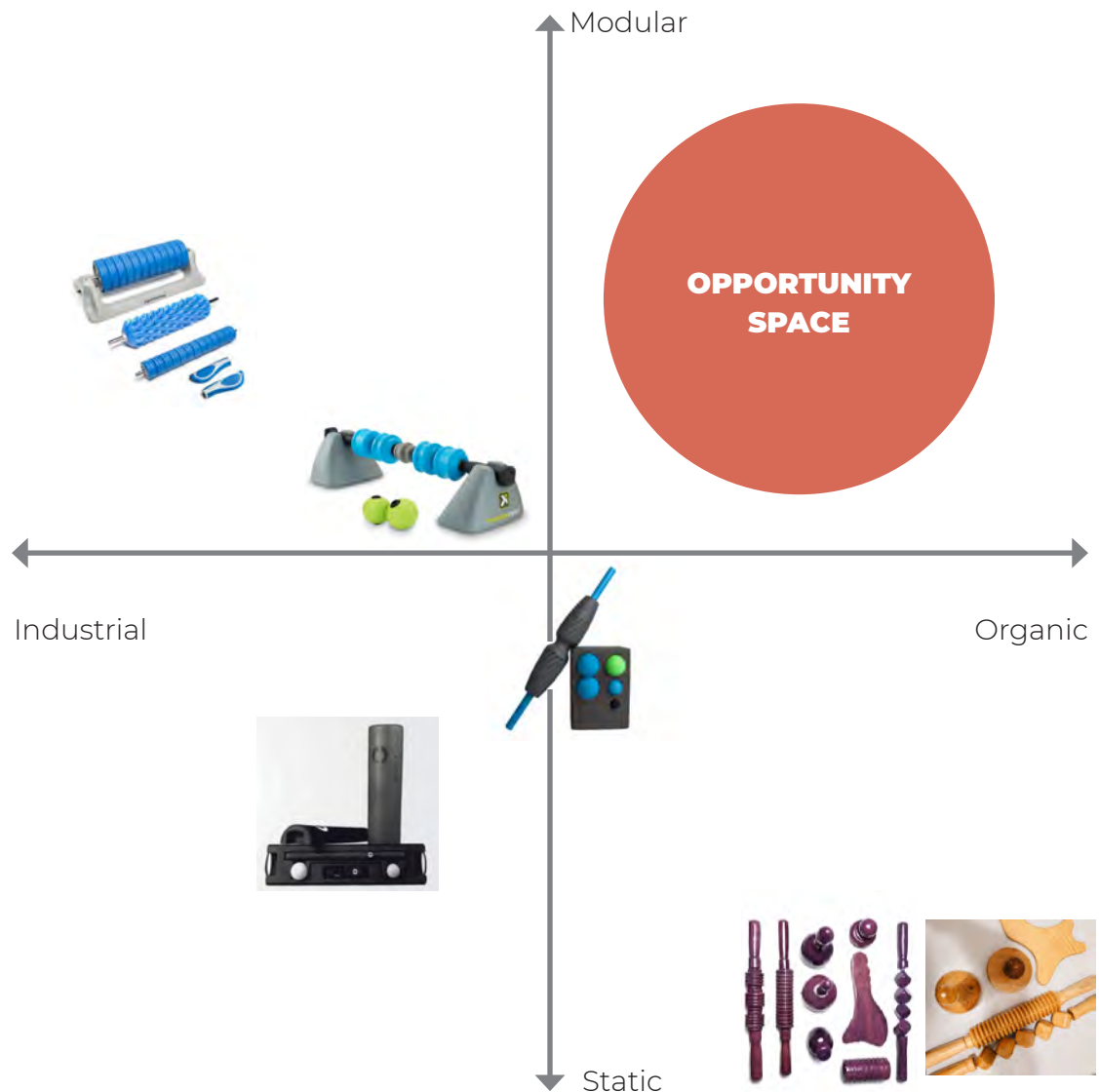
As seen on the previous pages, there are numerous solutions available on the market today. Hundreds of solutions exist in a variety of forms. However, the research reveals an opportunity space. Ad hoc solutions observed reveal the needs of consumers are not being met by current solutions.

The opportunity space identified resides at the intersection of wooden therapy tools / techniques and readily available metal / rubber / plastic solutions. Nothing available today falls into both the wooden therapy massage category and the modular/versatile category. A great opportunity to design a modular system of organic materials exists. The solutions available today are not sufficient in meeting the needs of people using them and thus an opportunity to design for these needs exists.

Seen to the right, a matrix of the most popular solutions in each category are charted.

An large opportunity space to provide a solution both organic in form and modular in function can be seen as the large circle. This project set forth to provide a solution in this space to appease the needs of stakeholders. Along the way, feedback was constantly solicited from experts to drive the direction of the product. This ensured the product was indeed fulfilling the needs of those who used it the most.

Market Matrix



A market matrix can be seen above with currently available solutions. The horizontal X axis represents form and ranges from a more industrial form to an organic form. The vertical Y axis represents the function of the product and if it is modular in nature. The range for the Y axis is static (serving only a single purpose) to modular in nature and the ability to configure in a variety of ways.

The Market Capabilities

	Number of pieces	Pressure Point Tool	Container Piece	# of Uses or Configurations
minmis	9	✓	✓	250+
Rad Roller	7			100+
Knotty Roller	5	✓	✓	200+
BattleStar	6			10+
Trigger Point	18			100+
Wooden Therapy	5			25+
SculptICE	9			25+

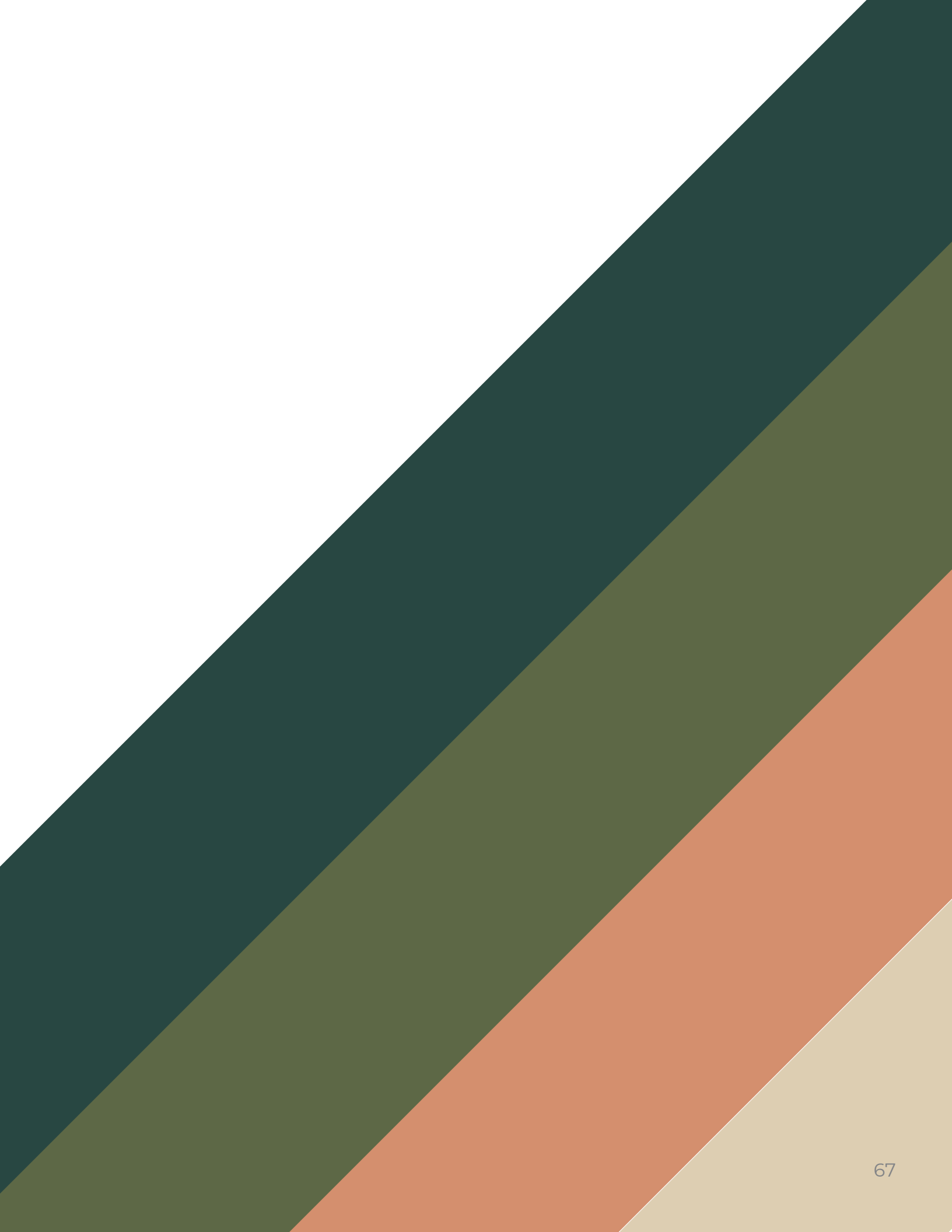
Comparison Matrix

Exploring the different aspects of each product side by side allowed for a visual representation of the different capabilities of the market players. Seen below, a matrix compares the various aspects of each product offered. In doing so, it became apparent minimis checked every single box where other solutions fell short. It provided a solution to every category; whereas, the other mobility solutions only provided certain product elements or limited solutions.

	Travel Friendly	Massage Stick	Contains a Band/Strap	Mobility Balls	Modular in Use
	✓	✓	✓	✓	✓
		✓		✓	✓
	✓	✓	✓	✓	
		✓			✓
		✓			✓
		✓			
		✓			

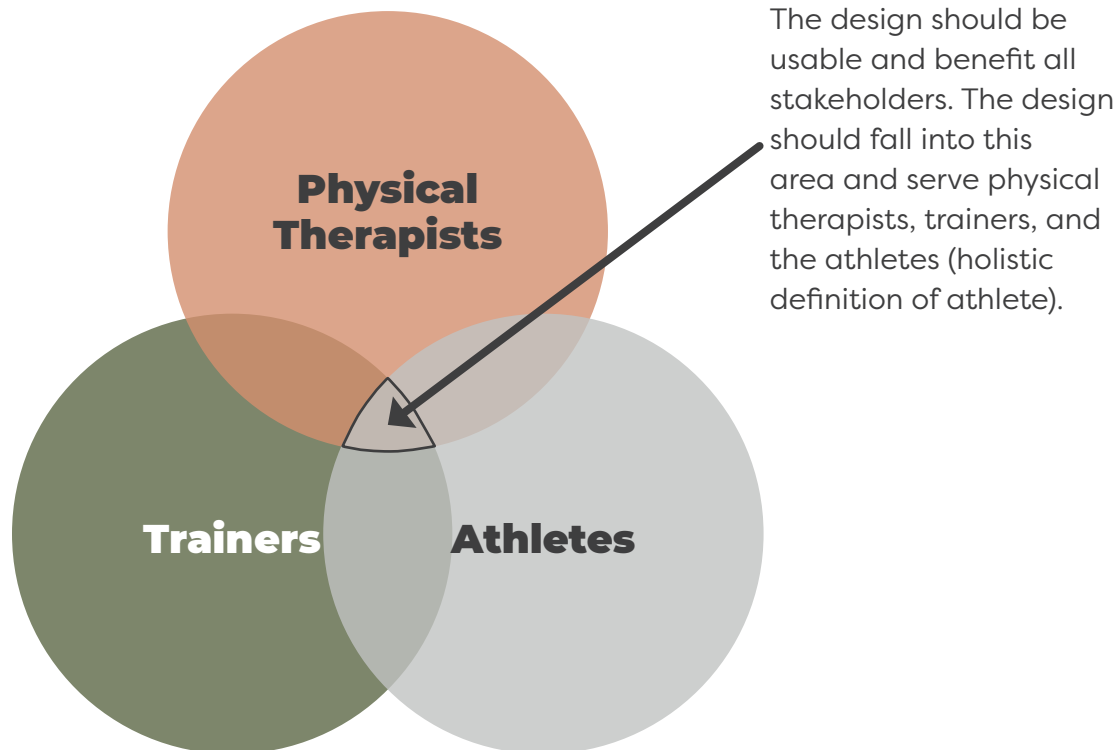
PART 05

DESIGN



Design Opportunity

Taking into account the feedback and observations from the experts the design opportunity was distilled into one key statement (seen to the right).



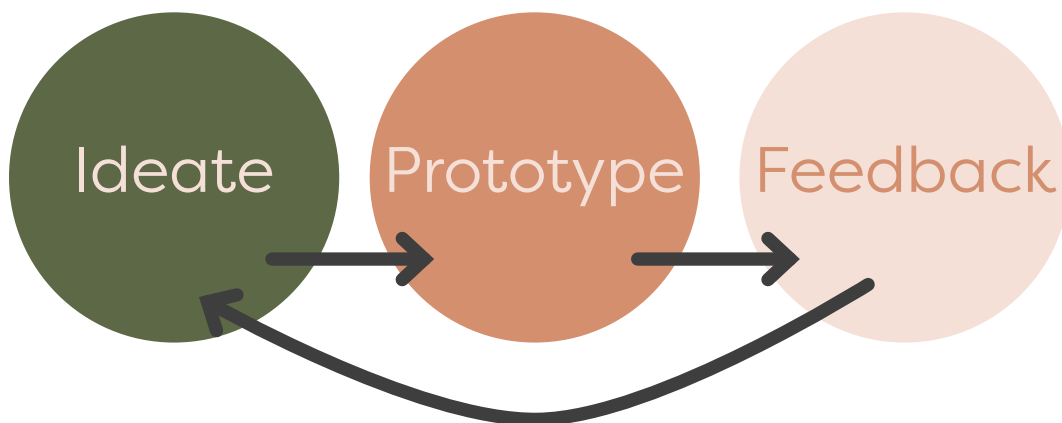
IS
MODULARITY
VALUABLE IN
A PHYSICAL
THERAPY
RECOVERY
SETTING?

Ideation and Prototyping

With a traditional approach to industrial design, ideation and prototyping of various fidelities were used to develop the project direction. Rapid ideation sketching created numerous sketches which then led to prototype concepts. The inspiration for the sketches was drawn from the Velcro kit modeling sessions. Lower fidelity prototypes were initially created to understand the form and function of different parts of the product. Each iteration, the models were taken to experts in the field for feedback to stay true to nature of the participatory model of design.

The most well received ideas and aspects of the prototypes were then iterated on once again and refined. This cycle continued throughout the design process.

The expert feedback on the concepts was vital for the creation of more refined concepts and modifications to ensure the needs of the users were being met. For the purpose of evaluation, **value** was defined as providing utility to the participant. **Utility** meaning the ability to be useful and provide satisfaction over other readily available options today.



IDEATION

● Prototype 01



● Prototype 02



● Prototype 03



● Prototype 04



● Final Prototype



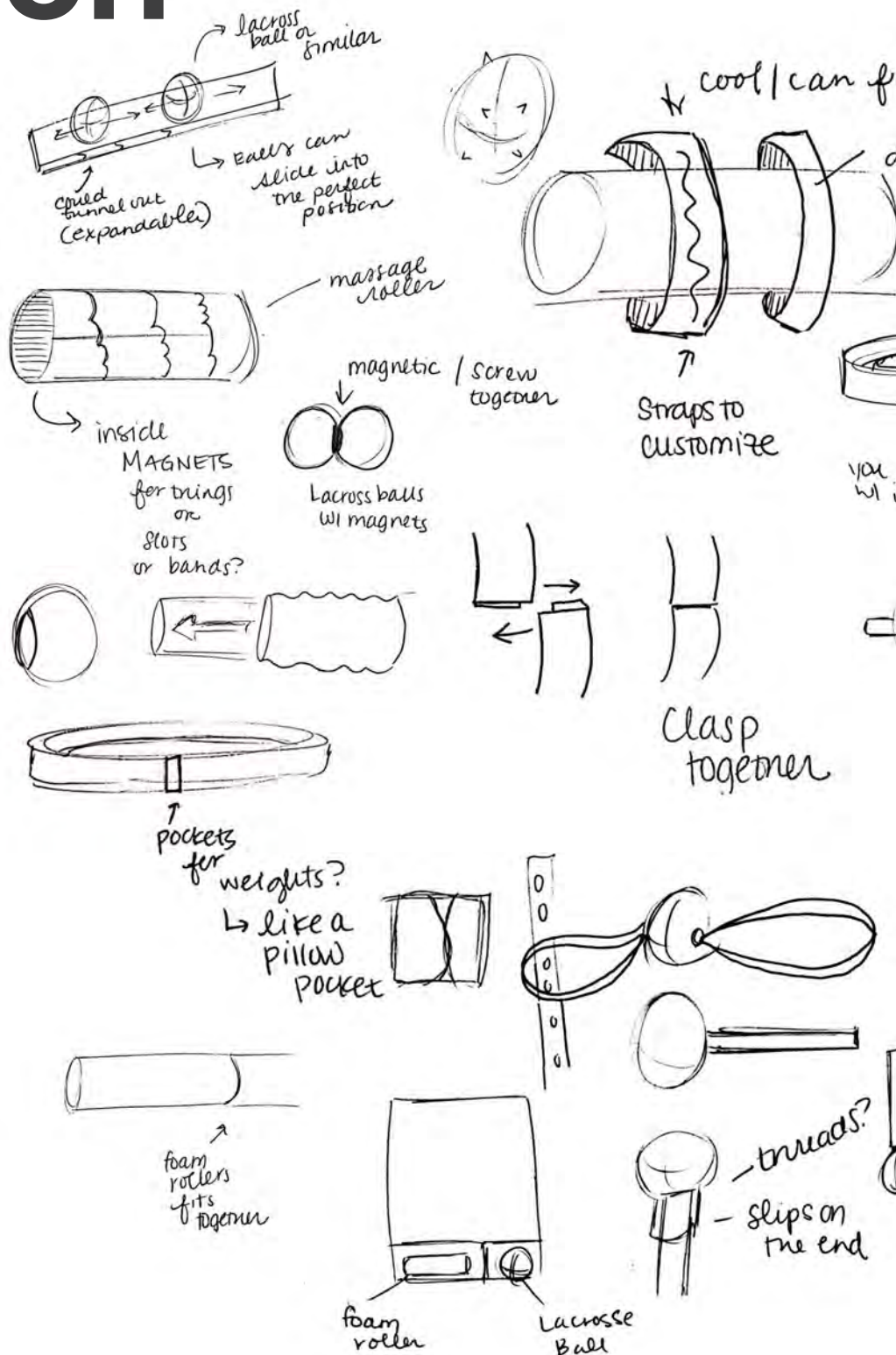
Ideation

Multiple sketching ideation sessions were conducted in order to rapidly create ideas and form factors. The original sketches were created using pen and paper and were then digitized.

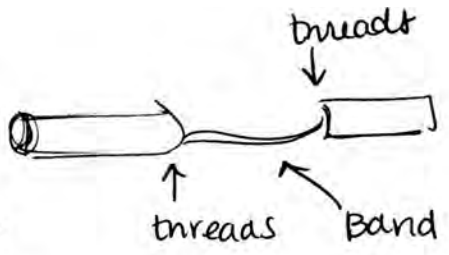
Considerations of the identified baseline mobility equipment was taken into account for these initial sketches. This equipment included items such as foam rollers, lacrosse or similar balls, bands, or a rig.

Over 50 initial sketches were rapidly created with the idea of refinement and subsequent improvement of consideration at a later stage of the design process. These sketches served as a starting point to identifying key factors to creating a mobility kit.

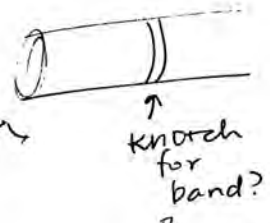
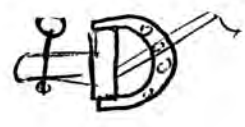
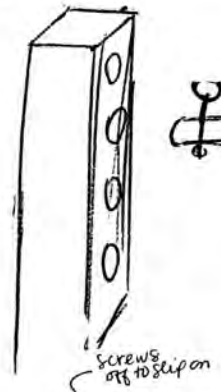
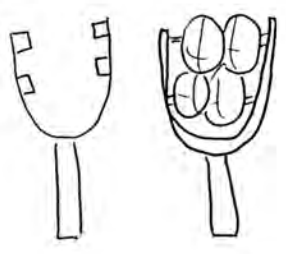
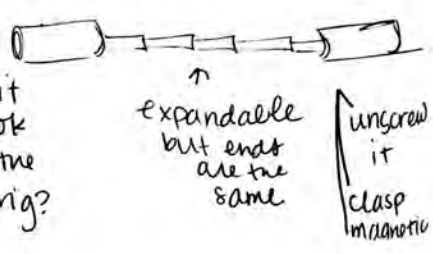
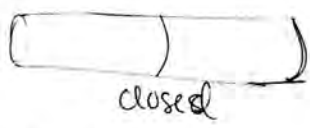
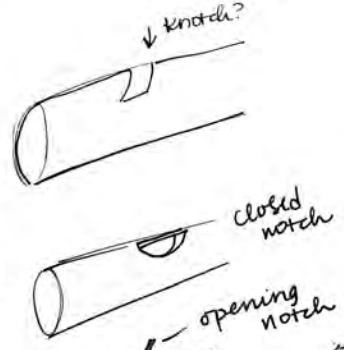
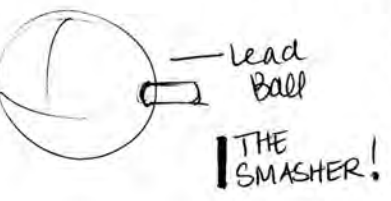
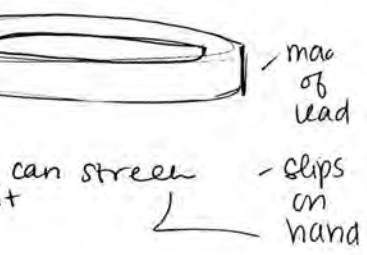
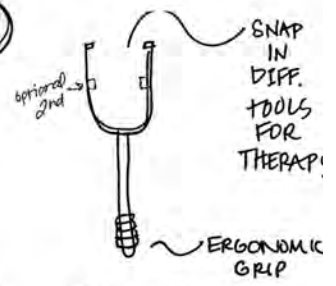
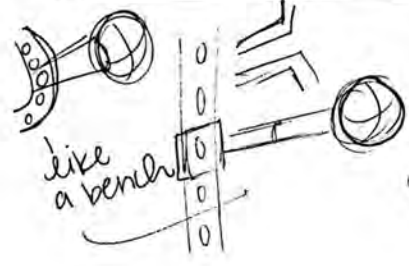
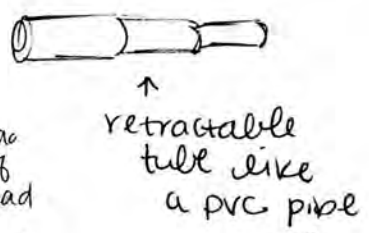
Sketches will be translated into numerous prototypes of increasing fidelity over the course of the project.



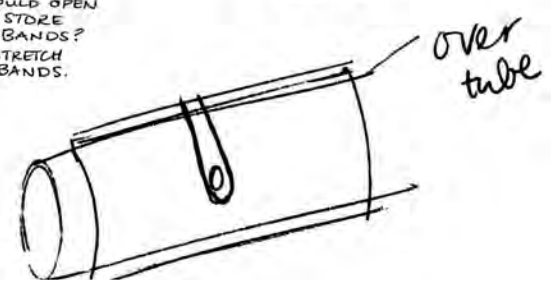
freeze
different textures? materials



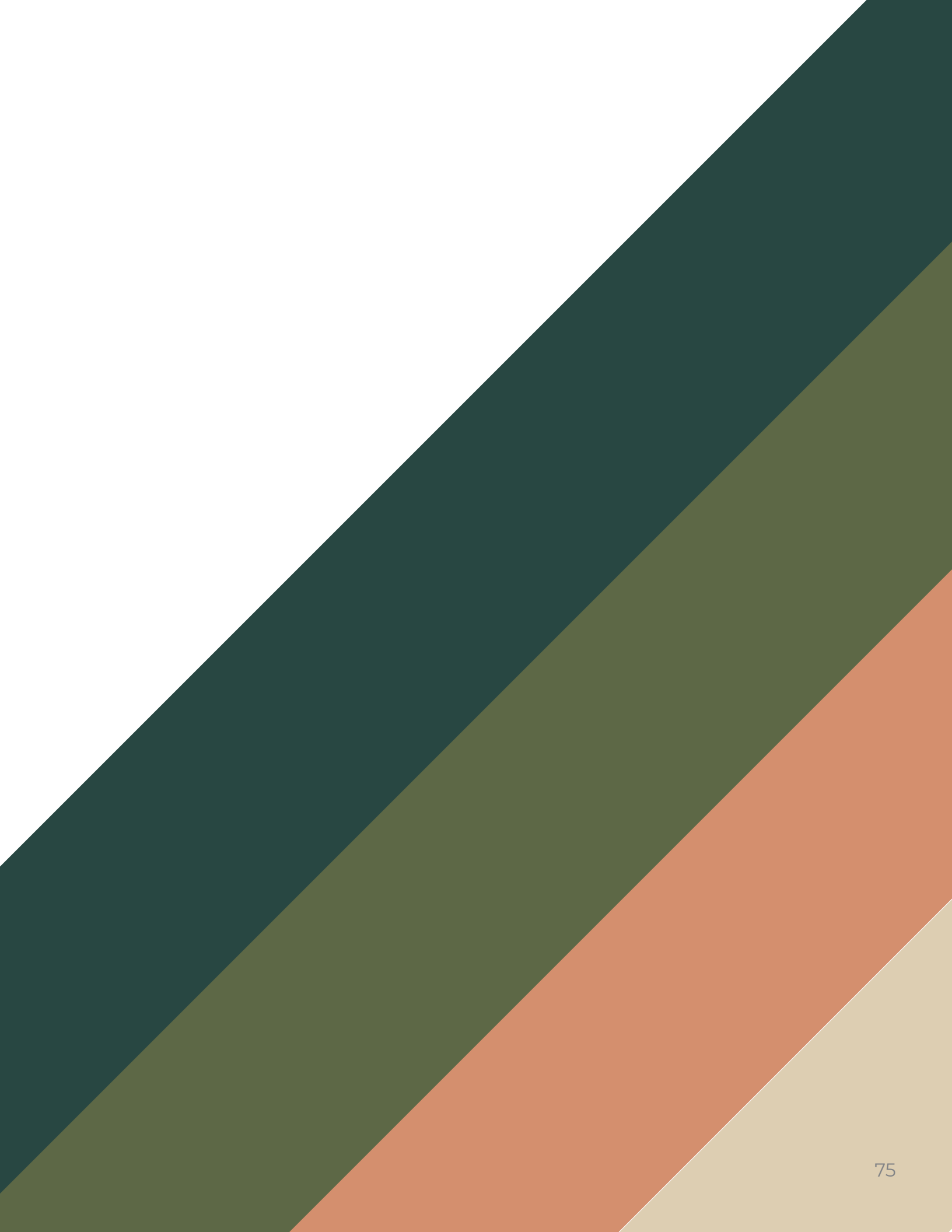
KEY IS BALL w/ attachment
— point —



* - spiked balls
□ - rollers
● ● - Balls - Various sizes



PART 06 PROTOTYPE & BUILD



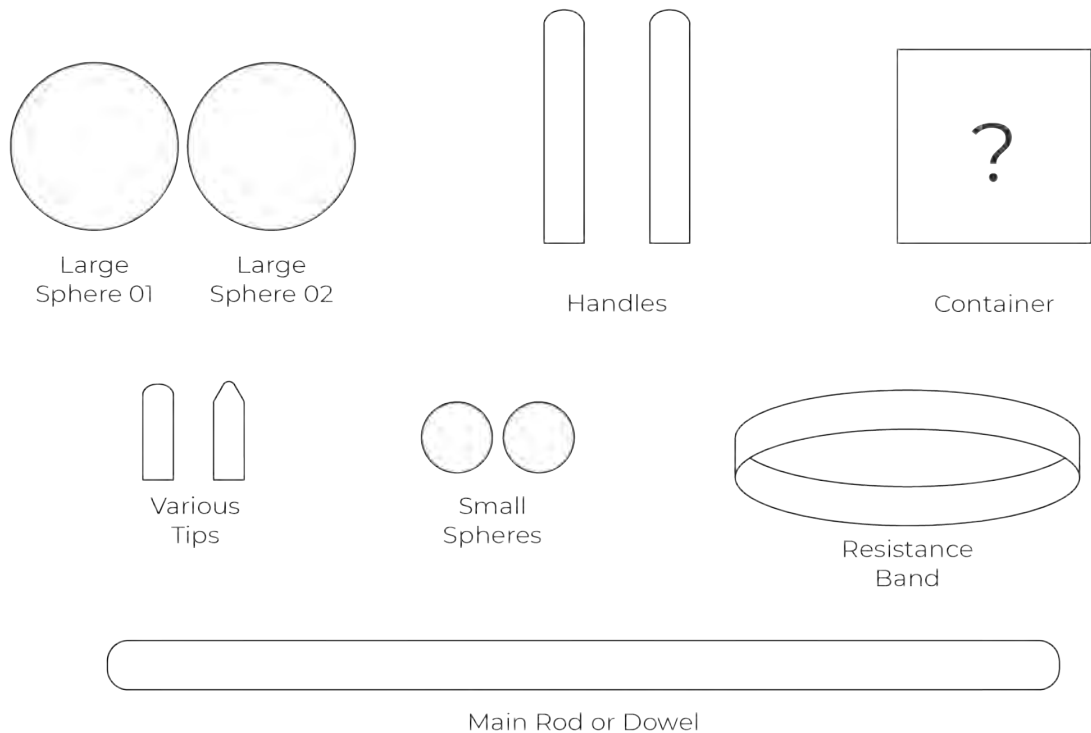
Configurations & Pieces

A list of configurations to achieve was made in order to keep the product direction on track. This took into account the design criteria, but most importantly the models created by

participants in the Velcro modeling sessions. As the research continued, this list was referenced to see how the product evolved to achieve each of these design configuration parameters.

- 1 Configuration of a large peanut shape
- 2 Configuration of a smaller peanut
- 3 Interchangeable or variable tips for pressure/trigger point work
- 4 A set of handles for ease of rolling main rod
- 5 A main rod to configure pieces in a variety of ways
- 6 Containment Piece

Pieces Needed



Seen above were the basic necessities for the design. These were the maximum number of parts needed to achieve the criteria identified previously. As the project evolved the parts refined in design. During prototyping and

refinement, some of the parts were combined to limit the overall number of pieces. This did not compromise the overall functions of the pieces but rather allowed them to serve multiple purposes.

Prototype Number 01

The participant models coupled with the expert interviews informed the direction of the design of Prototype 01. The ideation served as the starting point for the low fidelity prototypes seen on the opposite page. It incorporated a smaller “peanut” of two small wooden balls adjoined by a wooden dowel. The small peanut then sits inside a Styrofoam ball to form a larger “peanut.” The larger

peanut, made of the Styrofoam balls is held together by both Velcro and the smaller wooden peanut. This allowed the exploration of attachment methods of the larger spheres. A channel was also drilled through the middle in order to see the form and function of a dowels ability to run through the center and be used as a handle.

Benefits

- Use of both internal and external components of the prototype
- Compact size and no additional parts to attach the main spheres
- Space and proportion gave users the feel of the product

Opportunities

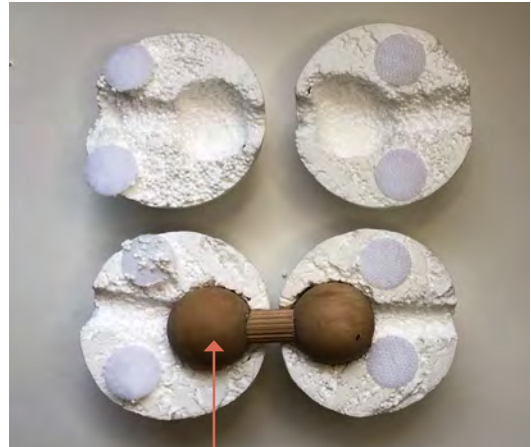
- Participants wished to be able to actually apply pressure the spheres and were limited by the material (Styrofoam)
- The spheres are sliding around on the roller and do not maintain their desired position

Prototype 01

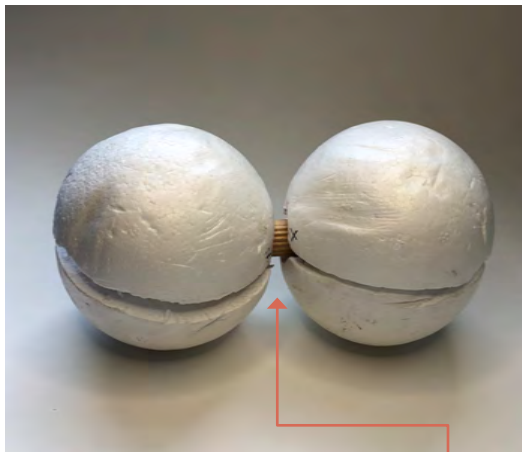
Velcro dots for attachment



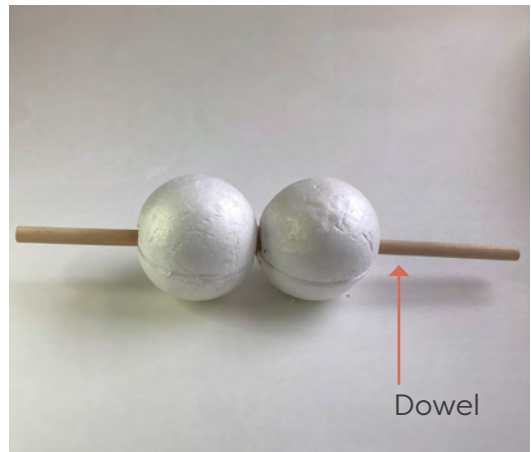
The design of nested objects was intentional to understand the form and function of the different pieces forming the basis of the mobility kit.



The smaller peanut serves at the core stabilizer of the larger spheres.



Smaller peanut can be seen here in the center of the two larger spheres forming the larger peanut.



The channel through the middle allowed the observation of how a dowel rod could maneuver through the center of the spheres.

Prototype 01 Configurations

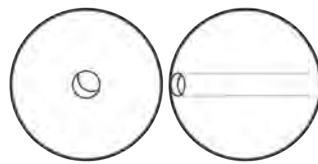
Prototype 01 introduced the two main spheres made of Styrofoam, the smaller wooden peanut, and a wooden main rod. This achieved the configurations and pieces seen below from the prior list. In addition,

this allows for individual uses of some of the pieces such as the larger sphere. It could be used on its own without any additional equipment for rolling out muscles and targeting specific areas. This was true of the smaller peanut too.

- 1 Configuration of a large peanut shape
- 2 Configuration of a smaller peanut
- 3 Interchangeable or variable tips for pressure/trigger point work
- 4 A set of handles for ease of rolling main rod
- 5 A main rod to configure pieces in a variety of ways
- 6 Containment Piece

Parts & Uses

Parts



Large
Sphere 01

Large
Sphere 02

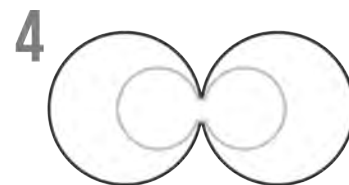
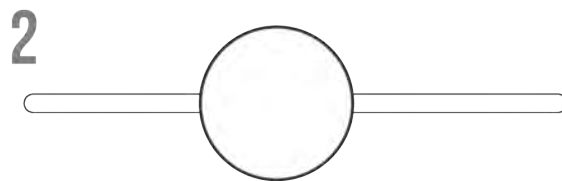
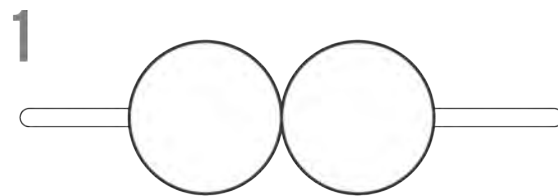


Small
Peanut



Main Rod or Dowel

Sample Configurations & Uses



Prototype Number 02

Prototype 01 was taken into consideration when designing the subsequent version Prototype 02. The participants provided feedback of the desire to be able to actually use the “peanut” in order to more properly evaluate the design. Therefore, the decision to move to an actual lacrosse ball was made.

Prototype 02 keeps in mind modularity and the ability to connect different kit pieces to each other to create unique mobility pieces. Therefore, a smaller wooden “peanut” was crafted to have a quick connect metal piece to facilitate multiple variations of the pieces to the kit.

Benefits

- Use of both internal and external components of the prototype
- Quick connect gives option to place ball on the end of a dowel to use by itself
- Utilized for both the “peanut” solo shape as well as the “peanut” on a roller configuration

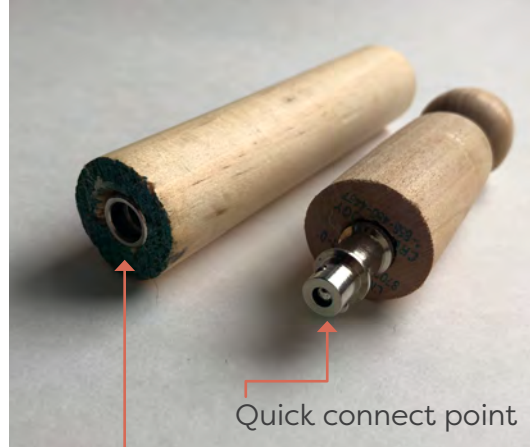
Opportunities

- Main spheres should not have to break apart for attachment
- The spheres slid around on the roller and did not maintain their desired positions
- Quick connect was difficult to disconnect and did not provide enough stability for the experts

Prototype 02



Quick connect/disconnect piece of the small inner peanut. This allows for a disconnect of the inner peanut.



Connection point on a handle attachment. This allows for the variation of different tips for pressure point work and release.



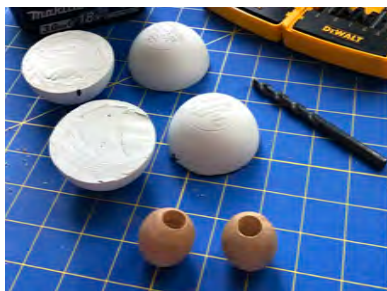
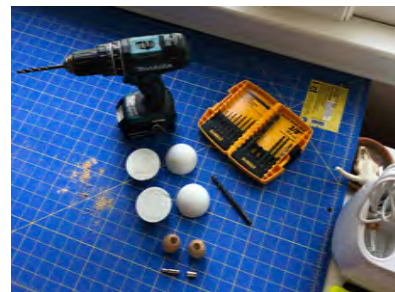
Wells and small dowel rods serve as a stability factor in order to keep the lacrosse balls firmly together.



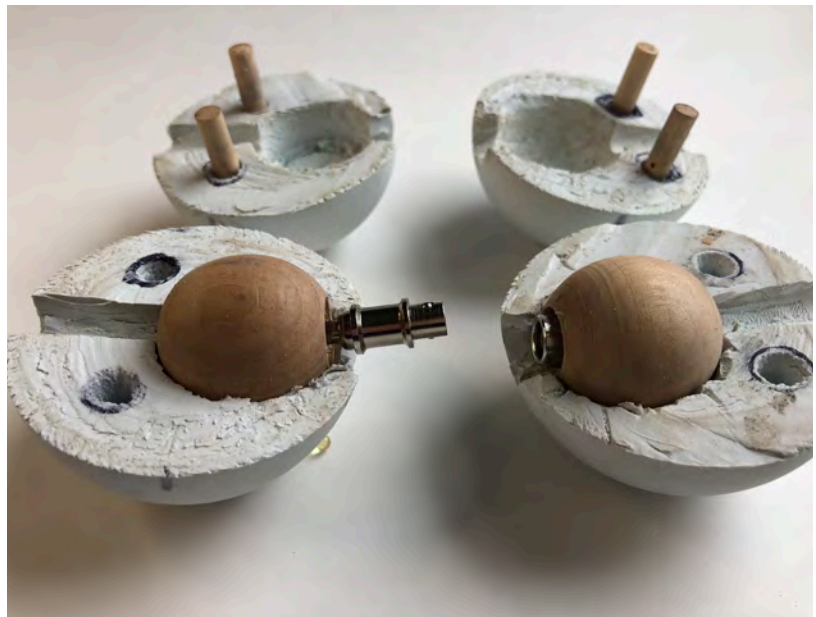
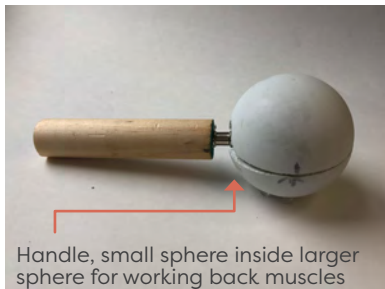
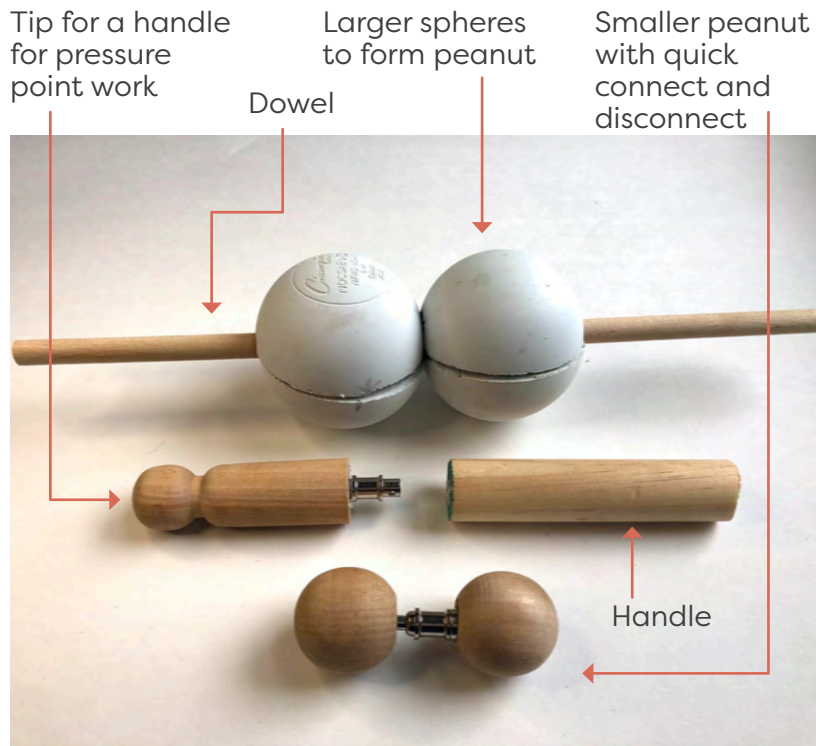
In this iteration, lacrosse balls were used for the first time.

The creation of Prototype 02 involved cutting a lacrosse ball in half. A sharp kitchen knife produced the cleanest cut. A Makita impact drill was used to drill a 1/2" hole directly through the lacrosse ball. Finally, a Dremel tool was used to smooth out the channel and create a sphere cavity for the internal smaller "peanut."

The inner "peanut" was made from wooden balls adjoined by a quick connect metal piece for modularity. The quick connect component can be disconnected to enable various tips to be used for various configurations of the pieces. The channel through the center of the lacrosse balls allows for the roller dowel to be utilized.



Prototype 02



Prototype 02

Feedback

- 1 Participants enjoyed the interchangeable tip idea but not the exact execution; they wanted pieces to have more configurations
- 2 The lacrosse balls are an improvement over the Styrofoam but are slightly harder to put together
- 3 Participants enjoyed being able to actually use the spheres so this material or similar should be used in the future
- 4 The smaller peanut disconnect system needs to be improved because it is hard, if almost impossible to disconnect



To the left, the participant struggled to take the smaller peanut apart to use it in the interchangeable pieces. This should be improved upon as noted in number 4 listed above.

Feedback Prototype 02



Below, the participant put the two halves of the lacrosse ball together to assemble into a peanut shape. They noted future products should be once piece and not two halves for fear of coming apart during use.



As seen above, the participant explores the interaction between the smaller peanut and a single lacrosse ball.

To the right, the participant takes out the smaller peanut. They then explored the uses of the smaller peanut and using the interchangeable tips.



Prototype 02 Configurations

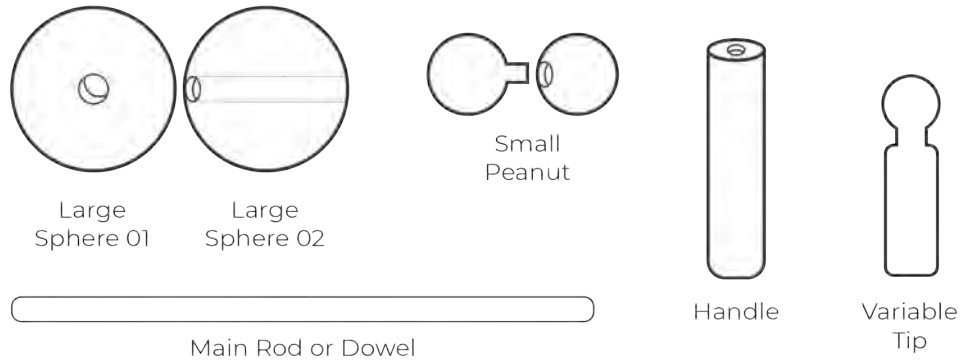
Prototype 02 introduced a quick release connection. Along with this, a handle was introduced to be able to configure pieces in numerous ways to try and achieve an interchangeable system of parts. Noted in the

feedback, this system was flawed and needed to be addressed differently. On the opposing page, you can see the parts of the system as well as sample configurations and uses of the parts.

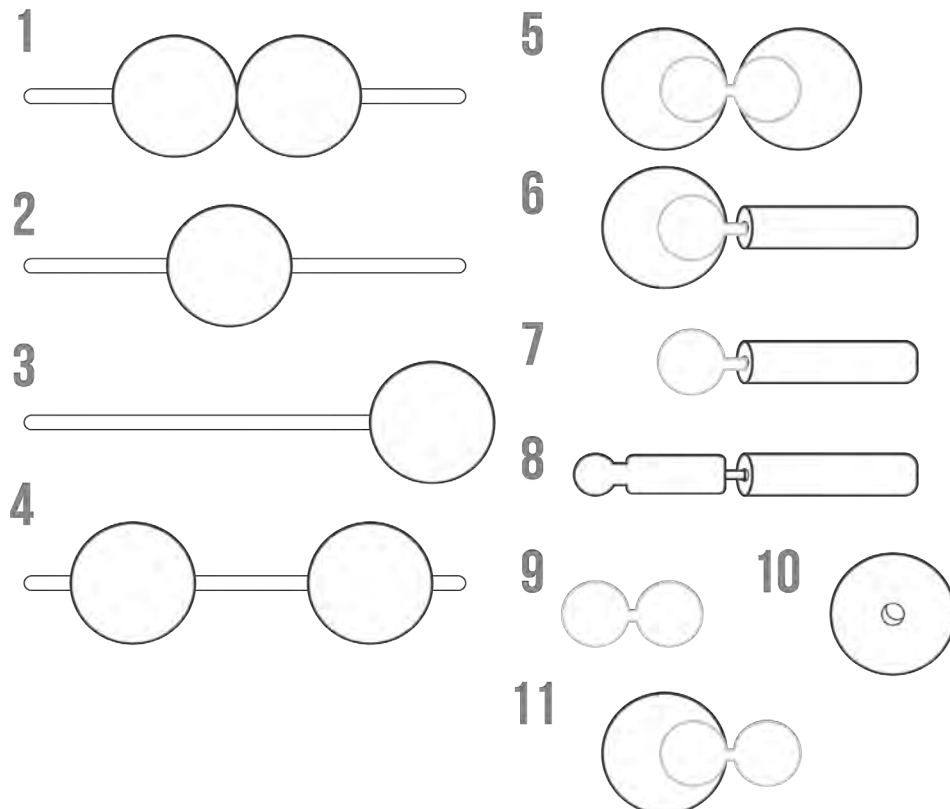
- 1 Configuration of a large peanut shape
- 2 Configuration of a smaller peanut
- 3 Interchangeable or variable tips for pressure/trigger point work
- 4 A set of handles for ease of rolling main rod
- 5 A main rod to configure pieces in a variety of ways
- 6 Containment Piece

Parts & Uses

Parts



Sample Configurations & Uses



Prototype Number 03

Feedback from subject matter experts, both trainers and physical therapists defined the direction of the development of the Prototype 03. Still staying true to the participatory design process, it was ensured the direction of the product followed the feedback from the experts. Their feedback was invaluable to this research. In this iteration, a foam roller was cut in half using a bandsaw. It was then carved out to form a cavity where all the kit pieces could fit. Three neodymium

magnets allowed for a solid closure. The participants indicated a desire for a way for the main sphere to be “locked in” on the dowel for a solid base for rolling muscles. Therefore, a ball catch was inserted into the lacrosse balls to create a catch for the dowel grooves.

The decision to alter the ends of the handles to accommodate wooden balls was made in order to eliminate additional parts. This way, the handles can be used as trigger point accessories as well.

Benefits

- Introduced a containment apparatus for all the pieces
- The ball catch provided enough resistance for the participants to actually use the rollers
- Experts stated they liked the use of a foam roller - could be used for multiple purposes

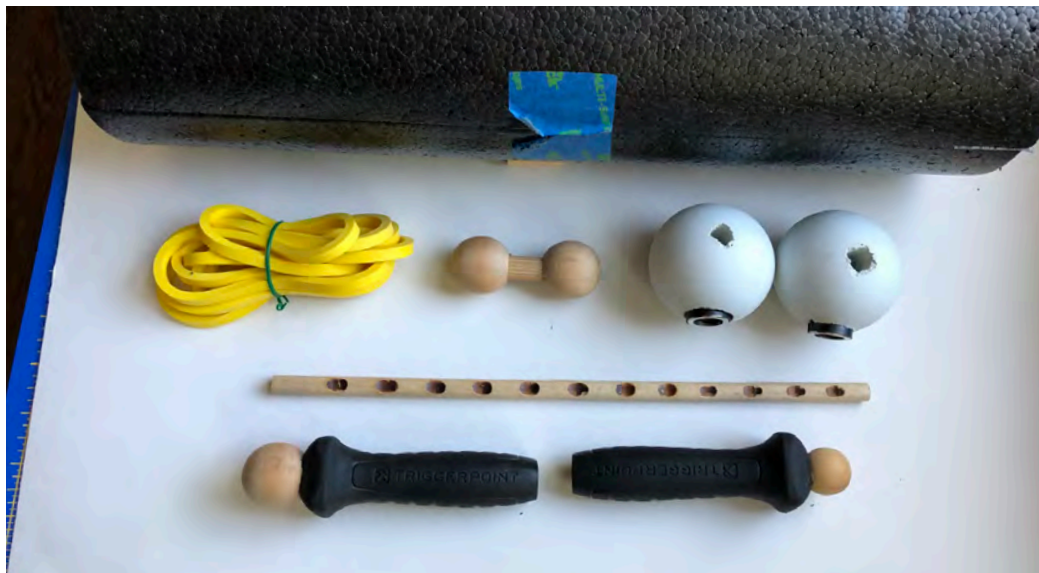
Opportunities

- A thicker mobilization band should be used in the kit
- A larger diameter dowel rod would make it more useful
- More structure should allow for utilization of the foam roller itself in the prototype

Prototype 03

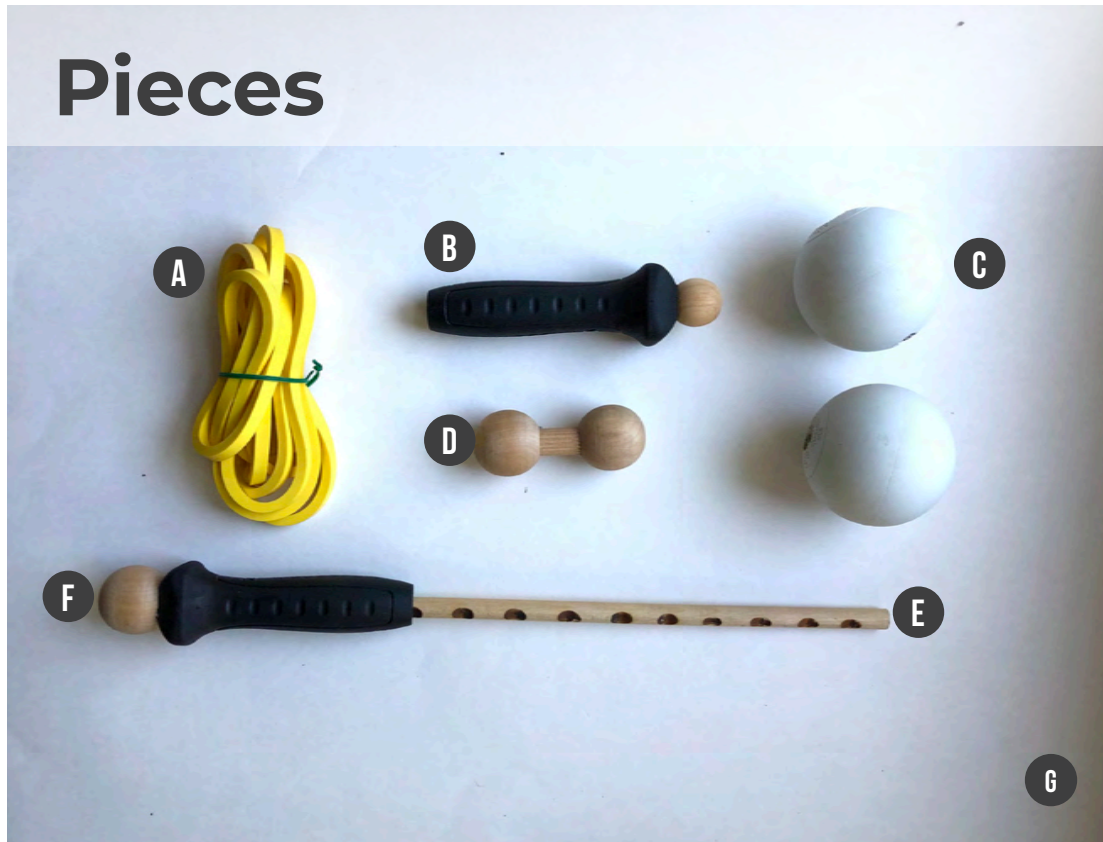


The kit with contents in the internal cavity



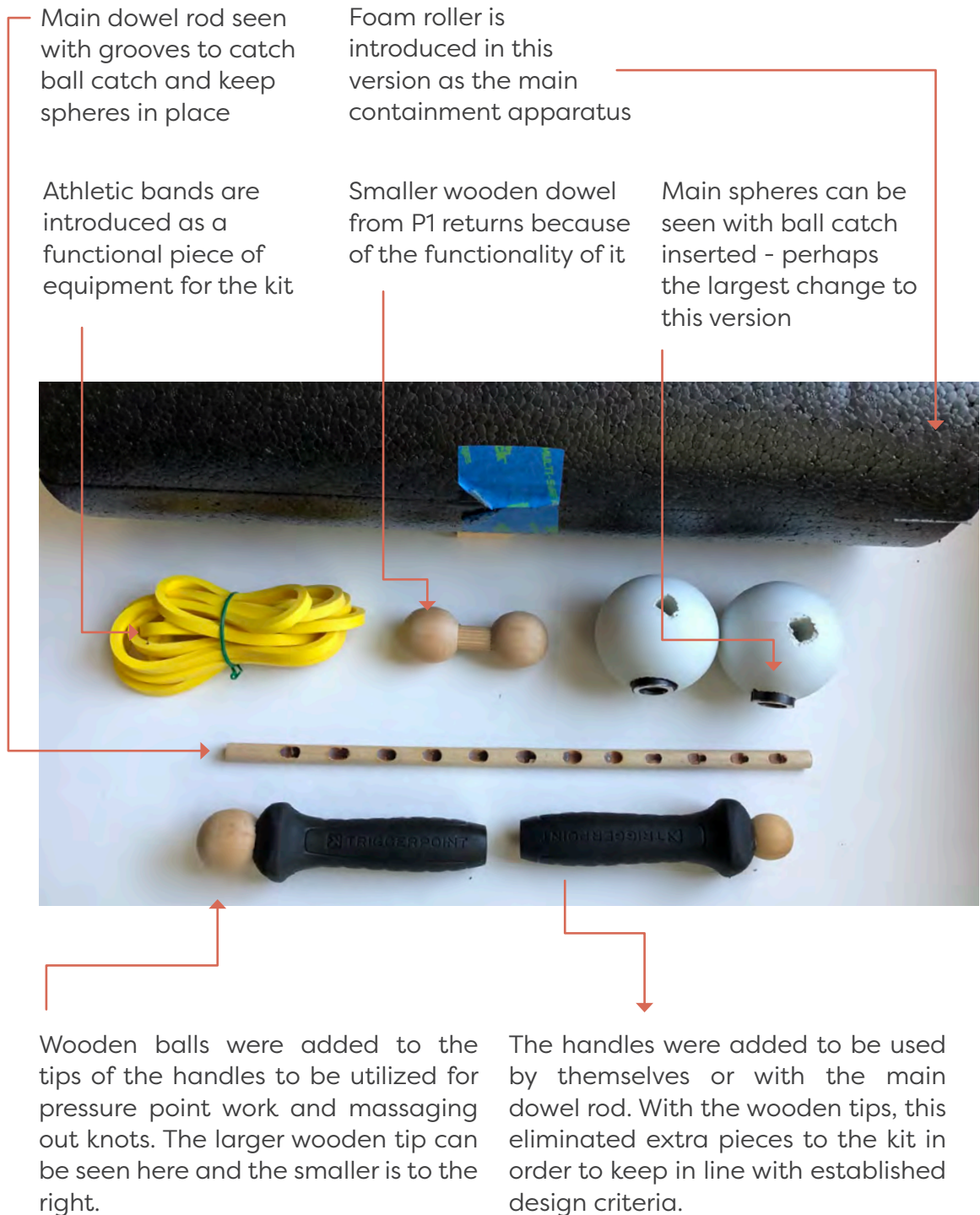
The kit with contents outside of foam roller containment apparatus

Pieces



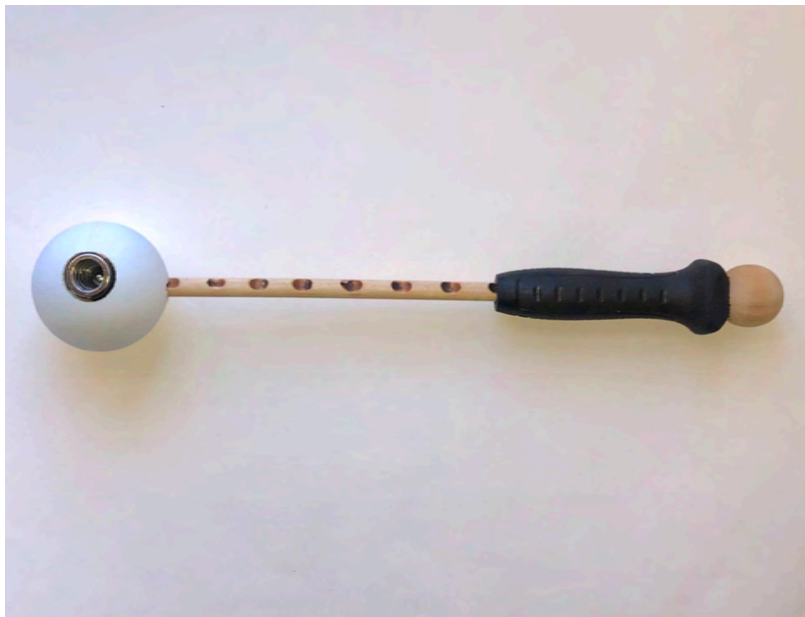
- A** Athletic band used for stretching - usually used by itself but can be used in tandem with larger spheres
- B** Rubber handle with smaller wooden ball tip for deep muscle massage or rolling with main dowel
- C** Main larger sphere lacrosse balls to be used by itself or in tandem with dowel/other sphere/band
- D** Small peanut to be used by itself to massage muscles deeply (due to small size)
- E** Main dowel rod can be used by itself or with handles/large spheres; grooves can be seen which worked with the ball catches
- F** Rubber handle with larger wooden ball tip for muscle massage or rolling with main dowel
- G** Not pictured is the foam roller containment system held together using magnets

Prototype 03

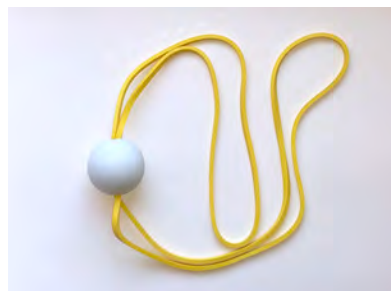


A ball catch inserted into the lacrosse ball provided a significant change to this version. A Dremel tool was used to create grooves on the rod for the ball to catch. The experts provided feedback this was “clever” and they liked the ability to lock the spheres in place. However, they voiced they wanted to be able to lock the spheres in order to use more force.

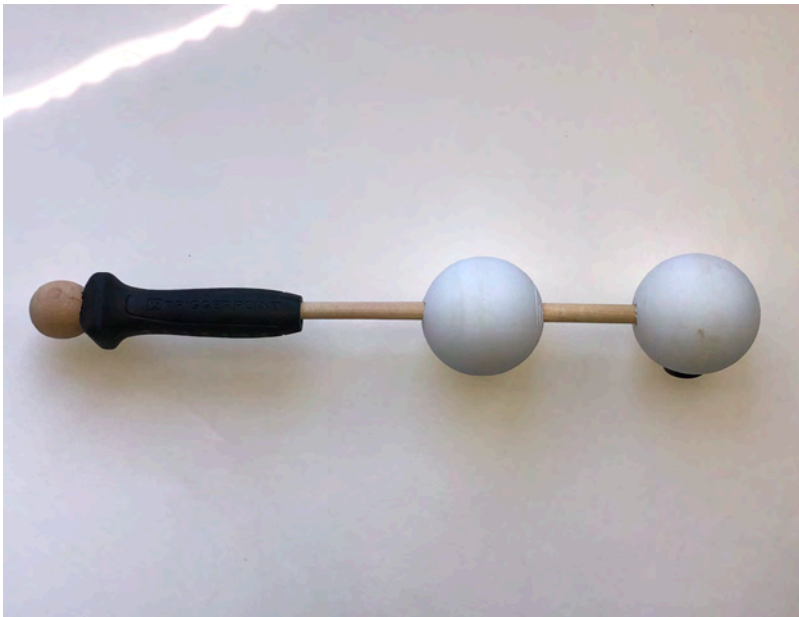
Handles from another mobility device were utilized for the kit in order to prototype the form concept. The ends of the handles were chopped off in order to accommodate two different diameter wooden balls. The handles and dowel could then be used for trigger point therapy. This iteration allows for multiple configurations of the items.



To the left you see an alternate configuration of pieces. As seen here, the handle is placed on one end of the dowel with a sphere placed on the opposite end. This allowed the participant to roll out particular areas.



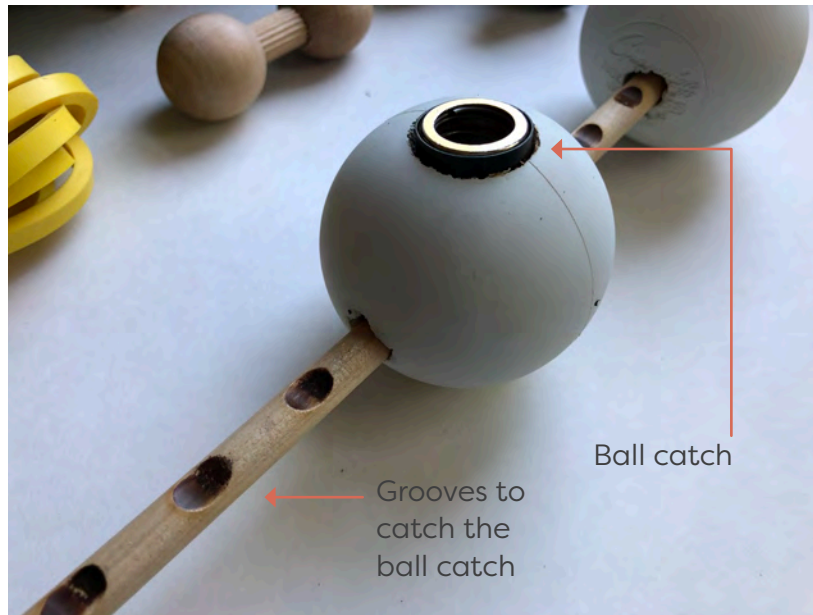
Prototype 03



Directly to the left, one can see the configuration of two spheres, the main rod and one handle. This configuration was used to roll out muscle groups such as the hamstrings, or back muscles. The handle provided the participants the ability to move the spheres into the exact position wanted. It was expressed in the feedback often it was hard to get a lacrosse ball into the exact spot one wanted - this helped remedy this issue.



Seen directly above, a channel through the center of the lacrosse ball allows the dowel to pass through. In the center, the ball catch "grips" the indentions on the dowel providing a sturdy "grip."



Prototype 03

Feedback

- 1 A locking mechanism is needed for the main pieces to ensure their stability under the stress of use
- 2 A set of directions or additional configurations would be helpful for the kit in both text and figures
- 3 The band resistance (size) should be increased
- 4 There should be a smaller rod for the configuration of the main “peanut” consisting of the lacrosse balls
- 5 The attachment of band and ball needs to be explored more; however, feedback was this would not detract from the overall value of the kit as a whole (sparsely used)
- 6 An enforcement of the main containment foam roller should be explored for the use of a single half for calf stretches
- 7 The physical therapists and trainers were overall excited to try the kit and enjoyed configuring the pieces together in a variety of ways

Feedback Prototype 03



To the left, the trainer can be seen utilizing the main dowel rod, the two lacrosse balls to form the “peanut,” and both handles to roll out his quad muscles. Below you can see the rolling motion.



To the right, a trainer can be seen utilizing half of the foam roller container to perform a calf stretch. Feedback from the trainer included more stability of the half of the container/roller to ensure it is strong enough under the pressure and weight of the use.



Prototype 03

Feedback



The participant can be seen utilizing the smaller wooden peanut to roll out the bottom of their foot.

Below, the participant changes the configuration of the sphere by sliding them on and off the rod. They stated they enjoyed the catch of the spheres and their inability to move.



Feedback Prototype 03



Here the therapist “locks” one of the larger lacrosse balls onto the end of the main rod and uses it to help in the trapezius and delt muscle areas.

Directly below the end of the handle is used to massage the forearm.



A handle is utilized for a pressure point and to release a tight muscle. It was suggested it could also be used to help mobility while the participant stretches, particularly in the pectoral muscle group to encourage muscle release for mobility.



Prototype 03 Configurations

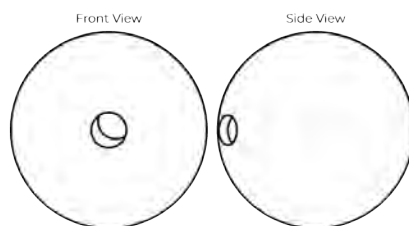
Prototype 03 addresses all of the points introduced in the beginning of prototyping. The introduction of a containment system and a band are considerable differences and help to address the items listed below. On

the opposing page, you can see the parts. In this version the handles also serve as trigger/pressure point pieces and therefore the decision was made to eliminate additional tips.

- 1 Configuration of a large peanut shape
- 2 Configuration of a smaller peanut
- 3 Interchangeable or variable tips for pressure/trigger point work
- 4 A set of handles for ease of rolling main rod
- 5 A main rod to configure pieces in a variety of ways
- 6 Containment Piece

Parts

Parts



Large Main
Sphere 01

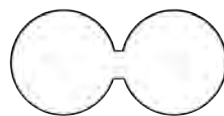
Large Main
Sphere 02



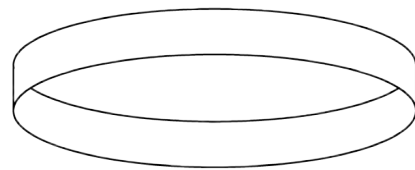
Small Tip
Handle



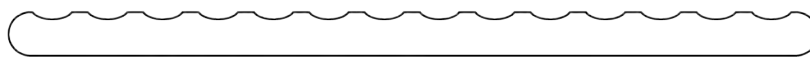
Large Tip
Handle



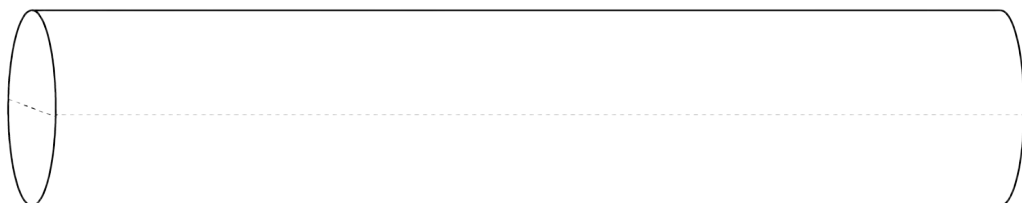
Small
Peanut



Resistance
Band



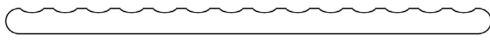
Main Rod or Dowel



Foam Roller / Container

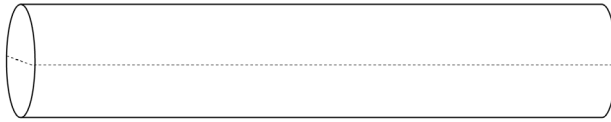
Configurations

1



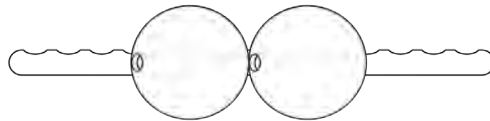
Use the rod for a firm roll-out of muscles

2



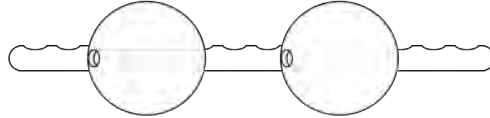
The foam roller as one piece can be used for rolling out any part of the body

3



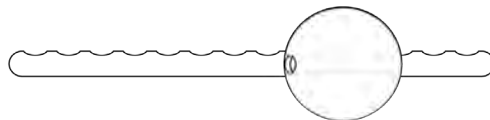
A peanut shape on the main rod used for rolling out back muscles, hamstrings, quads and so much more

4



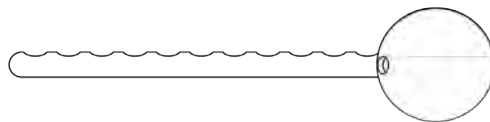
The spheres can be separated into a variety of positions along the rod

5



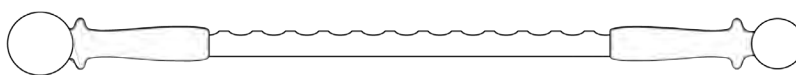
A singular sphere allows the massage of hard to reach areas while having control of where the ball sits

6



A singular sphere on the end of the rod can reach areas of the back otherwise inaccessible

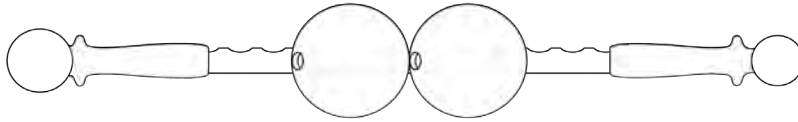
7



The rod can be used with or without the handles for rolling out muscles and targeting parts of the body

Sample Configurations

8



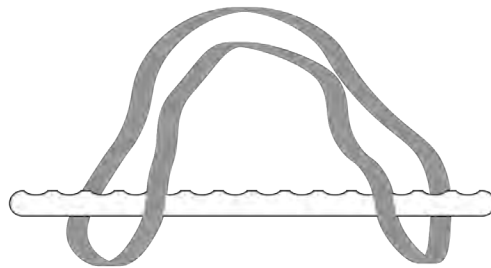
The peanut shape can be used with the handles on the rod or without

9



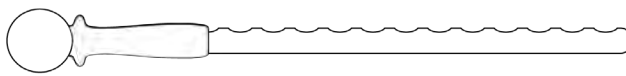
Use the top half or the bottom half of the foam roller to stretch the calves out or to stretch the back

10



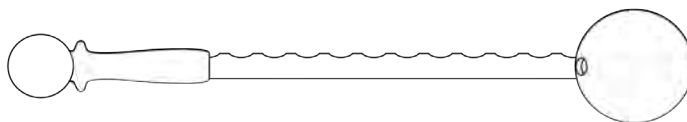
The band can be used in conjunction with the rod for stretching

11



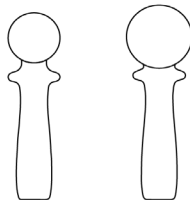
The rod can be used with a handle for trigger point therapy and massaging out knots on the entire body

12



A single sphere can be used with the rod and handle to get into muscles with precision and keep it where you want it

13



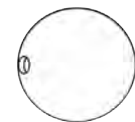
The handles themselves can be used as trigger point therapy and to target specific knots/areas on the body

14



The smaller peanut rolls out the bottoms and feet and targets deep into muscles

15



The sphere can be used by itself on all parts of the body

Locking Mechanism Prototypes V1

The internal component was created initially out of a PVC pipe, laser cut acrylic, a wooden dowel and a spring. This was a larger version of what would be feasible to be in a lacrosse ball. This allowed for the true understanding of the mechanism at a larger scale before shrinking it down to be true to size. Acrylic was chosen because it is a quick way to iterate different design decisions.

V1 Lock Prototypes

The initial iteration was comprised of multiple laser cut pieces which would then be glued into place on the PVC pipe. Seen to the right, the initial laser cut acrylic pieces explored a variety of shapes and sizes.



Different dimensions of the sliding mechanism were explored by cutting various sizes. This particular piece locks the main dowel rod in place. Therefore, it was important to try multiple shapes. Doing this allowed the feel of the “lock” of the acrylic against the PVC and dowel. The rings were used as holders around the main piece to ensure the clamping piece easily slid into position. This held the main piece in place and proved an essential piece.

V1 Locking Prototypes

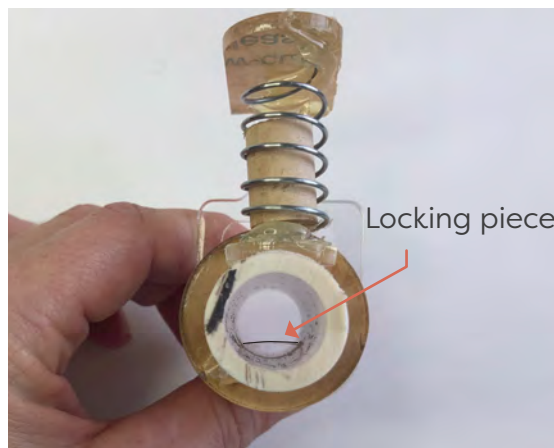
After testing the different pieces, the decision was made to create a piece with a more exaggerated curved portion at the bottom. This allowed the piece to sit further into the rod when inserted through the PVC pipe. In testing, it felt more stable and locked the PVC pipe in the position more securely. The main piece, seen to the right, was kept as two separate pieces of top and bottom to continue to explore different widths and angles of pieces.



V1 locking prototype seen to the left.

To the left below, you see the prototype in the engaged "locked" position. Notice the piece of acrylic protruding into the space of the tube. This is the locking mechanism.

Directly below, you will see the mechanism in the passive depressed position. This allows for the dowel to slide through without resistance.

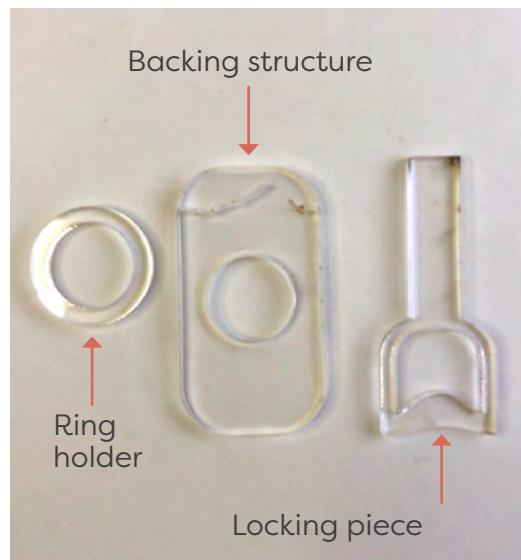
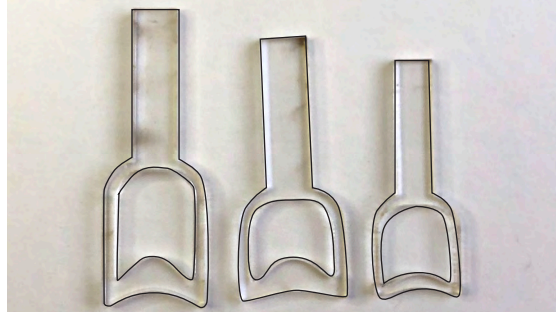


Locking Mechanism Prototypes V2

A few notable changes occurred making the V2 Prototype. First, a larger backing structure was created for the main clamping piece to slide against. This was chosen to guarantee the locking piece stayed on track to fall into the slotted portion of the pipe. In addition, the move to a brass pipe was made to decrease the wall thickness of the pipe. The entire mechanism was also considerably smaller.

V2 Locking Prototypes

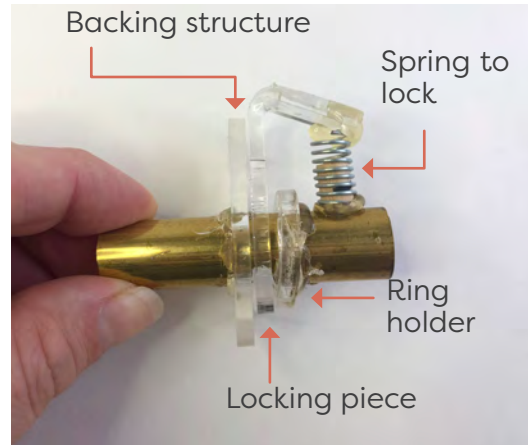
To the right, the form exploration of the main engagement and locking pieces can be seen. The longer stem was added at the top. The stem was then heated with a heat gun to create a curved piece.



Seen to the left, this trio comprises the main set of pieces. The ring is positioned beside the main piece and serves to hold it in place and give it a proper track into the slot of the brass pipe. The middle piece is the larger backing structure for the main locking piece to sit against. The top and bottom height were exaggerated to accommodate a variety of prototype pieces (seen above) for testing. The piece to the far right is the main locking piece.

V2 Locking Prototypes

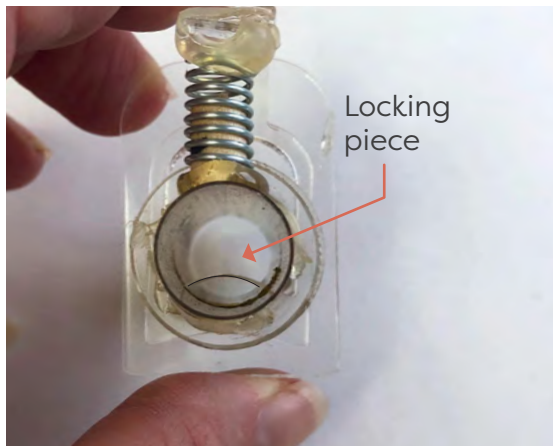
In this iteration, a smaller dowel piece was cut to size for the spring to sit on. The bottom of the wooden dowel piece was sanded to mimic the curvature of the pipe so it sat flush. It was then glued into place. A smaller spring was chosen because feedback included the desire for the least movement of the mechanism. Therefore, the spring sat at a lower height. The top piece was slanted intentionally to mimic curvature of a ball for the positioning of the button.



To the left, you see the final prototype of this particular iteration. It was too tall to fit into an actual lacrosse ball but did in fact engage and lock into place a dowel threaded through the center.

Below and to the left, you see the piece engaged in a locking position.

Directly below, the cleared pipe for a dowel rod to pass through easily can be seen.



Locking Mechanism Prototypes V3

In this iteration, V3, the brass pipe was kept in play because of the rigid structure and because of how thin the tube walls were. One of the most noticeable differences was the shape of the top of the main locking piece. It was trimmed down and then heat molded to a curved shaped. Another difference was the bottom of the backing piece was trimmed down to fit into the sphere.

V3 Locking Prototypes

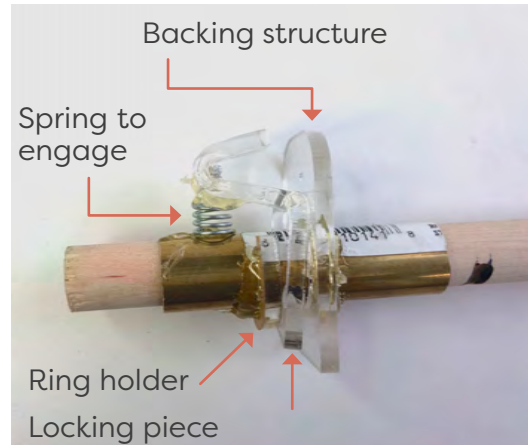
The passive position is shown to the right. The spring was so short it did not require a dowel for structural integrity. Therefore, it was not used. The trimming of the bottom piece can be observed in this picture too.



In the depressed position seen to the left, the acrylic piece was not engaged on the inside and allowed a dowel to slide through. Between the picture above and the picture to the left, one can see there is a subtle difference in movement. However, this subtle difference was measured time and time again to give the least movement with the most return. It is the least movement to allow the main locking mechanism to catch properly.

V3 Locking Prototypes

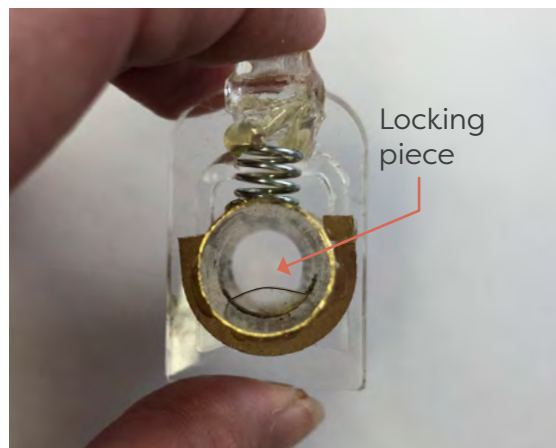
The main locking mechanism made of acrylic, seen in the middle of the three pieces to the right, was shortened in height to utilize every millimeter. It was an intentional decision to minimize the overall footprint of the internal locking mechanism. A heat gun was used to shape the form of the engagement mechanism as well. Counter to the prior version V2, this reverse bend allows for the most contact in the curvature of the sphere it will reside in.



On the direct left, the entire mechanism is seen by its lonesome.

On the bottom left, the locking piece can be observed. This was the position the device was in with nothing is present - the resting state.

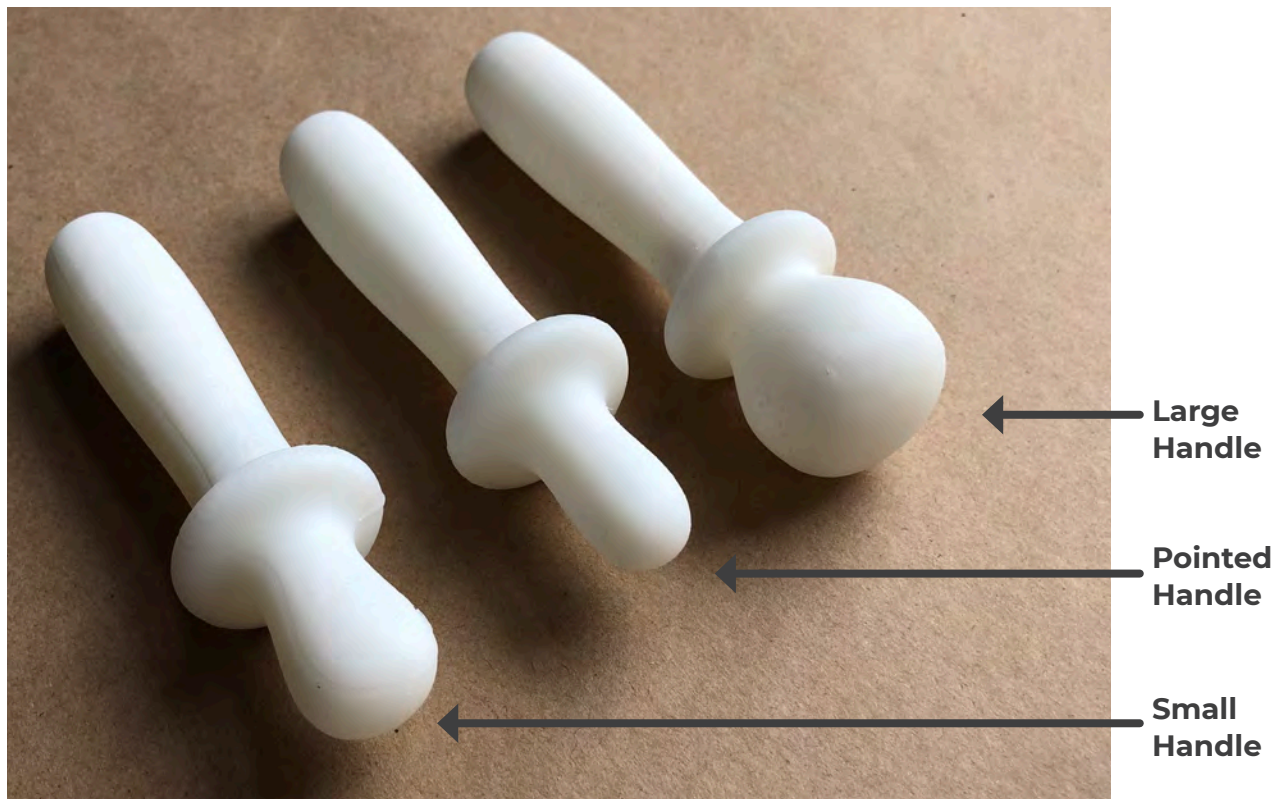
Directly below, when the top piece is depressed it allows for the passage of a dowel rod. When released it would engage to the picture seen directly to the left.



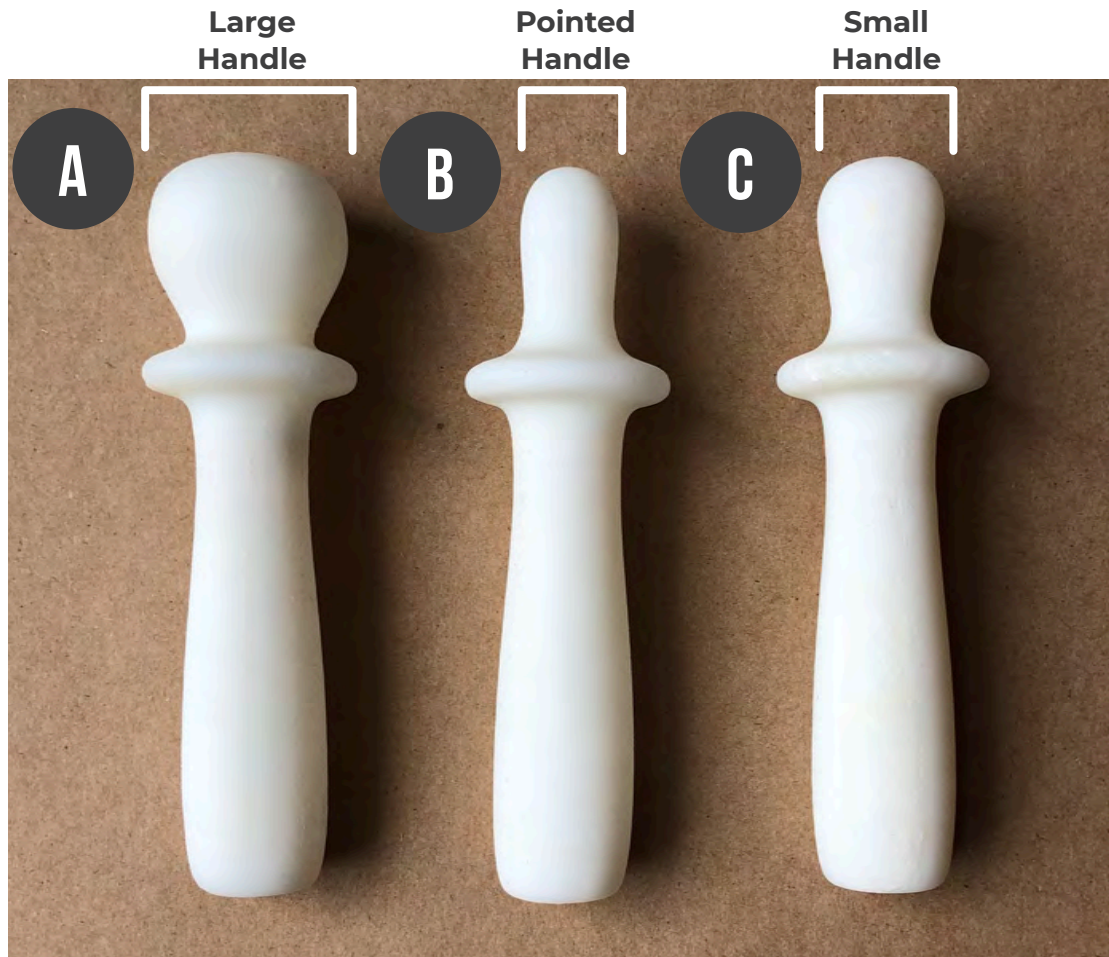
3D Physical Handles

The three handles were rapid prototyped using a 3D printing method in Polylactic Acid, commonly known as PLA. The handles were subsequently given to trainers, physical therapists, and athletes to gain feedback. A total of three handles were printed to gain a better understanding of what type of handles people would prefer to use or find valuable. These can be seen to the right. The following pages describe in more detail the value of each handle.

3D Printed Handles



Physical Handles



A **Large Handle** - this handle tip can be used to work out knots on the body or for pressure point release. The larger tip creates a larger surface area to use on the body.

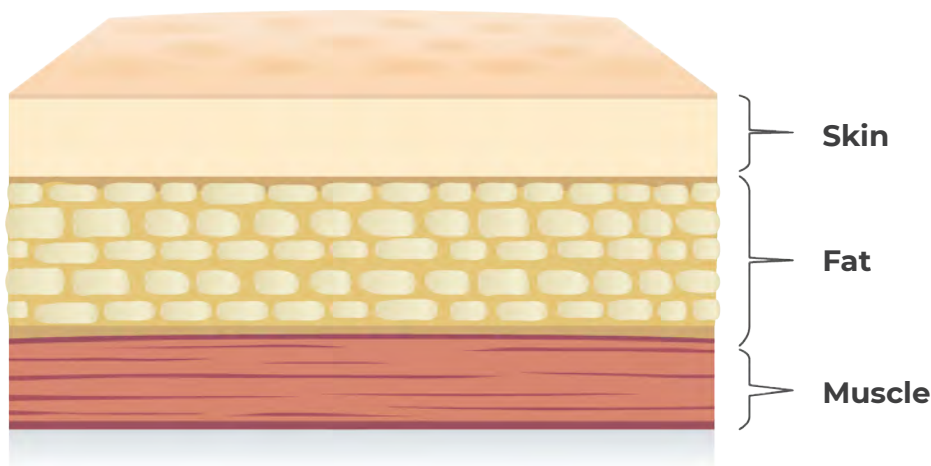
B **Pointed Handle** - this handle has the sharpest feature and therefore is used to get deep into the muscles. It should be used for deep muscle work and pressure point release.

C **Small Handle** - the small handle is a size between the more aggressive pointed handle and the flatter head of the large handle. It is more rounded to create slightly larger surface area to contact points on the body.

Handle Size Exploration

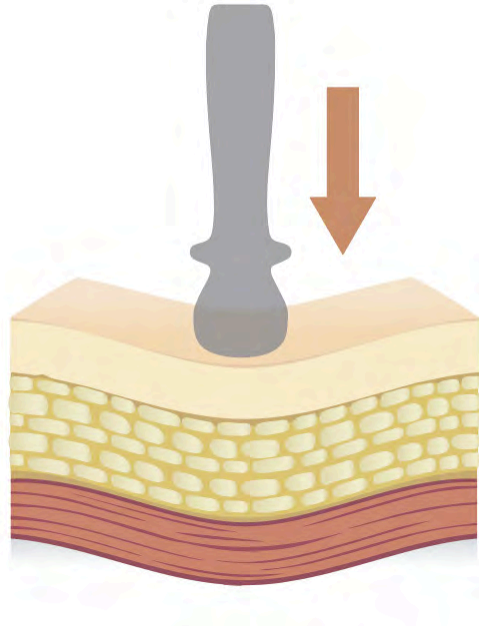
As the experts were consulted, feedback was gradually gained in regard to the three different handle prototypes. Overall, the feedback was all positive. Seen in the graphics below and to the right, the handles of the kit vary in width of the tip. This was the part in contact with the skin and therefore, it determines how “aggressive” the participants could get into their muscles. The smaller and pointed tip gave a much deeper penetration to muscles whereas the large handle tip gave a broader contact point and less penetration to muscles.

Skin Layers

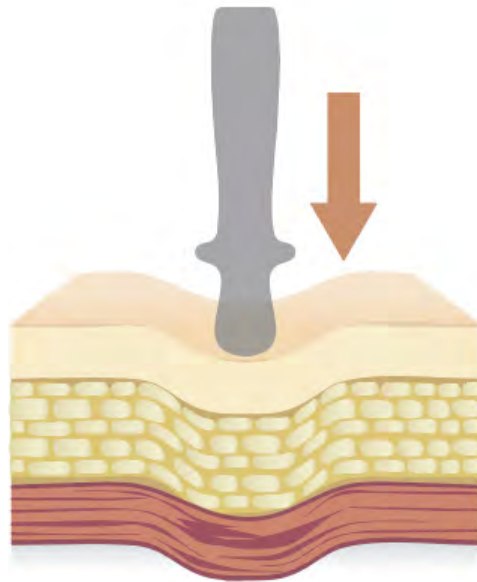


Handles

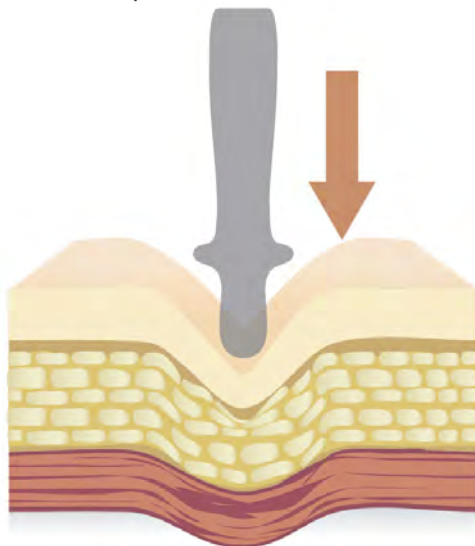
Large Handle - least aggressive



Small Handle - medium pressure



Pointed Handle - most aggressive
for muscle pressure



”

The large handle
is great to rub out
a larger knot; the
pointed is great for
deep tissue work.

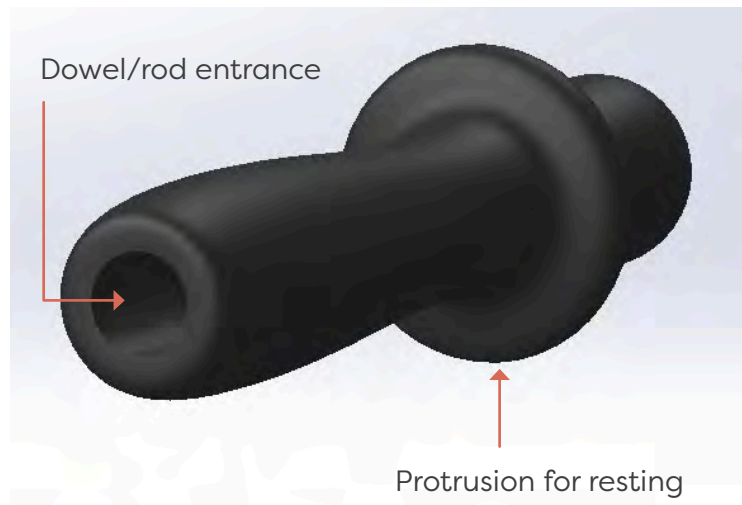
Handle Prototypes

After the experts gave feedback in the design of the handles of the kit, it was decided to move forward with a design to include varied size ends. By utilizing a participatory design still, experts were asked if this aspect of the kit had value and indeed they responded it was desired and of value. The handles were designed using Solidworks.

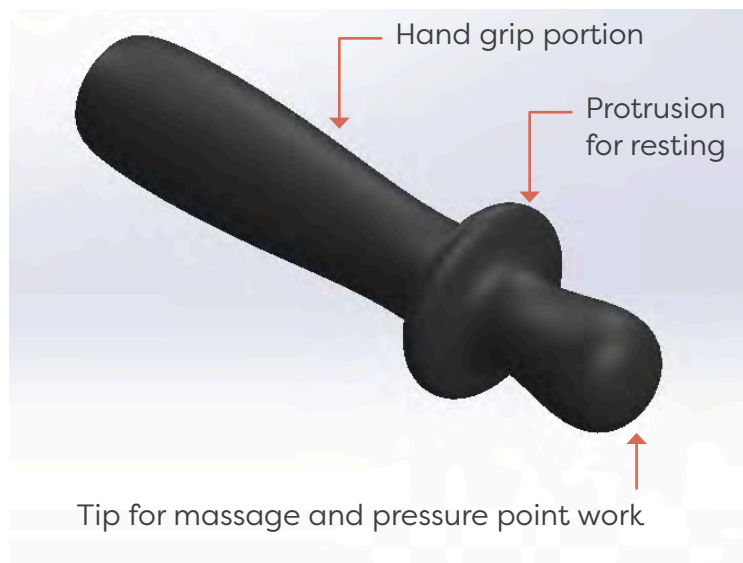
Prototype Features

Here the end of the handle can be seen. It shows the cavity where the middle dowel rod will slip in. The handle will be made of rubber for maximum grip. Also it can be noted here the protrusion will allow this end of the handle to rest on a surface.

This is the smaller of the rounded handle ends.

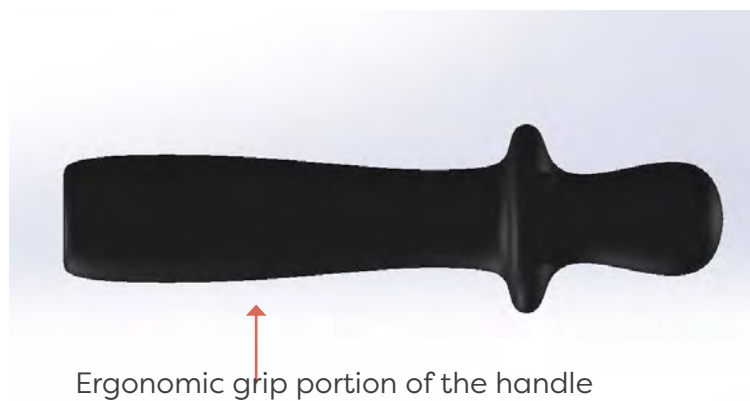


Small End Handle Prototype



Here the “small end” handle can be seen in a rendering. This handle has a small rounded ended to help with pressure point relief both by itself as well as if the person wanted to utilize it with a dowel rod. A person would utilize the end furthest to the right to press into their body while gripping just past the protrusion.

A profile shot of the handle shows the curvature of the ergonomic grip as well as the smaller rounded end. The protrusion serves as the cradle to the persons hand when rolling. It also allows the end of the handle to stay off of a surface if set down to mitigate damage to the end.



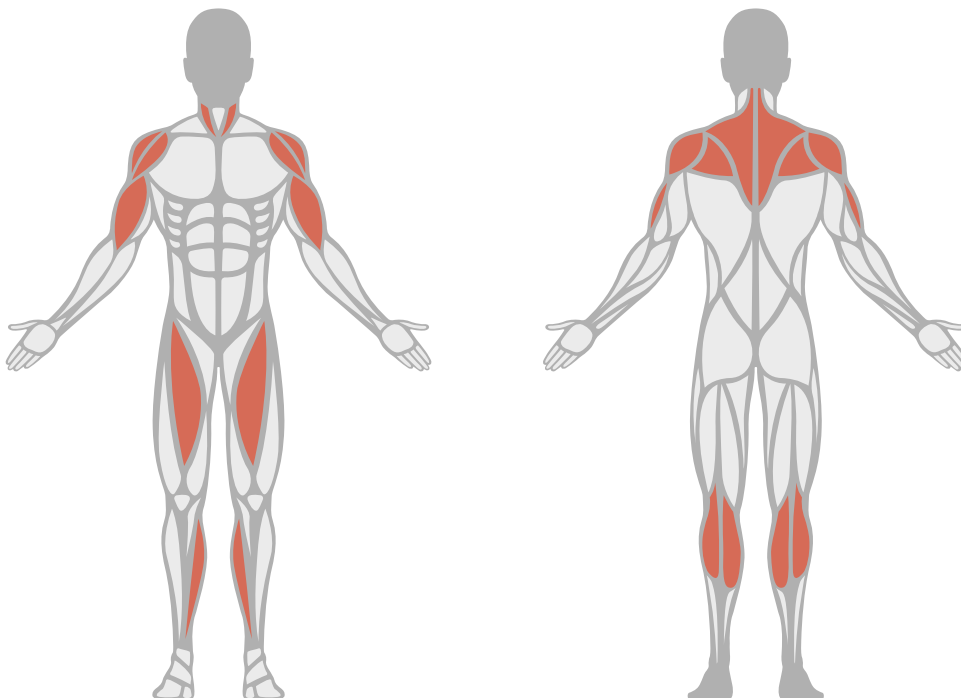
3D Handle Feedback

The handles were shown to athletes, physical therapists, and trainers to gain feedback. A total of 22 participants took part in giving feedback.

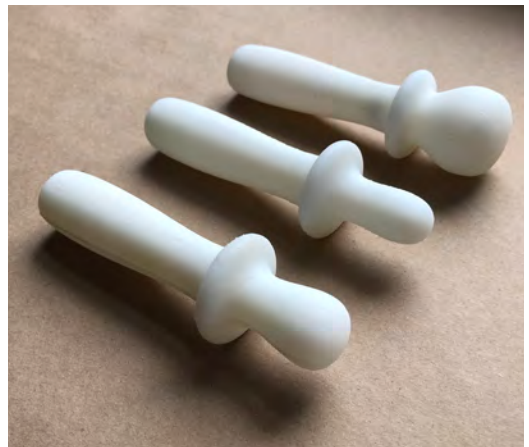
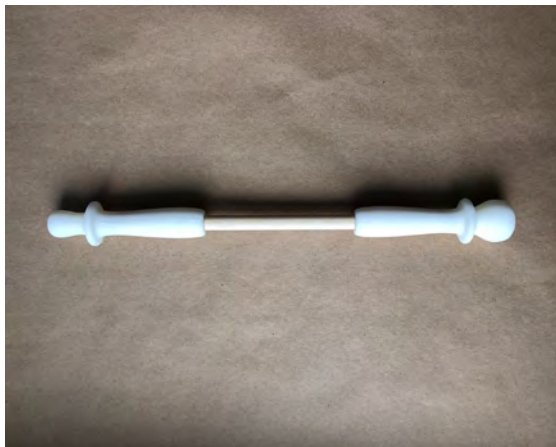
Overall the feedback was extremely positive. Since the handles were sturdy in the hands, they were used as pressure point relief by themselves and in conjunction with the dowel and spheres.

Participants reported they really enjoyed using the various handles. The pointed and small were the most desired by the participants. However, there was positive feedback for all of the handles with only a slight preference for the pointed and small ends.

The handles were used by participants on areas such as quads, shoulders, arms, neck, and calves. These could be used anywhere a knot in a muscle should be released. Seen below are the primary areas where the handles were used.



Handle Feedback



Prototype Number 04

Expert feedback from Prototype 03 directed the decision to 3D print a sphere for the main peanut pieces. In order to incorporate the internal components, the 3D sphere was printed using a rubberized filament. It was printed in two pieces so they could be assembled together with the internal components providing the pieces to engage and “lock” on the dowel/rod piece. This allowed for the locking of the spheres in a variety of pieces. In addition, a new dowel

was 3D printed in PLA to explore the form and gain feedback. These two new pieces allowed participants to lock the sphere in place and to gain a better understanding of how the pieces interacted with each other.

The mechanism in the sphere is engaged by pinching the sphere to release the engagement piece. Then, it can be slid into another groove and locked in a different place.

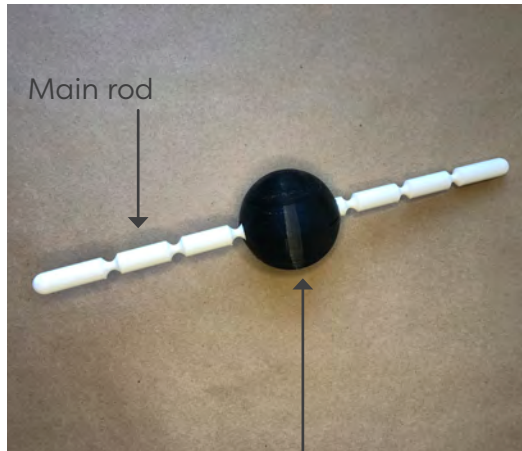
Benefits

- Participants reported they loved the way the main spheres could lock into one place
- Participants enjoyed the rod and sphere interactions overall
- Participants stated they enjoyed being able to put all the pieces into the containment foam roller

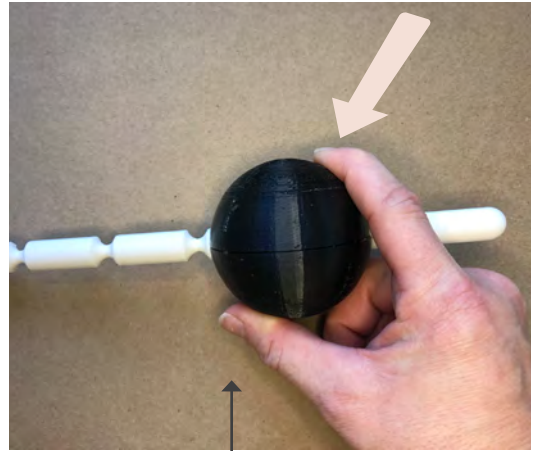
Opportunities

- The main sphere needs to be reinforced in order to be properly used by participants
- The rod cannot support weight and needs to be enforced and remade to be properly used
- The grooves on the rod need to be made smaller as to provide more stability

Prototype 04



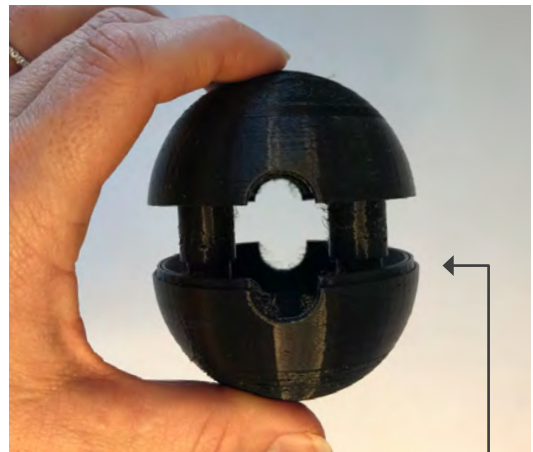
Main 3D printed rod with the sphere "locked" in a central location.



Seen above, the participant can pinch the sphere to slid it into another place



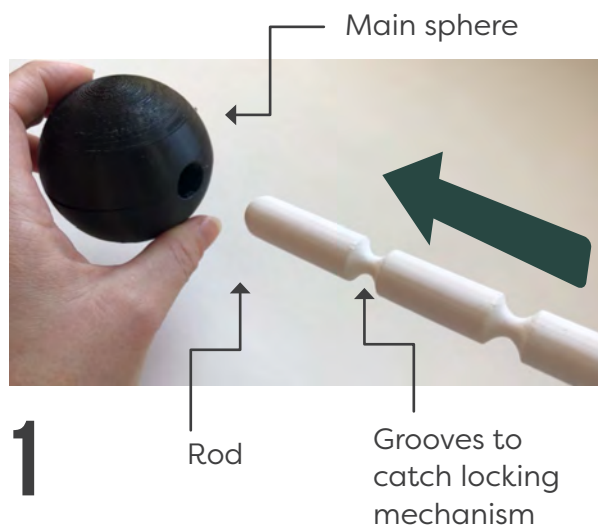
Main locking piece as seen when the sphere is taken apart. This locks the sphere into place on the rod.



Seen above, the two halves of the spheres can be seen put together.

Prototype Number 04

Here the main sphere can be seen being placed onto the rod. Then, the handles are added to create a roller. Participants used this to roll out areas such as quads, hamstrings, and back muscles.



4 The arrow above shows where force was applied to release the internal locking mechanism to allow the rod to slide through.

Prototype 04



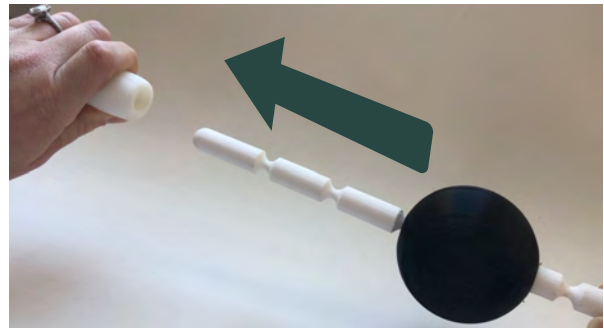
5 The sphere is slightly deformed here because of the force applied.



6



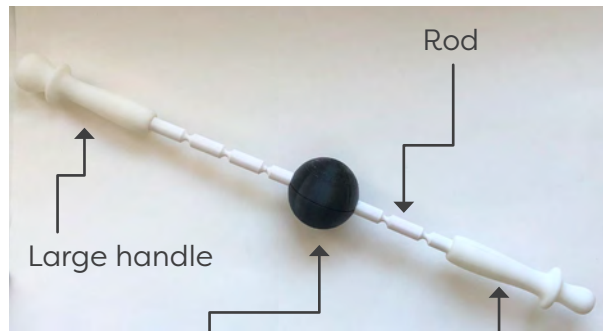
7



8 The handles are then placed onto the rod.



9



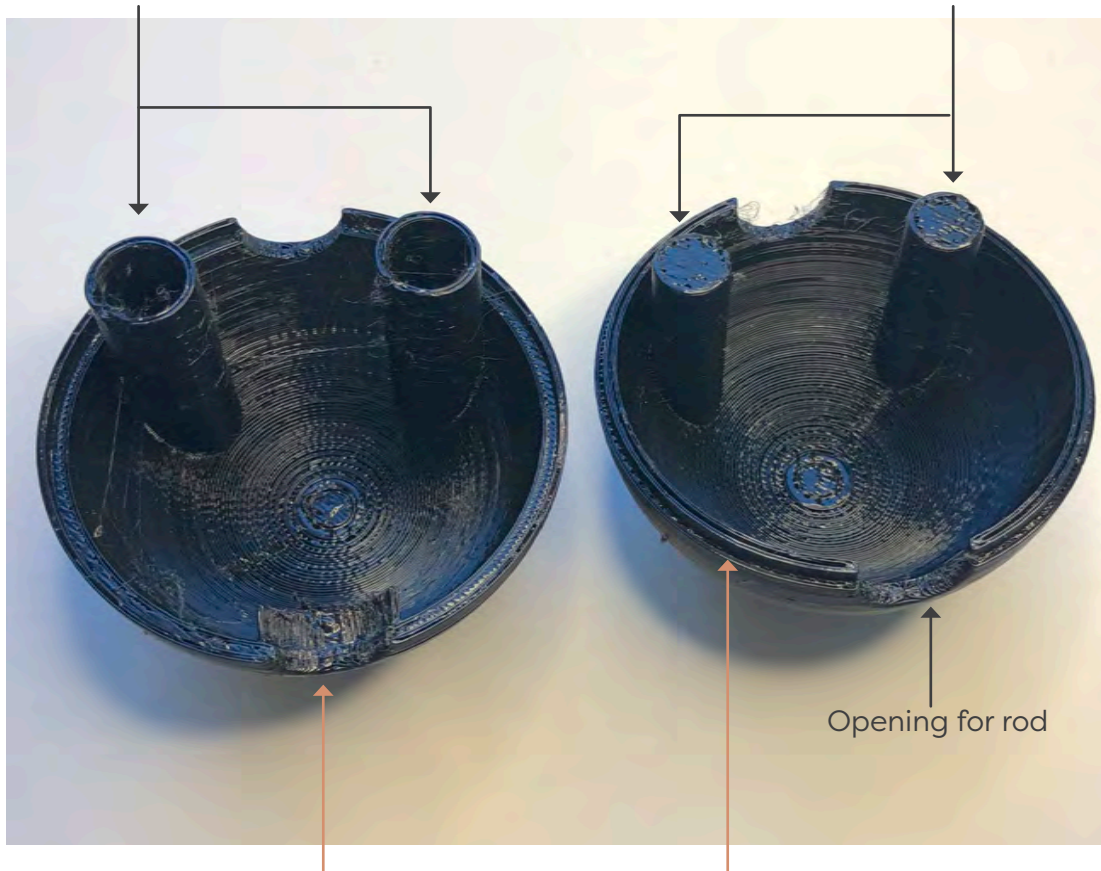
10

Main sphere Pointed handle

Main Sphere Diagram

Female column mates with the other side of the sphere to give stability and hold the two halves together

Male columns fit snugly into female component to mate two halves together.



Small lip to help align the internal locking mechanism sits inside the opening for the rod

Lip groove feature to mate two halves

Meet: minimis

The final prototype took shape. This iteration included a foam roller container lined with a PVC pipe for stability. Two magnets ensured the two halves stayed together in addition to a small PVC lip on each side. Three handles were included for the final assessment. A main rod was a central part of minimis. It had small grooves along the entire length of the rod. A smaller peanut made of wood was included along with a medium

weight athletic band. Finally, two novel spheres were included. These create the “peanut” when threaded onto the rod. Seen on prior pages, the locking mechanism was contained in the middle of the spheres and slots into the grooves on the wooden rod to ensure locked in place as defined by the person utilizing the piece. All of the items fit with plenty of room in the center of the foam roller compartment for any additional items a participant would like to add.



Final Physical Prototype



- | | | |
|--------------------------------|----------------------------|----------------------------|
| A Foam roller container | C Central rod/dowel | E Mini Peanut |
| B Three handle options | D Athletic band | F Two large spheres |

Final Feedback



The participant massages the wrist with the tip of the handle. They stated this would be great for conditions such as a tight wrist or even carpal tunnel symptoms.



Seen above and to the right, the participant can be seen rolling out their quad muscles. This configuration came about time and time again.

Directly to the right, a single sphere was used to roll out the forearm and lease tension. A single sphere was used in this arrangement.



Final Feedback

- 1 ALL participants said they would use minimis
- 2 Although three handles were included, participants utilized the small handle and the pointed handle the most
- 3 If taken forward, material considerations for situations such as flying should be explored in abide by TSA rules
- 4 The foam roller length should come in two sizes - a smaller 18" and roughly 24" too accommodate different exercises
- 5 Individuals suggested exploring or adding textures to items like the spheres and rollers
- 6 Individuals loved being able to lock the spheres in places because they expressed often an exercise ball "won't be in the perfect spot and wanders around"
- 7 Larger main rod with "sheaths" or sleeves should be explored

Final Feedback

The pictures here illustrate a variety of ways minimis was used during the final round of evaluations. During this time, all of the pieces were utilized by the participants. However, most gravitated toward using the handles either by themselves or with the rod and spheres. When prompted about this, participants responded with phrases such as “I know how to use a foam roller but I’ve never seen things like these [handles].”



”

***My wife would love
this because it would
replace the entire bin
of tools I have sitting
out in our living room.***

”

*This covers
every single
aspect of
my mobility
needs.*

Final Feedback



minimis

Minimis, as seen on the opposing page, would have a foam roller exterior made of EVA foam if manufactured. EVA was chosen over polyethylene foam for the foam roller because of its durability and unlikelihood of warping over time. The roller needed to be a bit more dense and EVA provides this whereas polyethylene foam tends to be softer. A more sturdy material such as carbon fiber, steel, or PVC would need to be explored further for the interior of the roller to give it structure and stability.

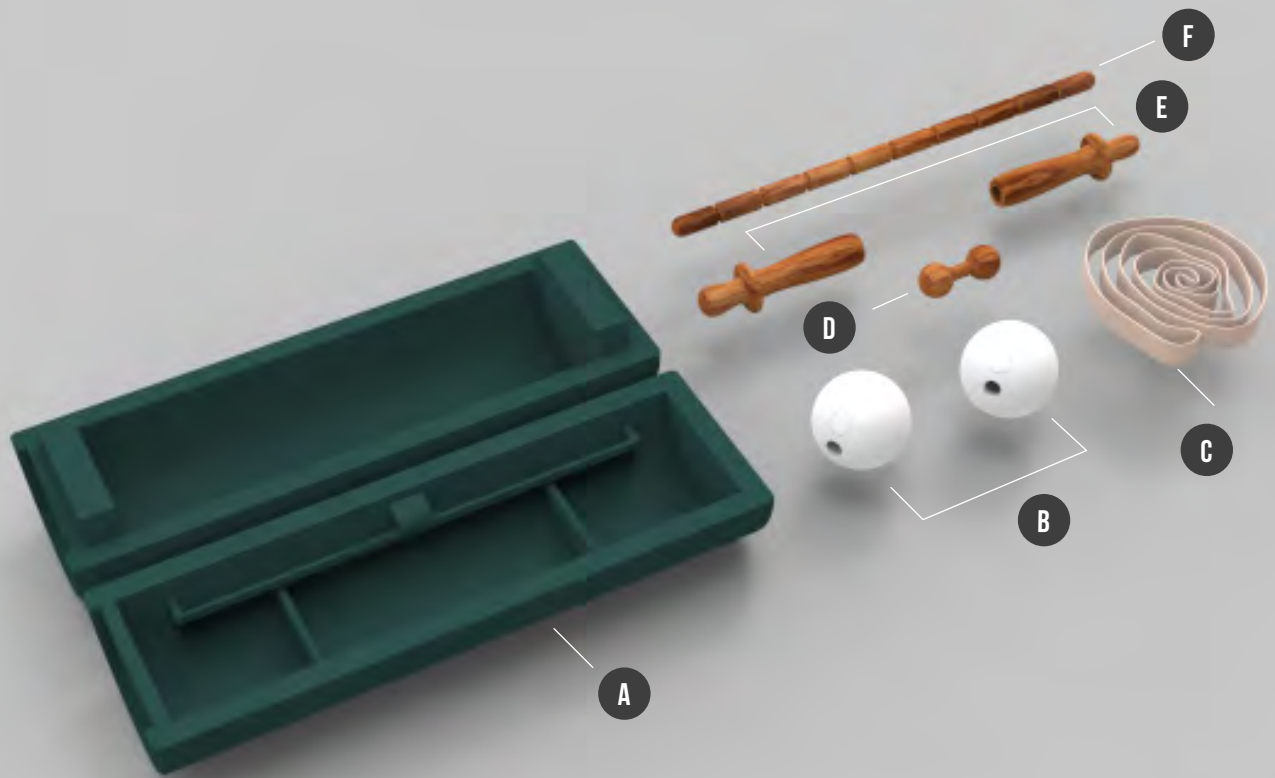
The wooden pieces of the kit are shown in hardwood. This gives it a unique look while also being durable. Participants enjoyed the look of this when shown options. Three options were given to participants when the final round of feedback was given - acacia, pine, and cherry wood. 22 of 25 people spoken to chose acacia and therefore it was chosen as the

final wood.

The spheres would be made from vulcanized rubber. This material would provide the sturdiness needed as well as the rubber feel participants enjoyed from the lacrosse balls. Stiff while also having some give.

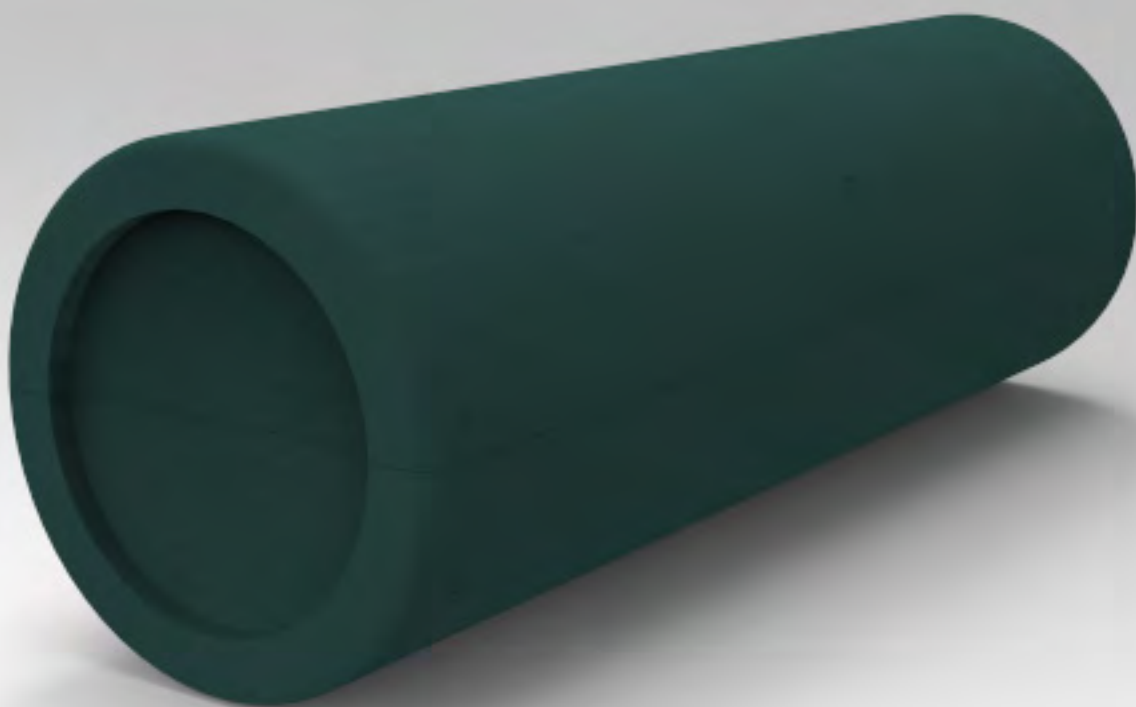
Finally, the internal components would need to be self contained and a process such as overmolding could be utilized to produce the final spheres. Since the tube through the center of the sphere needs to have more stability than rubber can provide, a metal or plastic material would need to be placed within the rubber. These parts would form the locking mechanism for the sphere.

Finally an athletic band should be in the range of 15-35lbs in resistance. Participants during the feedback sessions stated this was the best weight for mobility and recovery exercises and enjoyed using it.

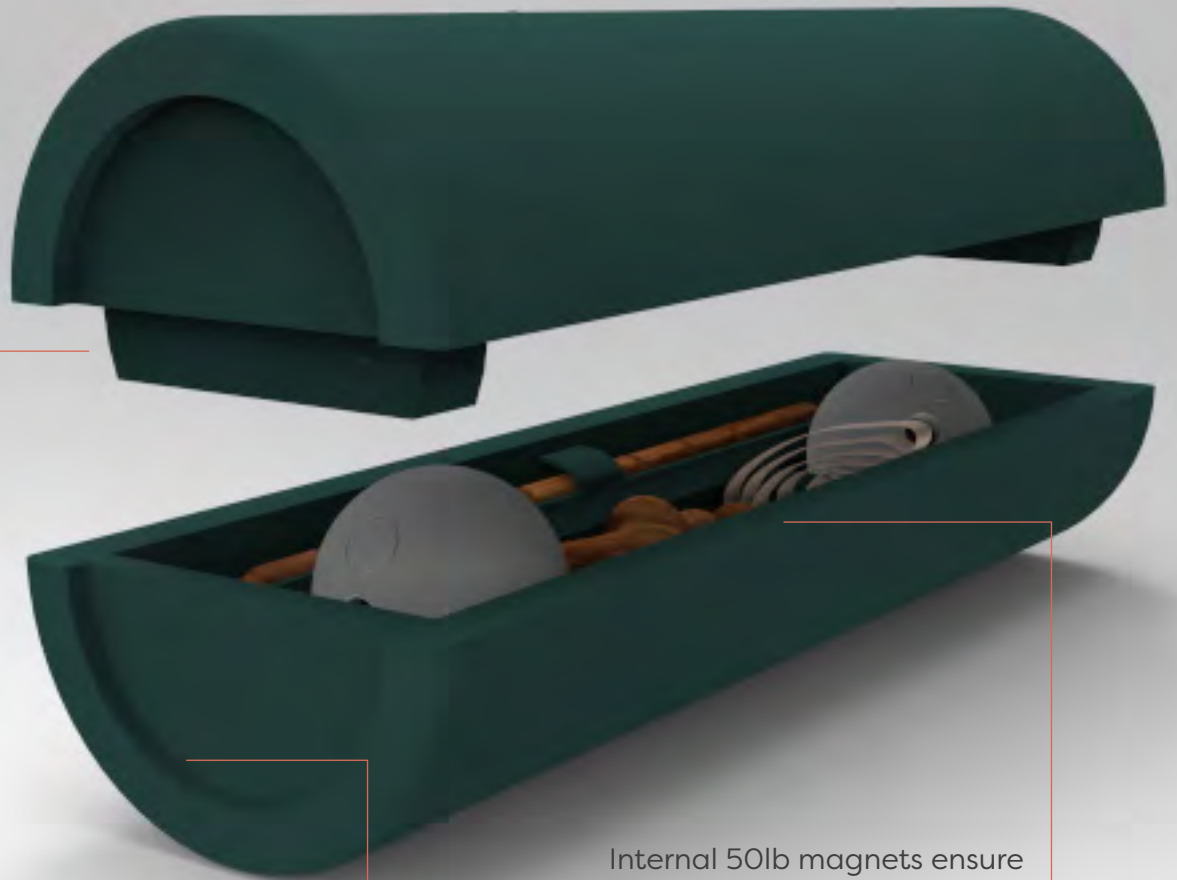


- A** Foam roller containment case
- B** Two rubber sphere balls with locking internal mechanisms
- C** Medium weight athletic band
- D** Small wooden peanut
- E** Two wooden handles with differing tips for muscle relief
- F** Wooden rod with grooves for locking

minimis



Minimis is held together with a protuberance on either end. These ensure the roller stays in place when being used. They serve to increase the height of the half of the foam roller for stabilization exercises.



Internal 50lb magnets ensure a tight and stable closure

The end of minimis has an indentation for maximum grip to separate the halves

Fully functional foam roller,
use only a half or the whole



Subtle button ring
indicates a place to press



All items easily fit into the
internal compartment

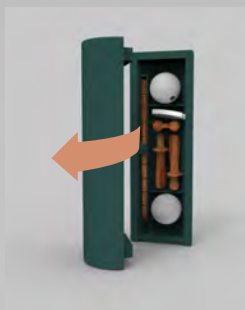
The top half has an open plan to allow for any additional pieces to be added

Latch with magnetic closure to hold rod in place



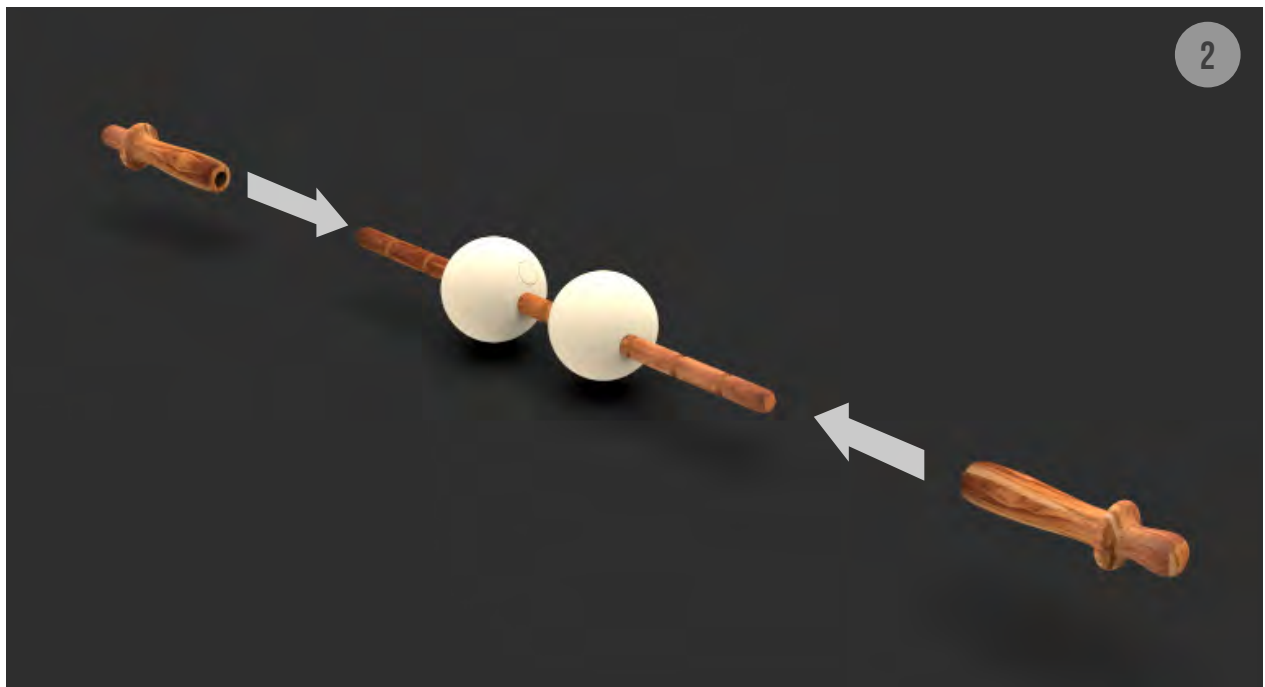
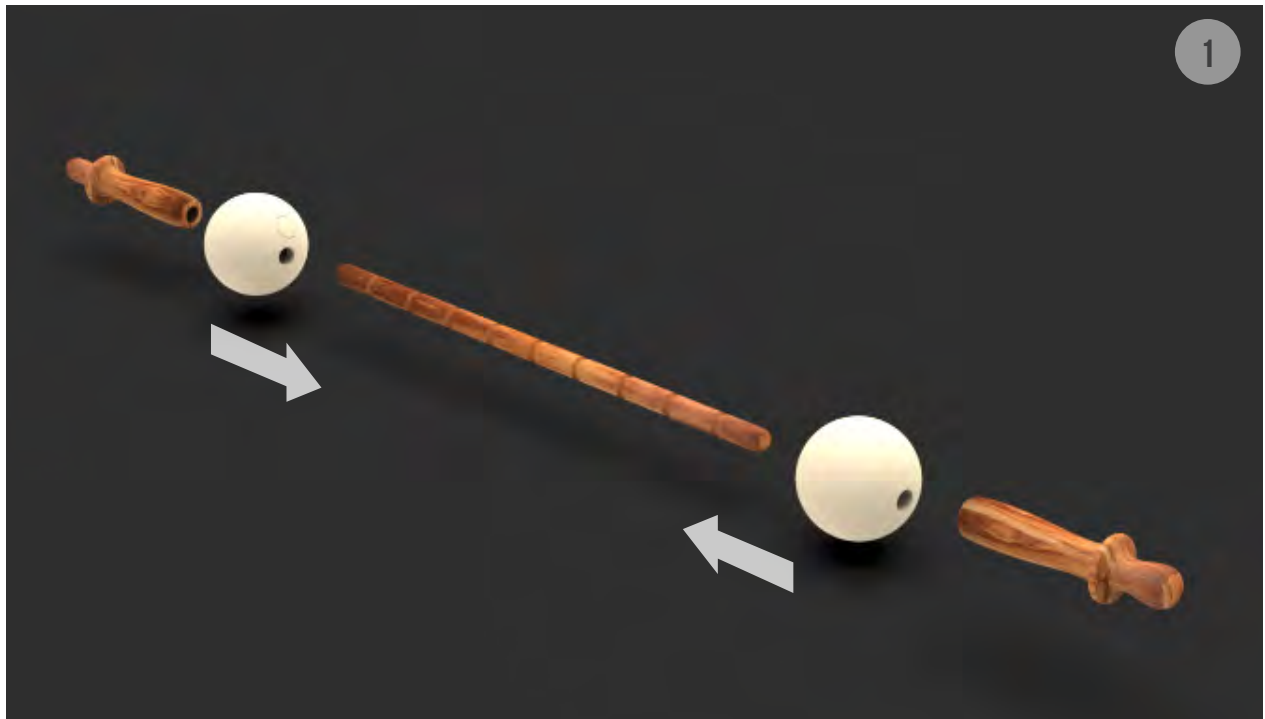
Dividers also serve as ridges for structural integrity purposes

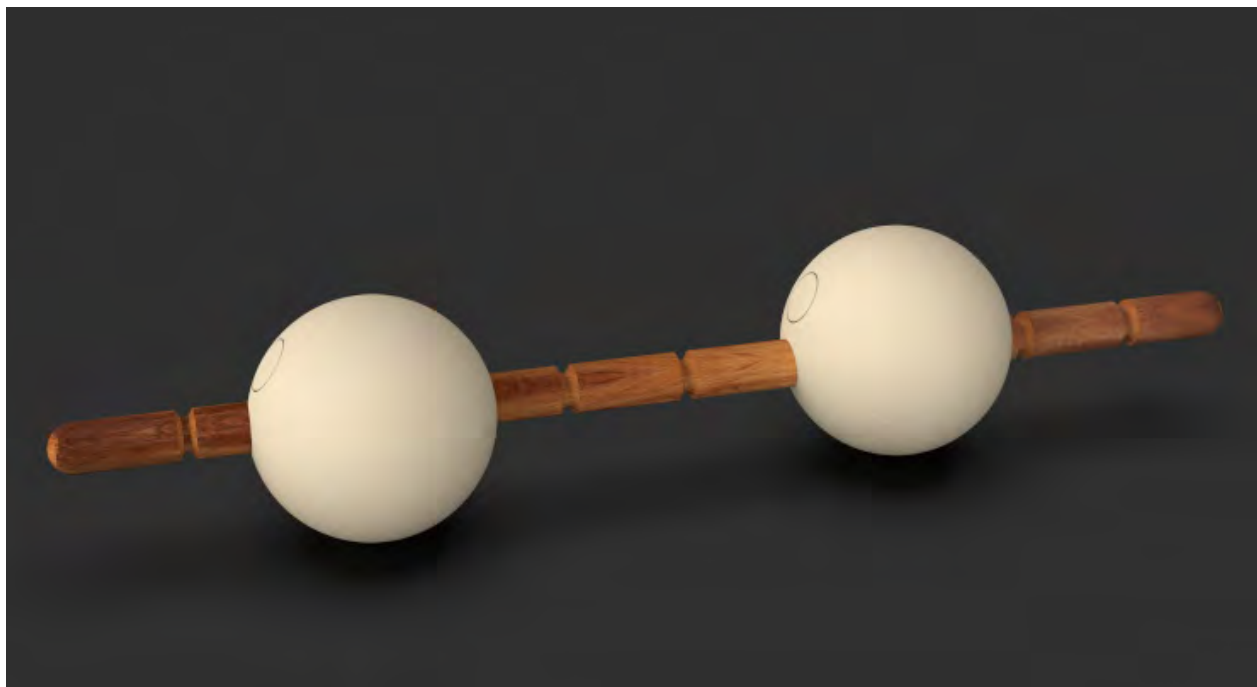
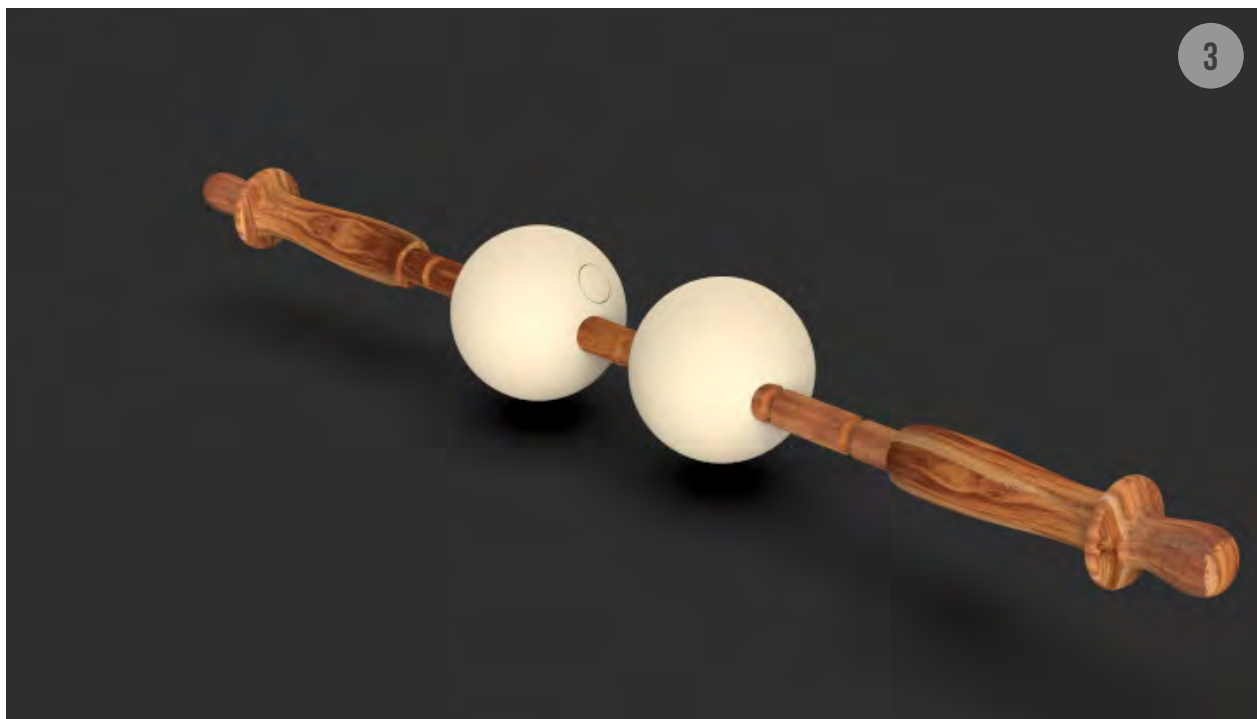
Compartment for rod

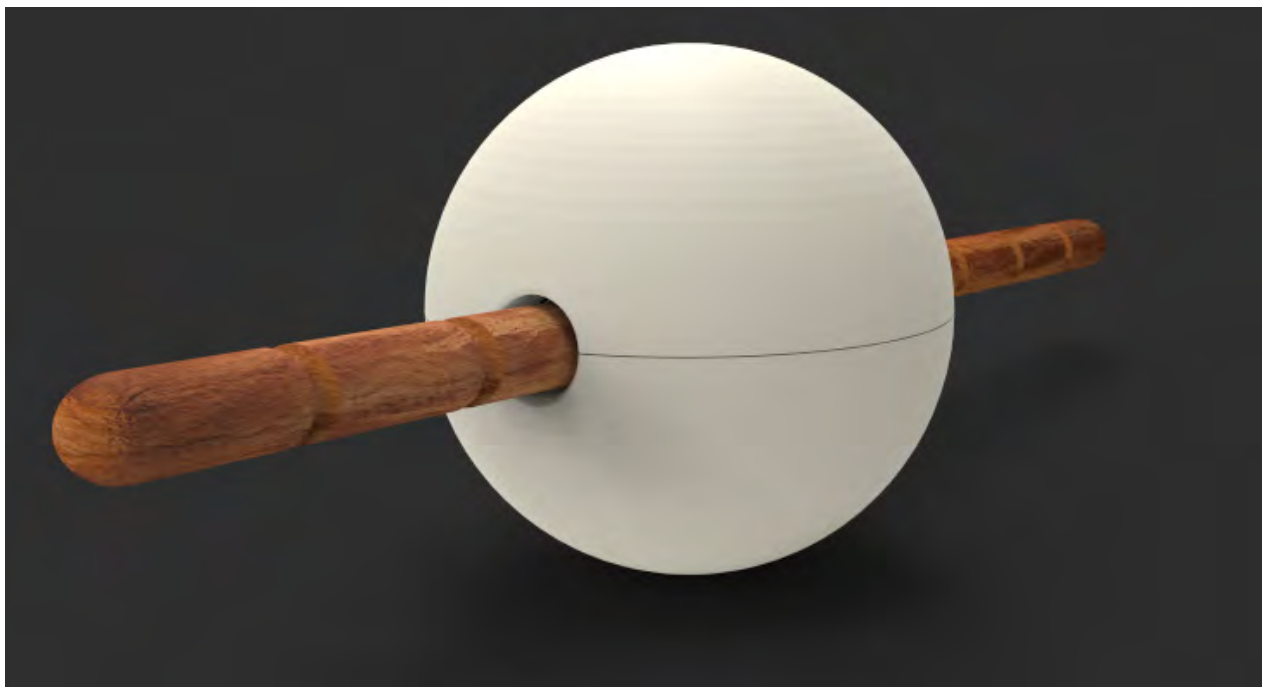




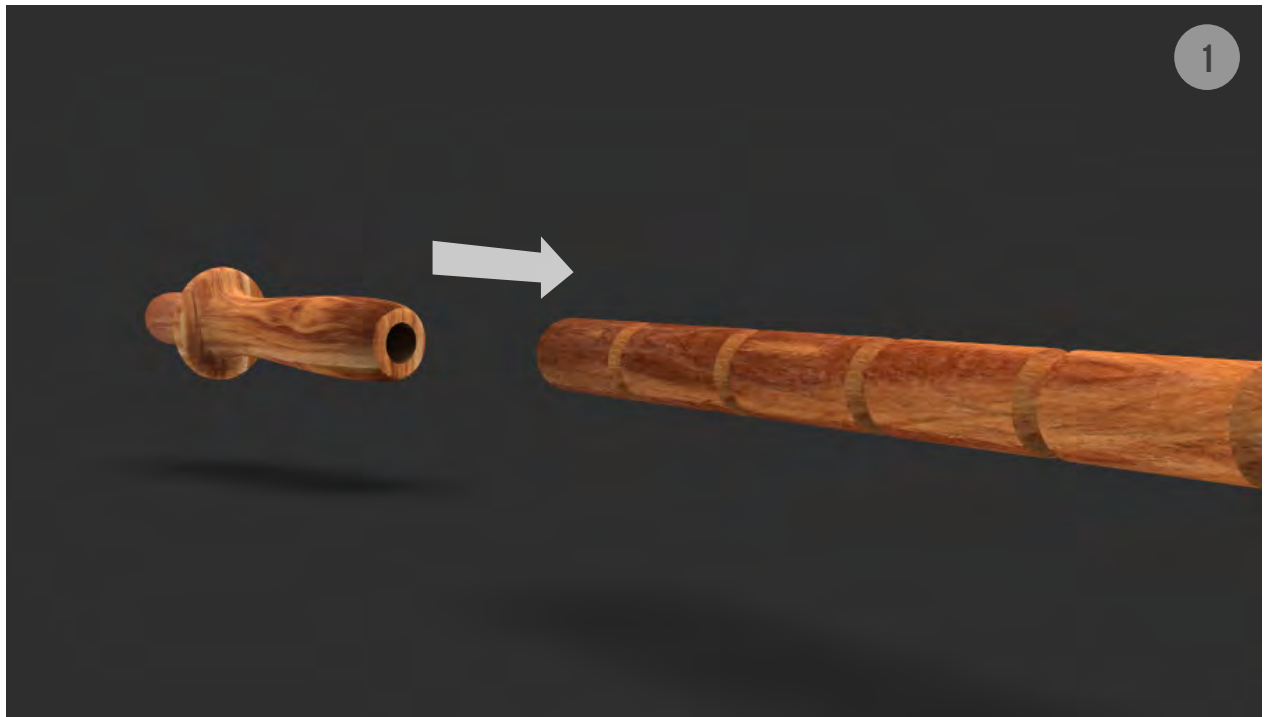
Configurations



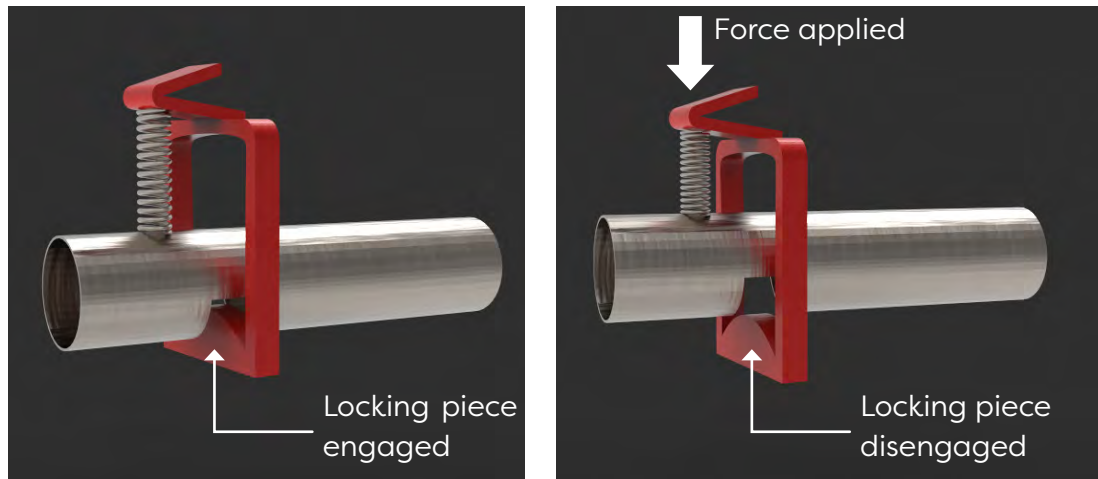




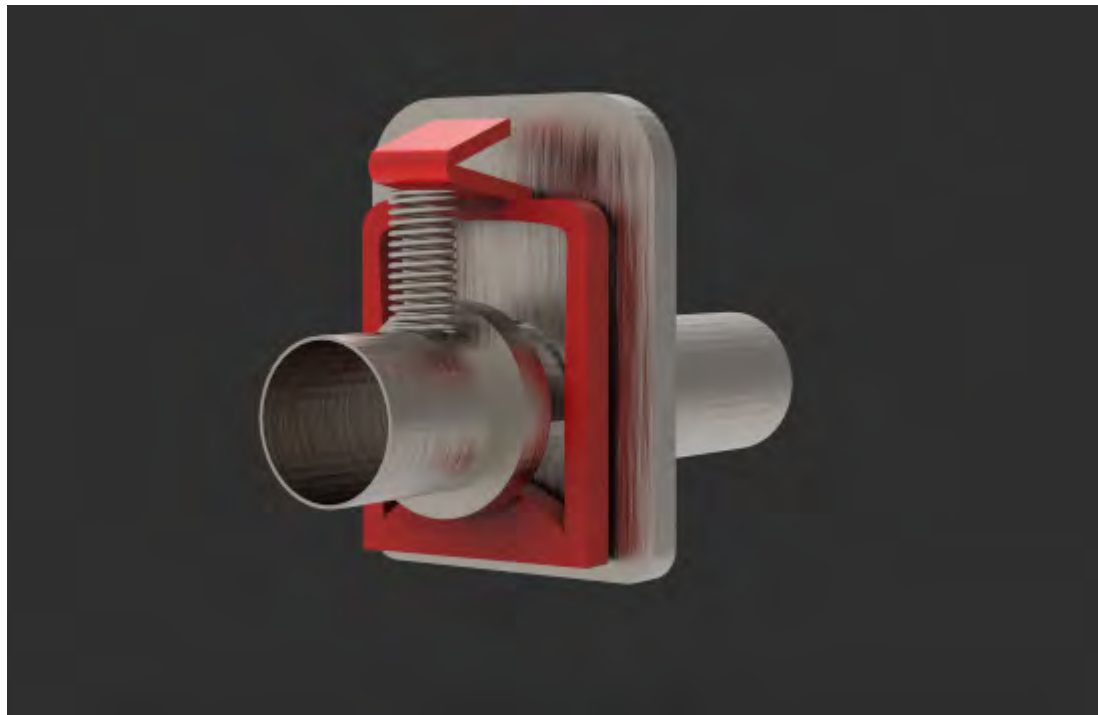
Views

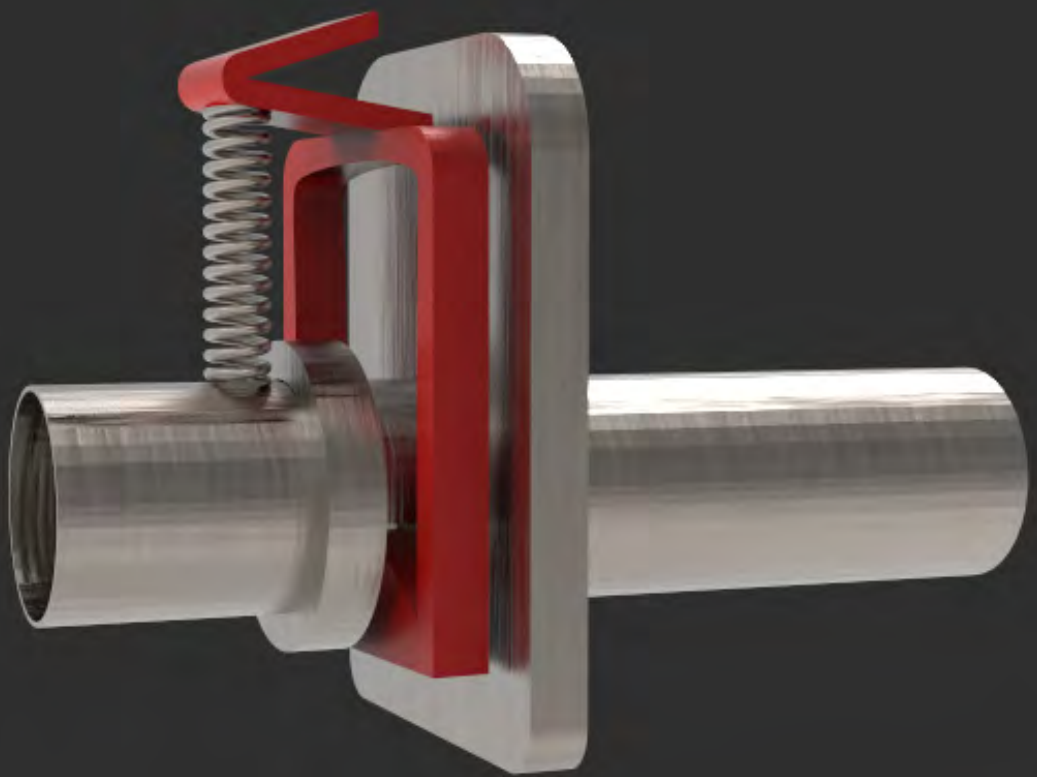


Internal Components

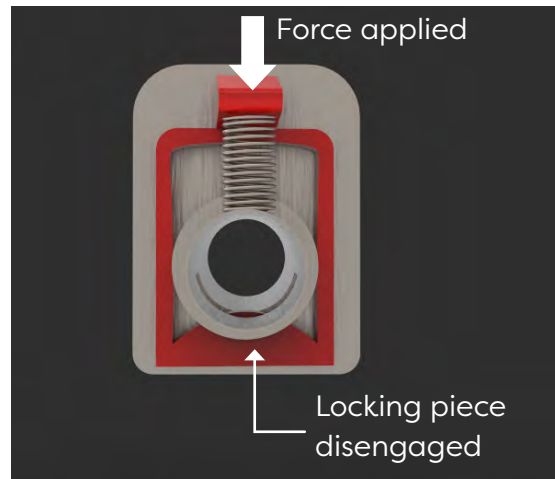
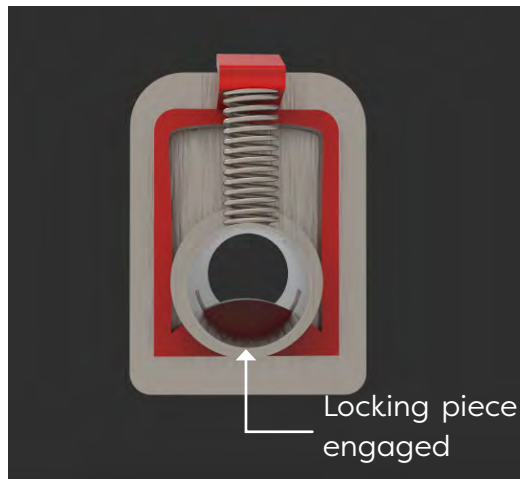


The illustrations above show the basic locking mechanism within the main spheres. In red, the locking piece is shown in both the engaged and disengaged position. This piece sits on the spring connected to the central tube. When depressed from above, the piece will slide out of the engaged position and allow the rod to slip through the tube. A person can adjust the position of the sphere on the rod. Below the part is shown with the pieces to keep it in place.

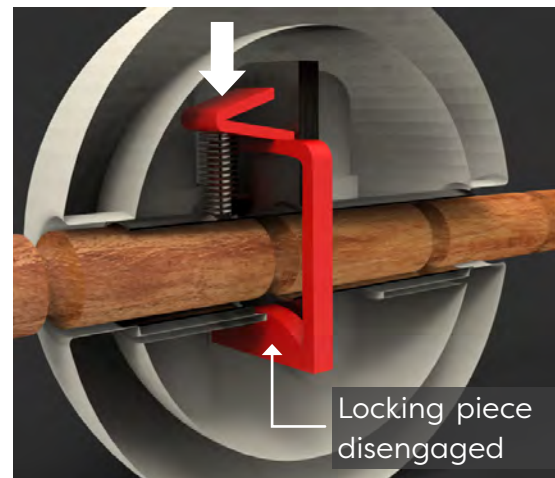
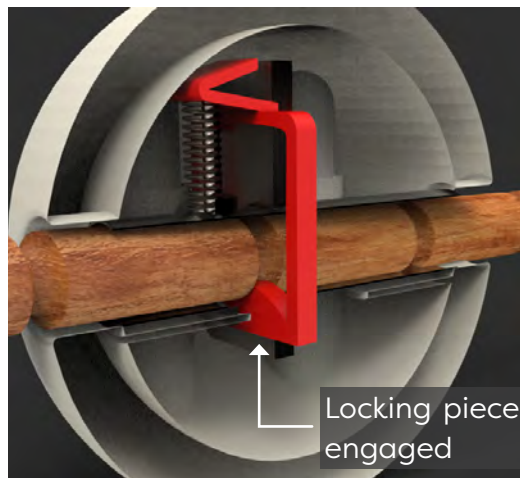




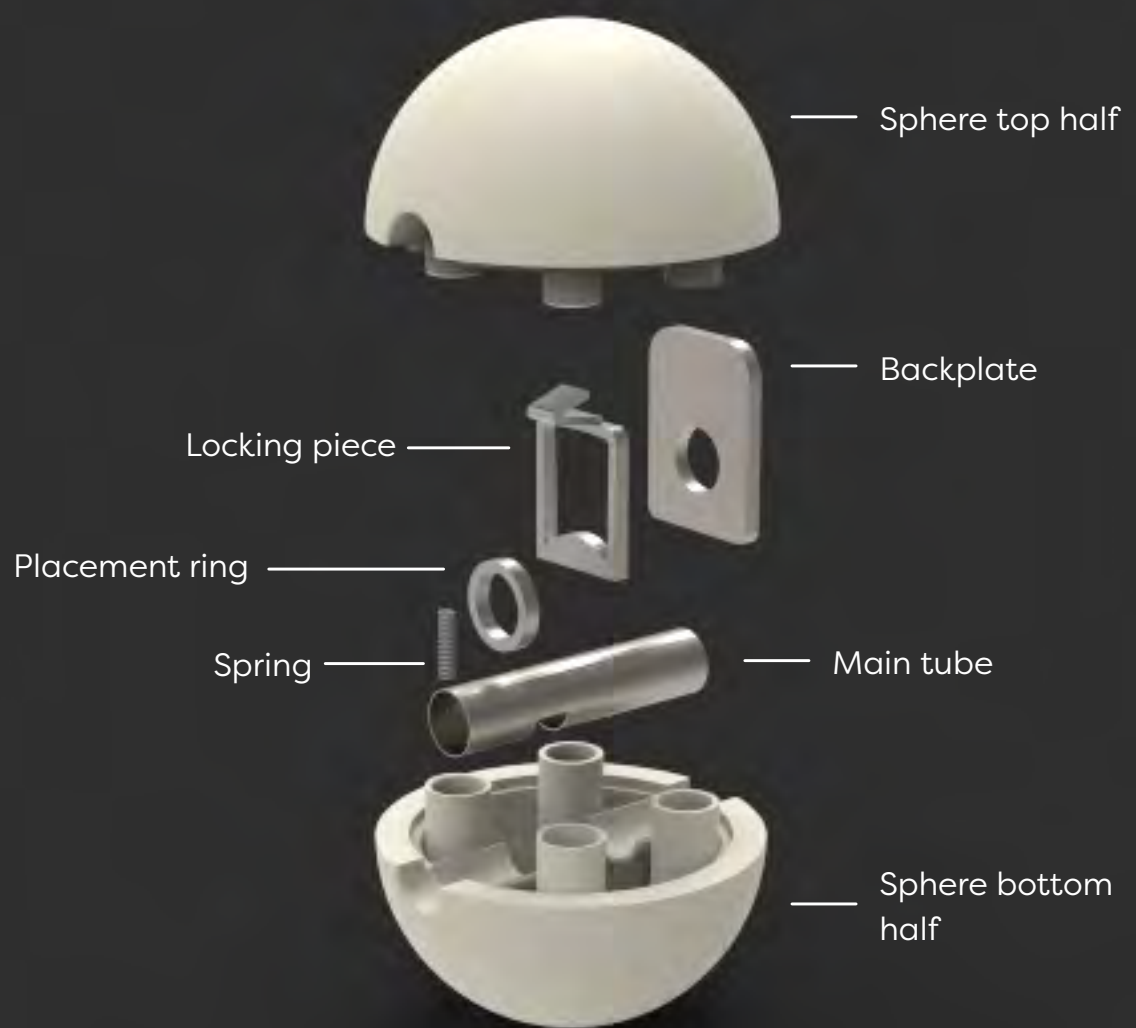
Internal Components

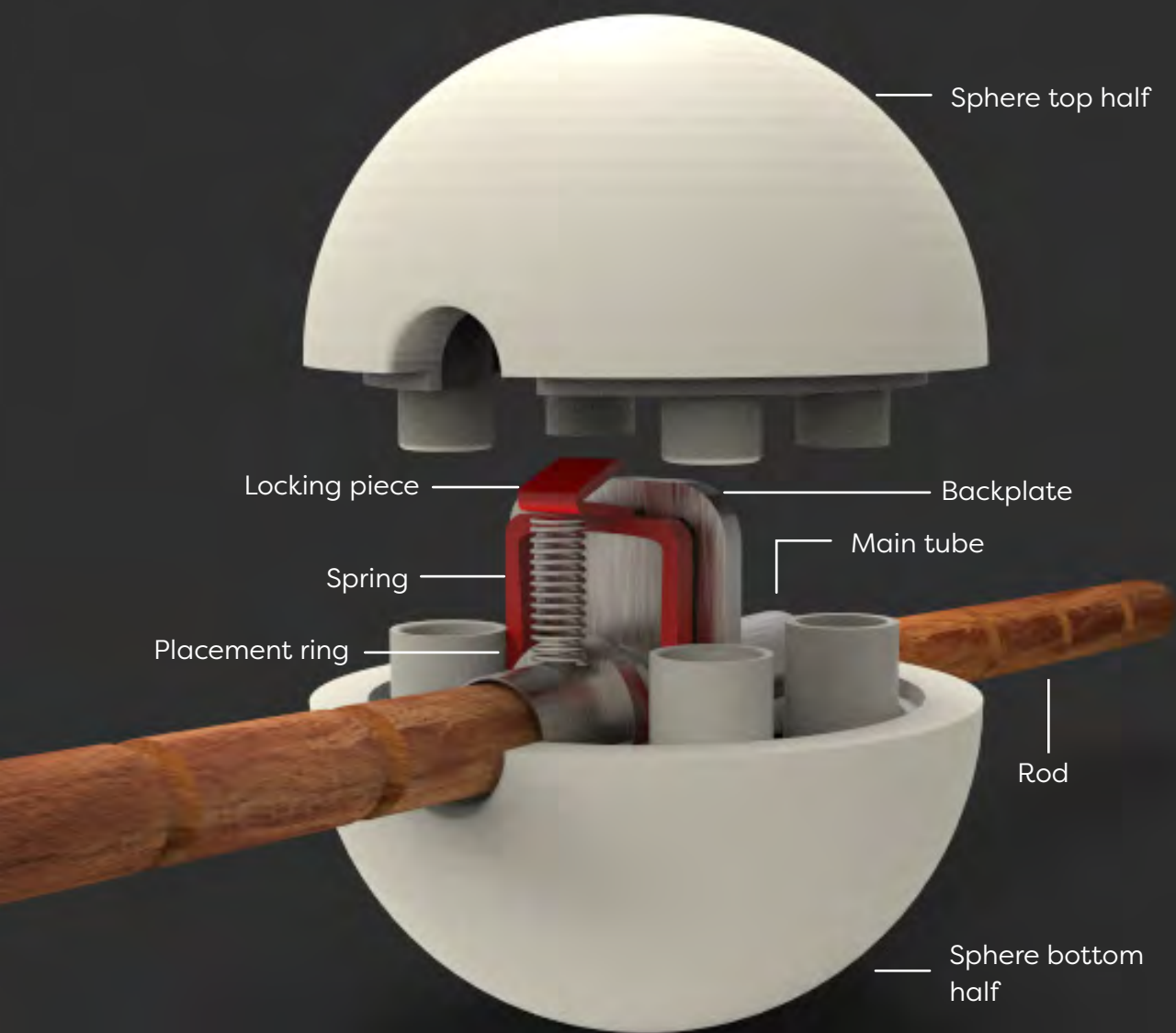


Above the internal component locking mechanism is shown in an orthographic view with the locking piece visible through the tube (shown again in red). On either side of the red locking piece, there is another piece of material to hold it in place. These parts are displayed on the opposing page as well.

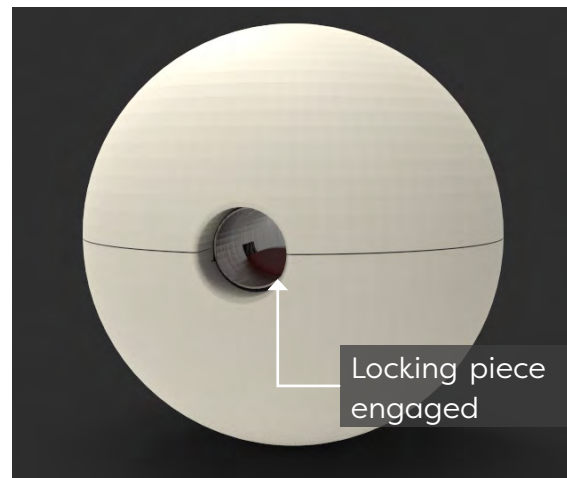
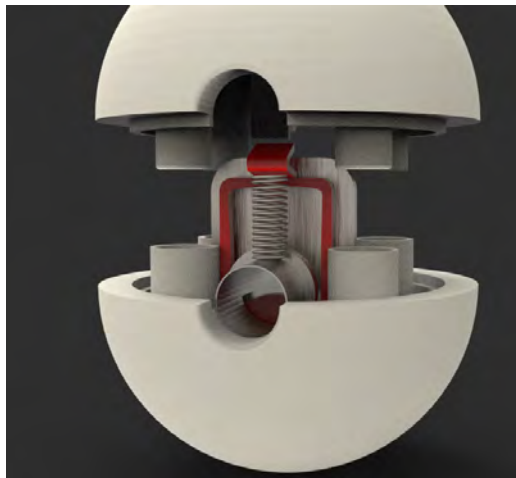


A view with the wooden rod and sphere is seen above. For illustrative purposes a cutaway view is used and the locking piece is shown in red. Here one can see how the piece actually engages with the wooden dowel to lock it into place when threaded through the main channel.





Internal



The views above show how the internal components fit together and nest into the sphere. Top the bottom sphere and all the internal components can be seen in the default engaged position. Below the sphere can be seen prior to the two halves being joined. On the bottom right the sphere is seen in a joined state. The locking piece can be seen in the resting engaged/locked position.

Sample Uses





Seen in context are various configurations of minimis as assembled by the person and recommended by physical therapists/trainers. Minimis can be used in a physical therapy office, gym, or on the go. The multiple parts work in tandem to give the owner the best mobility options.

Minimis in Action



The container itself, the foam roller, can be used for its intended purpose as a roller in addition to splitting in half for activities such as stretching the back or calves. Over two hundred configurations can be made with minimis. These are a few of the potential arrangements of pieces. Minimis pieces can be used by physical therapists, trainers or others on hard to reach places too.







Instructional Brochure

The expert interviews revealed the need for an educational piece to inform the user. With tools abounding in offices and gyms, participant feedback revealed the need for a set of instructions specific to minimis. A sample instructional brochure was created - seen on the opposing page.

The brochure provides a wealth of information. To begin, it lists the pieces and tools of the kit. Next, it lists out sample configurations of various pieces. There are over 250+ uses for these tools.

The samples give the person a starting point to how to configure in a variety of ways. At the bottom, a QR code leads the owner to an online repository with instructional videos, uses, and additional configurations. The information varies in the way it is presented. Some pages display target areas of the body to mobilize; whereas other pages show

a configuration of tools and how/where to use them on the body. Finally, instructions and images on how to utilize the band in conjunction with a rig or bar is seen in this example.

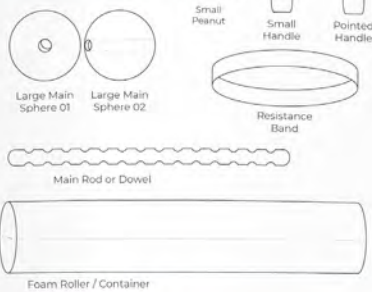
The instructional piece also provides a time and utilization recommendation as well. For instance, a person could look at the brochure and perform the exercises for the recommended amount of time and for a specific rep scheme to mobilize.

This instructional brochure would be small enough to reside inside the containment roller. It can be referenced when needed by the person using the kit or taken out completely.

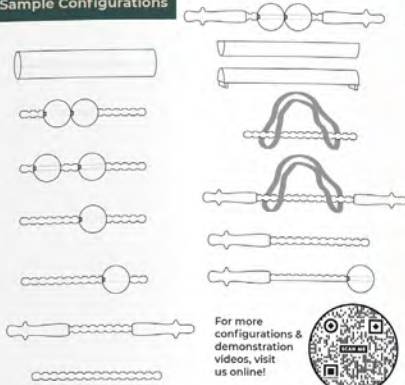
On the following pages, a variety of uses and configurations which would contribute to this knowledge repository can be seen. The images show the wide variety of uses of minimis.

minimis

YOUR TOOLS:



Sample Configurations



Legs - Quads and Hamstrings

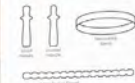


Arms - Biceps and Triceps



Time: 60 seconds
Rounds: 3x

Tools Needed:



Foam Roller Exercises



Time: 60 seconds
Rounds: 3x

Tools Needed:



Single Ball Configuration



Time: 60 seconds
Rounds: 3x

Configuration:

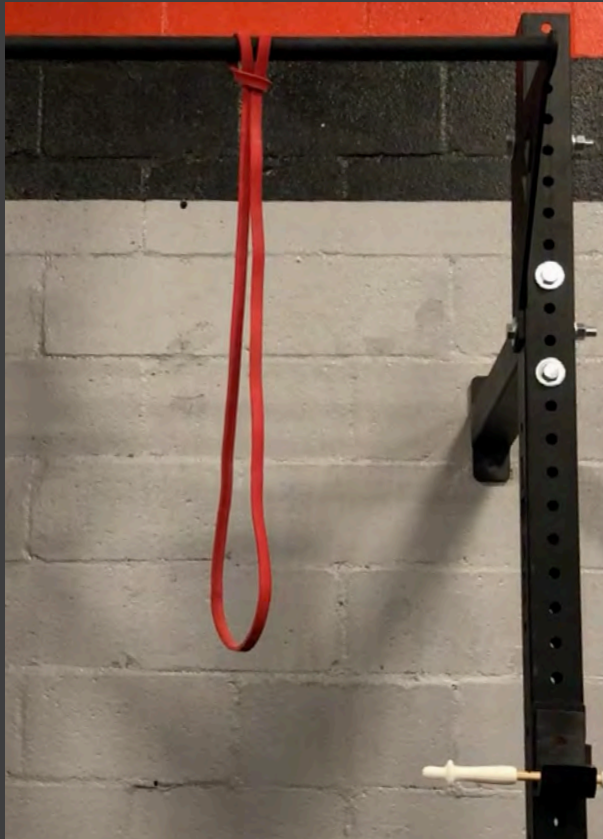










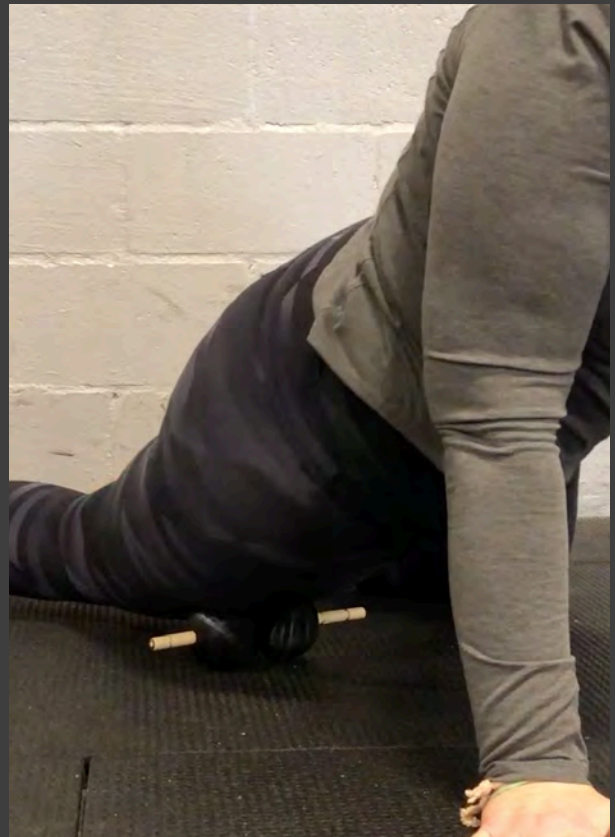
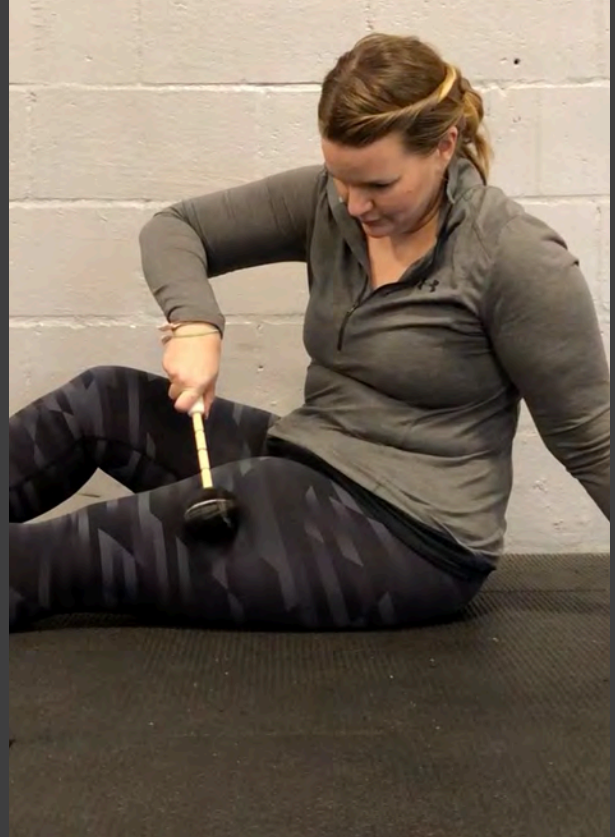


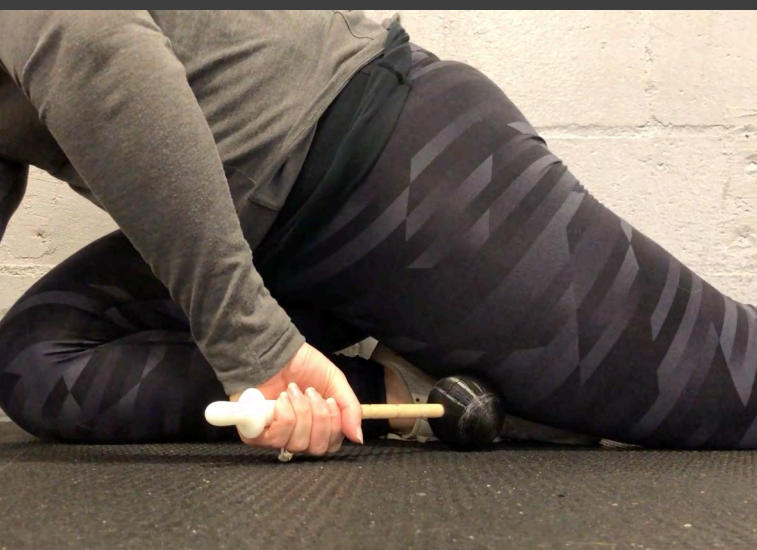










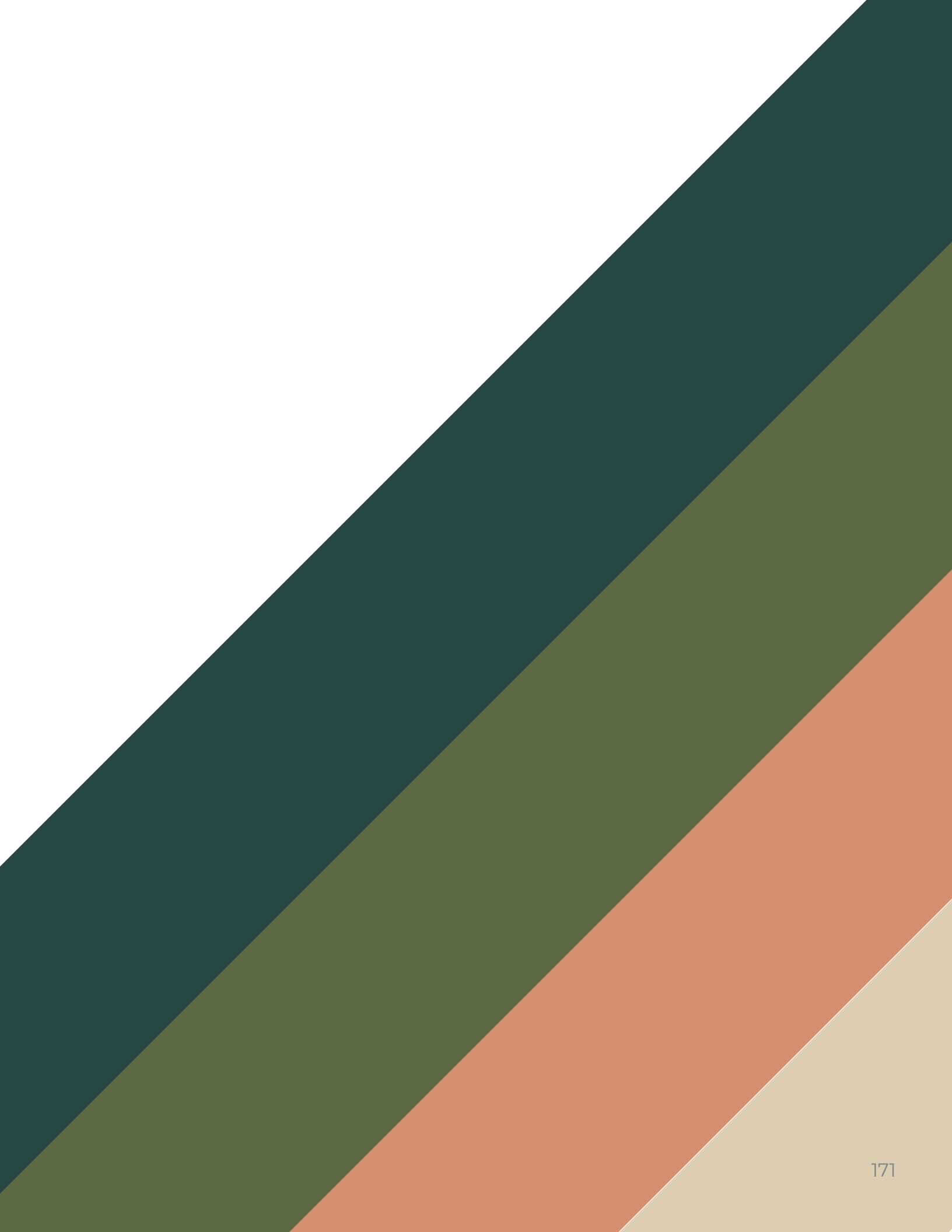




PART 07

FINAL

EVALUATION



Final Evaluation

Minimis was shown to 25 participants. After interacting and using the prototype, the participant was given a variation of the System Usability Scale utilized in user research. This part consisted of 10 questions utilizing 5 different answer selections ranging from Strongly Agree to Strongly Disagree using a Likert Scale format. A corresponding number value was assigned to each answer.

The questions were tailored for this project specifically. A final (11th) question asking a preference of wood was given to participants. See appendix for a sample survey format. This questionnaire addressed the usability of minimis. In the end a number (91.25) was calculated out of 100 for an overall acceptability level. Minimis was rated as excellent in usability.

A sample question is shown below.

1

I THINK THAT I WOULD LIKE TO USE THIS EQUIPMENT OFTEN.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Questions

NEGATIVE

POSITIVE

Q1

100%

of participants agreed or strongly agreed they would like to use this equipment

Q2

4%

of participants agreed or strongly agreed this equipment was unnecessarily complex

Q3

100%

of participants agreed or strongly agreed the equipment was easy to use

Q4

4%

of participants agreed or strongly agreed they would need the suggestion of an expert to use this equipment

Q5

92%

of participants agreed or strongly agreed the various functions of the equipment were well incorporated

Q6

4%

of participants agreed or strongly agreed there were too many features in this equipment

Q7

92%

of participants **agreed** or **strongly agreed** most people would learn to use this equipment quickly

Q8

4%

of participants agreed or strongly agreed this equipment was cumbersome to use

Q9

96%

of participants **agreed** or **strongly agreed** they felt confident while using the equipment

Q10

8%

of participants agreed or strongly agreed thought there was a steep learning curve with this equipment

Q11

88%

of participants chose **Acacia** wood when given the option between three samples

— 12%

of participants chose Pine wood when given the option between three samples

Question

System Usability Score



After the 25 participants submitted their questionnaires, a System Usability Score was calculated. The equipment, minimis, had an overall usability score of 91.25. This falls not only in the acceptable range, but was also excellent. This feedback was especially important. The final score of 91.25 revealed participants found the design of minimis satisfactory. However, this system does not take into account minor design details.

The SUS looked at three primary factors - effectiveness, efficiency, and satisfaction.

It should also be noted this questionnaire was given to experts in the field. Further investigation should be conducted to a more general population if the equipment was targeted as such.

Design Criteria Evaluation

Here the Design Criteria were measured against the final prototype. Each criteria number was evaluated as being achieved, not achieved, or potentially achieved but needs more exploration. Seen to the right is the original list with the numbers shown in the corresponding color listed below.

Of the six established design criteria, all were achieved in some manner. Number 6 a “possible attachment to a Rogue rig” does need more exploration. The band can be attached to the rig but is not an attachment piece itself.



Achieved



**Potentially achieved but
needs more evaluation**



Not achieved

1

**SMALLEST POSSIBLE
FOOTPRINT**

2

**MORE CONFIGURATIONS
THAN PIECES**

3

**AT LEAST EIGHT DIFFERENT
CONFIGURATIONS**

4

**DESIGNED TO RESIDE IN A
GYM OR PT OFFICE**

5

**HAS A CASE OR
CONTAINMENT SYSTEM**

6

**POSSIBLE ATTACHMENT TO
A ROGUE RIG**

Before & After

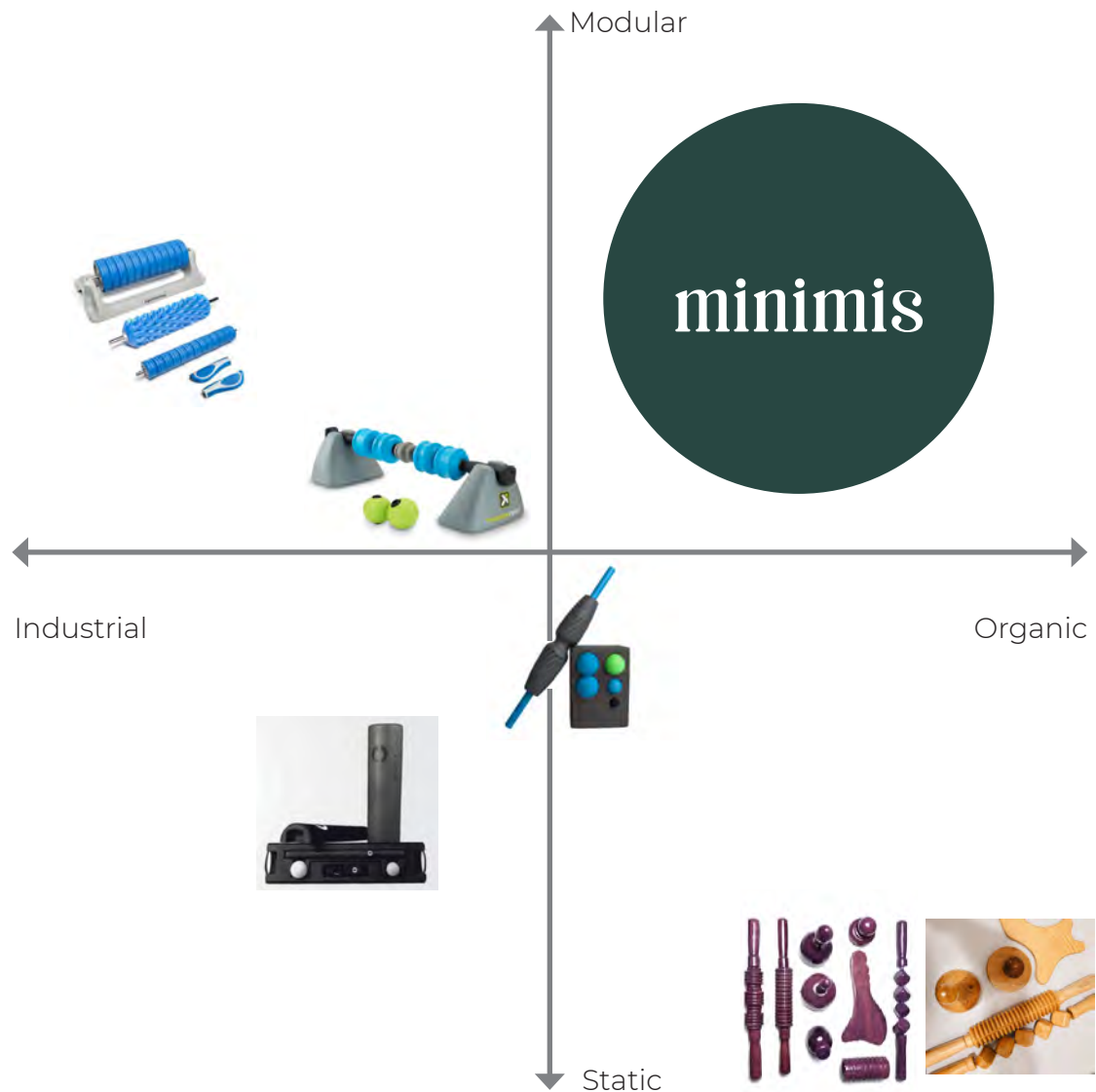


Prior to minimis, a corner of a gym or physical therapy office contained a plethora of mobility equipment. This included foam rollers, massage roller sticks, tennis balls, lacrosse balls, golf balls, softballs, PVC pipes, duct taped peanuts and numerous other ad hoc creations.

Now, an inclusive solution exists - minimis. As a self contained kit, minimis provides what the junky bin could not. The portability of minimis allows for a grab and go aspect unavailable for mobility equipment before. Physical therapists, trainers, and athletes can utilize minimis in a variety of ways to satisfy their mobility needs. No longer do gyms and physical therapy offices need junky bins and piles all over.



Market Matrix



As noted earlier, minimis provides a solution unavailable before. It not only satisfies the need for a more organic solution, but fulfills a major modularity need. Participants expressed their desire for a modular recovery tool to accomplish multiple needs. Therefore, on the market matrix above, you see where minimis fulfilled the market gap for both a modular and organic system.

Sample Applications





Sample Applications

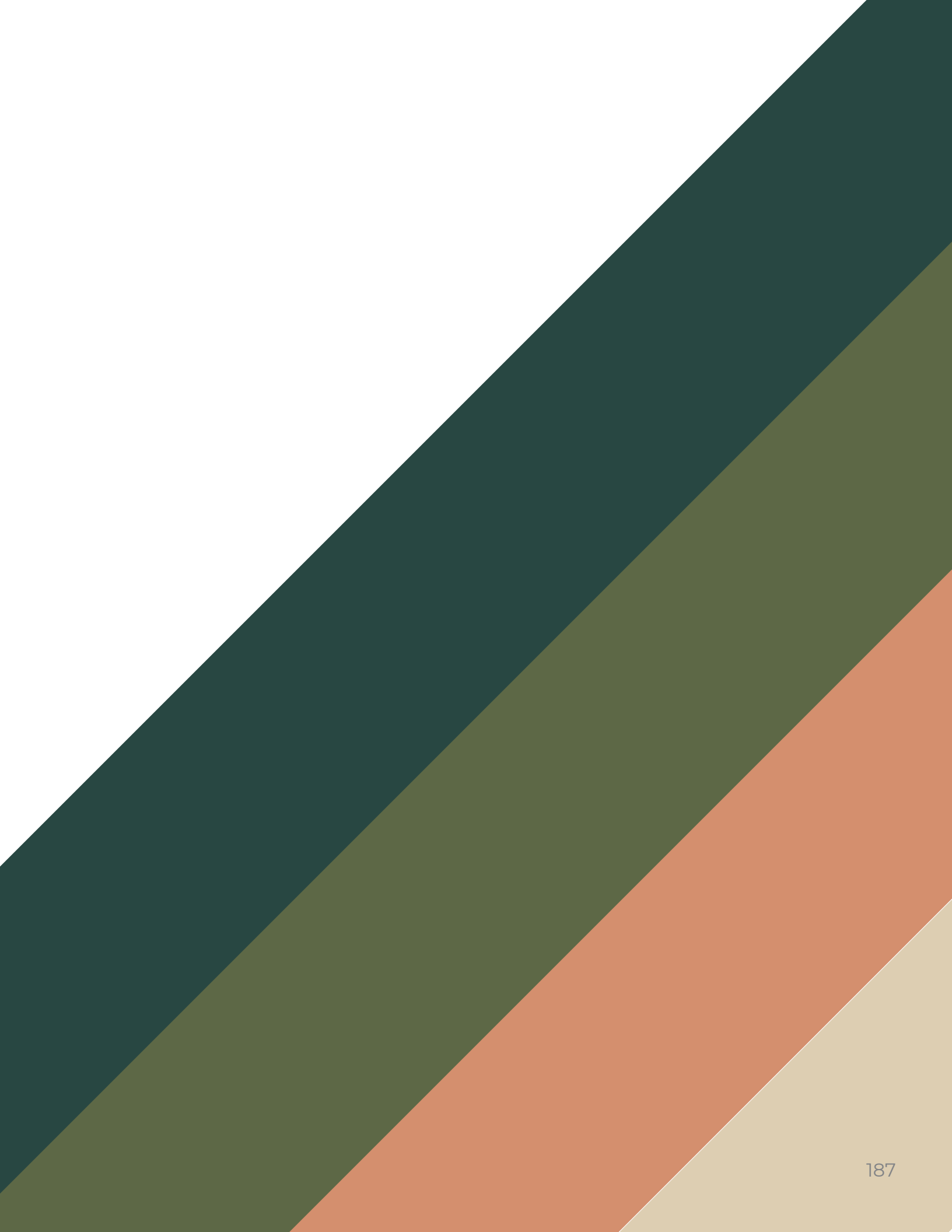






PART 08

BRANDING



Brand Identity

A variety of brand elements were vetted relentlessly. The main goal was to achieve an elevated and sophisticated brand image for the kit. The name “[minimis](#)” was settled on because of the Latin meaning of “minimal.” Minimis has the least amount of pieces to return the maximum value for the product/people. It represents a visual metronome to the eyes as it reads in text. The type face conveys both an organic yet geometric feel. This was important because “minimis” represents the structure of items for recovery and therapy while also taking on an artistic feel. Designed to reside in eyesight, minimis should be ever present and in the line of sight.

In a therapy office or a gym, the equipment should blend in seamlessly. Unlike other recovery equipment, it was designed not to be thrown in an equipment bin, basket, or in a closet with everything else. It was designed to be visually sophisticated. Its simplistic style also was purposeful as every piece of the kit serves an important purpose. Its pure nature warranted a neutral and modern color palette. The colors were

chosen because of their organic nature in tone. These do not convey man or woman, but a more natural organic simplicity. The brand image must also be approachable and unthreatening. Minimis was designed to be welcoming to all types of people.

The target customer for minimis was originally physical therapists or trainers. However, in conjunction with these stakeholders, athletes were identified as well because of their vested interest in recovery methods. Therefore, the target market for this brand would be anyone looking to mobilize more through movement. Minimis provides a path to better personal mobility.

The elements of the kit are efficient in both the function and form. They are a method to achieve a better range of motion and healing therapy. They are elegant in both their form and solution. A welcomed solution to current pain and a way to mitigate future discomfort. Minimis is always relevant to any athlete and an athlete is anyone with a body. The expert interviews showed these were the desired factors to a brand.

Product Name

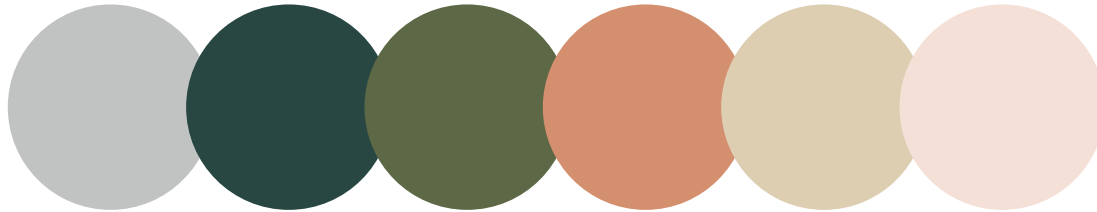
minimis

The brand shall be recognizable by the name itself rather than a defined landmark. This choice was purposeful to elevate the brand into sophistication. As the recovery methods were explored, it became apparent there were not many brands using neutral colors but rather stick with bold color palettes. Gender stereotypes and marketing become apparent when shopping for recovery tools. Neons and black/reds were often used for athletic and recovery gear. However, if it is specifically marketed toward women, pinks/purples/teals were often utilized. As the expert interviews for this project revealed, the need for a gender neutral feel in order to fluidly cross barriers was ideal.

The name shall be presented in lower case only. The rounded letters are inviting while elevating the brand. The chosen name was vetted in three ways.

- 1 The meaning, logistics of acquisition of domains, practicality, and ready availability of the name of the brand
- 2 The auditory delight and “mouth-feel” of the word itself
- 3 The physical letter forms and the shapes, geometry and visual design they created

Color Palette



**MOON
ASH**

**HUNTERS
GREEN**

**MOSSY
TOUCH**

**PEACH
SPRITZ**

**SANDY
DUNE**

**BLUSH
BELLINI**

**R 193
G 195
B 194**

**R 040
G 071
B 066**

**R 093
G 104
B 070**

**R 212
G 143
B 110**

**R 221
G 206
B 178**

**R 244
G 224
B 215**

**C 25
M 18
Y 20
K 00**

**C 81
M 52
Y 64
K 45**

**C 61
M 43
Y 77
K 27**

**C 18
M 49
Y 59
K 01**

**C 14
M 16
Y 31
K 00**

**C 04
M 12
Y 12
K 00**

#C1C3C2 #284742 #5D6846 #D48F6E #DDCE62 #F4E0D7

As discovered through expert interviews, color was important to the participants when deciding on equipment to use. Therefore, the color palette needed to be gender neutral. Participants expressed their desire for products without bright colors or “in your face” aspects. Taking this into consideration, a neutral earth-tone palette was constructed. This is unlike many products in the market today.

Typography

The brand name shall be shown in the SORIA SORIA typeface only. However, secondary brand typography guidelines are shown below.

Typeface

Montserrat

ABCDEFGHIJ
KLMNOPQRS
TUVWXYZ
0123456789

HEADER TEXT Montserrat Black

AaBbCcDd

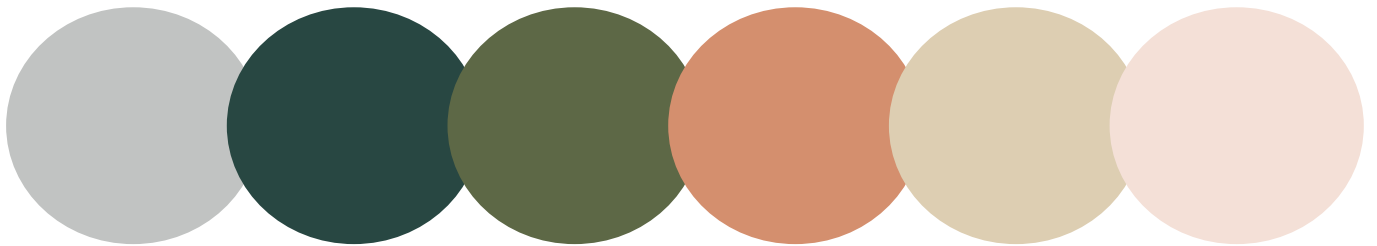
SUB HEADER TEXT Montserrat Medium

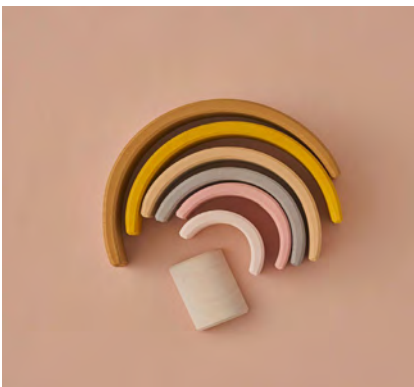
AaBbCcDd

BODY TEXT WEIGHT Montserrat Regular

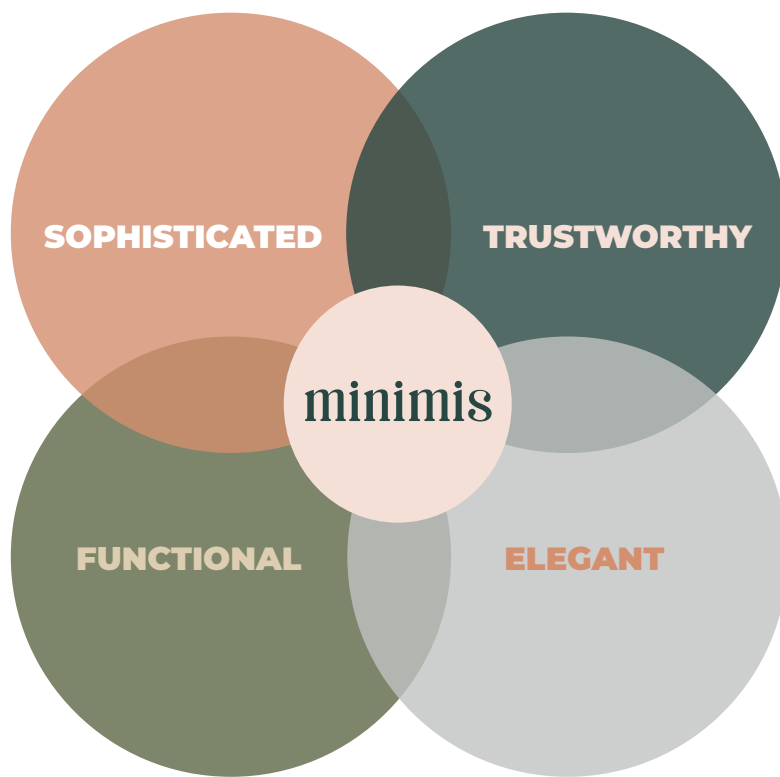
AaBbCcDd

Visual Inspiration





Brand Language



These words evoke the feelings a person would associate with minimis.

MISSION:

To make movement a part of everyday by empowering people to move efficiently and with purpose. To be the only stop on your mobility journey.

SAMPLE VOICE:

Designed to be in sight and top of mind, minimis encourages daily mobility through a sophisticated modular system of tools.

Find delight in your movement

Beautifully crafted, minimis urges you to move functionally to encourage your mobility. Whether preventing an injury, or using it for rehab, minimis is here to help.

Minimis focuses on core pieces to facilitate the purposeful movement of your body.

The minimum footprint of minimis allows you to have everything you need in a singular place.

Sophisticated? Yes. Intimidating? No.

The organic movement of the parts convey the ease of motion we help people achieve.

Mobility for the sophisticated everyone.

Movement for everyone.

Effectiveness meets design you love.

Brand Language

SAMPLE VOICE:

Minimis provides exactly what you need and nothing more.

The purist way to move.

Make movement a part of your everyday.

Ditch the chaos. Embrace the minimum.

One set of tools, 1000 ways to move.

The elegant solution to energize your muscles.

Everything you want meets everything your body needs.

Discover the way your body is supposed to move.

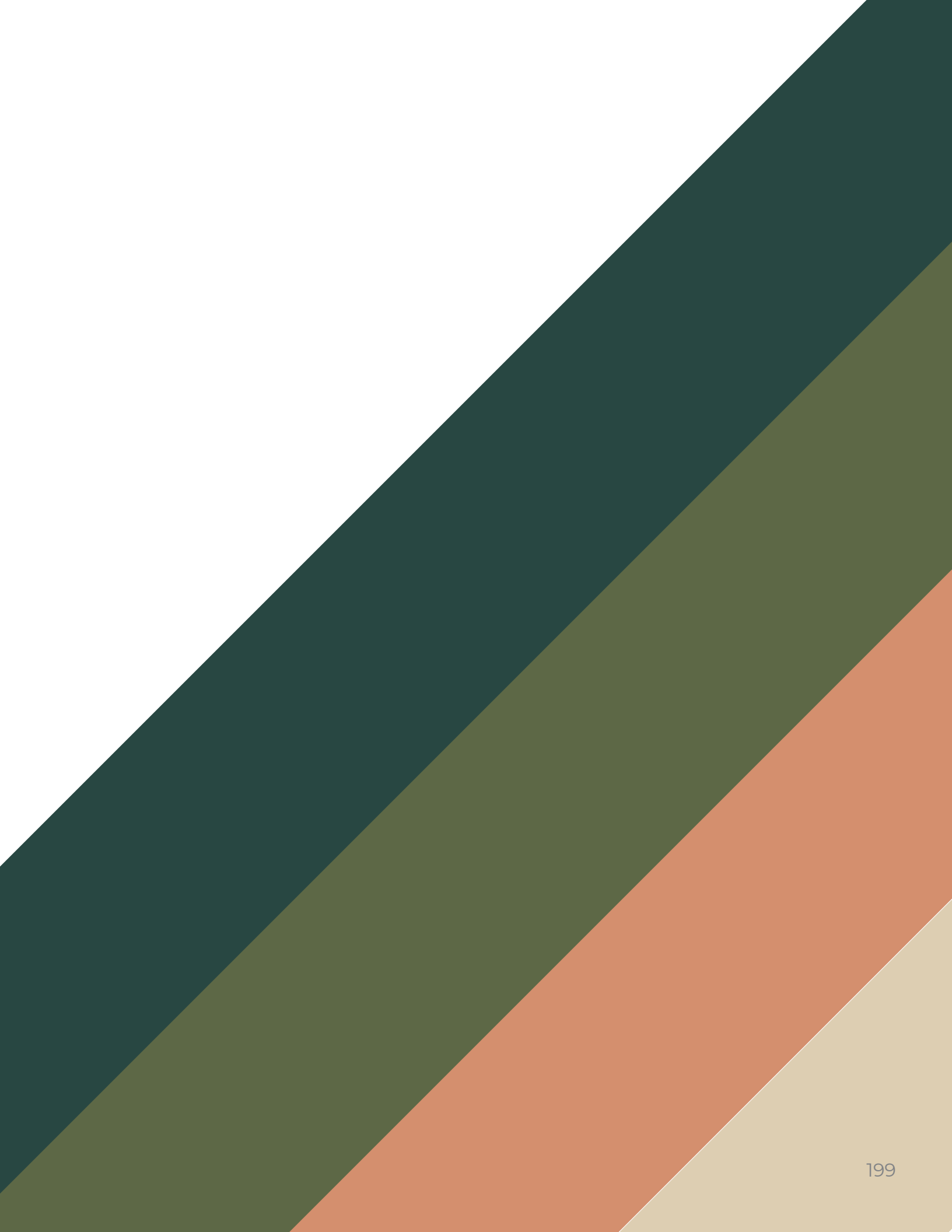
Recovery made elegant/stunning/beautiful.

Find delight in your movement.

Minimum pieces maximum movement.

**DITCH THE
CHAOS &
EMBRACE THE
MINIMIS**

PART 09 LOOKING FORWARD



Looking Forward

(and slightly backward)

Reflection

The results of this project indeed confirmed the value of modularity in physical therapy spaces and gyms. By creating a self contained system, the project reduced the overall footprint of intervention and recovery tools in physical therapy, gym, and recovery spaces. It also created value for the experts and participants by limiting the number of pieces needed to produce a desired variety of recovery methods. It provided utility to participants by being useful in configuring in various ways while also providing satisfaction in its ability to help participants in their recovery methods.

The prototypes were incredibly well received. Participants were genuinely excited for the next iteration and for that I was so grateful.

Minimis eliminated unnecessary clutter by providing solutions to participant needs in a new, modular, and streamlined way. Ad hoc solutions provided the runway for this project to take off. Now, instead of 5 adhoc items to achieve 5 specific recovery needs, minimis provides a set of 8 tools tot tackle over 250+ needs. Overall, the feedback from experts concluded the concept and prototype minimis has validity.

My hope was to provide a solution to a real need. Thank you to everyone who helped me along the way.

Moving Forward

Now let's look forward. Minimis has potential commercial viability; however, more research into market potential would be warranted. Although this project revealed the desire for this product, a more thorough and larger market study should be conducted. This would identify the items such as specific target markets and customer segmentation. In addition, a price point would be established in accordance with customer willingness to pay.

Minimis, if commercialized, could have the ability to have additional items and expansion packs for specific needs. This project was derived from industry experts and any deviation of such should come with additional research. The sample size of this project was simply not large enough to translate to a meaningful market conclusion on commercialization. Therefore, the sample size would need to expand. A larger scale study would need to be conducted.

An initial patent search was conducted, but a patent attorney should be consulted if commercialized. In addition, research into potential for medical device regulation should be taken into consideration.

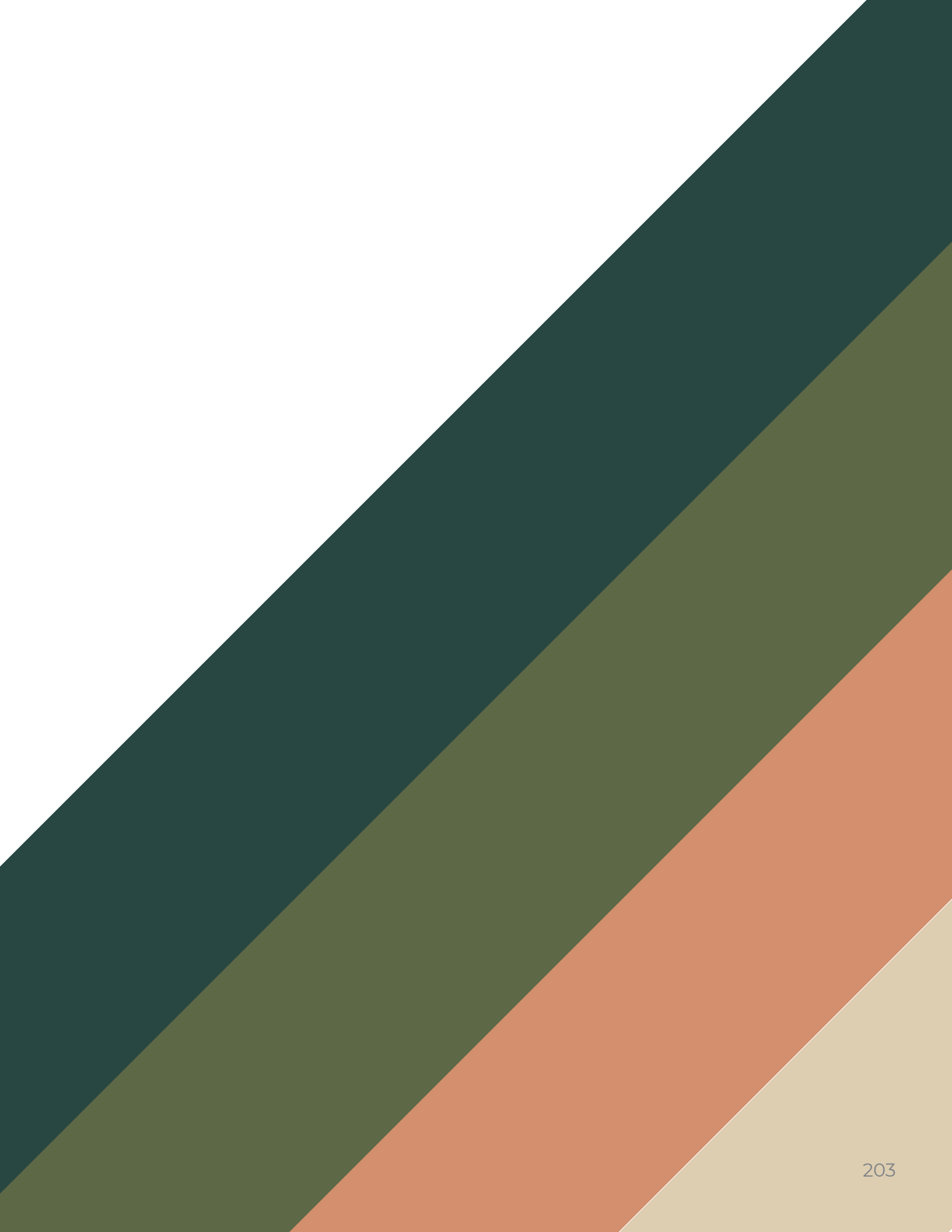
Material considerations and testing is an important aspect of this design. Therefore, multiple materials should be tested for functionality, viability, and durability. This would also contribute to cost considerations of manufacturing and the subsequent revenue impact of such decisions.

Perhaps most importantly, design is never done. Therefore, additional refinement of the design details should continue. Ideally, these would be tested by participatory design methodologies and iterated upon to ensure the best design and functionalities are being utilized.

I don't know what the future holds, but perhaps one day I will have to opportunity to commercialize. We will have to wait and see what 2021 holds in store.

PART 10

APPENDIX



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IRB Protocols

Research Study of Physical Therapy Settings

You are being asked to be a volunteer in a research study.

Purpose

The purpose of this research study is to understand if modularity is valuable in a physical therapy setting by understanding the most commonly used interventions are in a recovery setting. We expect to have 5 to 20 participants in the study.

Exclusion/Inclusion Criteria

Participants in this research study must be at least of 18 years of age, be currently physically present in the United States, fluent in English.

Procedures

If you decide to be in this research study, your part will involve an interview approximately 60 minutes long. In the interview, you will be asked a series of questions regarding physical therapy tools, interventions, and procedures. You will be asked to demonstrate and speak aloud using a stream of consciousness to describe your intervention decisions and methods. With your permission, we will videotape these demonstrations only recording hand movements. This visit will take approximately one hour. Remember, you may stop at any time.

Risks or Discomforts

The risks involved are no greater than those involved in daily activities such as performing your daily job.

Benefits

You are not likely to benefit in any way from participating in this research study. We hope that what we learn will help future research studies that aim to improve the physical therapy experience.

Compensation to You

There is no compensation for participation in this research study.

Storing and Sharing Your Information

Your participation in this study is gratefully acknowledged. It is possible that your information/data will be enormously valuable for other research purposes. By signing below, you consent for your de-identified information/data to be stored by the researcher. If you agree to allow such future sharing and use, your identity will be completely separated from your

information/data. Any future research must be approved by an ethics committee before being undertaken.

Use of Photographs, Audio, or Video Recordings

Investigators may choose to use video (moving picture), audio (sound), or photograph (image) to record information for research. Methods of recording research participants can include use of a camera, camcorder, smartphone, voice note, Skype, Adobe Connect, etc. The investigators will be the only persons with access to these medias. The media will be kept on a secure password protected hard drive at Georgia Tech. If hardcopies are made, these media shall be stored in a locked cabinet. The media will only be used to inform future designs and no faces shall be shown, only hands and devices.

Please provide initials below if you agree to have this interview recorded or not. You may still participate in this study even if you are not willing to have the interview recorded.

_____ I do not want to have this interview recorded.

_____ I am willing to have this interview recorded.

Confidentiality

Your responses to the questions asked are being documented via video and notes and shall be stored on a password protected hard drive. No personally identifiable data shall be stored in conjunction with these files as to reduce the risk of being identified.

Your privacy will be protected to the extent required by law. Your name and any other fact that might point to you will not appear when results of this study are presented or published. The results of this study will only contain group mean results and will contain no personal information. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB or OHRP may review study records.

Costs to You

There are no costs to you, other than your time, for being in this research study.

Participant Rights

- Your participation in this research study is voluntary. You do not have to be in this research study if you don't want to be.
- You have the right to change your mind and leave the research study at any time without giving any reason and without penalty.

-
- Any new information that may make you change your mind about being in this research study will be given to you.
 - You may choose to download or print a copy of this consent form to keep.
 - You do not waive any of your legal rights by completing the interview.

Questions about the Study

If you have any questions about the research study, you may contact the Principle Investigator, Kevin D. Shankwiler at (404) 229-5052 or kshankwiler@gatech.edu (or) Co-Investigator, Christina Anderson at (404) 680-5054 or canderson335@gatech.edu.

Questions about Your Rights as a Research Participant

If you have any questions about your rights as a research participant, you may contact Ms. Melanie Clark, Georgia Institute of Technology, Office of Research Integrity Assurance, at (404) 894-6942

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

Participant Name (printed)

Participant Signature

Date

Time

Signature of Person Obtaining Consent

Date

Time

Consent to Store and Share your Information:

[Insert signature line with clear options for subjects to agree or decline.]

"I agree that my de-identified information/data may be stored and shared for future, unspecified research.

SIGNATURE _____

I do not allow my de-identified information/data to be stored and shared for future, unspecified research. These may only be used for this specific study.

Georgia Institute of Technology
Image License & Release Form for GT Activity

SIGNATURE _____

Image Release

For good and valuable consideration, the sufficiency of which is hereby acknowledged, I, Participant (as identified below), agree as follows:

1. During my enrollment and/or participation in the Interview of Physical Therapists, Trainers, and Others Involved with Recovery Methods (hereinafter "Activity"), I understand that I may be videotaped, photographed and/or recorded. I hereby grant permission and authorize The Board of Regents of the University System of Georgia by and on behalf of Georgia Institute of Technology ("Georgia Tech") to videotape, photograph and/or record me, my voice and/or my property during my enrollment and participation in the Activity(hereinafter collectively known as "Image").
2. I hereby grant to Georgia Tech and Georgia Tech Research Corporation ("GTRC") an irrevocable, non-exclusive, royalty-free, sublicensable, perpetual license to use, display, publish, post, reproduce and allow others to use, display, publish, post, and/or reproduce the Image, in whole or in part, individually or in conjunction with other images, printed or electronic matter, in any media now or hereafter known, for educational, promotional, or marketing purposes or any other legitimate purpose whatsoever, and to use my name in connection therewith if Georgia Tech and/or GTRC so chooses. I also hereby grant Georgia Tech and GTRC the right and permission to alter, transpose and/or edit images, videotapes, recordings or other media featuring the Image to the extent necessary to use, display, publish, post or reproduce the Image, in whole or in part, in any media or format, now or hereafter known, and/or on the World Wide Web or in any other manner. I hereby waive any right to inspect or approve Georgia Tech or GTRC's use of the Image or any finished version or display incorporating the same.
3. As part of my participation in the Activity, Georgia Tech or GTRC may display, publish or post the Image on the World Wide Web or another widely accessible manner. I understand that the Image shall be readily accessible by the general public. I acknowledge and agree that Georgia Tech, The Board of Regents of the University System of Georgia ("Board of Regents"), GTRC and their members, officers and employees individually shall not be responsible for any use of the Image by any third party accessing the Image through the World Wide Web or any other manner.

4. I hereby release and forever discharge Georgia Tech, The Board of Regents, GTRC, and their members, officers and employees individually from all claims, demands, rights, and causes of action of whatever kind, arising from and by reason of any known or unknown, foreseen or unforeseen injuries, damages, and the results thereof resulting from the use of the Image, including without limitation, claims of slander, libel, invasion of privacy, or rights of publicity. I understand that the acceptance of the release and waiver of liability herein by Georgia Tech and The Board of Regents shall not constitute a waiver, in whole or in part, of sovereign immunity by Georgia Tech, The Board of Regents, and their members, officers, and employees individually.
5. This license and release shall inure to the benefit of the heirs, legal representatives, licensees and assigns of Georgia Tech, Board of Regents, and GTRC. This release shall be binding upon me and my heirs, legal representatives and assigns.
6. If any provision of this authorization and release shall be held invalid or unenforceable, such provision will be deemed deleted from this authorization and release without invalidating the remaining provisions of this authorization and release or affecting the validity or enforceability of such remaining provisions.

BY MY SIGNATURE BELOW, I, PARTICIPANT, HEREBY CERTIFY THAT I AM 18 YEARS OF AGE OR OLDER, NOT SUFFERING UNDER ANY LEGAL DISABILITIES AND THAT I HAVE BEEN ADVISED AND UNDERSTAND THAT THIS RELEASE IS NOT REQUIRED IN ORDER TO PARTICIPATE IN THE ACTIVITY. I FREELY AND VOLUNTARILY PROVIDE THIS LICENSE AND RELEASE.

Participant Signature

Date

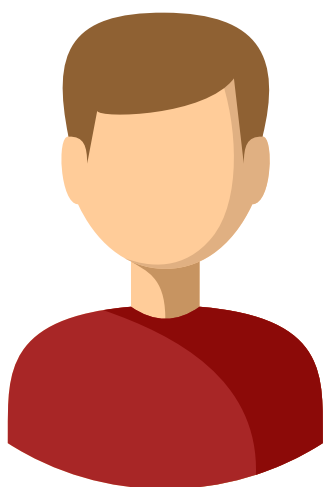
Signature of Parent or Guardian if
Participant is under 18 years of age

Date

***“I use a
variety of
different
tools daily to
mobilize.”***

Expert No. 1

Interview



TITLE: Physical Trainer

YEARS OF EXPERIENCE: 8

BACKGROUND:

A personal trainer for 8 years, this expert also has multiple certifications in exercise training. The expert was chosen because of their current participation as an athletic coach in a gym.

KEY INSIGHTS

- People are intimidated by the amount of mobilization tools available if left to their own.
- Newer gym members are less likely to mobilize.
- Trainers who travel and go to events do not want to haul a huge bag or kit of items but a smaller assembly of tools.
- We try to mobilize before and after every class but it's something people need to be doing daily.
- Having a resource (guide) to refer back to could be helpful for a new beginner such as a photograph or booklet.
- Color is important. As a male, I do not want to necessarily roll out on a hot pink foam roller.
- I do not even know what some of the items in the mobility bin do or are designed to do.

Expert No. 2

Interview



TITLE: PHYSICAL TRAINER

YEARS OF EXPERIENCE: 10

BACKGROUND:

A trainer for ten years, the participant has a degree in higher education related to athletics. An athlete by trade, the participant mobilizes daily and has made custom tools to mobilize.

KEY INSIGHTS

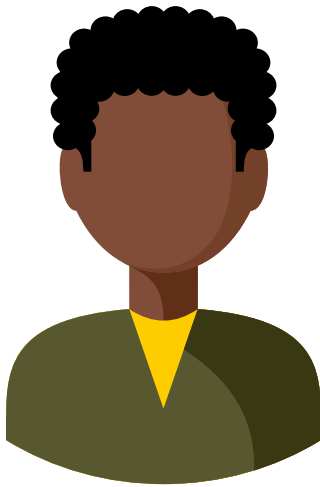
- You can walk into a gym and depending on the most common injuries seen in a gym you will see more “stuff” made for those injuries.
- CrossFit gyms in particular are good at creating what they need to mobilize.
- Duct tape and lacrosse balls are staples of any good gym.
- Different body types require different equipment.
- Size and density are really important when rolling out muscles for mobility purposes.
- If someone is just starting out, the tools should be softer because their muscles are fresh to being smashed and aren’t used to being manipulated in this way.
- If members can’t find a tool or item to reach an area someone will duct tape configure something to reach/ mobilize the tight or injured area.

“Not all the tools fit my body shape and size. I wish I could customize.”

***“Motion is
lotion **in**
athletics.”***

Expert No. 3

Interview



TITLE: COLLEGIATE ATHLETIC TRAINER

YEARS OF EXPERIENCE: 15

BACKGROUND:

A head athletic trainer at the collegiate level, the expert not only designs training programs, but also is involved in recovery methods. Athletes seek guidance in how they should recover by involving this expert.

KEY INSIGHTS

- Movement at a fundamental level is key for mobility and recovery.
- Go back to primal patterns, these are the baseline for how we move.
- Thoracic mobility with The Peanut helps correct the hunched positions we are in all day.
- We spend much of our days in immobile positions, so it is key to mobilize daily.
- Bands, balls, and rollers are the must haves for mobility and can be used in a variety of ways.
- Traveling as an athlete can be hard if you have lots of equipment.
- Space in the gym is important, but travel space is more limited and more important.
- Having a case is ideal because it puts everything in one place.
- The facility uses tools such as tape, mobility balls, and rollers in a variety of ways.

Expert No. 4

Interview



TITLE: BOOTCAMP TRAINER

YEARS OF EXPERIENCE: 12

BACKGROUND:

A bootcamp instructor as well as a certified Level 1 CrossFit trainer, this expert knows how to use bodyweight as well as functional movements to achieve goals for the client.

KEY INSIGHTS

- People should learn how to use their bodies before they learn how to use weights.
- Lacrosse balls are a staple in any gym, travel pack, or mobilization effort.
- Size is always a factor when talking mobility at home or on the go - I do not haul lots of equipment when I travel to see clients or athletes.
- People do not mobilize because they simply do not know enough about it (their body).
- Education of proper mobilization is key for people to perform the correct movement to get the results they want and are expecting.
- Mobilization should never hurt!!
- The density of mobility tools varies as the levels of familiarization varies.

***“Mobility
is the
single most
important
factor in
preventing
injuries.”***

***“You have
to think
differently
when
mobilizing.
Think about
your muscles
and the
positions they
are in.”***

Expert No. 5

Interview



TITLE: PHYSICAL THERAPIST

YEARS OF EXPERIENCE: 9

BACKGROUND:

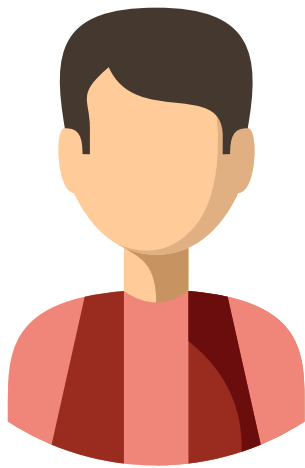
A licensed physical therapist for 9 years, this expert performs a variety of methods of recovery and intervention. This expert takes new technology classes and seminars to stay up to date with available methods.

KEY INSIGHTS

- ART (active release therapy) is the number one service performed in the office. It even has an app with videos I refer back to often.
- When a new client comes in a diagnostic testing sheet is given to them for the initial evaluation.
- I tend to perform interventions my patients ask or like because it makes them feel better.
- Over-manipulation of muscles can have a detrimental effect.
- Methods such as cupping for recovery can be incredibly time consuming and hence, are not utilized as much as other methods.
- Lacrosse balls are the single most important thing in recovery methods.
- Temperature, vibration, and compression are methods being utilized in totally new ways today (such as a foam roller which vibrates and changes temperature).

Expert No. 6

Interview



TITLE: PHYSICAL TRAINER

YEARS OF EXPERIENCE: 8

BACKGROUND: 4

A certified Level 2 CrossFit coach, the expert actively coaches athletic classes and well as some personal training. Utilizing what is available, this expert does not hesitate to make their own tools if needed.

KEY INSIGHTS

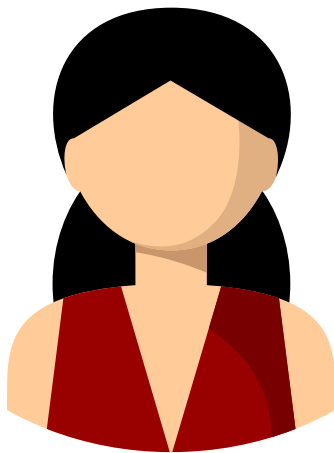
- The colors of the tools actually matters - especially if it is bright in color scheme.
- There is value in reducing the size and overall footprint of mobility tools.
- Minimal tools are better so as not to overwhelm people.
- People tend to use what they know more simply because they know how to use it not because they do not want to use anything else.
- There is a stigma to having tons of mobility equipment and taking it everywhere. But, there should not be a stigma.
- If the expert could only have one mobility tool it would be a lacrosse ball because it is so versatile.
- At a competition you will always see people using foam rollers, bands, and mobility balls. Those are the three most common items to travel with an athlete.
- Less is MORE¹

“You look around the gym to find items to get to the areas you need to roll out. I will use anything.”

***“Knowing
how to
use the
equipment is
as important
as using it.”***

Expert No. 7

Interview



TITLE: PHYSICAL THERAPIST

YEARS OF EXPERIENCE: 17

BACKGROUND:

Trained in numerous techniques, this expert prefers a hands on approach. By utilizing their hands as a guiding force, this expert practices a hands only muscle release technique.

KEY INSIGHTS

- The hands are the most important tool of all. Being able to feel the difference between a good muscle and an injured muscle is key to what I do.
- Recovery methods have changed dramatically the past few years to include temperature, vibration, and percussion/compression.
- Mobility prevents injuries. Period.
- Proper form comes from mobility and mobility comes from a daily commitment to mobilize.
- Correct mobilization form is as important as the form when an athlete is working out.
- Pre and post mobilization is ideal but after a workout is what is recommend most as the long as a warm up is completed.
- Any items in the gym can be used as a mobility tool.

Final Evaluation Questionnaire

Please circle the number which corresponds to your feelings or opinion.

1 *I THINK THAT I WOULD LIKE TO USE THIS EQUIPMENT OFTEN.*

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2 *I FOUND THIS EQUIPMENT UNNECESSARILY COMPLEX.*

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

3 *I THOUGHT THIS EQUIPMENT WAS EASY TO USE.*

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

4 *I THINK THAT I WOULD NEED THE SUGGESTIONS OF AN EXPERT PERSON TO BE ABLE TO USE THIS EQUIPMENT.*

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

5 I FOUND THE VARIOUS FUNCTIONS OF THIS EQUIPMENT WERE WELL INCORPORATED.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

6 I THOUGHT THERE WAS TOO MANY FEATURES IN THIS EQUIPMENT.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

7 I WOULD IMAGINE THAT MOST PEOPLE WOULD LEARN TO USE THIS EQUIPMENT VERY QUICKLY.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

8 I FOUND THE EQUIPMENT VERY CUMBERSOME TO USE.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

9 I FELT VERY CONFIDENT USING THE EQUIPMENT.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

10 I FELT THERE WAS A STEEP LEARNING CURVE WITH THIS EQUIPMENT.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

11 WHICH TYPE OF WOOD WOULD YOU PREFER FOR THIS PRODUCT?



Acacia



PINE



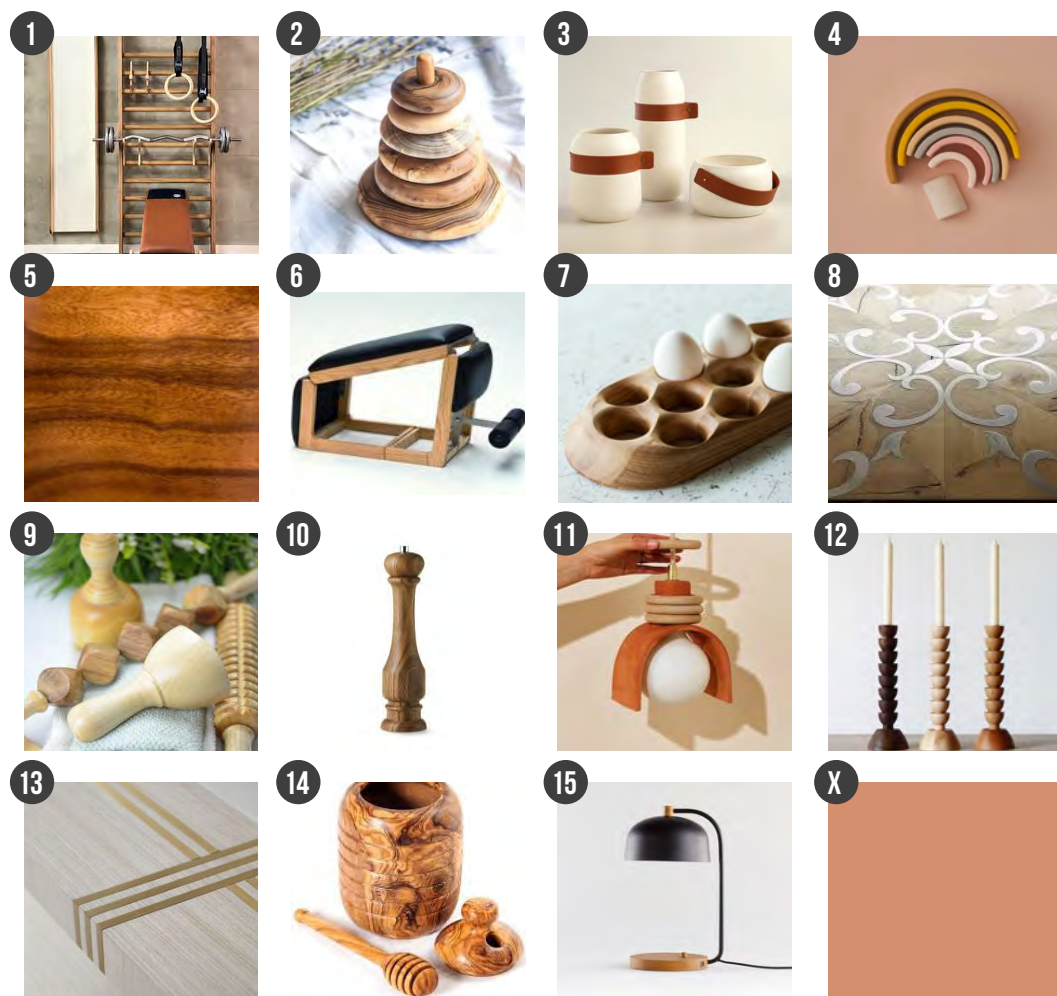
CHERRY

Final Evaluation Questionnaire Results

Participant #	Q1	Q2	Q3	Q4	Q5
1	5	1	5	2	5
2	5	1	4	1	5
3	5	1	5	2	5
4	4	2	5	2	5
5	5	1	5	2	5
6	5	1	5	2	5
7	5	1	5	2	5
8	4	1	5	1	5
9	4	2	4	1	5
10	5	1	5	1	4
11	5	1	5	1	5
12	5	1	5	1	5
13	5	3	5	1	5
14	5	1	5	2	5
15	5	1	5	2	5
16	5	2	5	2	5
17	4	1	4	3	3
18	5	1	5	1	5
19	4	1	5	1	5
20	5	1	5	1	5
21	5	2	5	1	5
22	5	1	5	1	5
23	5	1	5	1	3
24	5	1	5	2	5
25	5	1	5	1	5
AVG	4.8	1.24	4.88	1.48	4.8

Q6	Q7	Q8	Q9	Q10	Q11
1	4	1	5	1	Acacia
1	5	2	5	2	Acacia
1	5	2	4	1	Acacia
1	5	1	4	3	Acacia
1	4	1	5	2	Acacia
1	5	2	4	2	Pine
1	4	1	5	2	Acacia
1	3	1	4	2	Acacia
1	5	1	5	1	Acacia
1	5	1	5	2	Acacia
2	5	2	5	2	Acacia
1	5	2	5	1	Acacia
1	4	3	5	2	Acacia
1	4	1	3	1	Acacia
1	5	1	5	2	Acacia
1	4	1	4	1	Pine
4	4	1	4	2	Pine
2	5	2	5	3	Acacia
1	5	1	5	1	Acacia
1	5	1	5	2	Acacia
1	3	1	5	1	Acacia
1	5	1	5	1	Acacia
1	5	2	5	1	Acacia
1	5	1	4	2	Acacia
1	5	1	5	1	Acacia
1.2	4.56	1.36	4.64	1.64	Acacia

PHOTO SOURCES



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