Form

Ergonomic Industrial Sewing Workstation

Sam Parker
April 2018

Ergonomic Industrial Sewing Station

By:
Sam Parker

Submitted in partial fulfillment of the requirements for the degree of
Bachelor of Industrial Design
School of Applied Technology
Humber College of Technology and Advanced Learning

Supervisors: Dennis L. Kappen and Bruce Thomson

HUMBER
School of Applied Technology

Ergonomic Industrial Sewing Station

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2018

Abstract

The following report documents: the research findings, design process, development, and final results of a project to improve the ergonomics of an industrial sewing workstation. *Form* was developed to improve the working environment of industrial sewers who often over time, develop serious repetitive stress injuries in their fingers, hands, wrists, forearms, shoulders, necks, backs, and eyes. *Form* improves the ergonomics of the industrial sewing workstation to reduce the strain on the sewer's body, and it provides a more comfortable environment for the sewers to work in, improving their overall quality of life both at, and away from, the workplace.

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Student Name : Sam Parker

Acknowledgments

I would like to thank all those involved in helping me complete this thesis: the sewers that I interviewed, my thesis advisor Andrew Gardiner, and my professors at Humber College. I would also like to thank both of my parents, Julia Williams, and Wayne Parker, and my partner Beth Parkin for their support throughout this process.

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Problem Definition

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1.1
The goal of this thesis is to create a more ergonomic sewing work station that is able to reduce stresses on the sewer that lead to repetitive stress injuries.

Labour laws | TheFableists. (2014). Retrieved September 20, 2017, from https://thefableists.wordpress.com/tag/labour-laws/

Bain, M. (2016). HMB: H&M reportedly used garment factories that worked 14-year-olds for 12-hour shifts — Quartz. Retrieved September 21, 2017, from https://qz.com/763384/hm-reportedly-used-garment-factories-that-worked-teens-for-12-hour-shifts/

1.2
Approach Taken

Research Topics

- Causes of Sewing Related Stress Injuries
- Work Station Ergonomics
- User Interfacing Across Cultures
- Manufacturing Work Flow Design
- Current Solutions
- Cost, Materials and Manufacturing
- Target demographic

Key Questions

- How can we reduce the instances of stress related injuries?
- How can we make these machines more intuitive for a diverse group of users?
- How can we improve the work flow of these stations?
- How can we use new manufacturing techniques to revolutionize the sewing industry?

1.3 Background
History of the Sewing Machine

1755
Charles Weisenthal patented a needle for mechanical sewing.

1790
Thomas Saint patented a machine to pass a needle through leather.

1810
Balthasar Krems developed a machine to sew caps.

1814
Josef Madersperger developed a series of machines for sewing, none are found to function.

1818
John Adams Doge and John Knowles created a machine that can stitch short lengths.

1830
Barthelemy Thimonnier patented a machine made from wood that was able to sew lines of stitching reliably. These machines were then used to sew French army uniforms until the factory was destroyed by tailors who were worried about their job security after the invention of the new machine

1833
Walter Hunt invented the first lock stitch machine; however, it could only sew short lengths.

1844
Elias Howe patented the first working modern style sewing machine.

Fig 1.1 Sewing Timeline
(Forsdyke, A Brief History of the Sewing Machine, Retrieved October 1, 2017)

1 out of every 10 Canadian adults had an Repetitive Stress Injury (RSI) serious enough to limit their normal activities in 2000-2001

15% **4.5 Million People**

15% of Canadians are affected by RSIs

Women are more likely than men to develop RSIs

% of Reported Common Injuries

25% Neck or Shoulder

23% Wrist or Hand

19% Back

16% Elbow and Lower Arm

17% Lower Extremity or Unspecified Body Part

Stats Can (2003)
Canadian Armed Forces (2017)
Center For Occupational Therapy (2017)

STRESS Risk of RSI

Stress has been proven to increase the risk of RSI

23%

In 1999 23% of men and 31% of women with RSI reported chronic pain

31%

Free photo: Sewing, Machine, Hand, Needle - Free Image on Pixabay - 2345477. (n.d.). Retrieved February 19, 2018, from https://pixabay.com/en/sewing-machine-hand-needle-thread-2345477/

Carpal Tunnel

Carpal Tunnel is the medical name for a compression of the nerve in our carpal tunnel which is located in our wrists. This compression usually causes numbness and tingling in our hands and arms and can also result in weakness. In the workplace this is usually caused by over use; however, vibrating tools have also been known to exacerbate the issue.

Mayo Clinic, Retrieved October 1, 2017)

Tendonitis

Tendonitis is the medical term for inflammation of a tendon. Tendons attach muscles to our bones. Tendonitis is usually brought on by repeating a movement over and over again for prolonged periods of time. Shoulders, elbows, and wrists are the most common areas of tendonitis in people working in the textile and apparel industry.

Mayo Clinic, Retrieved October 1, 2017)

Tenosynovitis

Tenosynovitis is a term used to describe inflammation of the sheath that surrounds our tendons. In the textile and apparel industry this is usually caused by excessive stain or overuse. Wrists and hands are some of the most common areas affected by tenosynovitis.

MedlinePlus Medical Encyclopedia, Retrieved October 1, 2017)

Bursitis

Bursitis is a condition that affects the bursae sacks in our joints. Normally these sacks cushion bones, tendons and muscles near joints. When these sacks become inflamed, it is called bursitis. Inflammation generally occurs from frequent repetitive motion. Bursitis develops most commonly in our elbows and shoulders.

Mayo Clinic, Retrieved October 1, 2017)

Aye Min Soe. (n.d.). IMG_6504.jpg (1000×667). Retrieved February 19, 2018, from http://www.globalnewlightofmyanmar.com/wp-content/uploads/2015/08/IMG_6504.jpg

IVAN PIERRE AGUIRRE. (n.d.). How NAFTA has hurt Canadian auto jobs | Toronto Star. Retrieved February 19, 2018, from https://www.thestar.com/

Social Context

Demographics

Sewers in North America are mostly female, with an average age of 42 years old. They are culturally diverse and have an average annual income of $20,000-$30,000 (Data USA, 2015). Unfortunately women are also more susceptible than men to develop repetitive stress injuries.

Product Trends

Industrial sewing machines today are far more advanced than the original machines designed back in 1844. Today these machines are seamless hybrids of computers and machines allowing them to offer more advanced features. Apart from offering more features, these machines are significantly more powerful, faster, and are importantly, more efficient. Several elements that are important to factory owners that play a large role in design are size, durability, noise level, and efficiency. Today it is common for these machines to have high powered motors, multiple needle positions, laser technologies, and LED lighting. (Nikam, Industrial Sewing Machine Trends 2017-2027, 2017)

Industry Trends

Within the industry, high end industrial machines are becoming commonplace due to their capacity for high volume and accuracy. They are becoming quieter and more efficient, making them a more favorable choice for factory owners. As the population grows globally and with the rise of the middle class in India and China, it is estimated that the need for industrial machines will grow over the next several decades. (Nikam, Industrial Sewing Machine Trends 2017-2027, 2017)

Media

In today's world, it is becoming more common for consumers to hold companies accountable for their manufacturing practices. It is not uncommon to see newspaper articles and news clips documenting the poor working conditions in underdeveloped countries. In most cases, these articles talk about the unfair wages and endless hours workers are required to work. However, what is often not reported is the number of people working long hours, struggling with repetitive stress injuries.

Research

2

Reformation. (n.d.). Retrieved February 19, 2018, from https://www.thereformation.com/weareformation

User Research 2.1
User Profile 2.1.1

Reformation. (n.d.). Retrieved February 19, 2018, from https://www.thereformation.com/weareformation

Jenny Zu
Industrial Sewer:
Name: Jenny Zu
Gender: Female
Age: 43
Experience: Highly Experienced
Job: Sewing Machine Operator
Income: $25,000 annually.
Location: Kitchener, Ontario
Frequency of use: Monday - Friday
Duration: 8.5 hours / Day

Primary User

Demographic
Location: Canada and the US
Ethnicity: Mixed
Average Age: 42
Gender: Predominantly Female
Income: Low to Middle
Use Period: Full Work Day

Experienced sewers are highly valued at companies producing textiles and garments within North America. Entrance into the industry is usually easy because companies are generally willing to take on sewers with little to no experience and train them. However finding experienced sewers is more difficult because sewers tend to stay in their jobs. The intensity of physical strain on the body is usually low and users often do not realize the repetitive nature of the job can be damaging in the long term.

Sewing Activity

Jenny works from Monday to Friday at the factory sewing textiles. She often arrives at 6:00 am because she wants to be able to leave work earlier in the afternoon to pick up her kids from school. She has her own sewing station that she works at every day and has set up her workspace to suit her needs. She works hard throughout the day getting a thirty minute lunch and two ten minute breaks, one before and one after lunch. She works fast to meet her quotas, and she often wear headphones to listen to music to help keep her focused.

Jenny's Relationship With Her Sewing Machine

Jenny has been assigned a machine to use while at work and while she is working it is her responsibility to take care of the everyday maintenance of the machine. The first thing she does when she gets to work is to remove the sewing cover which protects the machine from dust and moisture. She then carefully wipes up any oil that has dripped from the machine overnight and gets a new bobbin ready for sewing. She threads the machine, flips the on switch, and begins. As her sewing machine is older, she is the only one who knows all of the quirks and how to sew well with it.

Natalie Lui
Industrial Sewer with RSI:
Name: Natalie Lui
Gender: Female
Age: 56
Experience: Highly Experienced
Job: Sewing Machine Operator
Income: $28,000 annually
Location: Kitchener, Ontario
Frequency of use: Monday - Friday
Duration: 8.5 hours / Day

Anton Pavlov
Mechanic:
Name: Anton Pavlov
Gender: Male
Age: 55
Experience: Highly Experienced
Job: Sewing Machine Mechanic
Income: $48,000 annually
Location: Kitchener, Ontario
Frequency of use: Monday - Friday
Duration: 8 hours / Day

Maintenance Services to Keep Your Sewing Machine Functioning Properly. (n.d.). Retrieved February 19, 2018, from https://theinspiredsewist.com/maintenance-services-to-keep-your-sewing-machine-functioning-properly/

Users Secondary

Once a sewer has begun to develop a repetitive stress injury it can be very hard to continue working. Sewers with repetitive stress injures often require more breaks in order to stay comfortable and at the onset of injury can require up to 28 days to recover. Working with a repetitive stress injury often requires sewers to slow down and in some cases use medication. Often businesses with benefits packages will be able to help reduce the cost of therapy for those with repetitive stress injuries; however, therapy often results in days off work and lost productivity for the business.

Sewing Activity

Natalie works from Monday to Friday at the factory sewing textiles. She arrives at 6:00am to be there when all of the other workers start. Natalie is a very skilled sewer due to her years working in the industry and for most of the morning her hands, fingers, arms and shoulders don't bother her too much, but by lunch time she usually needs to take pain medication in order for her to be able to finish her shift. She tries to switch up her activities while sewing to give her arms a rest, but she is very sore after a day at work.

Natalie's Repetitive Stress Injury

Natalie first started to have problems sewing when she was 43. Her doctors told her that she would need a lifestyle change and that continuing to sew everyday without sufficient breaks would only make it worse. Natalie is a good sewer, and she needs the money, so she uses pain medication to alleviate pain during the day.

Users Tertiary

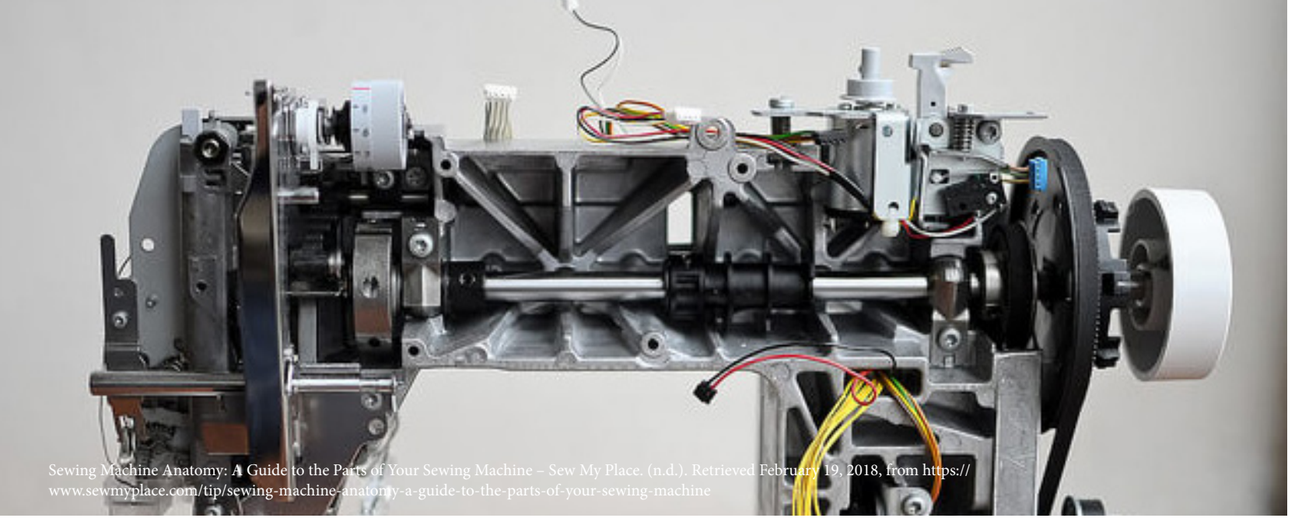
Sewing machine mechanics are highly trained and often work for a third party. They are usually tasked with driving to the factory, and working on the machines on the factory floor. This offers a mixed bag of working conditions, and mechanics have to be able to communicate with the operator of the machine, diagnose the problem with the machine and then perform a repair. Often lighting can be poor, and machines are complex and hard to work on.

Day to Day Activity

Working as a sewing machine mechanic Anton has to travel from factory to factory working on the machines on site. Anton went to school to be a sewing machine mechanic and has worked in the industry for over 20 years. He brings his own tools and can diagnose and fix most problems during his first visit.

Anton's Experience With Sewing Machines

Anton has experience working on many different brands of sewing machines. Because he brings all of his own tools, he is ready to deal with most problems. When there is a part broken, he will order the part and schedule a return appointment when he will come and finish the repair. Often working on the machines is difficult because it can be hard to get inside the cast metal frame of the machine and there are many small moving parts. Lighting for repair work is seldom ideal.



Sewing Machine Anatomy: A Guide to the Parts of Your Sewing Machine – Sew My Place. (n.d.). Retrieved February 19, 2018, from https://www.sewmyplace.com/tip/sewing-machine-anatomy-a-guide-to-the-parts-of-your-sewing-machine

2.1.2 Current Practices

Normal Operation

Sewing machines are intricate, complex machines and as such there are a number of steps that sewers have to take on a day to day basis to keep their machines running well and functioning the way they should. When sewers sit down to begin sewing, they must first clean up the oil that is used to lubricate the machine which also often drips down onto the work surface. After cleaning the oil the sewers will decide what colour of thread they would like to use and what colour of bobbin thread they need. If they do not have a pre-wound bobbin with the correct colour of thread, they have to un-thread the rest of the sewing machine while they wind the bobbin. Once the machine has been threaded and is ready to go, the sewers can begin. The sewers will continue to sew until the bobbin runs out and needs to be switched for a fresh one again; this process sometimes needs to be repeated every three to five minutes.

Why Do People Sew

Sewing was first used in an industrial setting to sew French army uniforms in 1830 (Forsdyke, A Brief History of the Sewing Machine, Retrieved October 1, 2017). Ten machines were built and operated by sewers in order to speed up the process of making uniforms and increase the accuracy of the stitches and quality of the garments. However it wasn't until the late 1840's that industrial sewing machines started to be adopted on a larger scale.

Sewing machines have also made an entrance into the consumer market early on. It became common for households to have a machine for repairing and making clothing, bedding and many other fabric products in the home.

Today it is becoming less common to find sewing machines in homes; however, there is still a loyal demographic of sewers who will sometimes have many machines who view sewing as more of an art or creative crafting outlet, often creating stunning quilts and other wall hangings and garment.

Industrial sewing machines are now used to sew almost all of the world's garments and much of our textiles in a huge variety of settings ranging from the automotive sector, to lifejackets, to household drapery. These industrial machines have become the absolute standard for creating products and goods from fabric.

Development of the Modern Lock-stitch

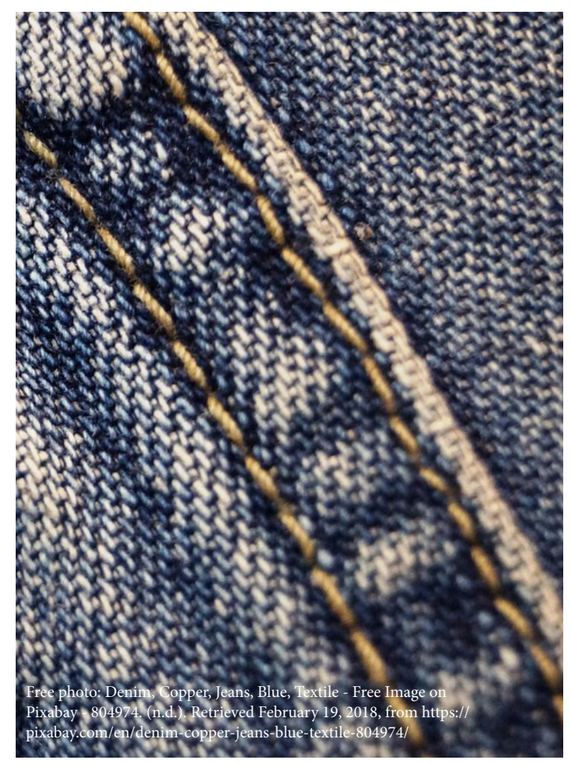
Because performing the delicate maneuvers required to complete a traditional hand stitch is not possible with a machine, a new type of stitch had to be created to mechanize the process.

Chain Stitching

Chain stitching was the first stitch used on a sewing machine. It is created by using a needle to pull a loop of thread up through the fabric and passing it through the previous loop which is still on top of the fabric. Although this stitch can be used effectively to sew, it is very easily pulled apart.

Lock Stitching

The lock stitch was developed many years later and was an entirely separate process. This stitch was the first to require a needle with an eye in the end of it. When the needle was passed through the fabric and then pulled back up it left a loop underneath the fabric. This loop was then grabbed and pulled around what is called a bobbin, which is a separate spool of thread.



Free photo: Denim, Copper, Jeans, Blue, Textile - Free Image on Pixabay - 804974. (n.d.). Retrieved February 19, 2018, from https://pixabay.com/en/denim-copper-jeans-blue-textile-804974/

Sewing Post-Injury

Although sewers with repetitive stress injuries are able to perform most of these tasks, they do so with some level of discomfort and pain. These injuries are usually built up over time and are caused by the repeated motions mentioned below. Continuing to repeat these motions results in worsening of the injury.

Sewing Pre-Injury

A sewer without any repetitive stress injuries is able to perform the motions of operating the machine and maneuvering the fabric into the machine without experiencing any discomfort. The most common motions used in sewing are:

- Pinching the fabric together using the hands and fingers.
- Pressing the fabric down onto the table using the hands and forearms.
- Guiding large pieces of fabric into the machine using the arms and shoulders.
- Changing the bobbin which is located under the sewing surface which requires bending down and reaching with arms.
- Reaching up to advance the stitch by hand.
- Changing thread which usually requires standing up and reaching using arms and shoulders to place the new spool in the holder and re-thread the machine.

1 CHANGING THREAD

When: beginning to sew, after running out of thread, or when the sewer needs to change color the sewer must change the thread. This requires standing up and reaching over the machine in order to get the thread into the thread stand and fed through the machine.

2 CHANGING THE BOBBIN

The bobbin is the second spool of thread, and is placed under the needle. This spool is much smaller and needs to be changed very frequently. This requires bending over, reaching under the machine and feeling for the bobbin release.

3 HEMMING

Hemming is the process of turning over an end of fabric and sewing it down to create a finished edge. With heavier fabrics especially, this can be hard on the fingers and hands as the sewer needs to press down firmly to hold the fabric in place.

4 SEWING DIFFICULT MATERIALS

Sewing tough materials like foam requires a high level of maneuvering requiring the sewer to hold the fabric in awkward positions while feeding it into the machine.

5 ADVANCING STITCHES

When a sewer is performing a more decorative top stitch or coming to the end of a seam and needs to advance one more stitch carefully, the sewer will often reach up to the hand wheel to advance the stitching in a controlled manner.

6 UN-SEWING AND TRIMMING

When sewing fast, sewers can sometimes sew a piece incorrectly which requires them to un-sew or remove the seam by hand using small scissors. These scissors are also used often to trim loose ends and cut thread to tie on new thread.

7 SEWING VISIBILITY

Sewers often have to bend over and strain their eyes when threading the machine or trying to look closely at the machine they are working with. Sewing lights are often very harsh and hard to look at for long periods of time.

8 MOVING PRODUCT DOWN THE LINE

This process can vary depending on the factory and the product being sewn; however, often sewers have to pick up piles and move them, twist to reach fabric or reach up to clip products onto a conveyor belt.

Fig 2.1 Activity Mapping

Activity Mapping 2.1.3.1

1 CHANGING THREAD

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7 VISIBILITY INTO STORAGE

Sewers often have to bend down and reach out to a side to access the storage of the work station. Often the visibility into the storage compartment is poor.

8 PRODUCT FINISHING

This process can vary depending on the factory and the product being sewn; however, often sewers have to pick up piles and move them, twist to reach fabric or reach up to clip products onto a conveyor belt.

Fig 2.2 User Observation

User Observation 2.1.3.2

Sailrite® Ultrafeed Industrial Sewing Table & Workhorse Servo Motor (110V) - Sailrite. (n.d.). Retrieved February 19, 2018, from https://www.sailrite.com/Sailrite-Ultrafeed-Industrial-Sewing-Table-and-Workhorse-Servo-Motor-110V

Current Ergonomic Sewing Solutions 2.1.4

Ergonomic Consideration on Current Machines

Current industrial sewing machines do have some ability to adjust to better fit the sewer; however, these adjustments are usually hard to make, and in some cases require tools.

The height of the current tables is adjustable to fit a range of users; however, this also requires tools, and in most factories these tables are all set at the same height for consistency and improved workflow within the factory. (Patenaude, 2003)

The foot pedal is the other area where adjustment options are seen. Usually the user is able to adjust their distance from the pedal, height and angle of the pedal, and its location to the left or right of the center of the machine. (Patenaude, 2003)

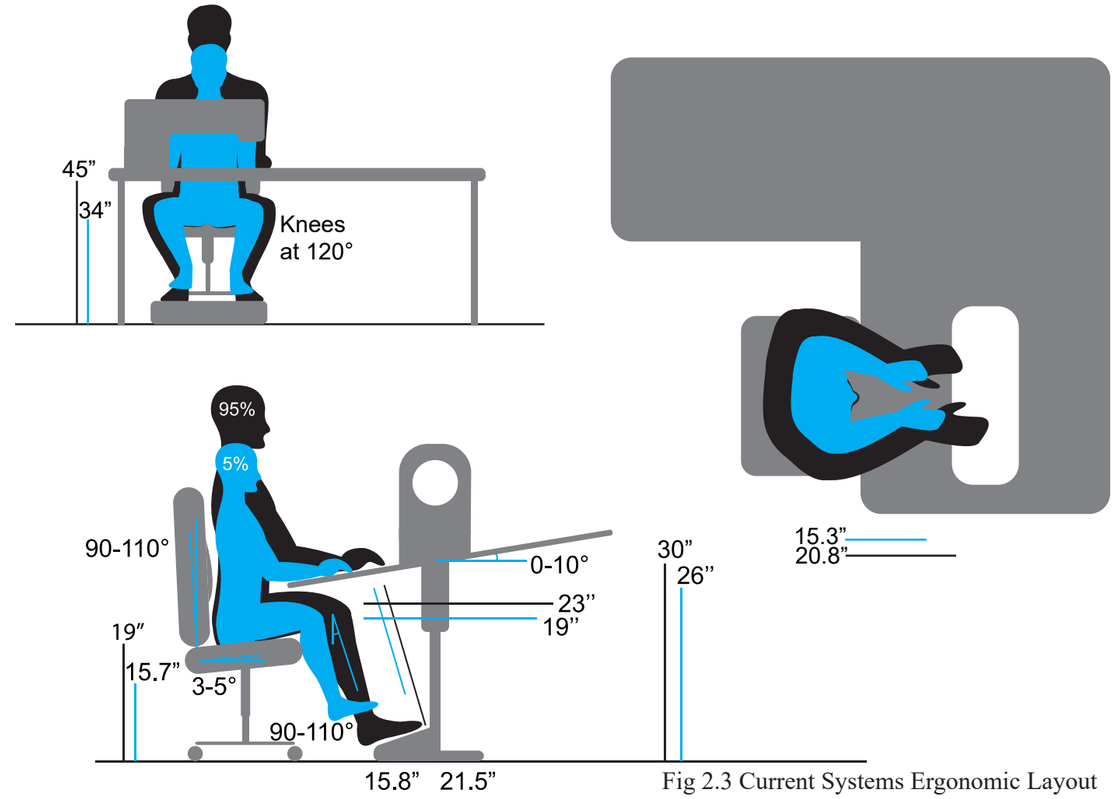


Fig 2.3 Current Systems Ergonomic Layout

Ergonomic Accessories for Sewing Machines

There are now a variety of third party accessories for sewing machines that can help to reduce the stress from the process on the body. These third party accessories are usually only found in specialty stores and can be costly. Although some business owners might be willing to invest in these accessories and have them installed, others will avoid this cost all together.

Health and Safety 2.1.5 (Activity)

Health:
Working as a sewer is one of the lower risk factory jobs with air quality usually being superior to other workplaces. However over time the repetition of motions can take its toll on the worker. (Patenaude, 2003).

Negatives
-Risk of RSI.
-Risk of sewing fingers.

Positives
-Less physically demanding than other professions.
-Lower risk of injury than other professions.

Safety:
Current solutions to safety in garment and textiles factories are usually based on preventing sewers from sewing their fingers, making sure the sewing tables and chairs are set at the appropriate heights, and making sure workers are not lifting heavy objects incorrectly.

Negatives
-Less focus on ergonomics.
-Machine is not ergonomically adaptable.
-No effort to break up repetitive motions.

Positives
-Setting the sewing surface and seat to the right height. can help reduce risk of back injury.
-Guards installed on machines can protect fingers from the needle.

Sewing machine stands – five series from the market leader. (n.d.). Retrieved February 19, 2018, from https://www.kessler-ergo.com/sewing-machine_stands/

Health and Safety (Current Products)

Health:
Many of the products on the market designed to improve the ergonomics of the sewing work station are based around the sewing work surface.

Negatives
-The work surface is usually already adjusted.
-The machine itself is not adjustable.
-Does not provide an opportunity to change the position while in use.
-These tables are usually costly for employers to purchase and implement.
-They need to be set up properly to be effective.

Positives
-There are options available for sewers to improve their workstation.

Safety:
Ergonomic sewing tables are simple solutions to a complex problem and needs to be set up correctly to be effective.

Negatives
-Could result in an RSI in a different area.
-Does not play a role in improving work flow.

Positives
-Can be used in conjunction with other safety devices.
-Can be found in a variety of price ranges.

Product Research 2.2

Product Benchmarking 2.2.1

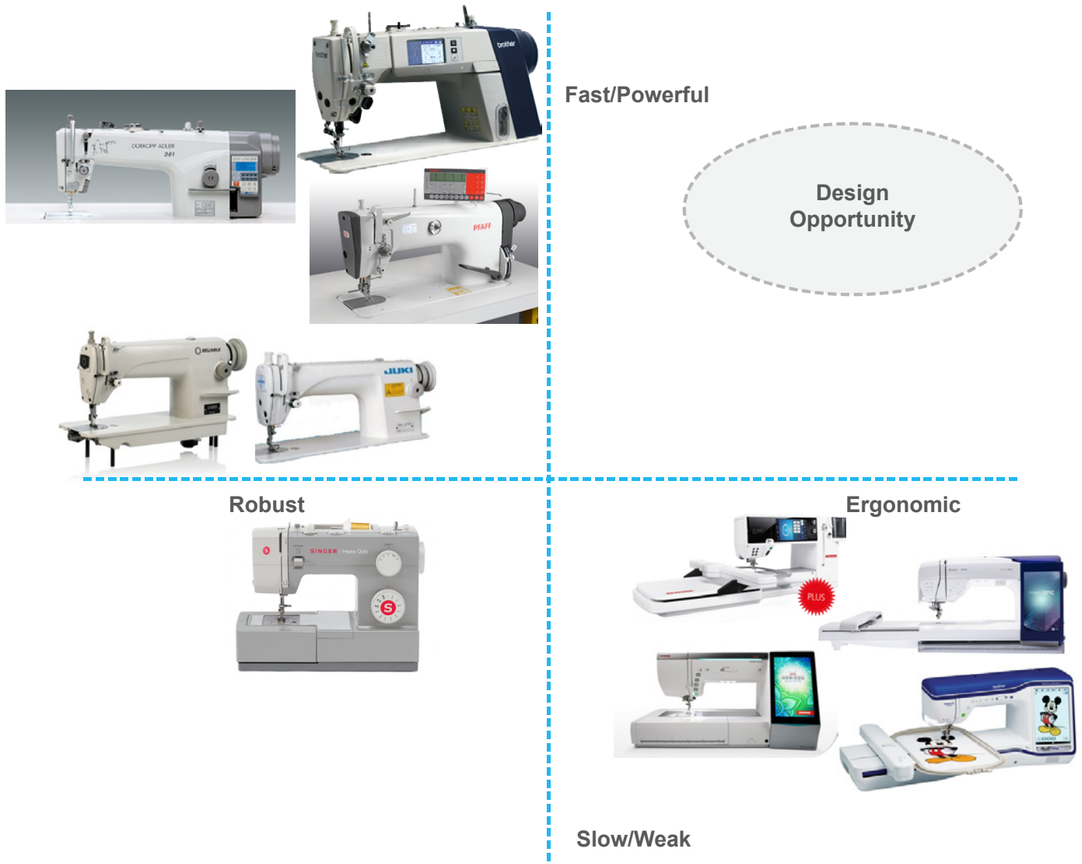


Fig 2.4 Design Opportunity Diagram

Power Versus Ergonomics Comparison:

Current sewing machines fall into two separate categories. There are home use machines which typically have less power, are slightly more ergonomic, and tend to have more features. These machines range in cost from approximately $100 to a top of the line $14,000 model. The second category is industrial sewing machines which tend to have fewer features, are built from more robust materials, and are generally less ergonomic. These machines range in cost from approximately $1000 to $6000 for a straight stitching machine (Crafty Seamstress, 2016).

Features:

There are several common features that are shared amongst current industrial sewing machines that provide the necessary functionality to complete most tasks in an industrial application. These features are as follows:

Robust Construction

Oil Lubrication

Speed

Power

As these machines are designed to perform a single task very well, they tend to have fewer features than home machines.

Benefits:

Within the industrial sewing industry, there is a disconnect between design for the user and design for the owner. Because the owner of these machines is usually a business, manufacturers design their machines to provide the benefits to the business owner as opposed to the user. Many of the benefits these machines provide are related to production volume and operating cost. The current product benefits are as follows:

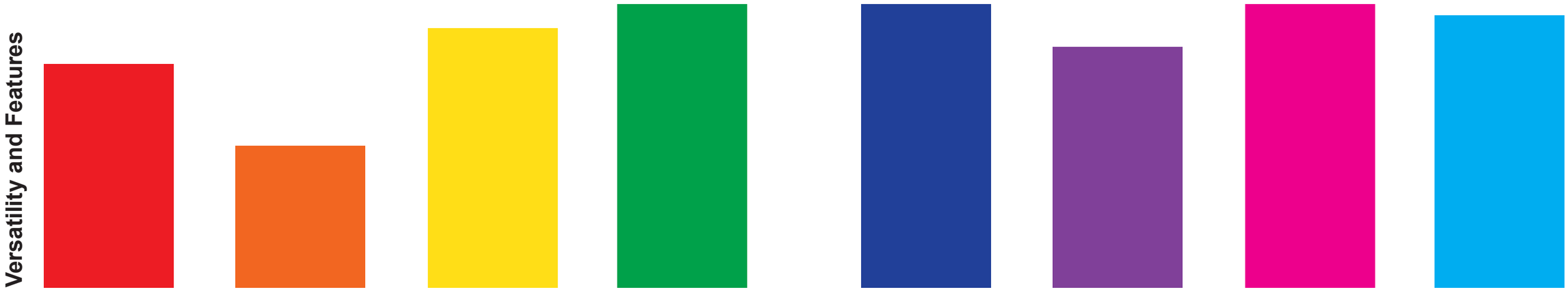
Quality

Speed

Power

Long Service Life

Benchmarking Functionality 2.2.2



Industrial Machines

Juki DDL-8700 Servo Motor

-Servo motor is efficient on electricity

-Servo motor is quieter than normal clutch and belt machines

-Cast steel block is durable

-5,500 stitches per minute

Reliable 3100SD Drop Feed

-5,500 stitches per minute

-Automatic Lubrication

-Cast steel block is durable

-Available with servo or clutch motor

Pfaff 2081

-Low vibration drive unit

-Direct Drive servo motor

-Adjustable needle bar for large range in thread tension

-300mm arm clearance

Brother S-7300A

-Most ergonomic machine on the market currently

-Electronically controlled feed to help keep consistent stitch lengths over lapped material

-Semi-dry lubrication

- LCD touch panel for intuitive operation.

Home Machines

Husqvarna Designer Epic

-WIFI

-Large working area

-30% larger Bobbin

-Best LED lighting in segment

-Embroidery

Bernina 880 Plus

-1200 stitches per minute

-Extra large bobbins

-Embroidery

-Large touchscreen for easy use

-Needle Threader

Janome Horizon MemoryCraft 15000

-Huge touch screen for tutorials and easy use

-510 built in custom stitches

-Automatic thread tension

-Ipad app to design embroideries

Brother THE Dream Machine 2

-Thousands of built in embroideries

-5 inch distance from arm to sewing bed

-Adjustable bobbin winding speed

-Extra high lifting presser foot

-Ergonomic large start stop button

Single-needle sewing machine / lockstitch / with thread trimmer / direct-drive - S-7220C - Brother Industrial Sewing Maschines. (n.d.). Retrieved February 19, 2018, from http://www.directindustry.com/prod/brother-industrial-sewing-maschines/product-173838-1749104.htmlu

Aesthetics 2.2.3
Industrial Sewing Machines

Color
Most new machines are found in a white or cream color on the body; however, some of the older machines came in a lighter brown color. Machines sometimes have a single accent color on an accent panel or around a screen matched to the company's color scheme.

Shape
Industrial sewing machines can be found in a variety of shapes; however, straight stitching lock stitch type machines all look similar. The body of the machine where most of the mechanical components and the motor are housed sits to the right of the sewer and the arm of the machine crosses over in front of the sewer usually 5-6 inches above the sewing surface with the needle resting directly in front of the sewer.

Size
Interestingly, all straight stitch industrial machines are roughly the same size. This makes replacing machines in a packed factory easy because they have roughly the same footprint.

Texture
Almost all industrial sewing machines are built inside of a cast steel block that has been machined for the rest of its components. These cast blocks have the signature cast steel dimpling on the outside. Newer machines are beginning to adopt plastic panels and housings for various components. These plastic panels are usually glass filled for rigidity and have a light dimpled texture.

Materials
Steel is the most common material used in the manufacture of industrial sewing machines with glass filled plastics beginning to be introduced as panels and motor housings.

Symbolism
Industrial Sewing Machines

The design of industrial sewing machines is very honest to its purpose and its materials. There are rarely any pleasing aesthetics incorporated, the colours are chosen to help the user see dirt and threads that can accumulate on the machine and the form is purely based on function.

getting to know the DESIGNER EPICTM – Emily Hallman Designs. (n.d.). Retrieved February 19, 2018, from http://emilyhallman.com/2017/12/31/getting-to-know-the-designer-epic/

Aesthetics
Home Sewing Machines

Color
Similar to industrial machines, the use of white and cream coloring is found commonly on these machines; however, companies have taken the liberty of applying their brands color schemes in creative ways to the exterior housing of the machine.

Shape
Higher end home machines tend to be much larger in size than industrial sewing machines and have begun to take on a more user centered shape with most of the controls angling towards the user. However the general shape of these machines remains similar to industrial machines and what has been seen in the industry for many years.

Size
Home machines tend to be much larger than industrial machines and in some cases can be significantly heavier too.

Texture
Home machines are often housed in plastic shells with a metal frame. The plastic is usually gloss and shows fingerprints easily.

Materials
These machines usually have a glass filled plastic housing with a painted metal frame. Cheaper home machines are often entirely plastic and are much less rigid.

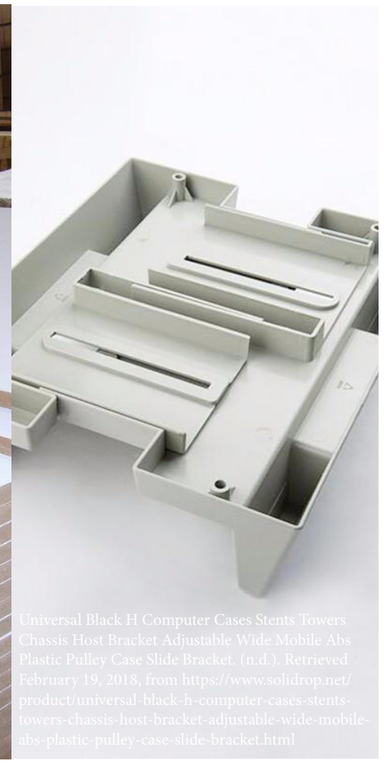
Symbolism
Home Sewing Machines

Home sewing machines keep the same general shape as traditional machines; however, where they differ is that these machines have started to adopt touch screens and some minor ergonomic styling. The higher end home machines are trying very hard to adopt a high tech feel.

Benchmarking 2.2.4
Materials and Manufacturing

Stainless_Steel_Braids_(3054915298).jpg (3888×2592). (n.d.). Retrieved November 1, 2017, from https://upload.wikimedia.org/wikipedia/commons/8/86/Stainless_Steel_Braids_%283054915298%29.jpg

Melamine-Faced-Laminated-MDF.jpg (1126×845). (n.d.). Retrieved November 1, 2017, from http://image.made-in-china.com/2f0j00KMuEpJcqEdgH/Melamine-Faced-Laminated-MDF.jpg



Universal Black H Computer Cases Stents Towers Chassis Host Bracket Adjustable Wide Mobile Abs Plastic Pulley Case Slide Bracket. (n.d.). Retrieved February 19, 2018, from https://www.solidrop.net/product/universal-black-h-computer-cases-stents-towers-chassis-host-bracket-adjustable-wide-mobile-abs-plastic-pulley-case-slide-bracket.html

Current Materials Used in Industrial Sewing Machines

Steel

- Strong
- Durable
- Rigid
- Cheap

Melamine

- Low friction top surface
- Low cost to produce
- Can be cut to any size
- Durable top coat

ABS Plastic

- Resistant to physical impacts and stress over time
- Resistant to chemicals
- Rigid (when glass filled)
- Inexpensive
- Injection Moldable

Steel has traditionally been used for the shell of industrial sewing machines because it is cheap and easy to cast, and provides a durable rigid frame for the internals to be mounted to. Melamine is used due to its low cost, and its smooth slippery top coating. ABS plastic is used because it is low cost, easily moldable, rigid and durable enough to withstand heavy use.

Passion for Sustainability Inspires Alum's New Venture - TextilesTextiles | NC State University. (n.d.). Retrieved February 19, 2018, from https://textiles.ncsu.edu/news/2017/08/passion-for-sustainability-inspires-alum/

Benchmarking 2.2.5
Sustainability

When sewing machines first became common place in the average home in the United States in the 1900's, they were built entirely from metal and were able to sew flawlessly without breaking for an entire lifetime.

Today manufacturers expect sewers to get three years of use out of their home machines before they need to be replaced. The introduction of plastics and electronics has added more functionality to the machines; however, they have also had some negative effects on the lifespan and durability of the machines.

Industrial machines are often still made mostly from steel; however, increasingly computers and plastic bearings and actuators are being added. Although the mechanical parts of the machine may continue to function, the computer may become outdated and electrical connections can be lost causing the machine to shut down without being anything fundamentally wrong. When touring factories it is not uncommon to see machines pre-1970 intermixed with brand new state-of-the-art machines.

Needs Analysis

3

Barbara Davidson. (n.d.). American Apparel, others try to profit from domestic production. Retrieved February 19, 2018, from http://www.latimes.com/business/la-fi-american-apparel-made-in-usa-20140810-story.html

Needs Analysis 3.1

Needs and Benefits not Currently Met 3.1.1

The largest need in sewing industry is for ergonomic work stations for sewers. Although there are several options available for adjustable working surfaces, all of these products are stand alone. Without proper installation or pairing with ergonomic seating, these are effectively useless. These products can also in some cases cost as much or more than the machines that are being installed into them.

Accessibility

These products are often more expensive than the machines that they are being used with.

Good ergonomic products are not often sold through the manufacturer and businesses have to contact third parties in order to troubleshoot problems.

(Patenaude, 2003)

Comfort

Without proper seating and setup these ergonomic workstation surfaces are not effective at reducing RSIs.

Most ergonomic development in the industry is focused on the work surface not on the integration of the machine within the surface and the seating for the sewer.

Awareness

Most sewers are unaware of the potential for injury and do not discover the extent of their injuries until it is too late.

Ergonomic solutions need to be implemented before issues arise rather than after.

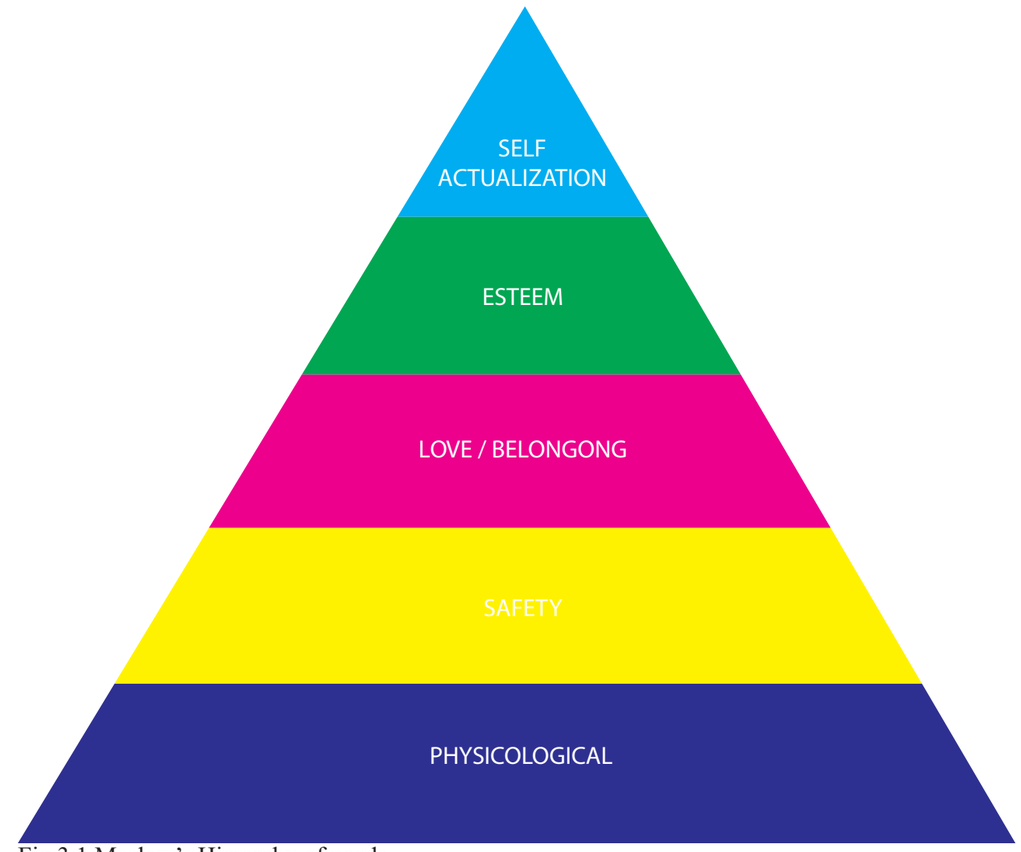


Fig 3.1 Maslow's Hierarchy of needs

Latent Needs 3.1.2

Latent Needs Statement:

Sewing is a creative activity that has its core appeal based on it being a **skilled** task that accomplishes **work**. **Subsistence** is realized through the machine providing a **safe** environment where the worker can **work** and **create**. **Quality** is related to the **abilities** of the machine to **work** and **create**.

	BENEFIT	POSSIBLE CORRESPONDING FUNDAMENTAL HUMAN NEEDS (FHN)	RELATIONSHIP BETWEEN BENEFITS AND FHN
1	Quality	Subsistence, Protection, Abilities, Creation	Moderate
2	Comfort	Subsistence, Health, Safety, Protection	Strong
3	Power/Speed	Creation, Work, Esteem, Ability, Skills	Moderate
4	Utililty	Ability, Skills, Build, Work, Creation	Moderate

Fig 3.2 Manfred Max-Neef Human Fundamental Needs

Quality
is related to the materials used to make the machine, and the ability of the machine to perform its tasks without breaking down. This is related to Abilities and Work, which fall under the Creation need.

Comfort
is related to the machine not causing harm to the user and providing a work environment that is conducive to being productive and safe. Health, Safety and Protection are all terms that fall under the Subsistence human need.

Speed and Power
are the terms used to describe characteristics of the machine that help it function quickly and efficiently while also giving it the versatility to handle heavier materials. The faster the machine can sew, the more the sewer can produce. Work, Esteem, Ability, and Skills are terms that fit with this benefit and they fall under the Creation fundamental human need.

Utility
is the term used to describe the functionality of the machine in relation to its production capabilities. The more capable the machine, the fewer machines the factory needs to own and the fewer times the garment needs to change stations to be fully sewn. Ability, Build, and Work are all terms that fall under the Creation fundamental human need.

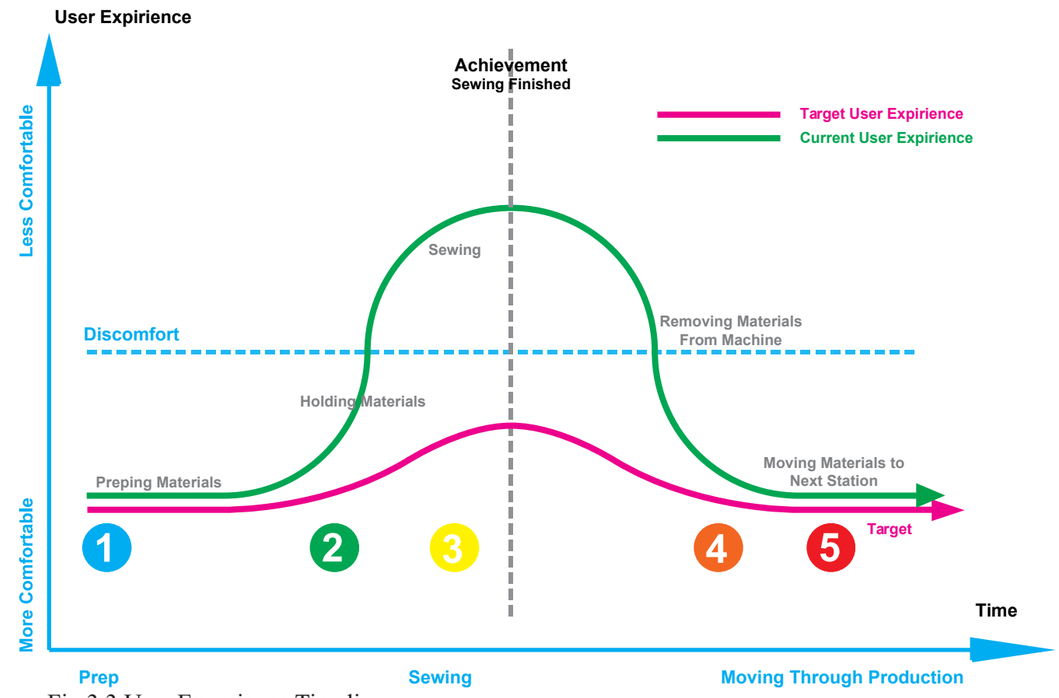


Fig 3.3 User Experience Timeline

Activity / Experience Graph 3.1.3

1 PREPPING MATERIALS

Comfortable, Preparing, Break from Straining Motions

2 HOLDING MATERIALS

Discomfort, Straining, Pressure

3 SEWING

Vibration, Straining, Pressure, Discomfort

4 REMOVING MATERIALS FROM MACHINE

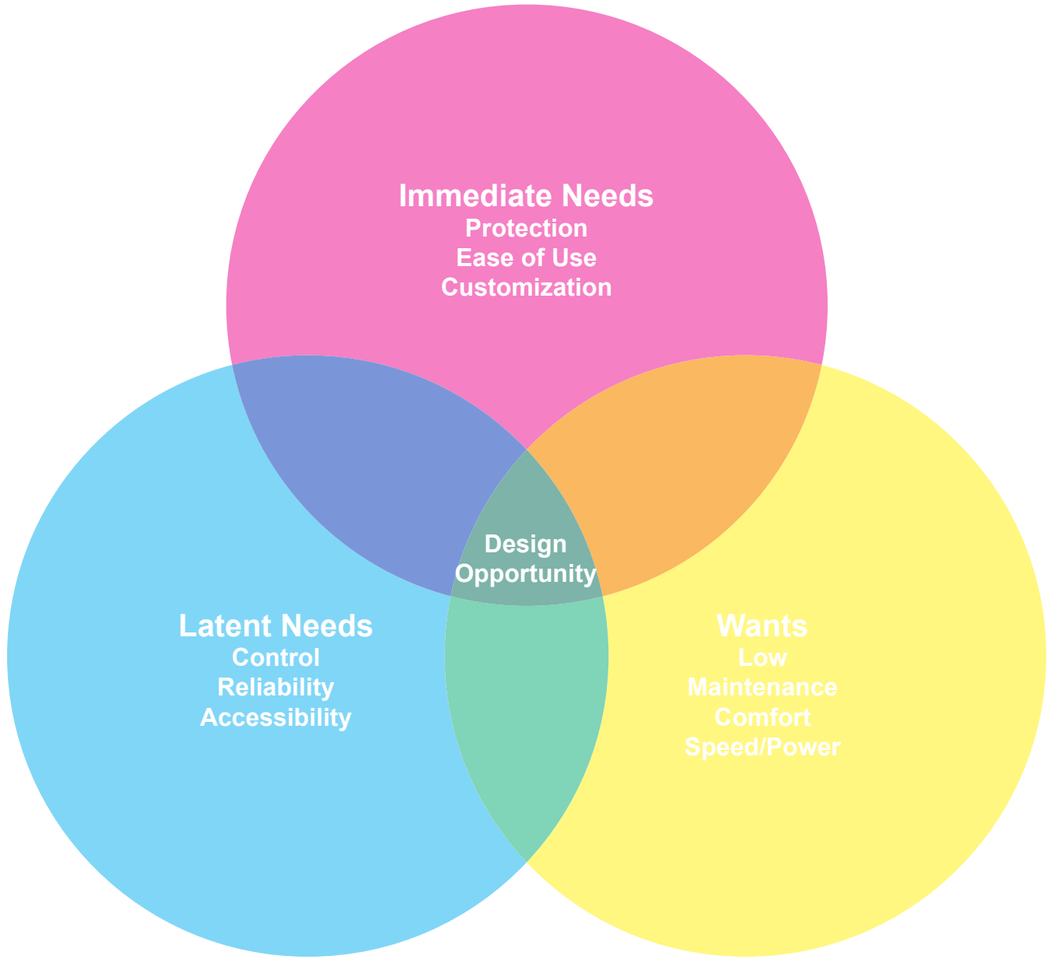
Relaxing Muscles, Non-Straining Motions

5 MOVING MATERIALS TO NEXT STATION

Comfort, Large Muscle Group Motions, Break

Categorization of Needs 3.1.4

Latent Needs	Immediate	Wants	Desires
Control: over the machine and the material being sewn. Convenience: ease of use. Reliability.	Preemptive injury prevention. Better integration with workstation systems. Easily adjustable by the user without tools.	Comfort: less strain on muscles. Reliable. Low maintenance: less attention needed for oiling.	Low vibration: effecting comfort in the arms and hands. Low noise: creating a comfortable workspace. Low maintenance: removes stress.



Needs Diagram 3.1.5
Fig 3.4 Needs Diagram

Weblet Importer. (n.d.). Retrieved February 19, 2018, from http://www.pksm.co.uk/product/used-brother-b737-413-e40-japan-made-industrial-sewing-machine/

Functionality 3.2
Effectiveness of Current Systems

Prevention of Repetitive Stress Injures

When properly fitted and combined with correct ergonomic seating, ergonomic work surfaces can be effective at reducing some of the strain on user's shoulders, backs, forearms, and hands. These work surfaces are usually height adjustable and tilt adjustable with a specially designed cut out where the worker sits to better support their arms while feeding the material into the machine. (Patenaude, 2003).

Comfort

Because machines, ergonomic tables, and ergonomic seating is all sold by separate parties, it can often be hard for sewers to convince their business to invest in all of the equipment required to help them work without risk of injury. However, each manufacturer approaches comfort from a different perspective aligning all the elements effectively is key to ergonomic success. Machine manufacturers usually focus on noise and vibration, while work surface and seating manufacturers usually focus on padding, seat and surface height and positioning.

Adjustability/Fit to the User

Because industrial machines and workstations are set up by the business, and because they often require tools to change the position, sewers do not often have the opportunity or the know how to make their workstation fit them in a way that is able to reduce the likelihood of developing repetitive stress injuries. (Patenaude, 2003).

Reliability

Before the era of computerization most machines were still able to run reliably provided they were oiled regularly and looked after. However, oil can be messy and can create stains on product passing through the machine. Most newer computerized machines have the ability to self oil, removing the need for the sewer to perform the task. However, most newer computerized machines are effected by electronic bugs over time and will often be put out of service due to their computers becoming outdated or loosing some functionality.

Utility

Many industrial machines are only designed to perform one function, and because of this, the motions required to perform that task are repeated which can lead to injury. If these machines were able to perform several other tasks, sewers might be able to change tasks while still being productive, allowing them to dilute some of the repetitiveness associated with single use machines.

Usability 3.3

Use - Adjusting

Interaction

A properly adjusted ergonomic sewing table can reduce stress on arms, shoulders, forearms, and wrists. However, most ergonomic work surfaces are designed to be adjusted after purchase and left in position, requiring tools for adjustment and specific knowledge of the ergonomics of sewing to adjust properly. (Patenaude, 2003).

Learn-ability

Learning how to adjust a work surface to fit your body can be a complicated task requiring tools and measuring equipment. The sewers who stand to benefit from current ergonomic sewing solutions often do not have the opportunity to adjust these work surfaces themselves, and have to rely on mechanics or the business owner to adjust the table for them.

Use - Sewing

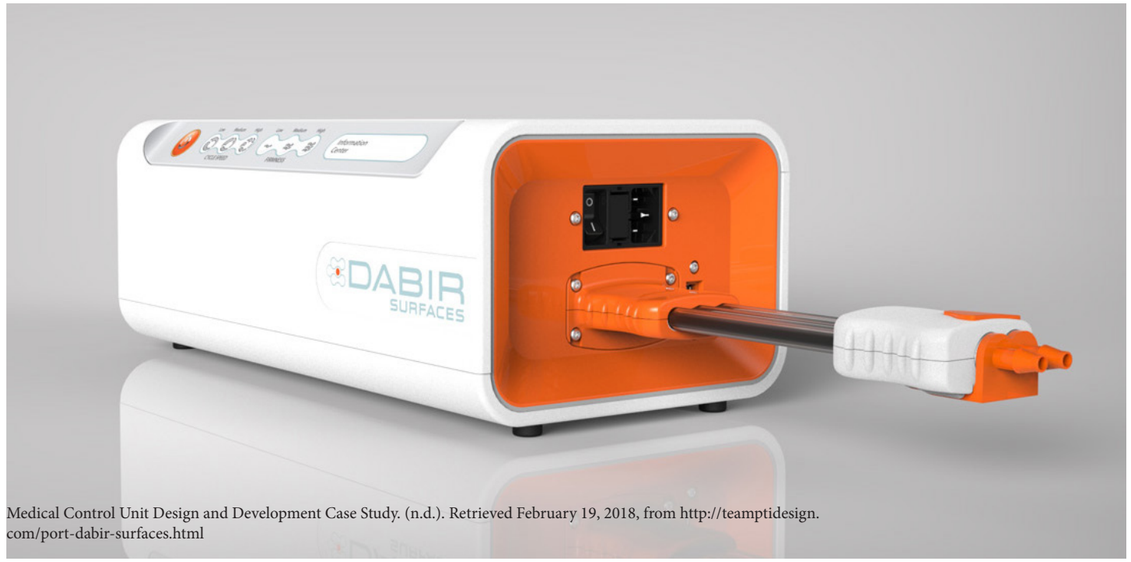
Uneven Work surface

Once the work surface has been adjusted properly for the sewer it is often sitting at a slight angle to the user's body. Working on a slightly inclined work surface can be difficult due to the fabric sliding down the table and the unusual angle sewers need to hold their hands at.

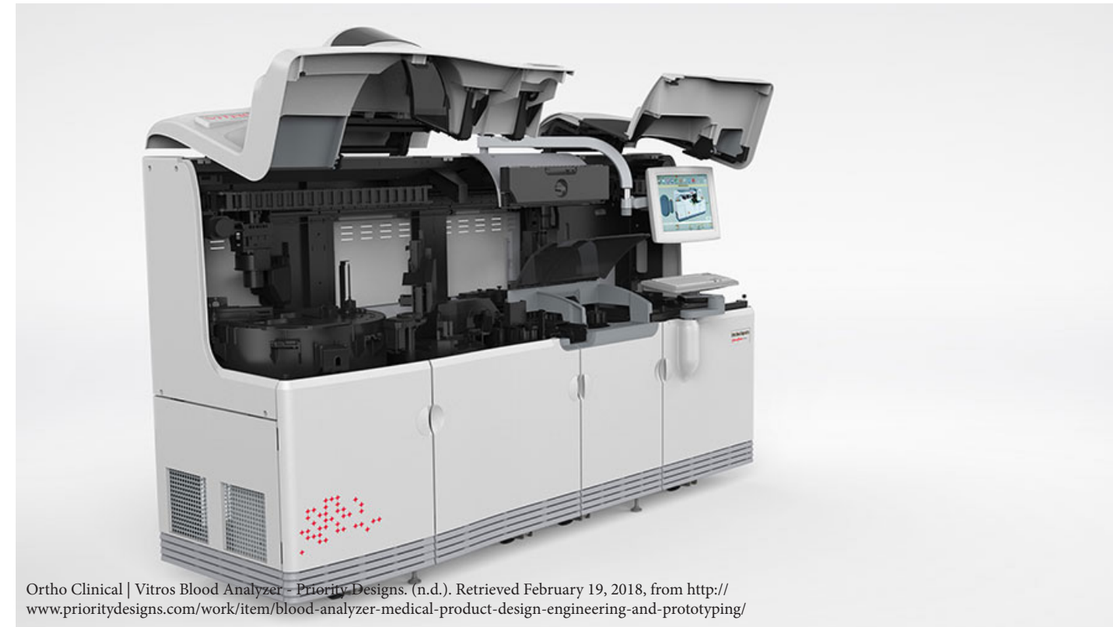
Use - Access

Entering and Exiting

With larger and more ergonomic work surfaces that are designed to more closely follow the contour of the sewer's body as they sit in the sewing chair, getting in and out of these tables can be cumbersome and tricky.



Medical Control Unit Design and Development Case Study. (n.d.). Retrieved February 19, 2018, from http://teamptidesign.com/port-dabir-surfaces.html



Ortho Clinical | Vitros Blood Analyzer - Priority Designs. (n.d.). Retrieved February 19, 2018, from http://www.prioritydesigns.com/work/item/blood-analyzer-medical-product-design-engineering-and-prototyping/

Aesthetics 3.4

Scientific and Medical Product Development - Design + Industry. (n.d.). Retrieved February 19, 2018, from https://www.design-industry.com.au/medical-product-design/

The aesthetic chosen to model the design of the ergonomic industrial sewing station, is based on the design style commonly used for medical products. This aesthetic was chosen because it is very sterile and purpose oriented which fits well in a factory setting. The design speaks to the use of the product without being disruptive and distracting. The ability for products to be easily cleaned is another factor that influences the design language of this aesthetic.

Retrieved February 19, 2018, from http://www.sz-nd.com/show-case.asp?id=31

Ion Proton System - Thermo Fisher Scientific. (n.d.). Retrieved February 19, 2018, from https://www.thermofisher.com/order/catalog/product/4476610

Sustainability 3.5

Safety

The goal of this thesis is to create a product that can reduce the likelihood of sewers developing repetitive stress injuries and increase the comfort level for those affected by repetitive stress injuries. This will hopefully lead to fewer days off work for sewers, higher productivity, and increased workplace satisfaction, resulting in greater profits for business owners.

Health

When businesses provide a safer work environment for sewers, and establish conditions that reduce the frequency of RSIs, sewers will have a much higher quality of life and be more able to take care of themselves into their later years. Allowing them to lead a more active and healthy lifestyle and increasing overall satisfaction.

Scientific and Medical Product Development - Design + Industry. (n.d.). Retrieved February 19, 2018, from https://www.design-industry.com.au/medical-product-design/

Sustainable Tourism 2016 - SEE Business travel & meetings magazine. (n.d.). Retrieved February 19, 2018, from https://www.seebtm.com/en/sustainable-tourism-2016/

Environment

Materials

Bamboo
Bamboo is a fast growing plant. When laminated, bamboo fibers form a strong durable sheet of plywood. Using this material as the work surface in the place of melamine coated fiberboard will increase the durability of the work surface and result in a smaller environmental footprint. Bamboo is one of the best renewable sources of plywood due to its rapid growth and biodegradability.

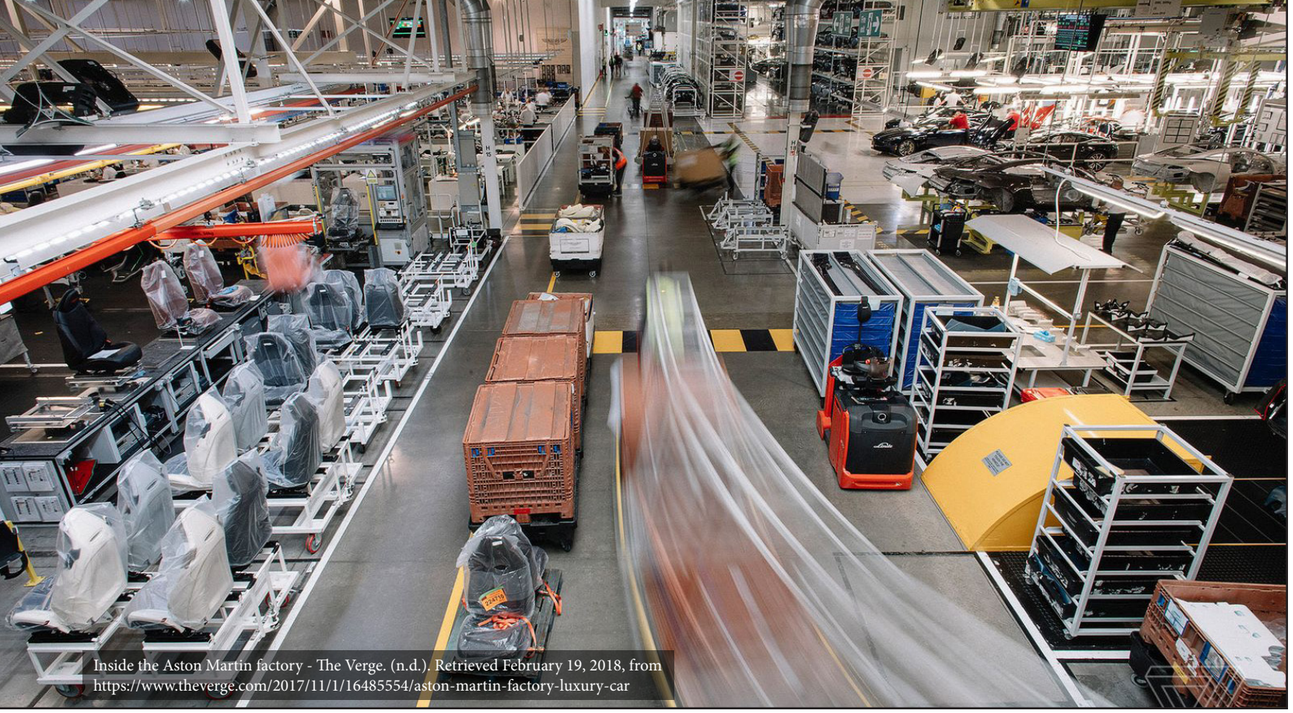
Recycled Aluminum
Recycled aluminum is a good material for this application because it carries less than 10% of the embodied energy from the previous products lifecycle. Aluminum can be recycled continuously and is easy to work with while also being rigid enough for structural applications.

Initiatives

Leasing and Recycling Program
By using a leasing based program, manufacturers would be responsible for maintenance of the machine and ultimately recycling and refurbishing of machines that have reached the end of their useful lifecycle. Holding manufacturers accountable for their product will result in a higher quality product for business owners and more environmentally conscious decisions made about manufacturing.

Online Support
Providing online diagnostics and tech support will help extend the lifespan of computerized sewing machines allowing them to stay current with software updates and remote repairs.

Oil Free Lubrication
By removing petroleum based oils from the sewing machines, we can remove the need for another environmentally taxing process.



Inside the Aston Martin factory - The Verge. (n.d.). Retrieved February 19, 2018, from https://www.theverge.com/2017/11/1/16485554/aston-martin-factory-luxury-car

Commercial Viability 3.6

Manufacturing - Methods 3.6.1

To maintain commercial viability, this product will be mass produced. This opens the door to injection molding and more advanced casting processes while still keeping costs down. By providing several styles of work surface with the machine and seat, business owners are able to find a solution that is right for them and their sewers without having to create their own work surfaces in house or buy custom solutions from another supplier.

The machine itself will be designed with modularity in mind, allowing it to be easily serviced and maintained, unlike most cast machines.

Manufacturing - Materials 3.6.1

One of the goals of this project is to bring new life to the sewing machine industry through design and new thinking. One of the areas that will have a big impact on the design and the industry is the use of new and sustainable materials; focusing on material selection to ensure the machines not only have a long life cycle but are also able to be recycled and reused responsibly in their next life cycle.

Cost - Price Range 3.6.2

For this product to gain traction within the industry it must fall within an acceptable price range. Most straight stitch industrial machines cost between $1000 and $4000. Although most machines come with a sewing table, after market sewing tables can range from $500 to $3000 and ergonomic seating can cost between $200-$300. For this product to be seen as an affordable solution for most businesses, it must not exceed $5000.

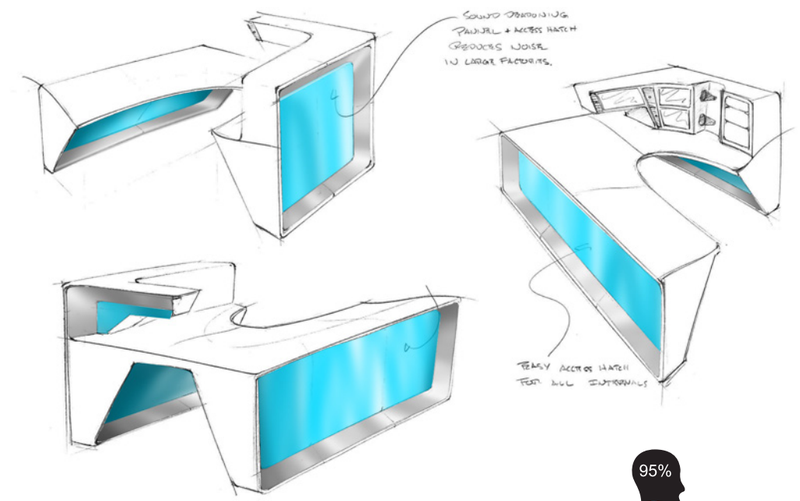
Design Brief 3.7

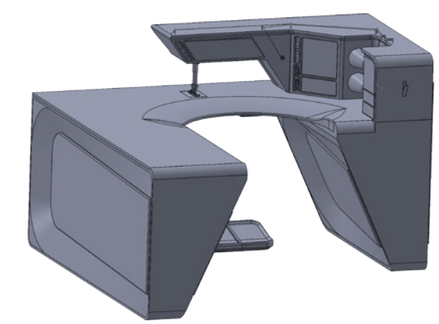
"Develop a **revolutionary** way to **reduce** the likelihood of industrial sewers developing **repetitive stress injuries**, and **increase comfort** for those with **repetitive stress injuries**. This product must **enhance the lives** of the users **while increasing their productivity** and that of the business owners."

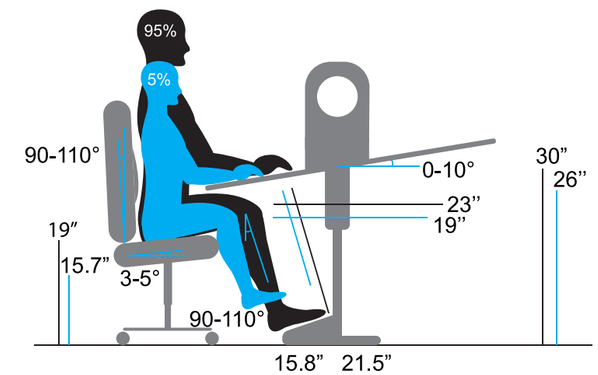
1. **Designed for The User**
   The product should be designed with the user's best interests in mind.
2. **Easily Adjustable and Customizable**
   The product should be easily adjustable for the user and customizable to their needs.
3. **Intuitive and Culturally Integrated**
   The product should be easy and intuitive to operate and have a design language that is accepted across all cultures.
4. **Universally Accessible**
   The product should be able to be utilized by people of all shapes, sizes, skills, and abilities.
5. **Improved User Ergonomics**
   The product must improve the ergonomic fit for all users and be comfortable throughout its use.
6. **Versatile**
   The product should handle a variety of products and fabrics to allow it to be used in a diverse cross section of industries.
7. **Sustainable Materials Used**
   The materials used in this product should be selected to optimize the life-cycle of the product and reduce the impact the product has on the environment.
8. **Reliable/Durable/Easy to Maintain**
   The product should be reliable and stand the test of time, while also being easy to maintain.
9. **Affordable**
   The product must fall within a reasonable price range in order to appeal to the businesses that will invest in it.
10. **Integration of New Technology**
    The product should take advantage of new technology and integrate it in a seamless way to improve performance and convenience.

Design Development

4







4.1 Ideation

4.1.1 Mind Mapping

To help develop a diverse crop of ideas at an early stage in the design process, a mind map was made. From there all sketches, concepts, doodles, and notes were organized in a time line format so that progress in the design could be seen visually as the project progressed.

4.1.2 Inspiration Board

Zhou Buyi | GIZMODO.cz. (n.d.). Retrieved February 20, 2018, from http://www.gizmodo.cz/?tag=zhou-buyi

Koop Easy Chair | Contract Furniture | Martela. (n.d.). Retrieved February 20, 2018, from https://martela.com/contract-furniture/easy-chairs-sofas/koop-easy-chair

Tempo // Sport Metronome Concept on Behance. (n.d.). Retrieved February 20, 2018, from https://www.behance.net/gallery/48391389/Tempo-Sport-Metronome-Concept

Connected. on Behance. (n.d.). Retrieved February 20, 2018, from https://www.behance.net/gallery/46766093/Connected

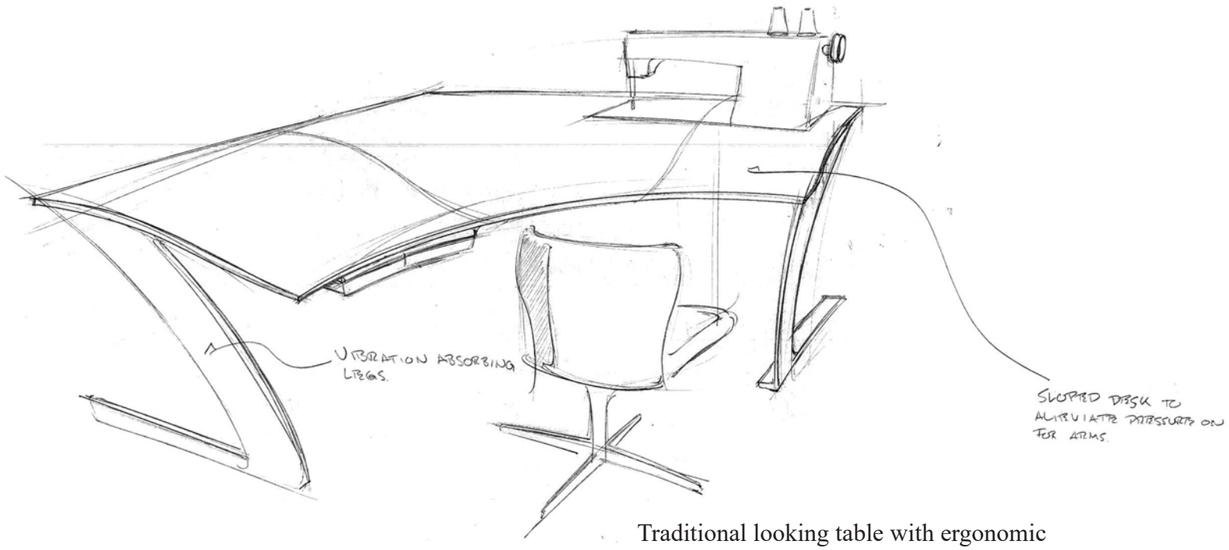
Aesthetifacts – Six N. Five. (n.d.). Retrieved February 20, 2018, from http://sixnfive.com/aesthetifacts

Google confirms Project Tango tablet for later this year | Pocketnow. (n.d.). Retrieved February 20, 2018, from http://pocketnow.com/2014/06/05/project-tango-tablet-2

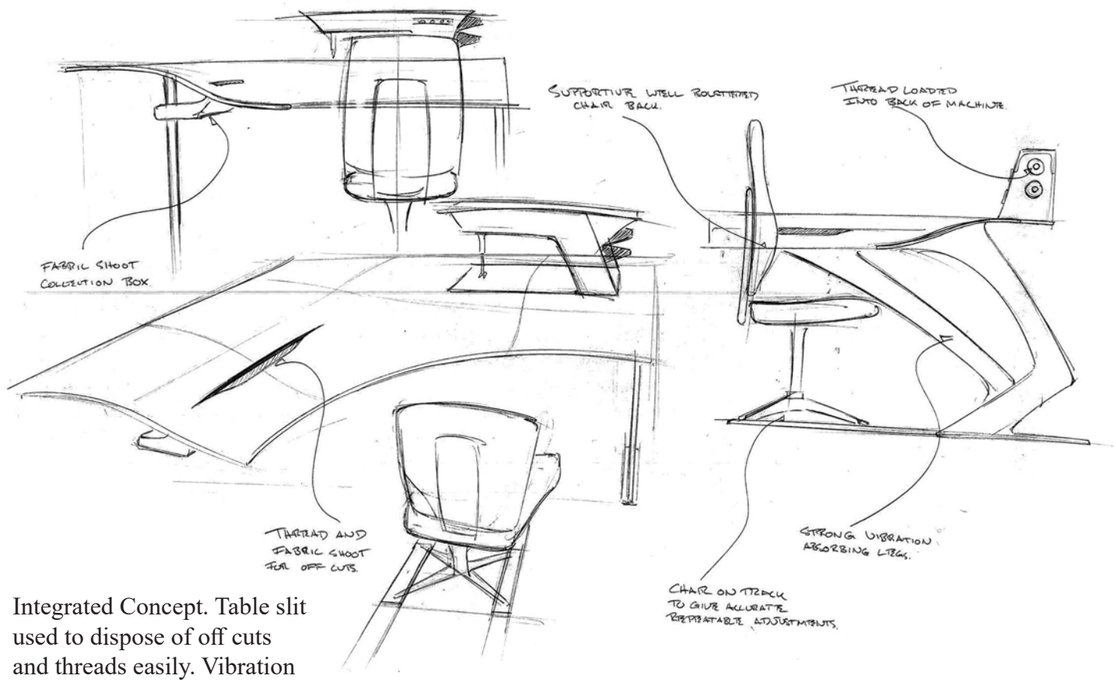
Caruso, music cabinet by Paolo Cappello. (n.d.). Retrieved February 20, 2018, from http://www.paolocappello.com/portfolio_page/caruso/

Home phone - Core77. (n.d.). Retrieved February 20, 2018, from http://www.core77.com/firms/layer/Home-phone

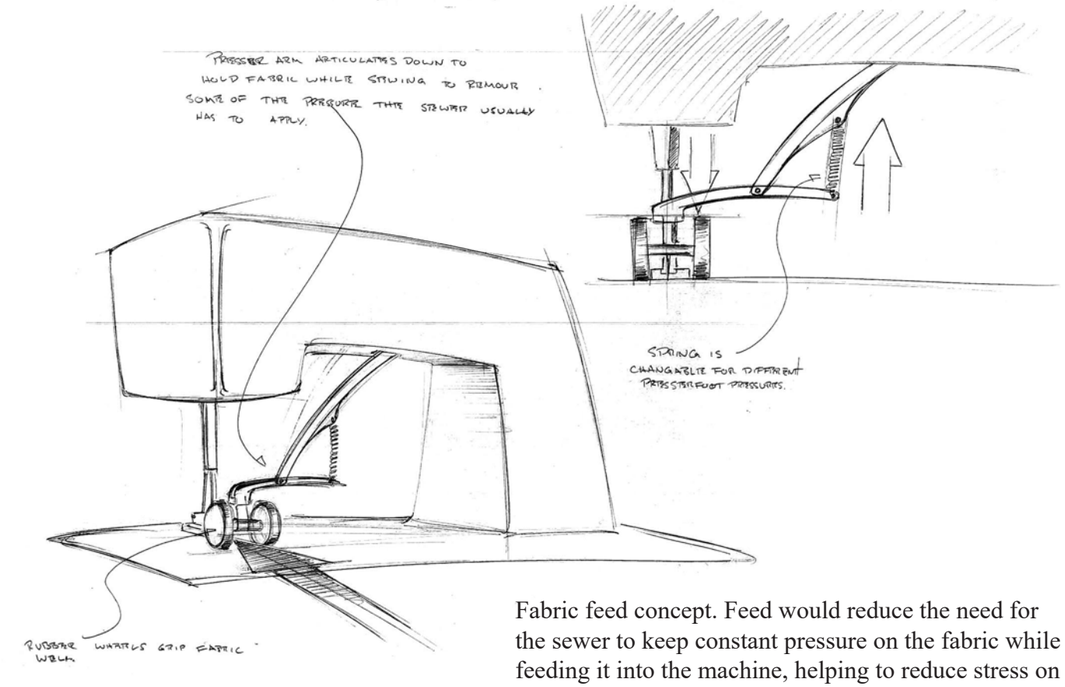
Idea Generation 4.1.3



Traditional looking table with ergonomic touches added. Introduction of the sloped table surface into the design. Existing sewing machine used.

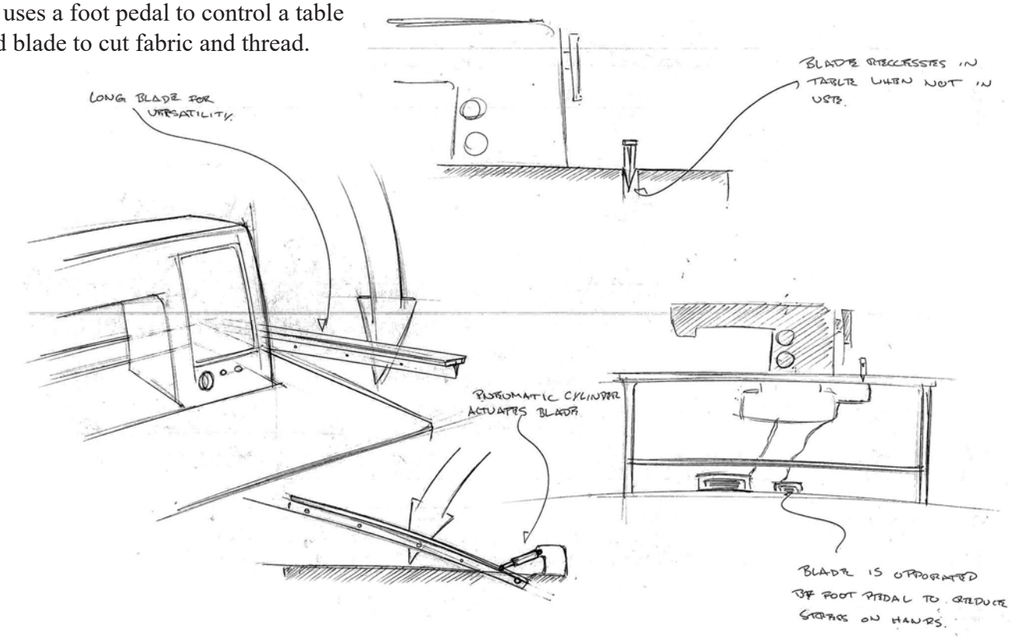


Integrated Concept. Table slit used to dispose of off cuts and threads easily. Vibration reducing legs.



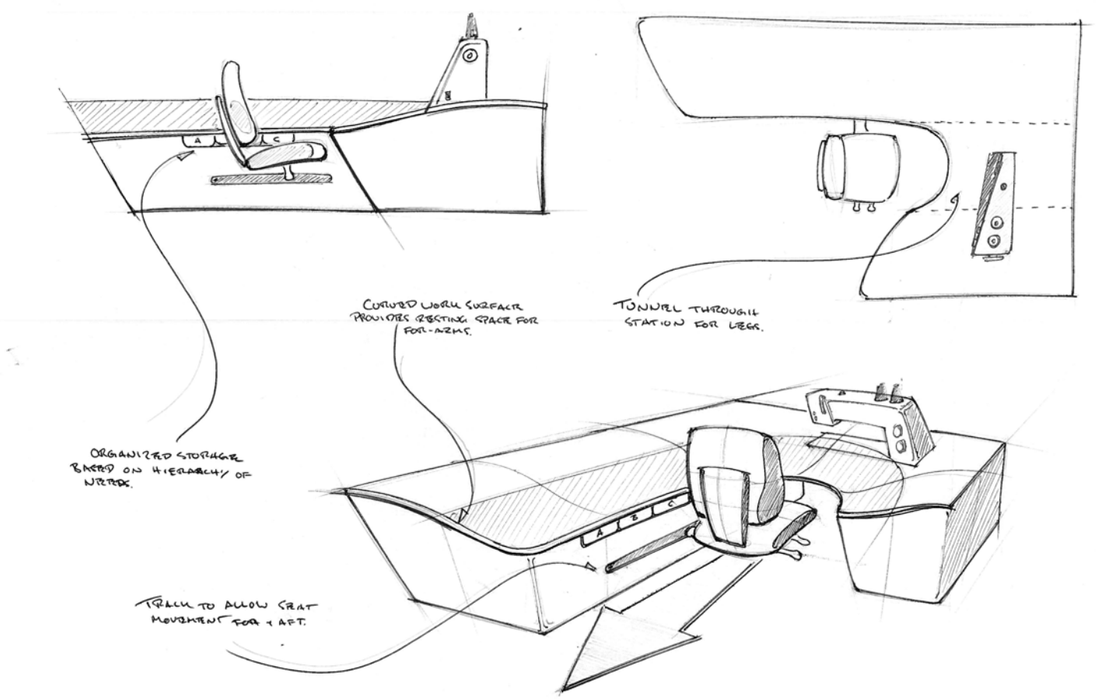
Fabric feed concept. Feed would reduce the need for the sewer to keep constant pressure on the fabric while feeding it into the machine, helping to reduce stress on fingers, wrists and forearms.

Using scissors is one of the motions that sewers identify as causing the most strain on their fingers and hands. Automated scissor concept uses a foot pedal to control a table mounted blade to cut fabric and thread.



Preliminary Concept Exploration 4.2

Concept 1



INTEGRATED SEWING WORKSTATION

Focus

Integrating seat, work surface, and machine.

Maximizing functional work areas.

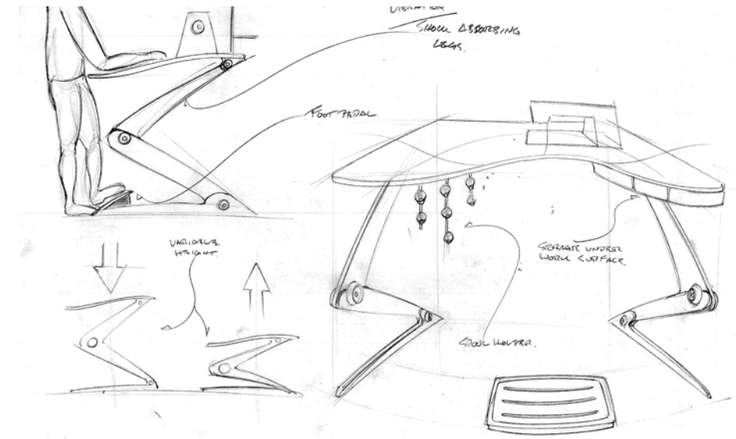
Optimizing ergonomics of the work surface.

Features

Integrated seat with repeatable ergonomic settings.

Sloped ergonomic work surface that forms around the user.

Large supportive work surface.



Concept 2

Features

Shock absorbing legs.

Height adjustable legs.

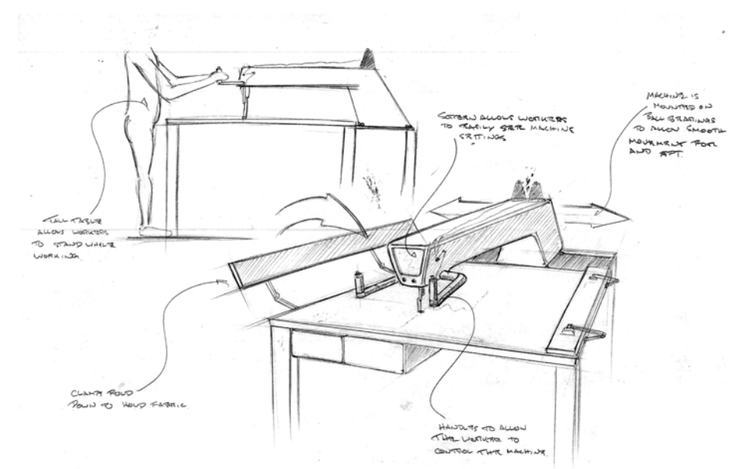
Integrated spool rack.

Contoured work surface to fit the body better.

SITTING AND STANDING SEWING WORKSTATION

Focus

Sitting and standing functionality.



Concept 3

Features

Fabric clamping arms.

Standing work surface.

Two axis movable sewing machine.

Dual handles for better control.

Sewing controls close to the user.

LONG ARM BASED SEWING WORKSTATION

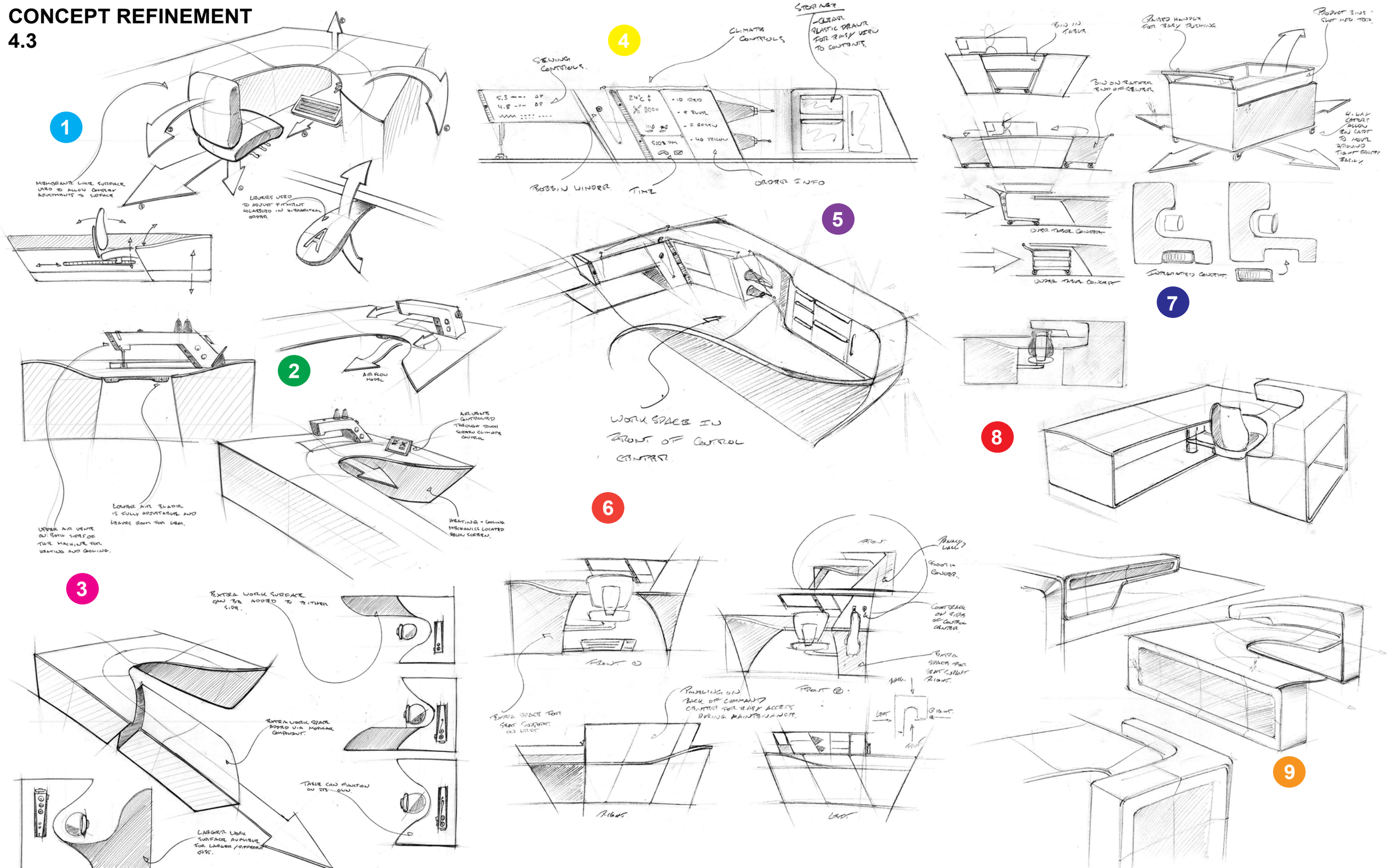
Focus

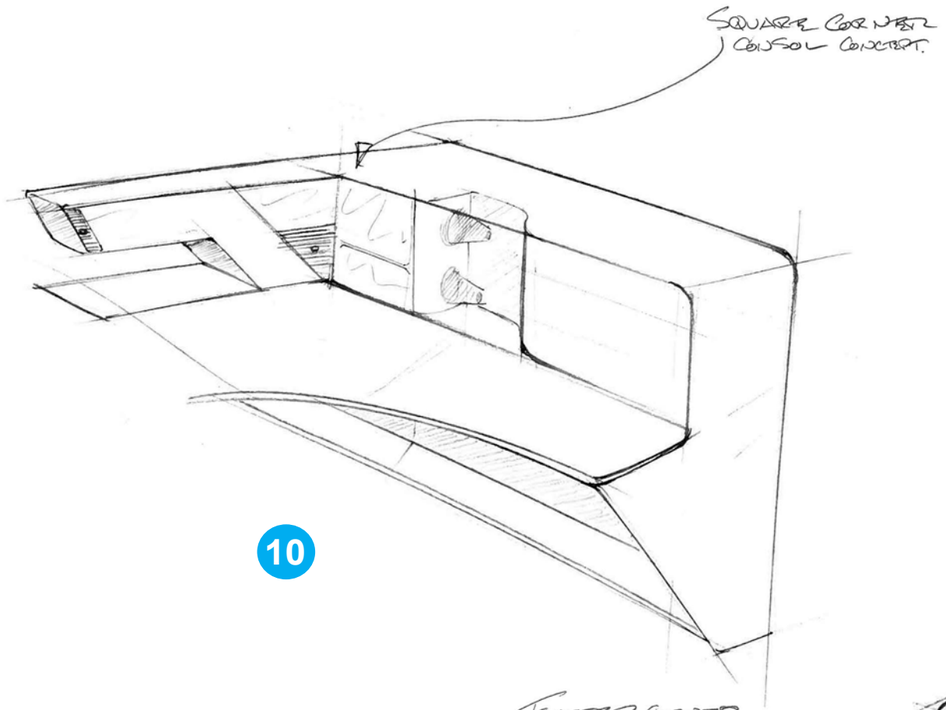
Standing over the work surface.

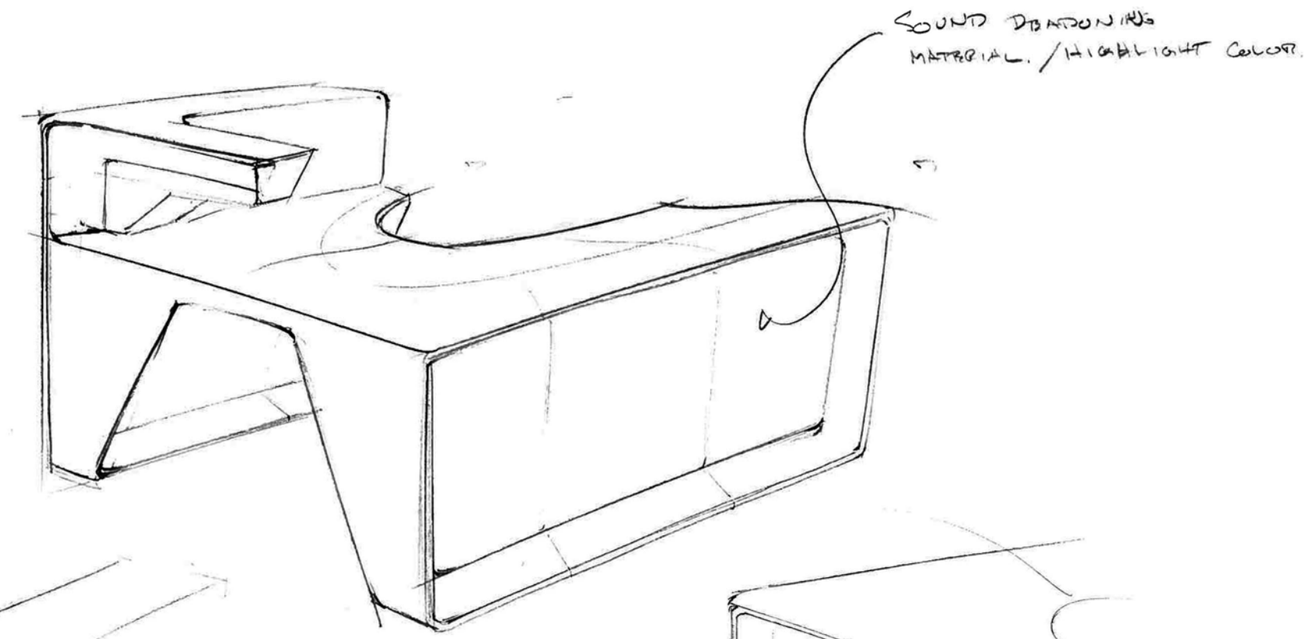
Trigger based sewing machine head.

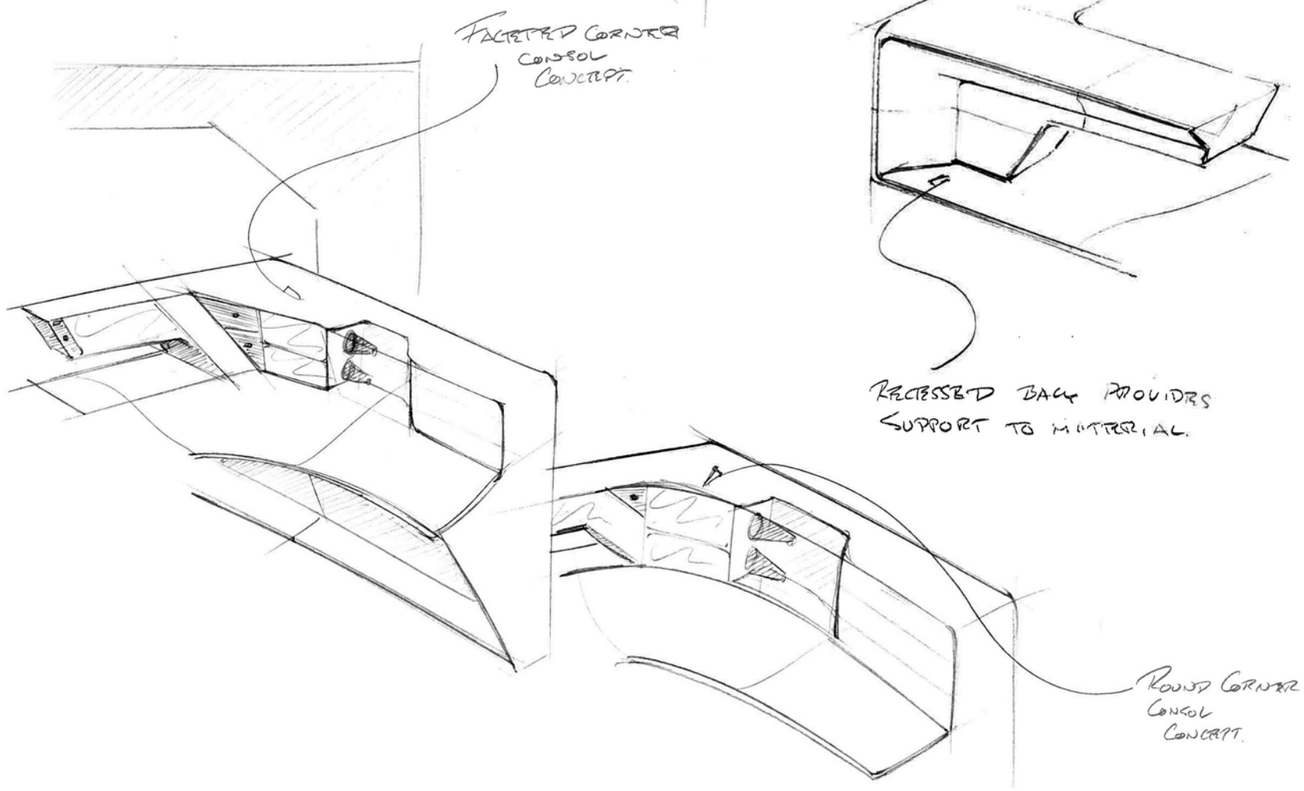
Sewer holds the machine, not the fabric.

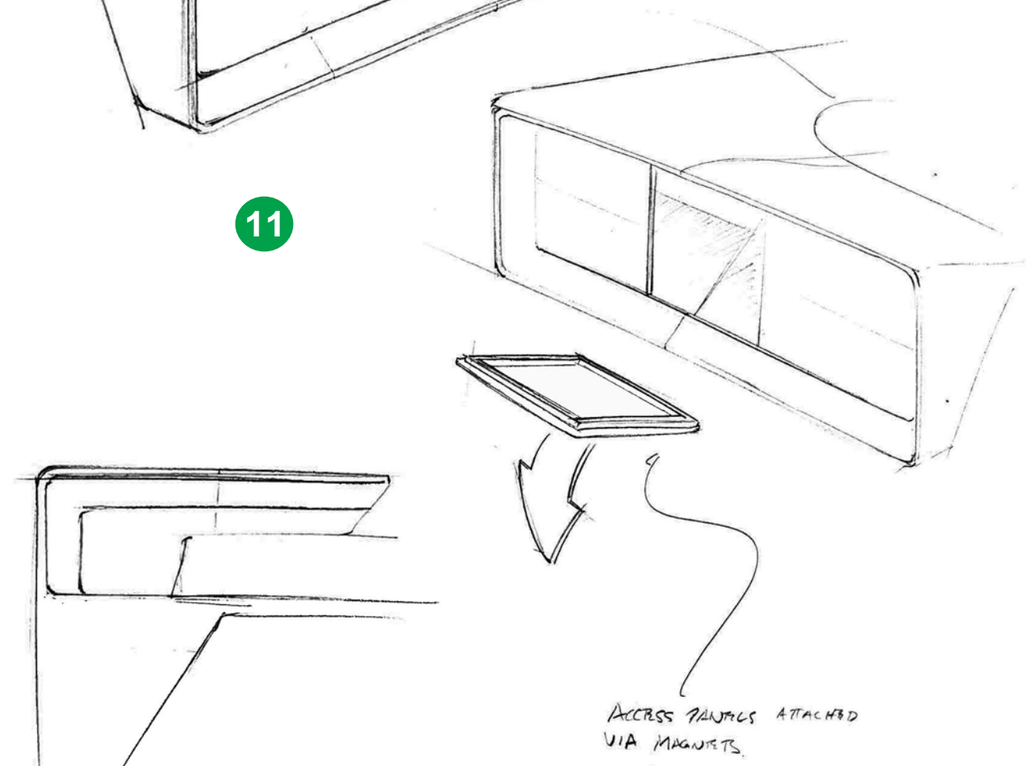
CONCEPT REFINEMENT
4.3



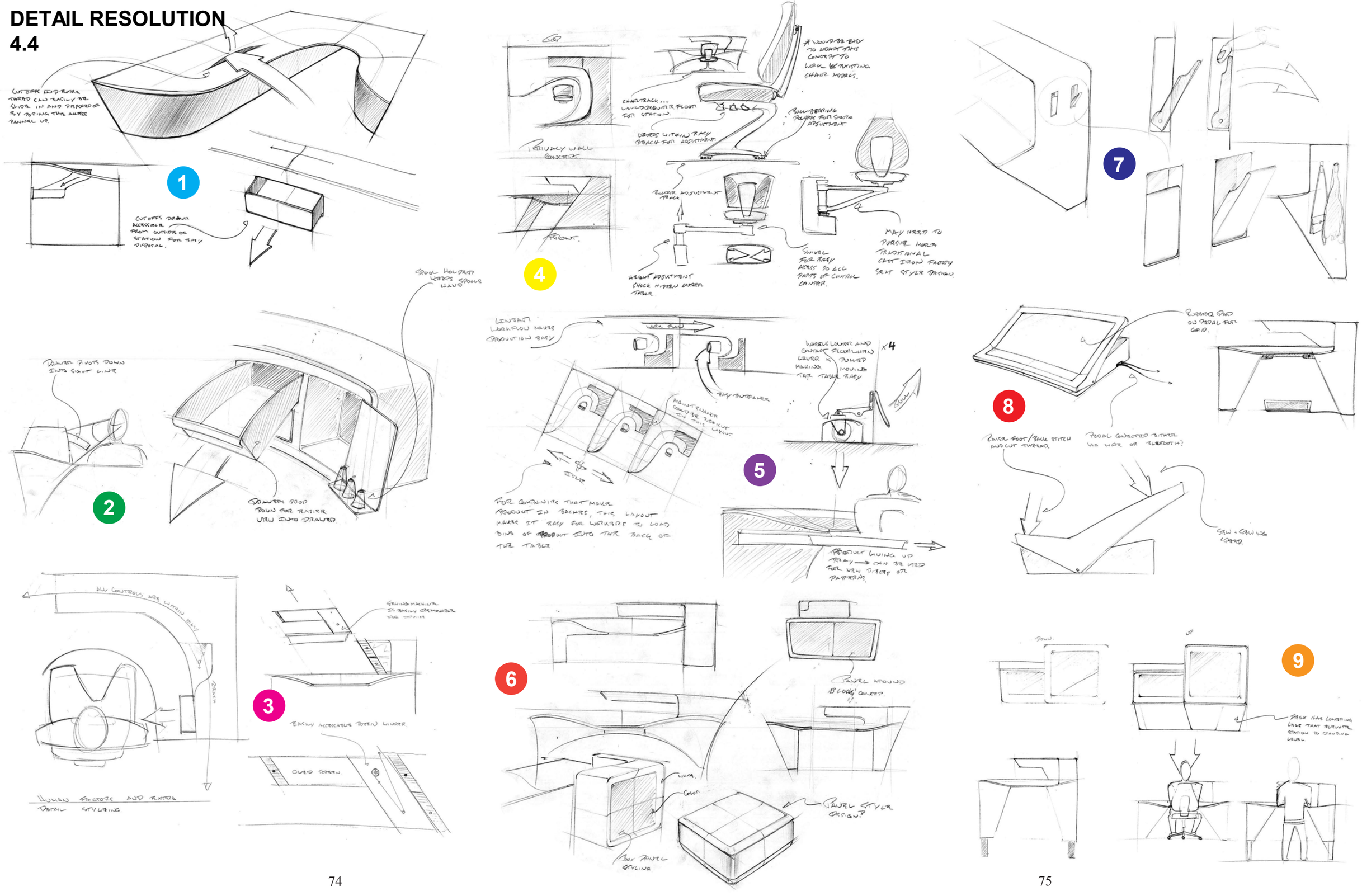

SQUARE CORNER
CONSOL CONCEPT.
10


SOUND DEADENING
MATERIAL. / HIGHLIGHT COLOR.

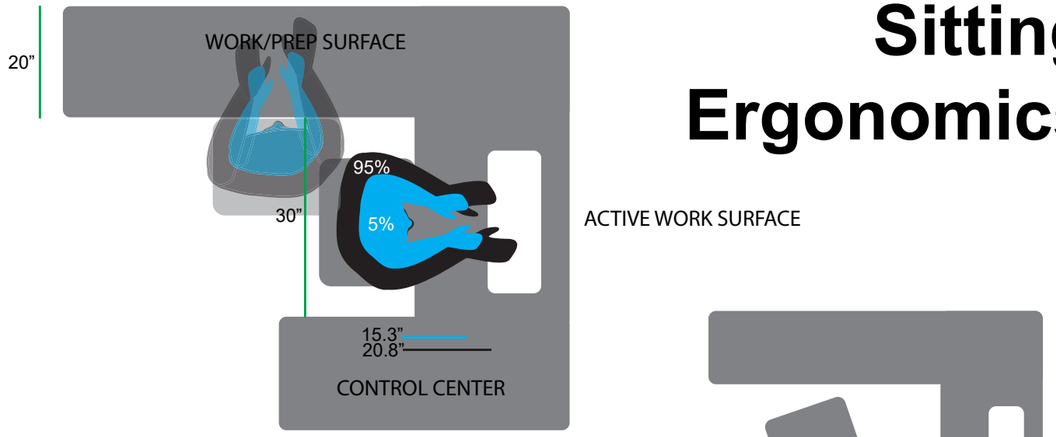

FACETTED CORNER
CONSOL
CONCEPT.
RECESSED BACK PROVIDES
SUPPORT TO MATERIAL.
ROUND CORNER
CONSOL
CONCEPT.

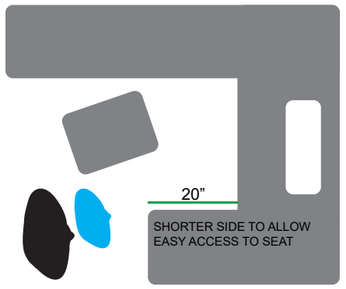

11
ACCESS PANELS ATTACHED
VIA MAGNETS.

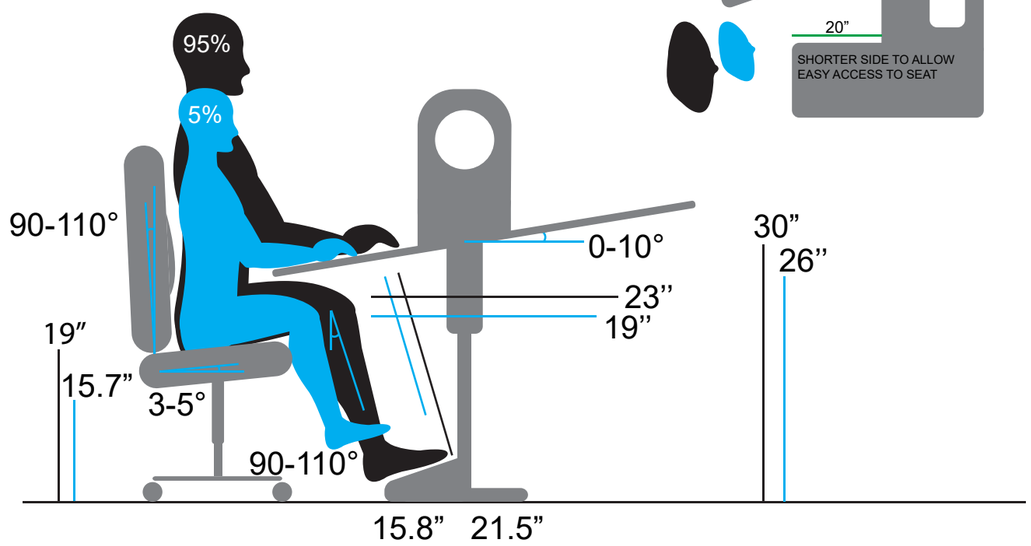
DETAIL RESOLUTION
4.4

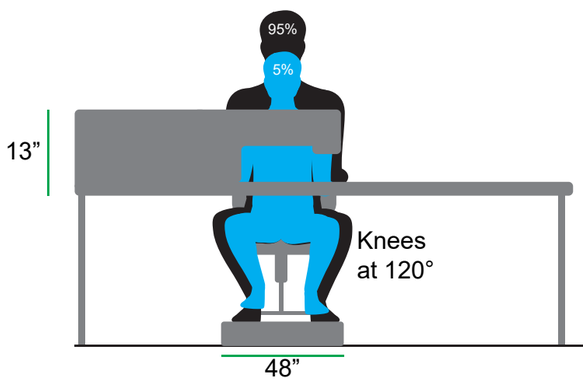


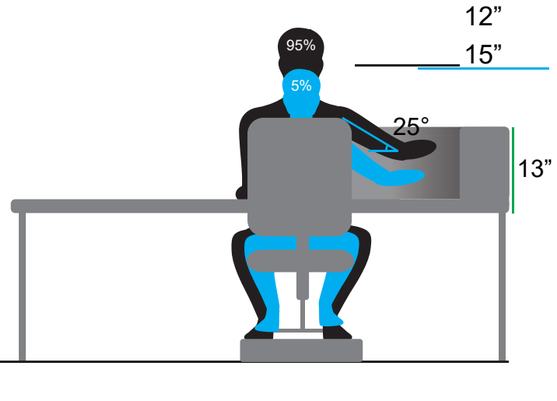
Sitting Ergonomics



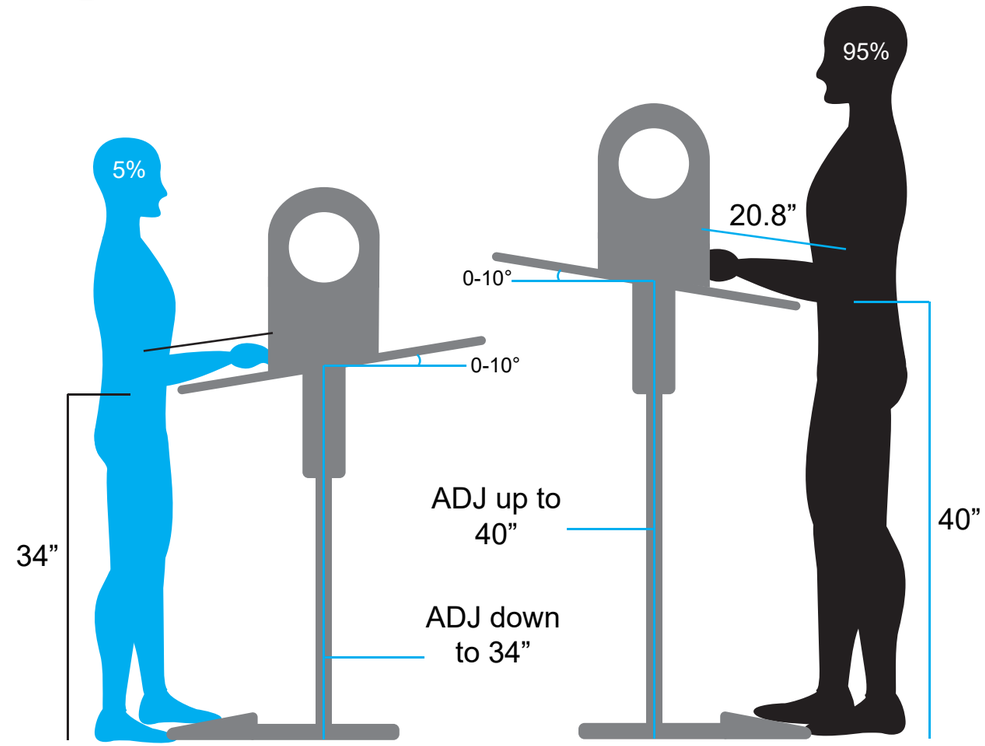


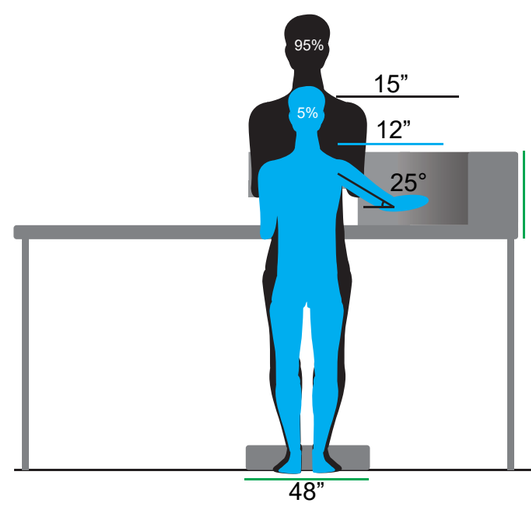


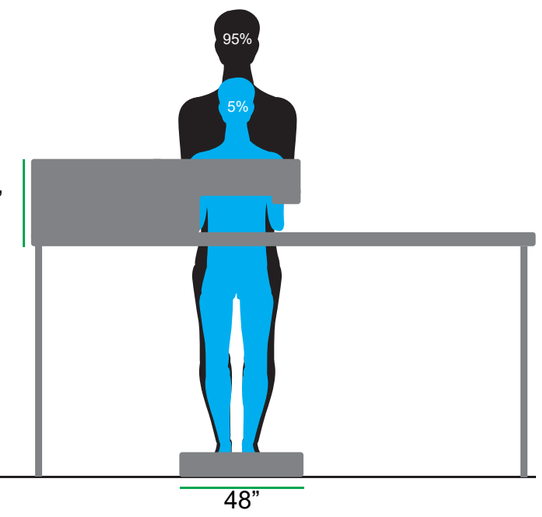




Standing Ergonomics







SKETCH MODEL 4.5
ERGONOMIC 1:1 SCALE MODEL 4.5.1

Ergonomic Model

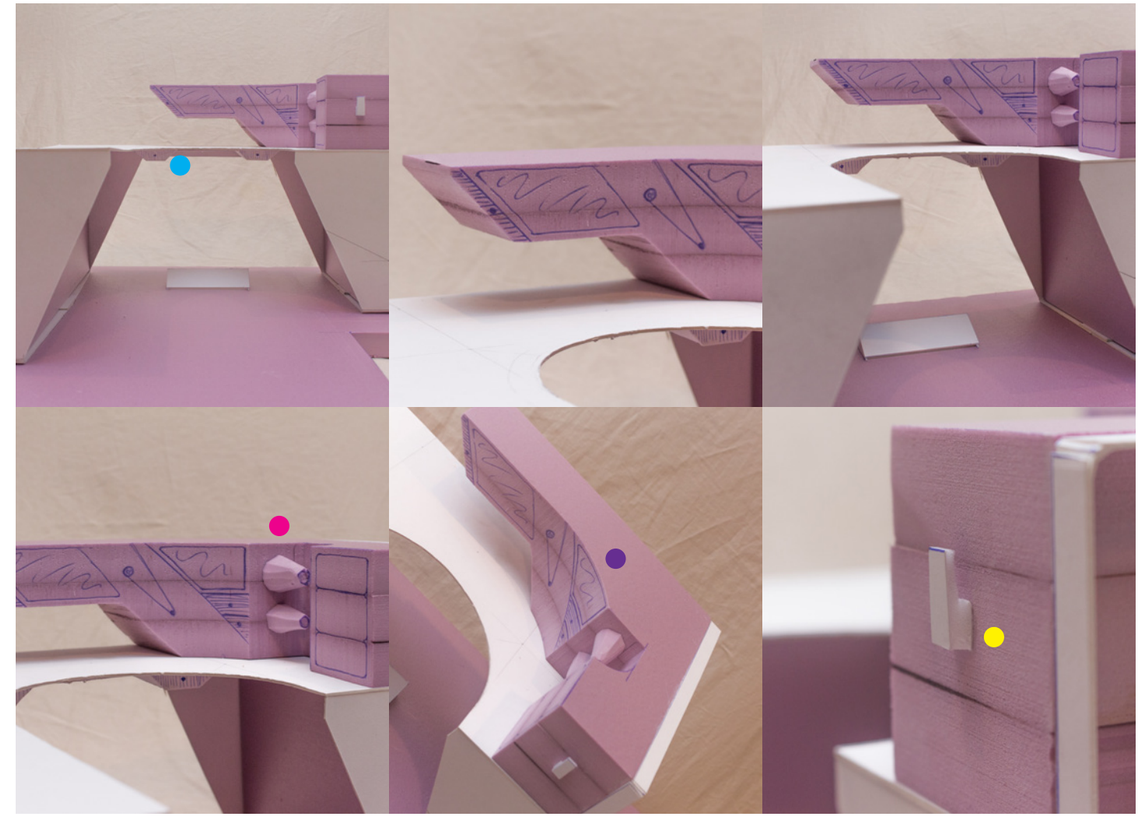
Early in the design process a 1:1 scale ergonomic mock up was created in order to better evaluate the proportions of the product and the motions used while interacting with the workstation. The mock up uses particle board as the work surface, 2x2 lumber to support the work surface, and a number of cardboard boxes attached together to simulate the shape and size of the sewing command center. Colorful construction paper cut outs were labeled and glued to the command center to enable the participants to get a feel for the location of various features, and to assess the reach and placement of others.

To simulate a fully adjustable and integrated system, a desk chair with an air shock was used to allow adjustment to be made to the height of the seat. The foot pedal was created from a sheet of MDF and attached to a guitar pedal to give it a more realistic range of motion, and the distances from the user were marked on the floor with tape.

One element that was not tested with this model was the functionality of the station when set up as a standing desk; however, ergonomic considerations have been made to accommodate the standing functionality of the workstation based on research found in *The Measure of Man* (Dreyfuss,1959,p51).

For these tests two participants were used: a 95th percentile male, and a 5th percentile female. Using the previously mentioned adjustments, the participants performed a series of motions emulating working at an industrial sewing workstation which allowed conclusions to be drawn about dimensions and placement of features.

SCALE MODEL 4.5.2



SCALE SKETCH MODEL

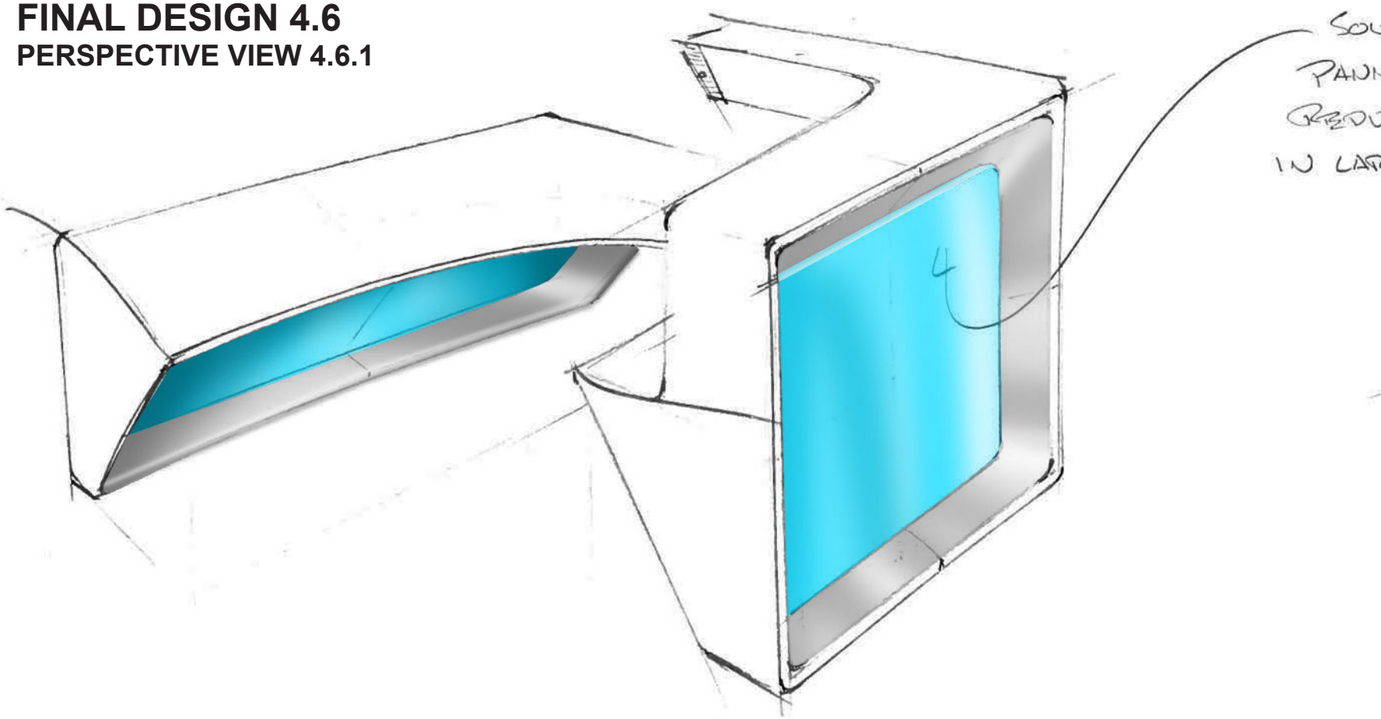
To help finalize the design of the sewing workstation a scale sketch model was built to resolve several final details of the command center. The model incorporates many of the final design's styling cues and features.

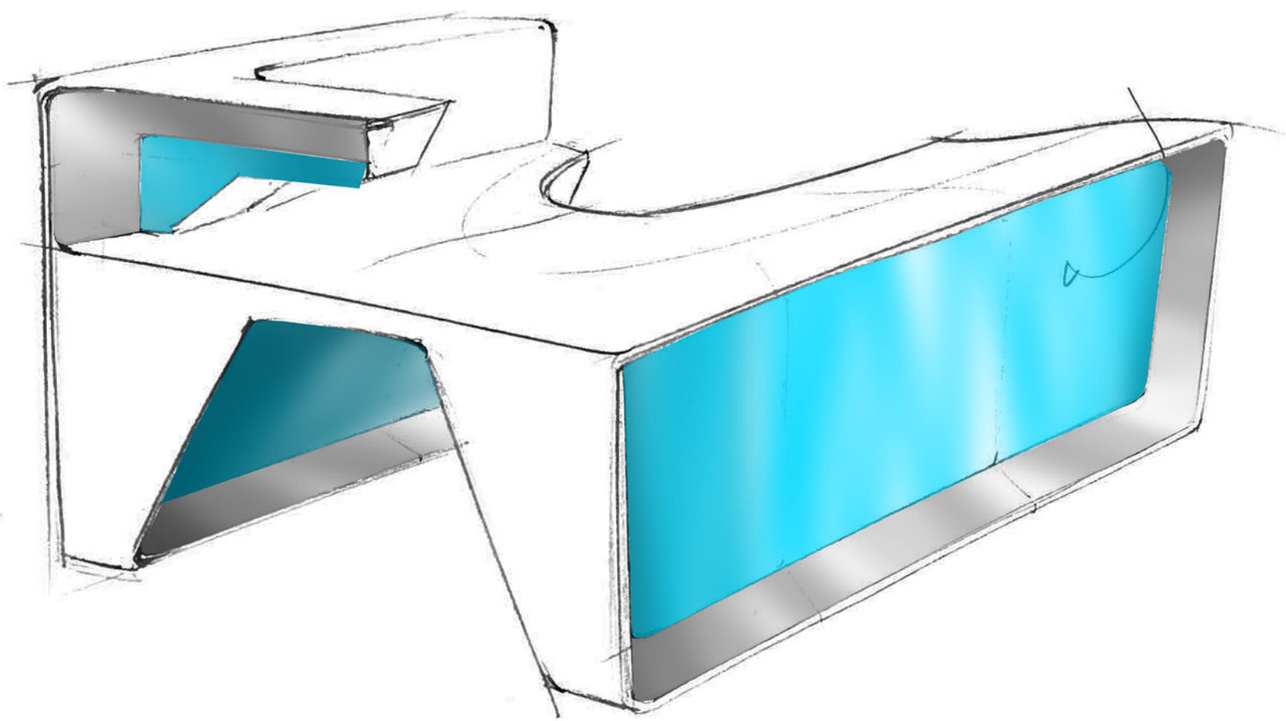
The model is constructed of pink foam and illustration board, and has many of the command center's features illustrated in pen on the surface of the buck.

Several key features were modeled:

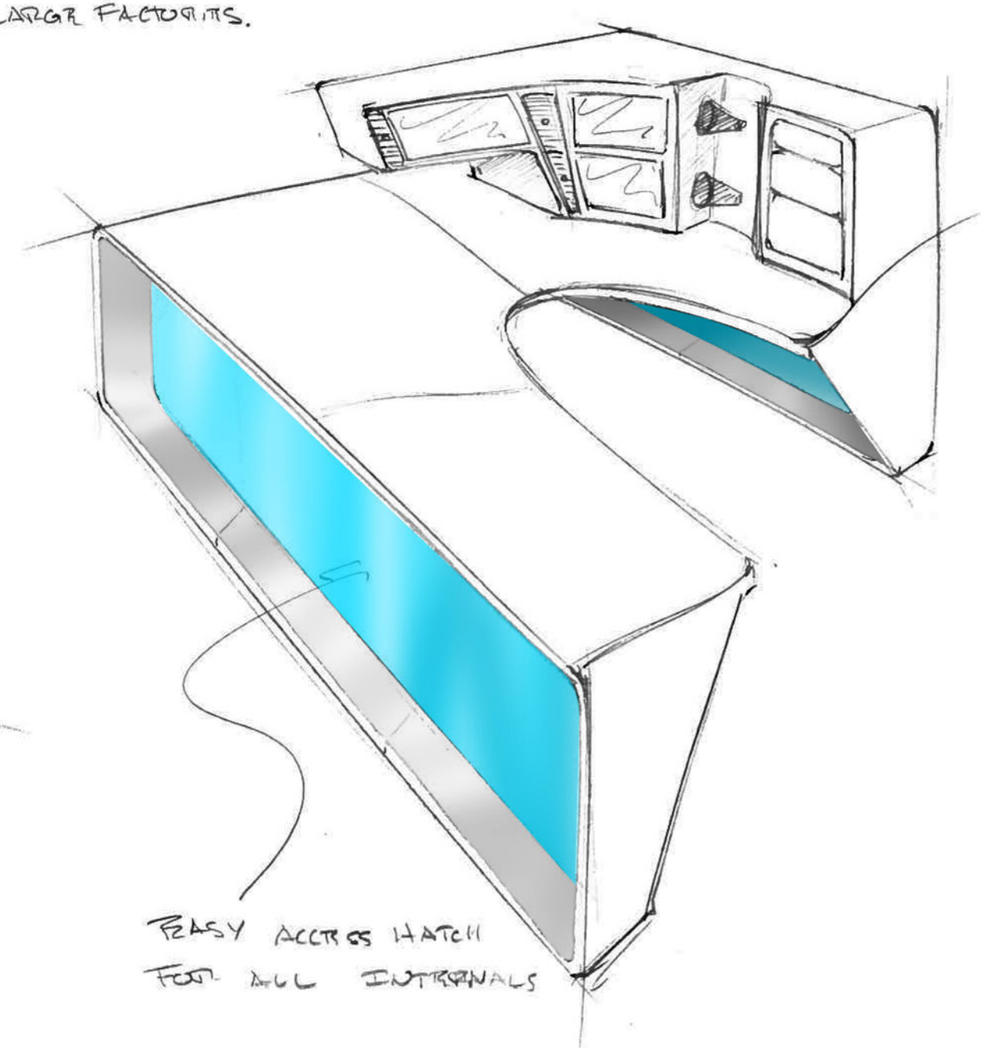
- Under-counter climate vents
- Foot pedal
- Spool holder
- Coat hook
- Command center inner corner radius

FINAL DESIGN 4.6
PERSPECTIVE VIEW 4.6.1





SOUND DEADENING PANNEL + ACCESS HATCH REDUCES NOISE IN LARGE FACTORITS.



EASY ACCESS HATCH FOR ALL INTERNALS

FINAL DETAILS 4.6.2

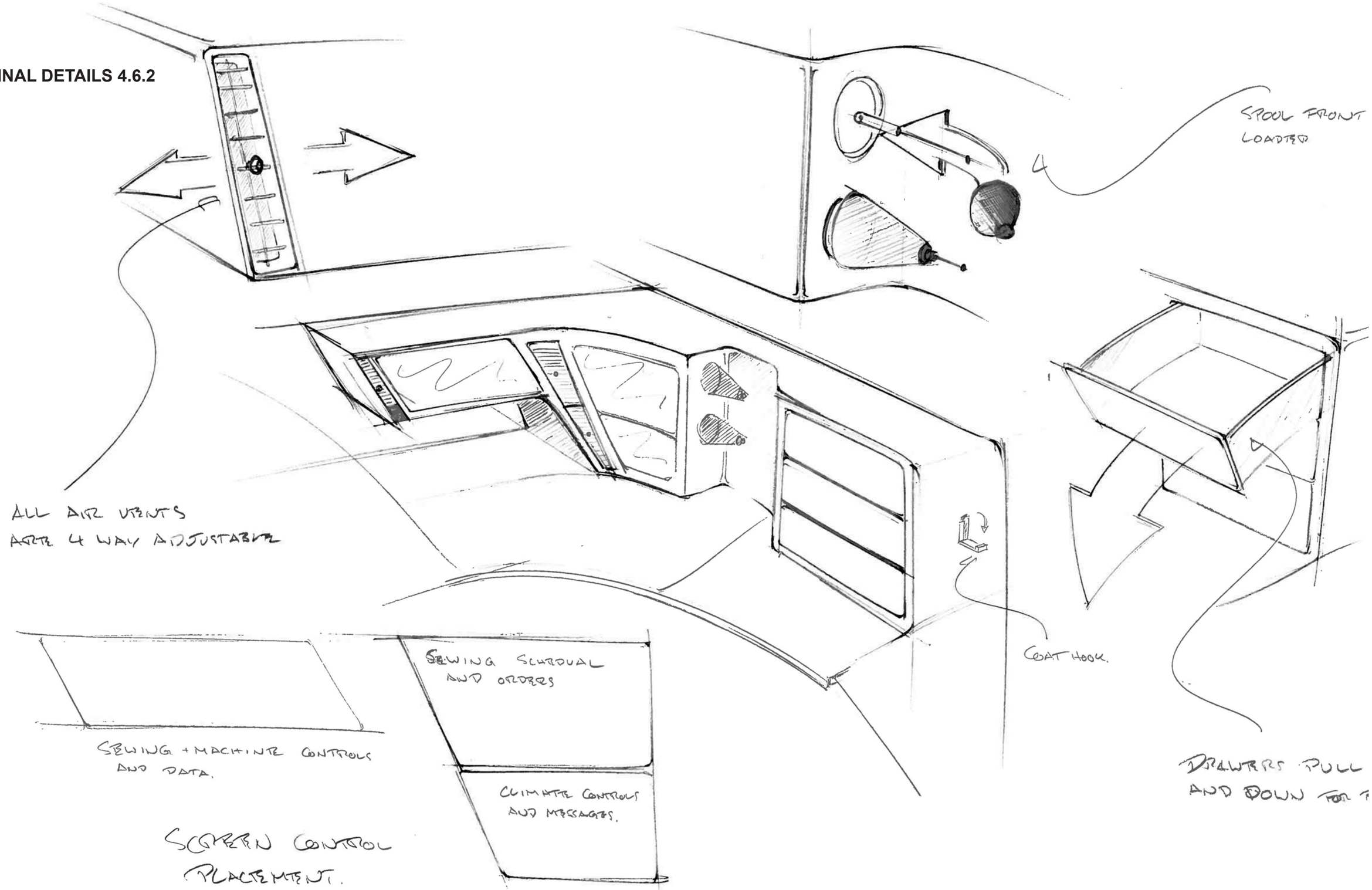
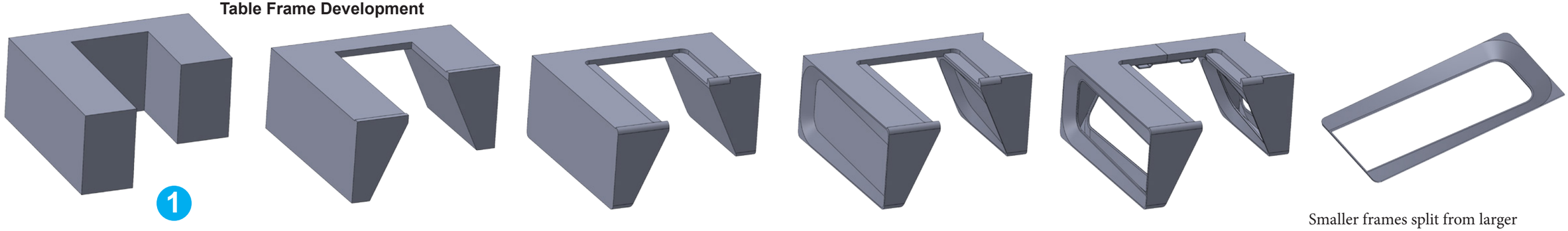
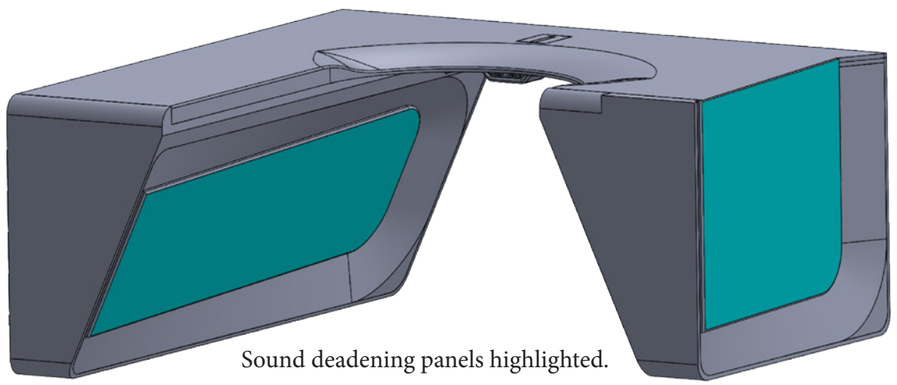


Table Frame Development

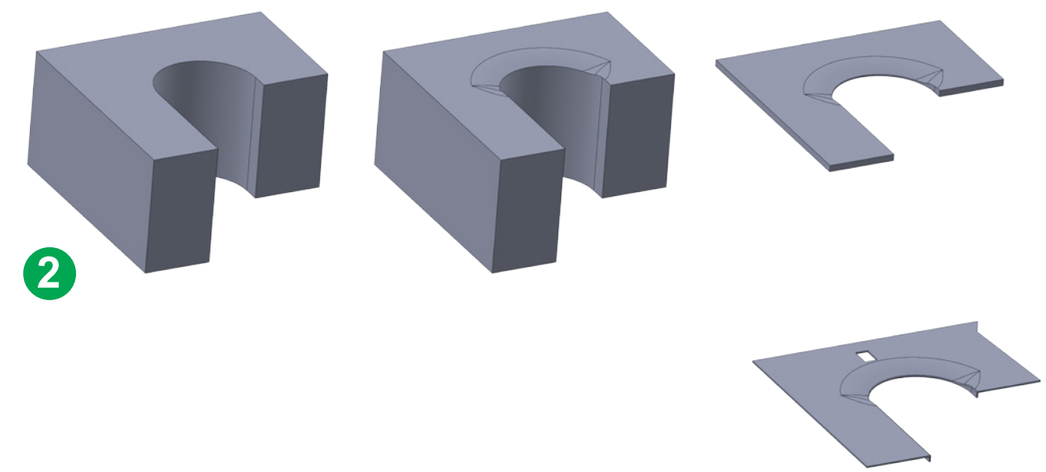


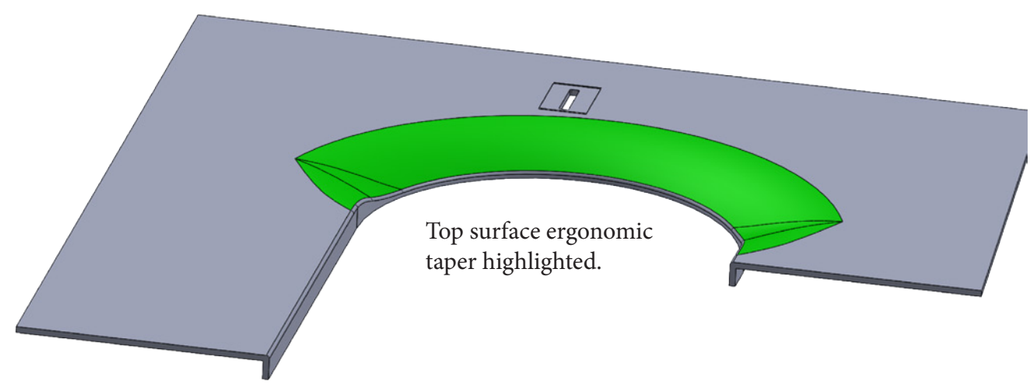
Smaller frames split from larger frame that hold sound deadening panels.



Sound deadening panels highlighted.

Table Surface Development





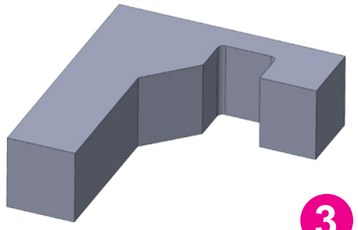
Top surface ergonomic taper highlighted.

CAD Development

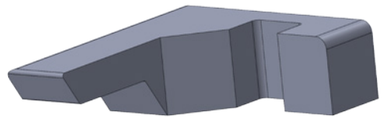
Once the final design was approved, CAD was developed to help flush out the details, finalize dimensions, and send for 3D printing.

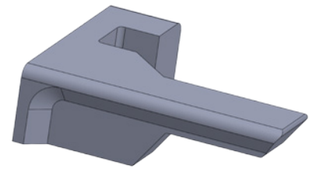
The base was constructed first, and a frame was made that held the side panels and command console. The table surface was then created and slotted into the top of the frame to create a molded work surface. Lastly, the console was created, and details added as the project progressed.

Console Development

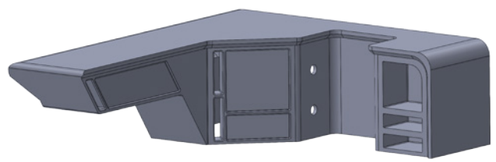


3

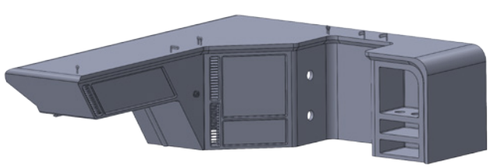


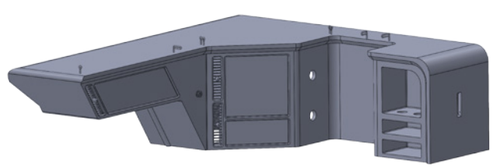


Initial form sculpted from a solid extrusion.

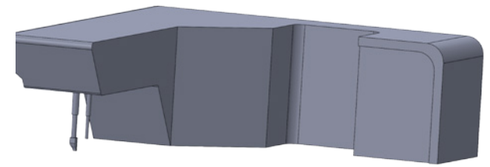


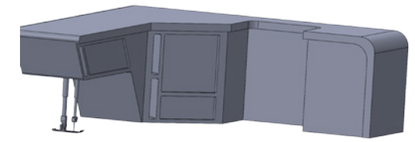
Body was shelled and recesses for storage created.



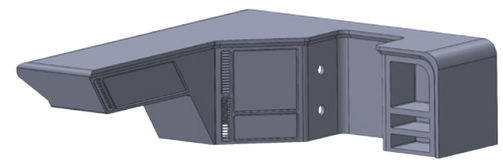


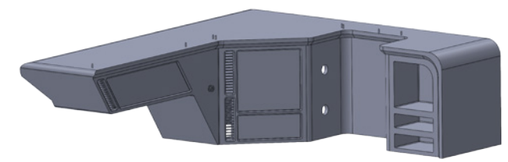
Addition of small details for thread routing.



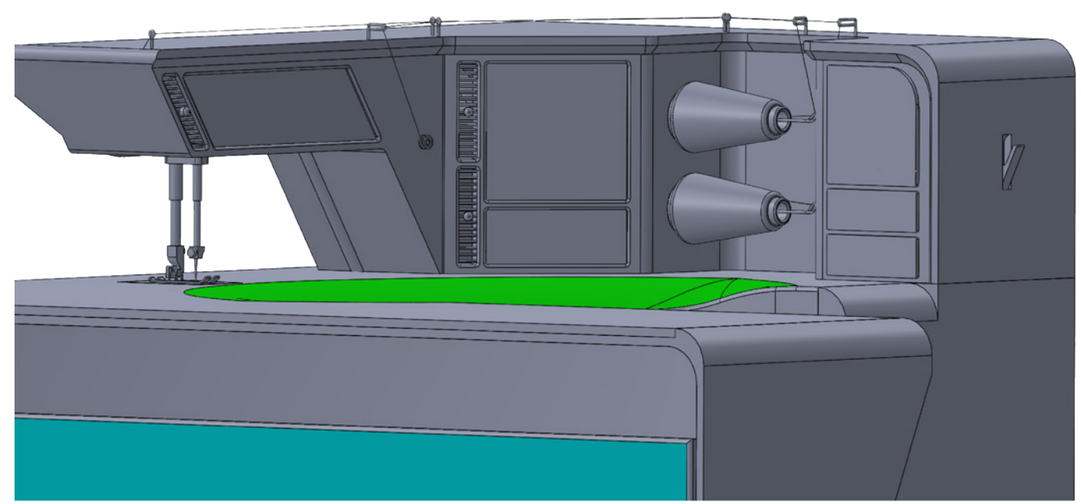


Sewing head built and split into seperate body.



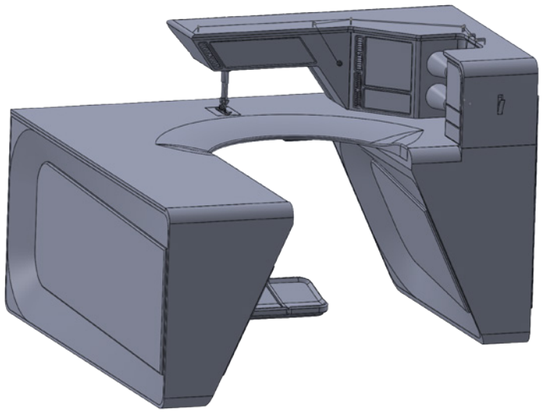


Addition of small details for air conditioning.

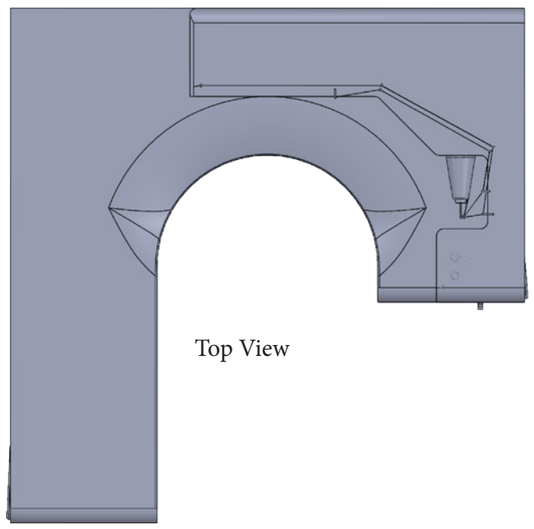


Final CAD Model

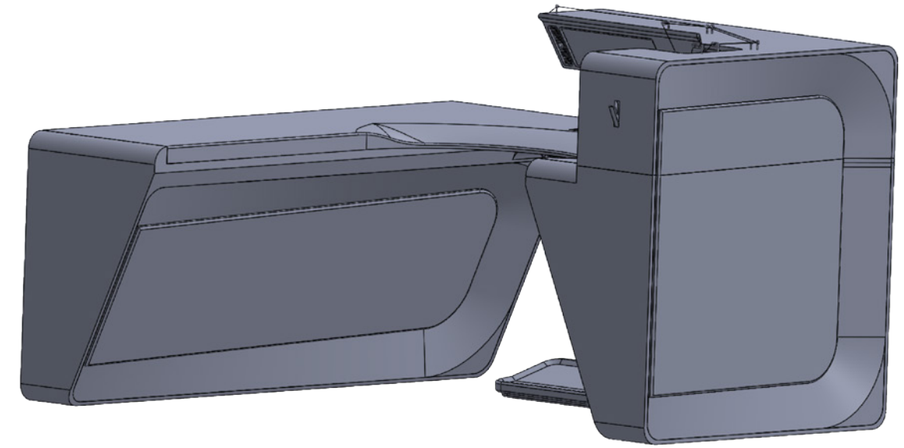
4

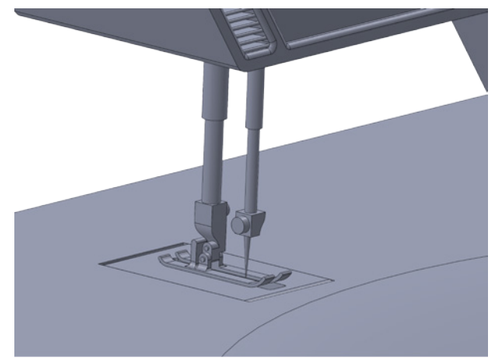


Front 3/4 View

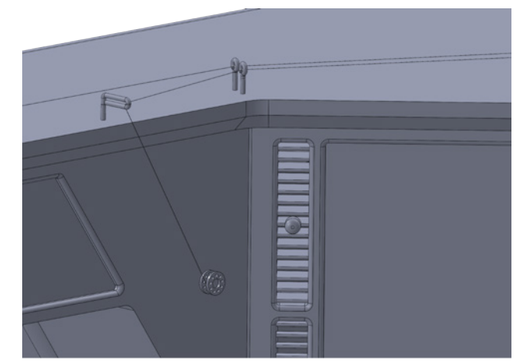


Top View



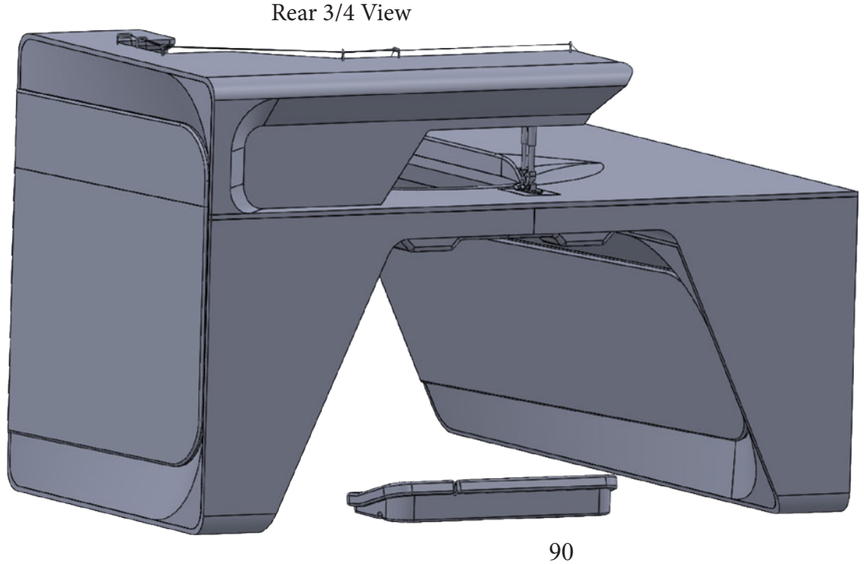


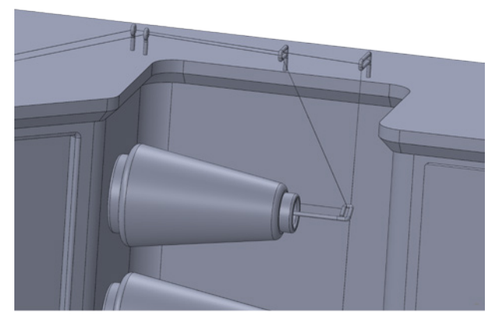
Needle Head Detail



Vent and Bobbin Winder

Rear 3/4 View

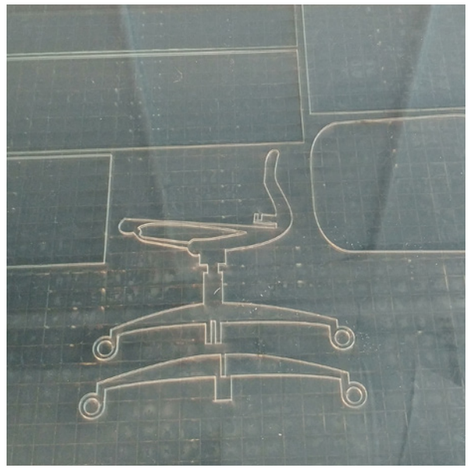
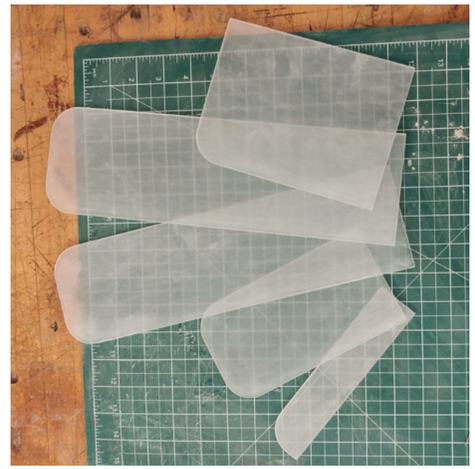
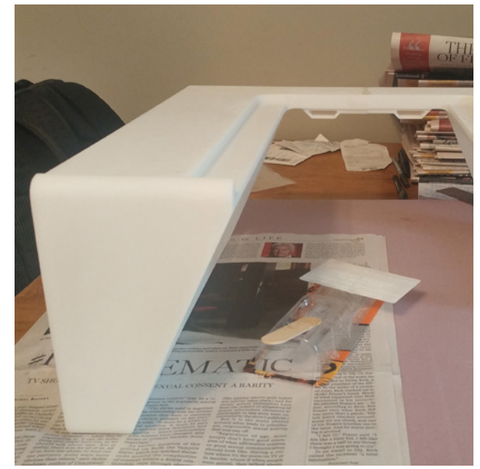
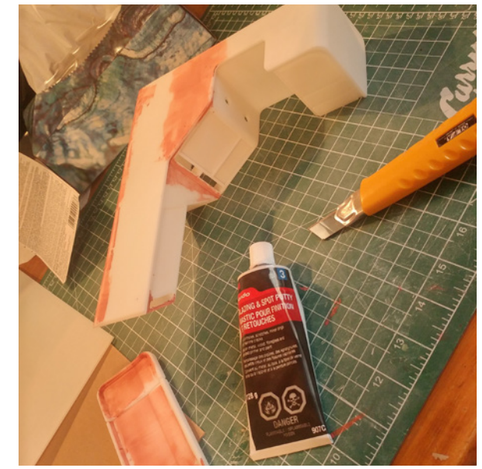


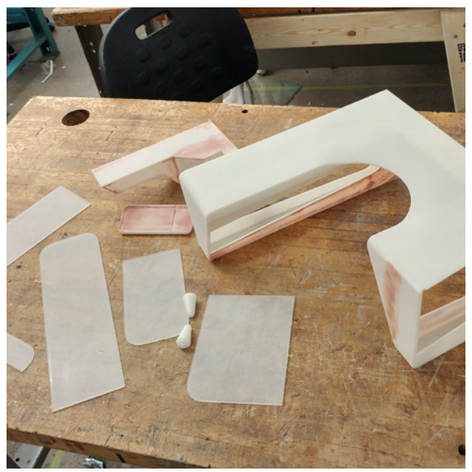
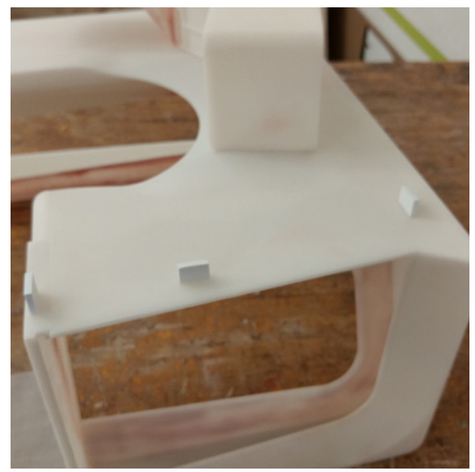


Spool and Thread Routing Detail

Coat Hook Detail

Hard Model Fabrication Photos 4.8

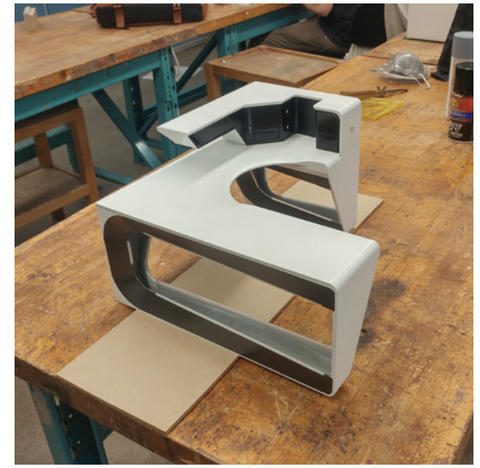







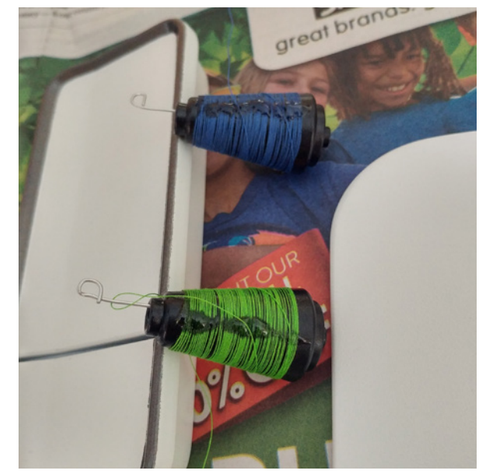
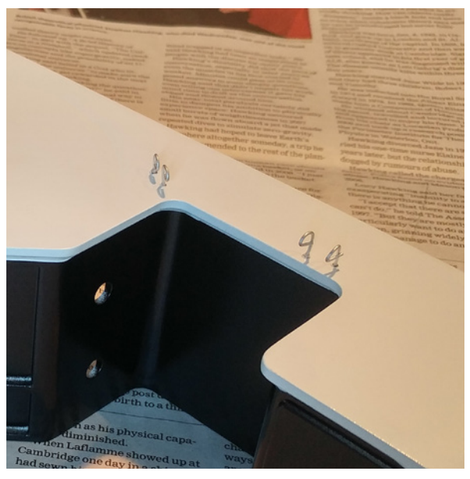
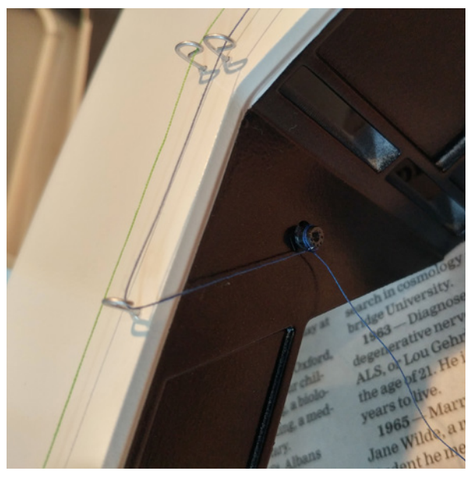


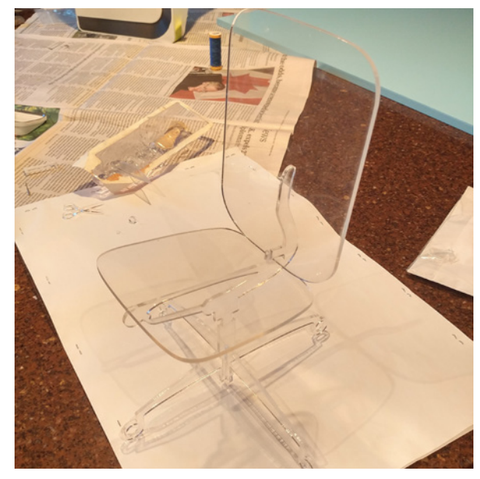
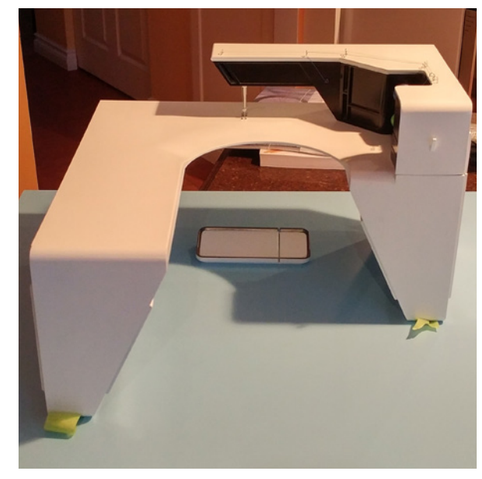


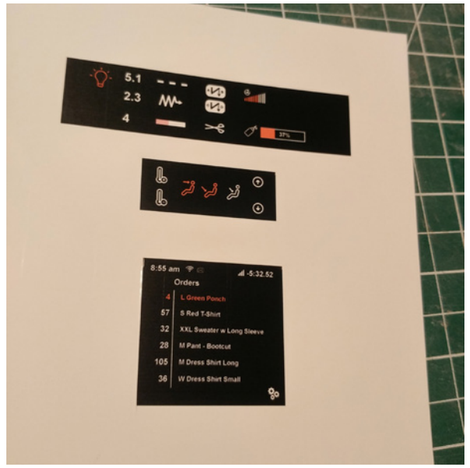


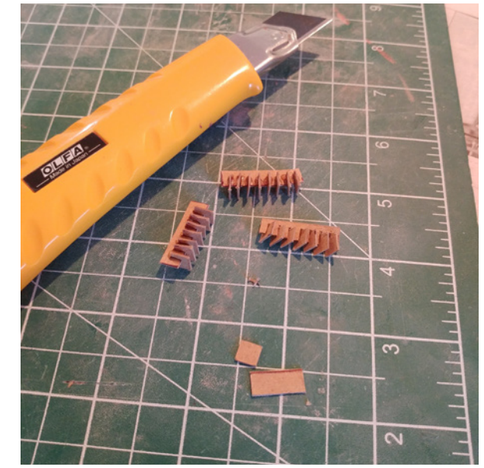


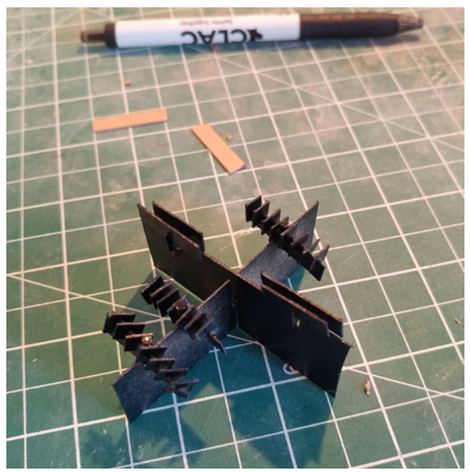


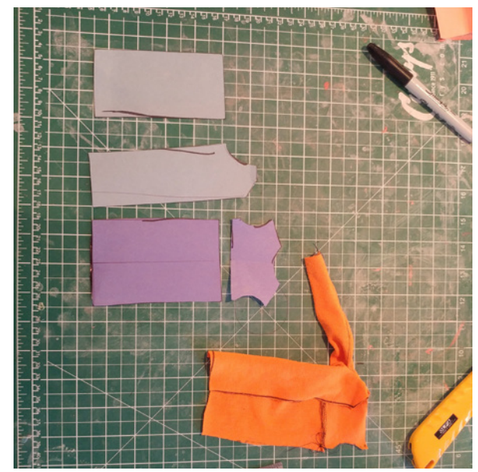




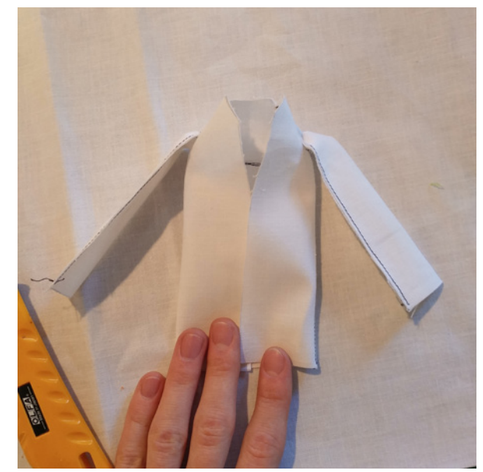



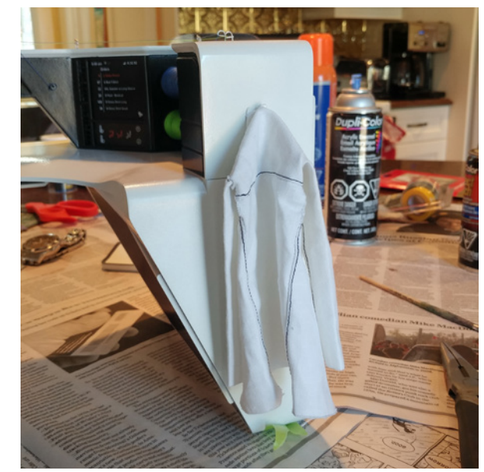

5.1
2.3
4
8:55 am
Orders
4 L Green Poncho
57 S Red T-Shirt
32 XXL Sweater w Long Sleeve
28 M Pant - Bootcut
105 M Dress Shirt Long
36 W Dress Shirt Small

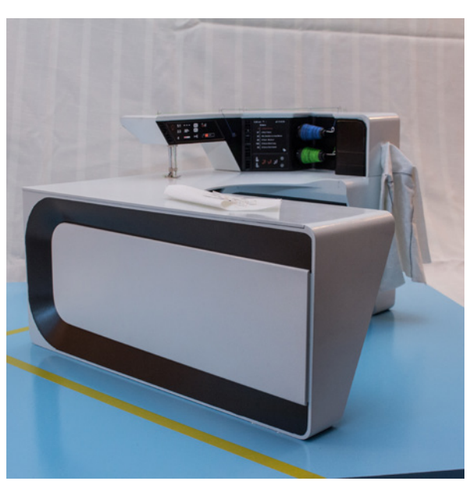


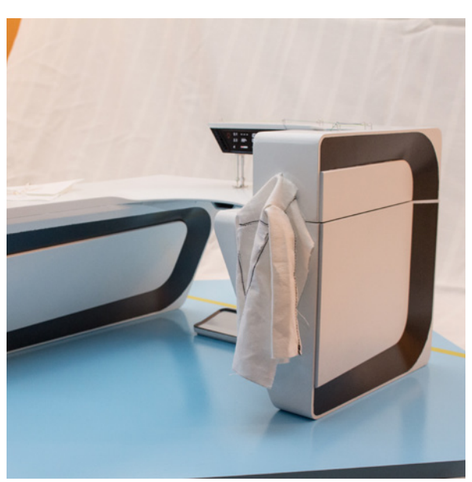


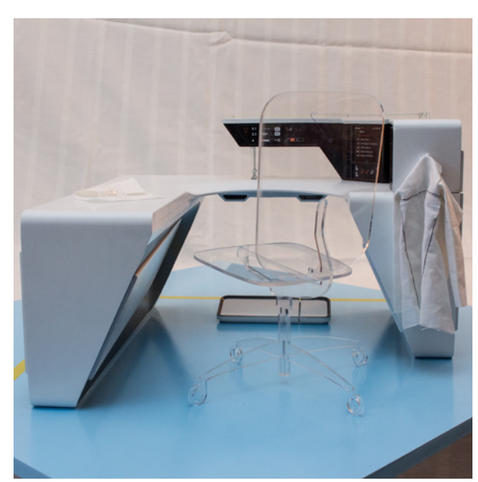


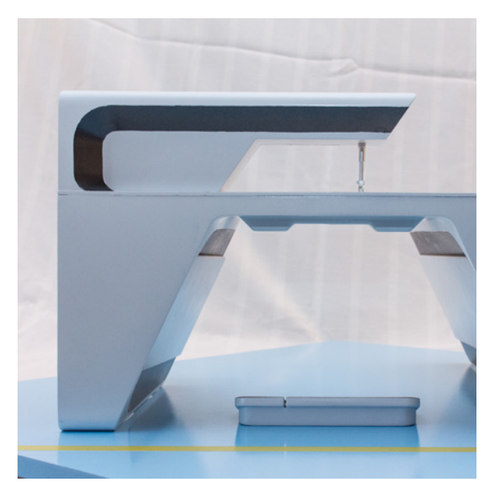








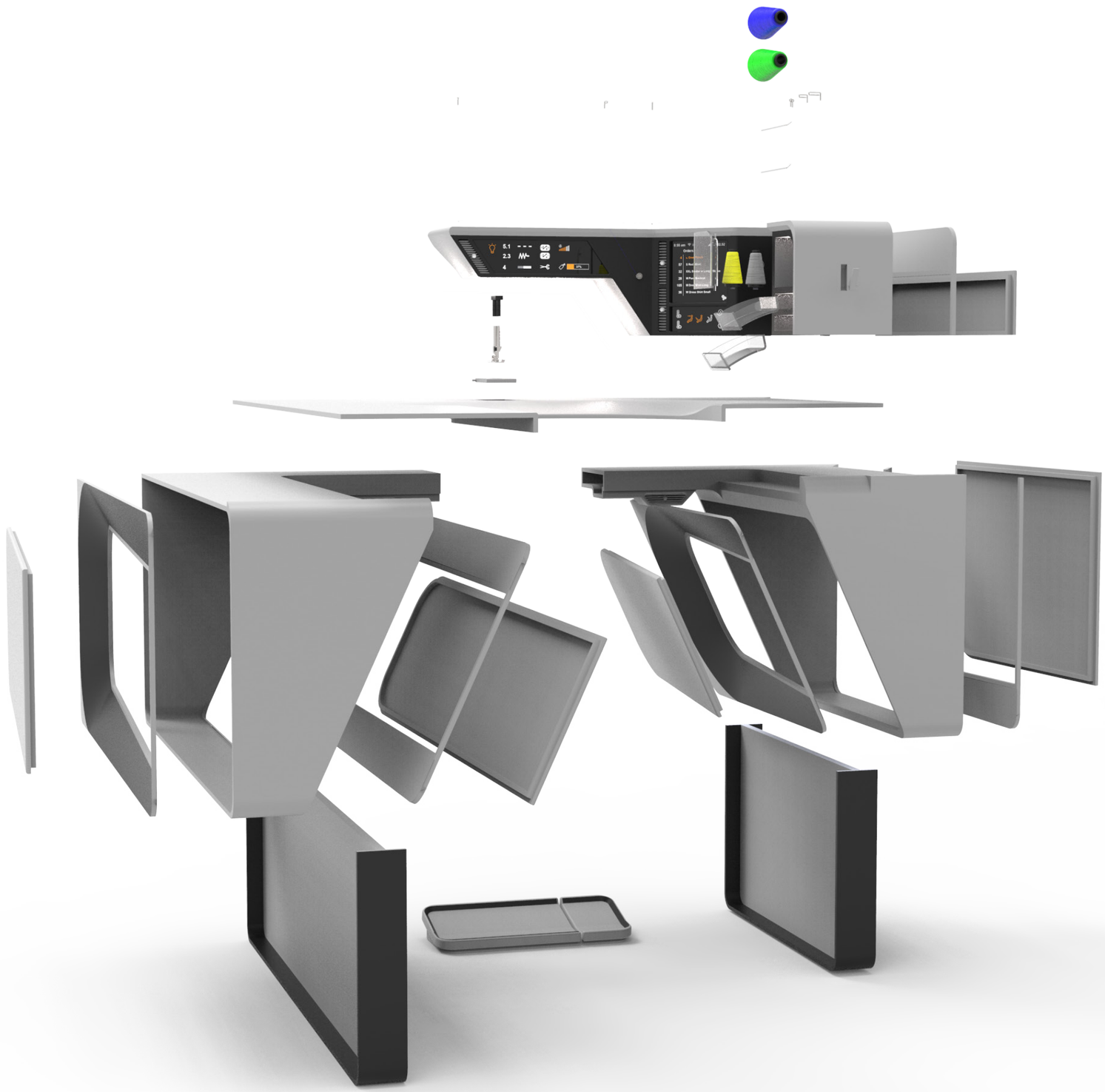




Final Model Assembled

Final Design

5



Summary 5.1

Description: 5.1.1

Form is a innovative new ergonomic sewing workstation that reduces the risk of sewers developing repetitive stress injuries, while creating a safe environment that fosters greater productivity.

Explanation: 5.1.2

Form uses a set of risers to allow the work surface to be adjusted between sitting and standing positions several times over the course of the work day. This adjustment plays a major role in the reduction of repetitive stress injuries in both the upper body and the lower body, while also contributing to improved general health.

This user centered methodology has also been applied to several other areas of the workstation, such as the layout of the storage and the positioning of the spools which are in easy, comfortable reach of the sewer.

Form incorporates a unique climate control system to allow sewers to adjust the temperature of their working environment to a setting that keeps them comfortable.

Advanced, programmable settings and reminders allow businesses to send order numbers directly to the sewers and perform updates and maintenance on the machine remotely, while also allowing sewers to create individualized work plans with reminders to help prevent them from remaining in a static position for an extended period of time.

Form is an essential tool for sewers and businesses, that allows them to create a safer and more productive work environment while improving the overall quality of life for the sewers.

Benefits: 5.1.3

Form provides an easily adjustable and adaptable work environment that allows sewer to take control of their workstations, making themselves more comfortable, while also reducing the risk of developing repetitive stress injuries

Form provides a organizational hierarchy that is superior to other products on the market, allowing sewers to easily find and reach the tools they need without compromising their longterm comfort.

Form creates an environment that keeps sewers more comfortable through the use of a unique industry leading climate control system which in turn allows sewers to be more productive while working.

Form takes advantage of modern OLED touch screens to allow sewers to quickly and easily interface with the workstation while keeping energy consumption to a minimum.

Form uses sound deadening and vibration absorbing panels attached to its frame structure that absorb factory and machine noise, while also helping to reduce the vibrations that are common in current sewing workstations.

Form incorporates homey customizable touches such as an integrated coat hook, color and brightness adjustable sewing arm integrated light, as well as a message center that allows sewers to send and receive messages and calls while on break.

Form takes advantage of the latest in direct drive sewing motor technology allowing the unit to keep energy consumption levels to a minimum, while also reducing vibration and noise.

Form incorporates a surface access bobbin hatch that allows user to easily gain access to the bobbin without having to bend over and reach under the table.

Criteria Met: 5.2

1 Designed for The User

Form is the first industrial sewing workstation designed with the user in mind. It focuses on providing the optimal position for the sewer while increasing their comfort through the use of its climate control system, and ergonomically designed storage solutions. Sound and vibration are kept to a minimum through the use of sound deadening and vibration absorbing material incorporated into the frame of the workstation. Form prioritizes the long term health and safety of its users and does not compromise.

2 Easily Adjustable and Customizable

Form uses electronic riser motors to allow users of all abilities to easily raise and lower the workstation to their desired hight. Both lighting and climate can be controlled simply through the three OLED touch screens that display clearly the current settings and can provide help menus if needed to assist in adjustments.

3 Intuitive and Culturally Integrated

Form incorporates three large OLED touch screens that allow users to easily access settings and customize menus. Large, easy to see and understand infographic buttons are used to help improve user interfacing and to make learning how to use the machine a quicker process. Region specific languages and formats can be chosen from the settings menu, and several control layouts are available and easily customizable based on user preference.

4 Universally Accessible

Form's full range of adjustment allows users of all shapes and sizes to get comfortable while sewing. Once the sewer has become comfortable with the workstation, menus and button layouts can be customized based on the job at hand and the skill of the sewer.

5 Improved User Ergonomics

The large range of motion in table height allows users to choose from an infinite number of positions based on their height and whether they would prefer to sit or stand. The ergonomically tapered sewing surface allows sewers to rest their forearms on the table surface while sewing, reducing stress on the sewer's hands, forearms, arms, shoulders, and necks. The improved placement of storage in the command center allows users to reach all of their required tools without having to reach outside of the comfortable range for the average user; improved placement of the thread spools as well as the bobbin case also aids in preventing awkward motions that may lead to repetitive stress injuries over time.

6 Versatile

Form provides ample table surface to allow projects of all sizes and shapes to be supported while sewing, while also conserving factory floor space. Form's powerful direct drive motor is also capable of sewing a variety of fabrics, from light silky fabrics to heavy leather and synthetic fabrics.

7 Sustainable Materials Used

Form incorporates sustainability into many aspects of its design; however, it also uses a variety of environmentally responsible processes and materials in its production. Form is constructed from a recycled aluminum frame, and uses a Paperstone™ work-surface, while the command console is constructed from recycled glass filled ABS plastic. Where recyclable materials can't be used, strong durable materials are used to increase the lifespan of the component and reduce the likelihood of replacement.

8 Reliable/Durable/Easy to Maintain

Through the use of tough materials and modular components, Form provides a solid platform for a long lasting reliable workstation. Modularity allows old components to be easily replaced and new components to be added, making it easy to keep an old machine running, or to upgrade to a new standard. Form also takes advantage of the latest sensors and software to be able to keep track of its maintenance schedule and to perform updates and maintenance remotely.

9 Affordable

Form is priced to compete with the some of the more expensive workstations on the market; however, Form becomes much more affordable when the increased production of its sewer is taken into account and the reduction in paid disability leave a business may have to take on when sewers develop repetitive stress injuries.

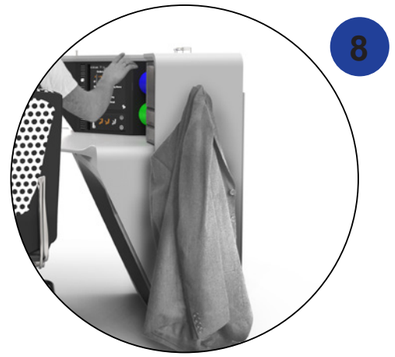
10 Integration of New Technology

Form is the only industrial sewing workstation to incorporate advanced order and messaging software accessed through three large OLED touch screens. Sewing data can be logged virtually and updates and maintenance can be preformed remotely. Form is also the only industrial sewing workstation to incorporate a state of the art climate control system, allowing users to set the temperature of their workstation to their preferences.

1

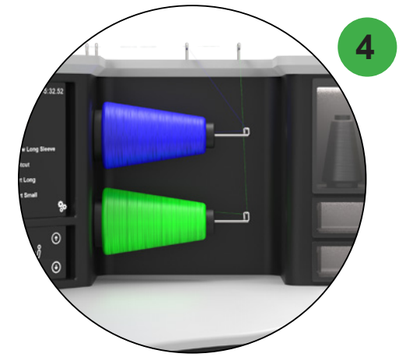
OLED touch screens provide easy and customizable interfacing. Large, easy to read and understand infographic buttons are used to help increase comprehension and machine learning.

8



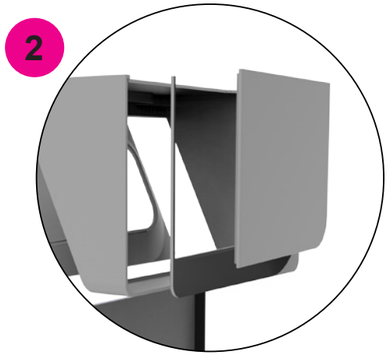
Flip out coat hook provides an easy storage solution, keeping jackets and shirts out of the way.

4



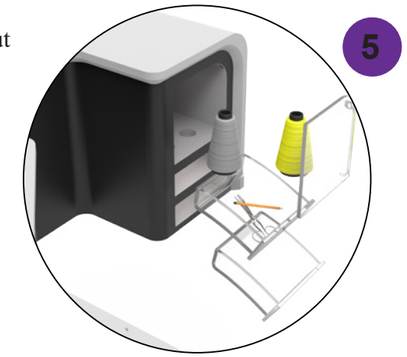
Spools are mounted directly to the right of the sewer to allow easy access for changing spools without having to stand up and reach over the machine for a new one.

2



Sound deadening and vibration dampening panels are mounted to the side of the lower table frame to help reduce factory noise, and reduce vibration from the sewing machine motor.

5

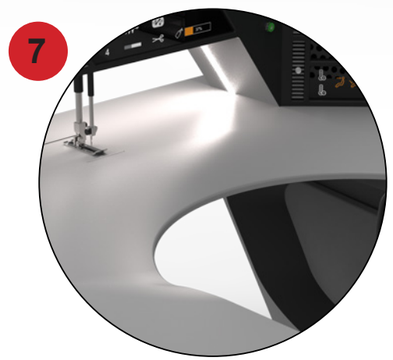


Ergonomically designed storage allows tools and extra thread spools and bobbins to be located quickly and easily. Clear polycarbonate drawers and doors are used to allow sewer to see where things are stored without having to rummage around in a dimly lit drawer. Drawers pull out and down to provide the optimal viewing angle into the drawer.

3

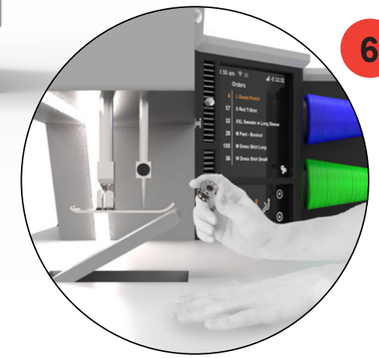
Three climate vents mounted above the work-surface and two below are used to direct air at the sewer to help heat or cool their environment to their preference.

7



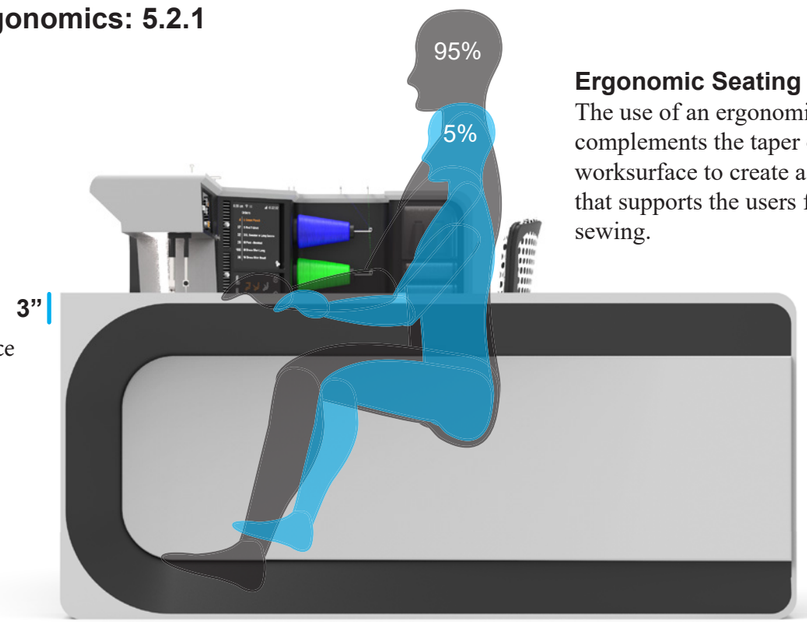
Tapered table surface provides support for sewers forearms.

6



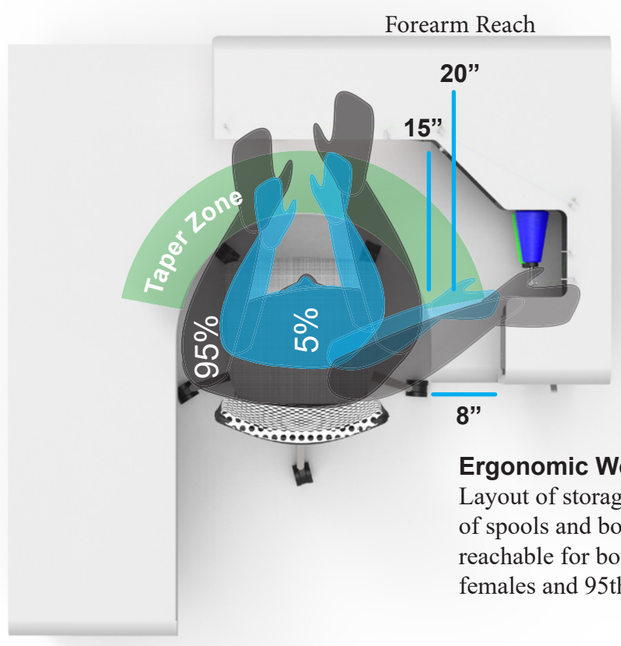
Top access bobbin case allows bobbins to be changed without the need to bend over and reach under the work-surface. The easy access flap also provides the optimal viewing angle to check for tangles and birds nests.

Final Ergonomics: 5.2.1



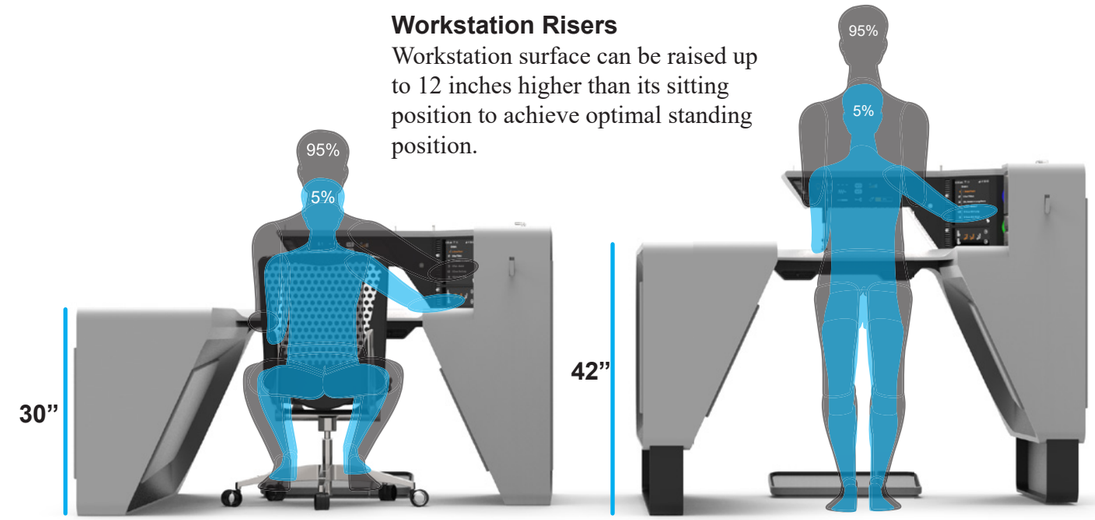
Drop in table surface taper.

Ergonomic Seating
The use of an ergonomic chair complements the taper of the worksurface to create a worksurface that supports the users forearms while sewing.



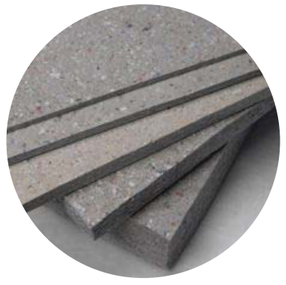
Ergonomic Workstation Layout
Layout of storage and positioning of spools and bobbins are easily reachable for both 5th percentile females and 95th percentile males.

Workstation Risers
Workstation surface can be raised up to 12 inches higher than its sitting position to achieve optimal standing position.



Final Materials 5.2.2

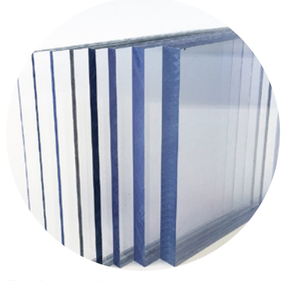
Final material selection was based on physical properties, embodied energies, ability to be recycled, and environmental impact.



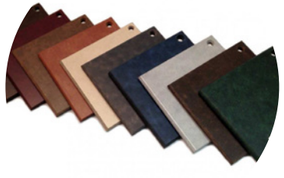
CFAB™ Sound Deadening
Used to absorb factory noise and sewing machine vibration when attached to the frame.

Recycled Aluminum
Used for the frame, risers, and support structure of the workstation.

Recycled GF ABS
Used for the command center shell and other internal sewing machine components.

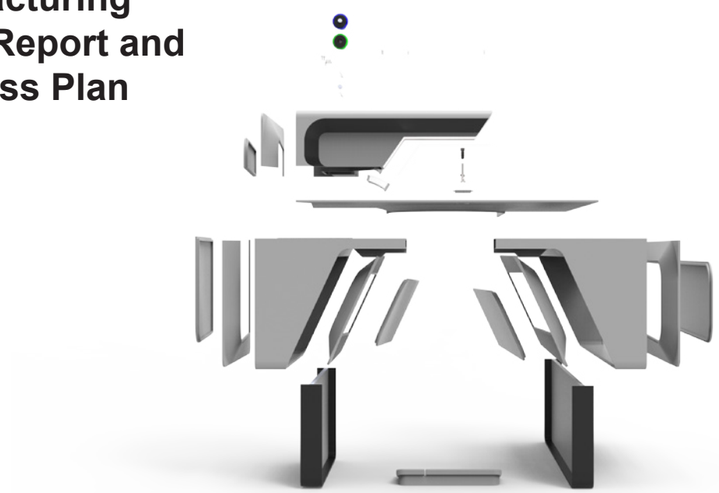


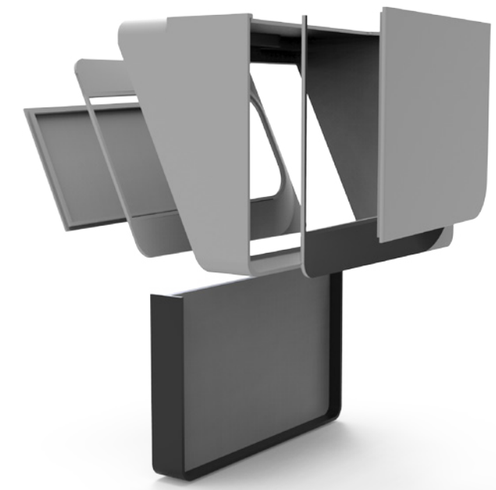
Polycarbonate
Used for the storage drawers and panels allowing easy viewing of stored tools and materials.



Paperstone™
Used for the work-surface due to its sustainability and its ability to provide a tapered work surface.

Manufacturing Costs Report and Business Plan 5.2.3





Executive Summary

Situational Summary:
Form is a unique new take on the century old industrial sewing workstation. The product provides a wide range of adjustability and features a redesigned layout, optimized for better ergonomics. These product defining characteristics will be patented and held by a company launched to sell Form and any further industrial sewing products designed using the Form platform. Form will look to build market share in the straight stitch sewing machine segment of the industrial sewing market, and future products will be brought to the market to fill other segments though the use of the Form platform. This will eventually expand to cover most sewing segments, with a variety of machines developed to serve different needs all built on the Form platform.

Target Audience:
Forms target audience is sewers within the North American textiles and garment industries; however, through the development of region specific software packages, Form will likely branch into overseas markets following success within the North American market. Form has the ability to create the most change within the industry if implemented before sewers develop repetitive stress injuries and can help companies keep their workers longer.

Positioning Statement:
Form provides an environment that adapts to the sewer, creating an experience that can change throughout the day. Form creates greater profits for businesses through more comfortable, efficient workers, and reduces the instances of paid disability leave due to repetitive stress injuries. Form is a premium product that gives sewers the ultimate control over their sewing and their environment, leading to more efficient production lines and greater profits.

Objective:
The objective of Form is to create a paradigm shift within the sewing industry from businesses that treat their workers like machines, to businesses that create positive and safe environments for their workers. The objective of this report is to outline the steps needed to bring Form from an initial concept phase to a fully functional, licensed workstation sold to manufacturers of all sizes on multiple continents.

Key Benefits:
1 - Improved Ergonomics:
Form provides the most improvement over existing workstations through improved ergonomics. A large range of motion allows the workstation to be easily adjusted to users of any size, and more areas of adjustment provide opportunities to reduce stresses on the body that have gone untapped in other products.

2 - Customizability and Accessibility
Customizability can be found in every aspect of Form's design. Users are able to adjust the temperature of their own environment, change their workstation from sitting to standing, customize the sewing menus to reflect the sewing they do, and adjust the pedal and seating settings to create an environment that fits them correctly. Through all of these customizable features, Form provides a more accessible environment to a broader range of users.

3 - Straight Forward Market Integration
Form was developed to allow easy integration with many of the current factory work flow layouts. This enables Form to be swapped in as old machines break down, without the business owner needing to buy into the new machine at a factory wide level. Form will also run on a normal 120V outlet to allow easy integration within factories of all sizes.

Schedule:

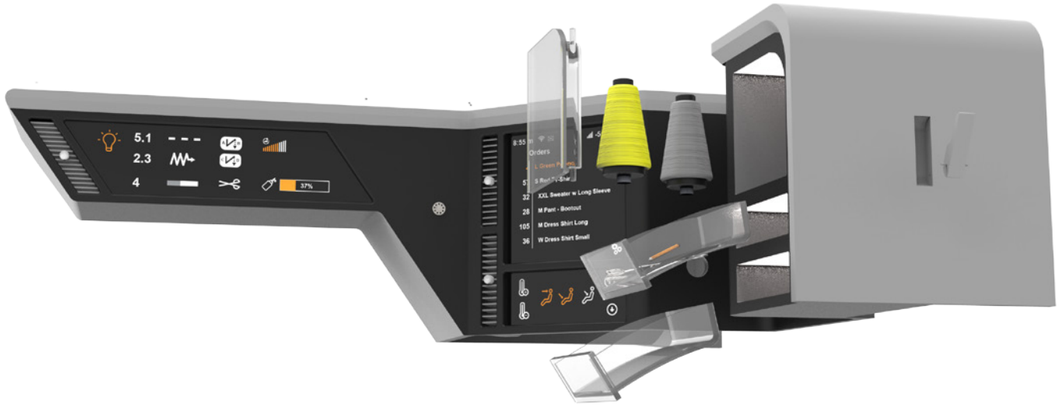
April – May 2018:
Finalizing of design for manufacturing. Tech drawing made and sent out for engineering.

June – August 2018:
Engineering of the sewing machine motor, drive, and internals. Initial patent drawings submitted.

September – December 2018:
Development of Software Packages. Finalization of patent applications. Dialog started with manufactures. Marketing and sales campaign started.

January – March 2019:
Patents applied for, product pitched to investors. Manufactures begin tooling process. Several clients lined up to receive delivery of first run.

April 2019:
First production run.



Budget:
There will be a high initial start up cost to launching this product due to the patents needed to protect the IP, as well as the high manufacturing and tooling costs due to the complexity of the product. Investors will need to be brought on to cover most of the initial start up cost. Workplace safety grants will be applied for with the government in an attempt to raise capital as well as to positively associate the brand with ergonomic work environments.

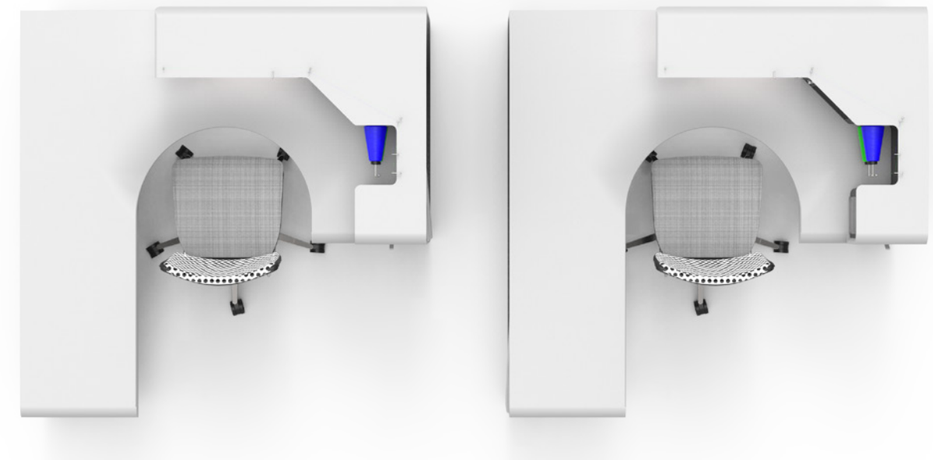
Risk and Contingency Plan:
The largest risk associated with bringing Form to market is the high cost associated with manufacturing. Due to the complexity of the product, there will likely be a long product development phase where testing and trouble shooting will be essential in creating a functional product.
To reduce risk in the event engineering our own internals becomes too costly, other sewing machine manufacturers could be contracted to provide internals for the workstation at a distribution cost. Through this method, Form would be able to take advantage of tried and true internals while providing an environment unparalleled by any current manufacturer.

Marketing Launch Strategies:

Objective 1: Patenting IP
Form derives much of its competitive advantage within the marketplace from a design that could be easily replicated by other more experienced manufacturers. This establishes the need to have patent pending statues prior to approaching investors, or other manufactures for licensing of their internals.

Strategy:
To best protect all relevant IP associated with Form, a patent lawyer will be hired to review the product and file for all relevant patents and IP.

Tactics:
The goal in bringing a lawyer on board at an early stage is to help expedite the patent application process and make sure that all aspects of the design are protected. When searching for investors and potentially licensing other manufacturers to provide parts, it is vital to keep interested parties from stealing the IP, which provides a competitive advantage over other competitors.



Objective 2: Engineering and Development
Due to the complexity of the workstation, it will be important at an early stage to involve engineers and developers to sort out many of the mechanical and software elements before approaching manufacturers with final prototypes.

Strategy:
By hiring engineers and software developers, the final elements of the workstation can come together before the initial prototypes are ordered from manufacturers.

Tactics:
Through the use of in house engineers and developers, product changes can be made rapidly and IP can be more closely protected.

Objective 3: Finding Manufacturers, Pitching to Investors, and Marketing

In order to bank roll the project start up, investors will need to be brought on board. At the same time, manufacturers will be sourced to create all of the necessary components needed for the workstation, and an assembly facility will be located/rented/bought. After receiving buy in from investors, initial prototypes will be ordered from the manufacturers and assembled to be tested. Once the prototyping phase has been completed, marketing will begin to find buyers for the first production run of workstations.

Plans and Deliverables:

1 - Complete development of final design.

2 - Create a list of patentable features and IP.

3 - Hire lawyer to apply for IP to protect the design at an early stage.

4 - Connect with engineers and developers to start work on the internals and software packages.

5 - Begin sourcing manufacturers.

6 - Pitch design to investors.

7 - Purchase/rent an assemble plant.

8 - Order first run of prototypes.

9 - Develop relationships with customers, and demo product.

10 - Final refinements after prototyping.

11 - Order first production run.

Bill Of Materials

Part #	Part	# of Parts	Material	Unit Cost	Cost
1	**Frame**				
1.1	Frame Bottom Right	1	Recycled Aluminum Extrusion	250	250
1.2	Frame Bottom Left	1	Recycled Aluminum Extrusion	300	300
1.3	Side Panel Holder Left Outer	1	Recycled Aluminum Stamped	50	50
1.4	Side Panel Holder Left Inner	1	Recycled Aluminum Stamped	50	50
1.5	Side Panel Holder Right Outer	1	Recycled Aluminum Stamped	35	35
1.6	Side Panel Holder Right Inner	1	Recycled Aluminum Stamped	35	35
1.7	Side Panel Holder Right Upper	1	Recycled Aluminum Stamped	30	30
1.8	Riser Motor Left	1	Direct Drive Stepper Motor	50	50
1.9	Riser Motor Right	1	Direct Drive Stepper Motor	50	50
1.1	Riser Track Left	2	Recycled Aluminum	5	10
1.11	Riser Track Right	2	Recycled Aluminum	5	10
1.12	Lower Legs Left	1	Recycled Aluminum	45	45
1.13	Lower Legs Right	1	Recycled Aluminum	45	45
1.14	Bolts for Frame Connection	4	Steel	0.5	2
1.15	Bolts for Side Panels	8	Steel	0.25	2
1.16	Bolts for Riser Track	8	Steel	0.01	0.08
1.17	Bolts for Riser Motor	8	Steel	0.01	0.08
1.18	Lower Frame Air Ducting	1	Blow Molded PP	45	45
1.19	Lower Frame Air Vent Grating	2	Injection Molded ABS	2	4
2	**Side Panels**				
2.1	Lower Left Outer Panel	1	STOP Sound Acoustic CFAB Panel-ing	50	50
2.2	Lower Left Inner Panel	1	STOP Sound Acoustic CFAB Panel-ing	50	50
2.3	Lower Right Outer Panel	1	STOP Sound Acoustic CFAB Panel-ing	40	40
2.4	Lower Right Inner Panel	1	STOP Sound Acoustic CFAB Panel-ing	40	40
2.5	Upper Right Outer Panel	1	STOP Sound Acoustic CFAB Panel-ing	10	10
3	**Table Surface**				
3.1	Table Surface Front Section	1	Paperstone	65	65
3.2	Table Surface Left Section	1	Paperstone	45	45

4	**Command Center**				
4.1	Command Center Shell	1	Injection Molded ABS	200	200
4.2	Sewing Drive Motor	1	Direct Drive Stepper Motor	50	50
4.3	Sewing Internals	1	Steel	350	350
4.4	Sewing Controls Touch Screen	1	OLED Touch Screen	35	35
4.5	Orders Touch Screen	1	OLED Touch Screen	35	35
4.6	Table Controls Touch Screen	1	OLED Touch Screen	35	35
4.7	Sewing Light	1	Multi-Color LED	0.75	0.75
4.8	Climate Control Fan	1	Injection Molded ABS	25	25
4.9	Climate Control Heater Core	1	Efficient Heater Core	45	45
4.1	Climate Control A/C	1	Micro A/C Unit	75	75
4.12	Climate Ducting	3	Blow Molded PP	45	135
4.13	Climate Grating	3	Injection Molded ABS	2	6
4.14	Drawers	2	Injection Molded Polycarbonate	5	10
4.15	Door	1	Injection Molded Polycarbonate	5	5
4.16	Bobbin Winder Assembly	1	Micro Stepper Motor	35	35
4.17	Needle Head Assembly	1	Steel	75	75
4.18	Spool Holders	2	Steel	0.5	1
4.19	Thread Routing Wires	10	Steel	0.1	1
4.2	Coat Hook	1	Injection Molded ABS	2	2
4.21	Fasteners for Command Shell	6	Steel	0.5	3
4.22	Fasteners for Door	2	Steel	0.2	0.4
4.23	Fasteners for Screens	12	Steel	0.1	1.2
4.24	Fasteners for Ducting	6	Steel	0.1	0.6
4.25	Fasteners for Climate Electronics	8	Steel	0.1	0.8
5	**Foot Pedal**				
5.1	Pedal Housing	1	Injection Molded ABS	85	85
5.2	Pedal Actuator	1	Actuator Assembly	25	25
5.3	Pedal Wireless Unit	1	Computer Board	15	15
	Total Cost	124			2564.91

Fig 5.1 Bill of Materials

Startup Costs

Action	Cost per Hour	Number of Hours	Total Cost		
Lawyer for IP	200	12	2400		
Patents			6000		
Engineering Costs	32	320	10240		
Developer Costs	28	160	4480		
	Cost Per Month	**Months**			
Assembly Plant Rental	5000	6	30000		
Tooling			50000		
	Cost Per Unit	**Number of Units**			
First Run of Prototypes	2564.91	3	7694.73		
First Production Run	2564.91	250	641227.5		
Total Startup Costs			752042.23		
Production Cost Per Unit	**Retail**	**Margin**			
2564.91	3500	935.09			
Break Even Analysis					
					Capital
Month	**Units Sold**	**Net Profit**	**Gross Profit**		**-752042.23**
Apr-19	50	175000	46754.5		-705287.73
May-19	25	87500	23377.25		-681910.48
Jun-19	75	262500	70131.75		-611778.73
Jul-19	200	700000	187018		-424760.73
Aug-19	50	175000	46754.5		-378006.23
Sep-19	300	1050000	280527		-97479.230
Nov-19	75	262500	70131.75		-27347.480
Dec-19	100	350000	93509		66161.520
Jan-20	125	437500	116886.25		183047.77
Feb-20	80	280000	74807.2		257854.97
Mar-20	95	332500	88833.55		346688.52
Apr-20	175	612500	163640.75		510329.27

Fig 5.2 Business Analysis

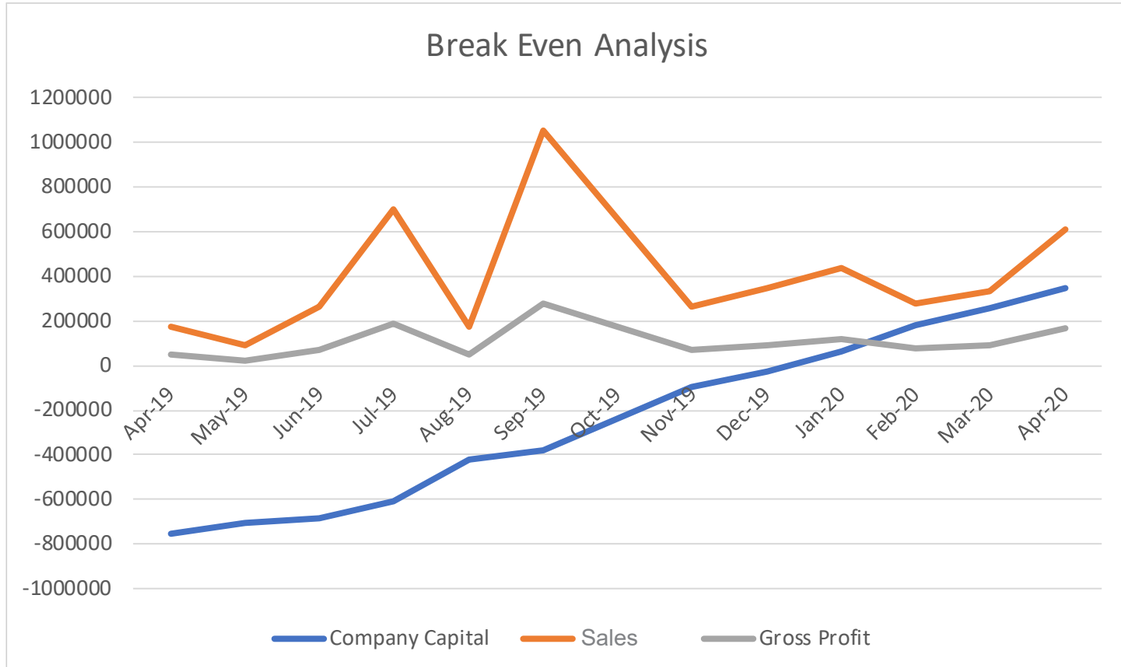
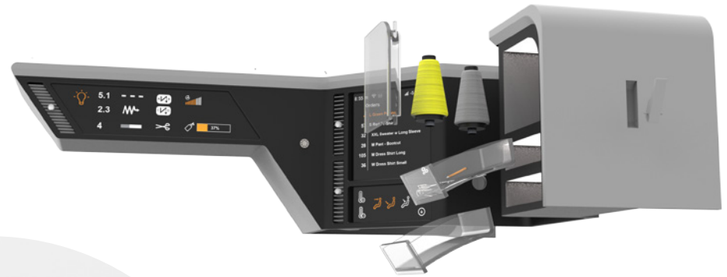
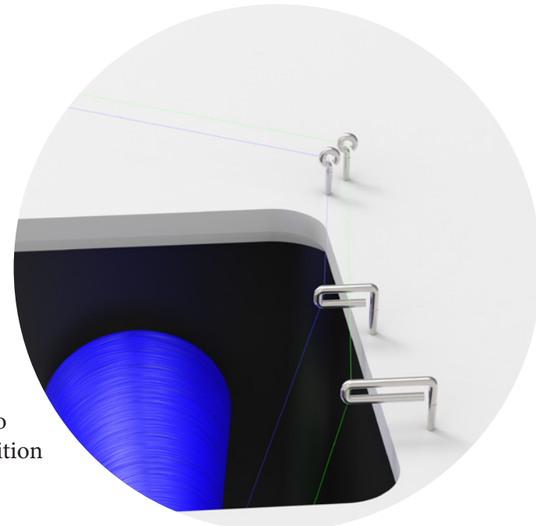


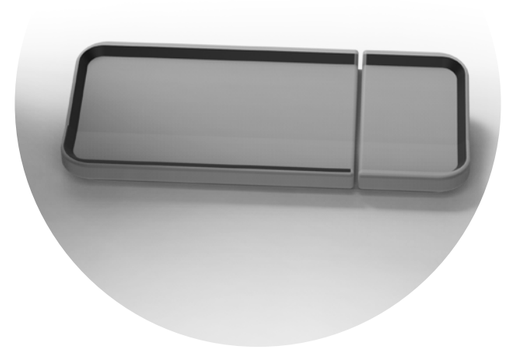
Fig 5.3 Break Even Analysis

Color and brightness adjustable under arm lighting.





Thread routing is easy to reach from a seated position and easily visible for re-threading.



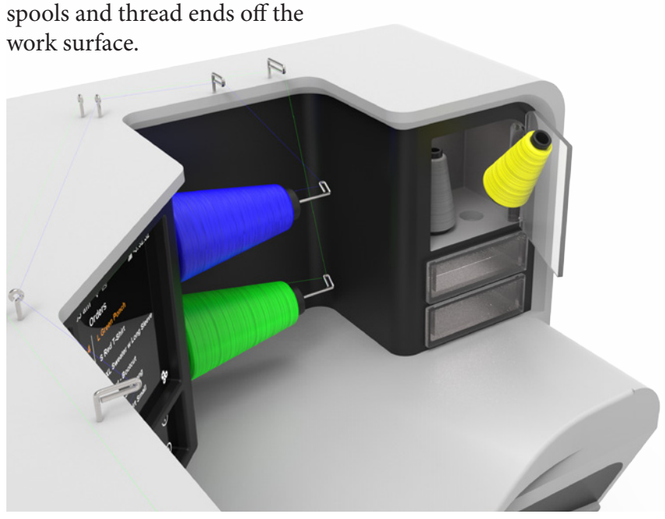
Programmable dual pedal allows users to choose what functionality they would like from each action.

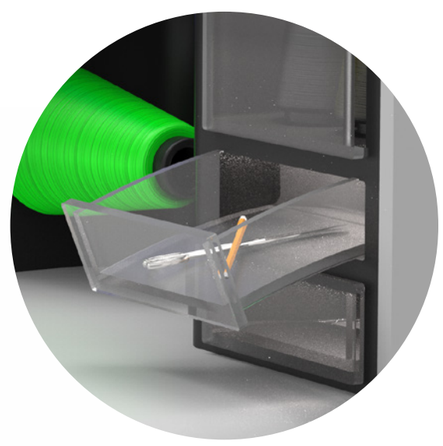
Modular sewing head allows business owners to swap heads for different jobs.

Final CAD: 5.3

Orders screen shows which products need to be sewn, and the quantities of each.

Storage for extra spools is located in the top cabinet which makes it easy for users to see how much thread they have left and keeps loose spools and thread ends off the work surface.





Drawers slide out and down to provide optimal viewing angle into the drawer when open.

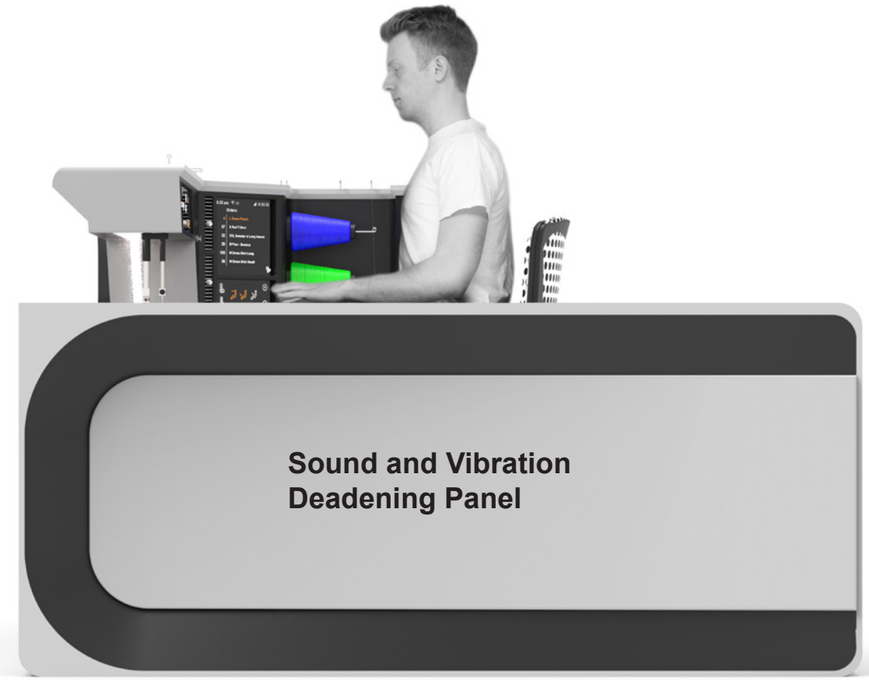
Sitting vs standing functionality of the workstation.

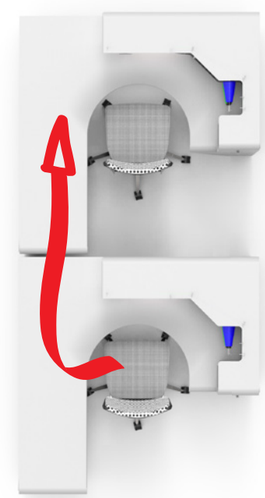
Color Options

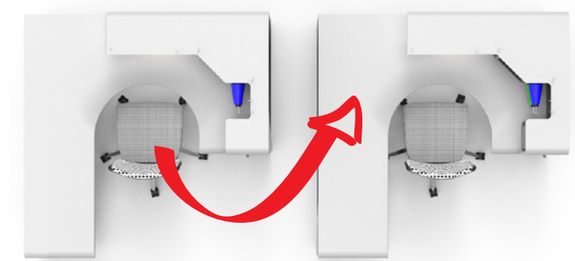
Several color options are available to meet different textile and garment needs, or to match company branding.

Top Access Bobbin Case

Allows sewers to replace and refill the bobbin without straining to reach it.







Work Flow Mapping

Form has been designed to accommodate both major factory work flow layouts, allowing for seamless integration with existing products.

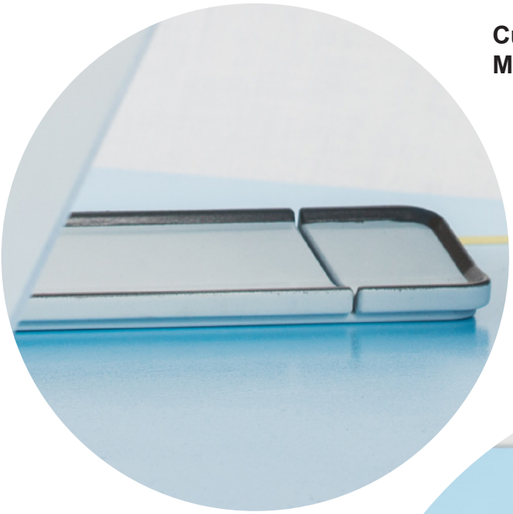
Final Hard Model 5.4

OLED Touch Screens

Sewing Head and Needle

Coat Hook

Under Work surface Climate Vent



Customizable Wireless
Multi-function Pedal

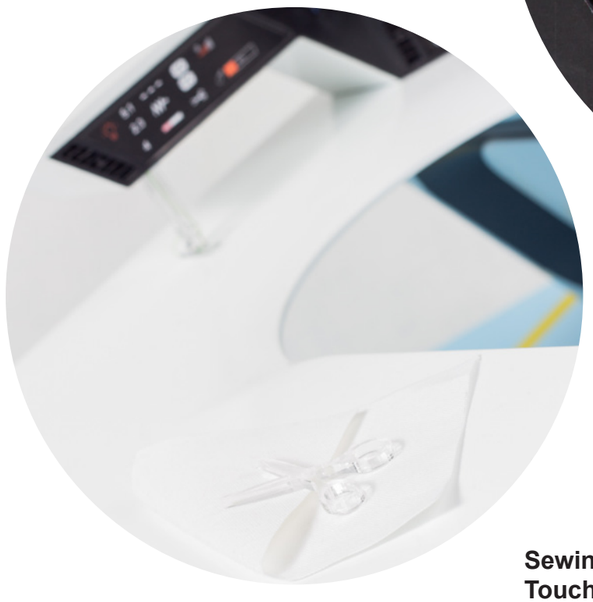
Top View

Thread
Routing

Sound and Vibration
Dampening Panels

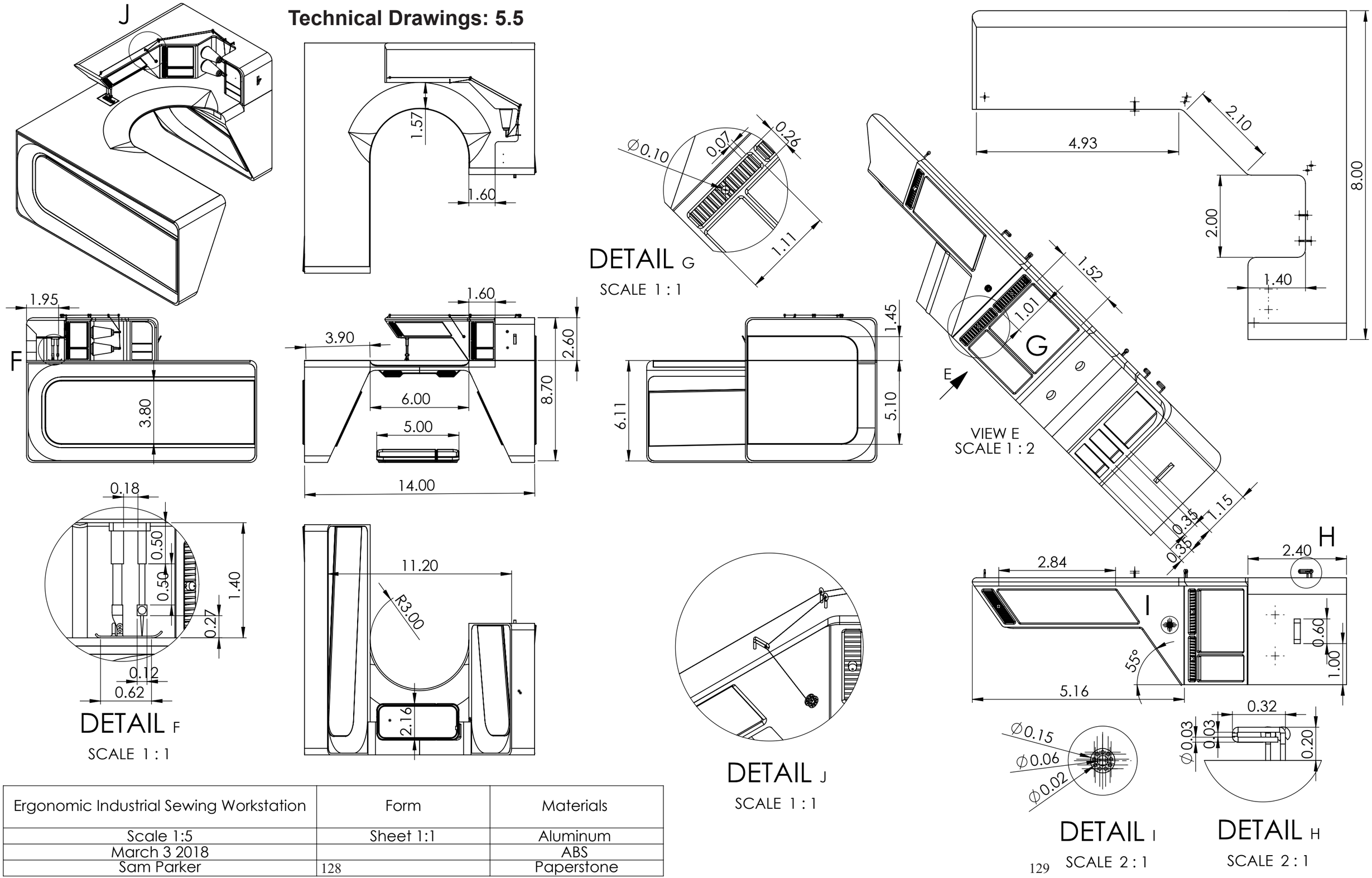
Bobbin Winder

Cutting and Prep
Work surface

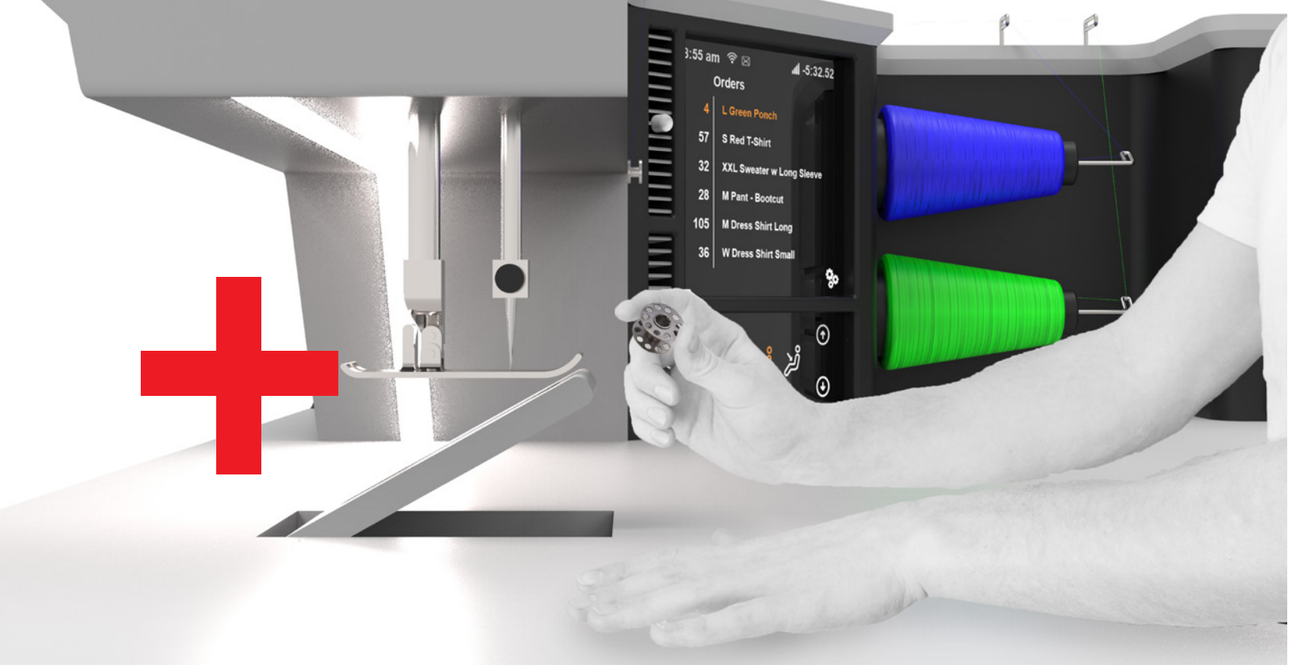


Sewing Command
Touch Screen

Technical Drawings: 5.5



Ergonomic Industrial Sewing Workstation	Form	Materials
Scale 1:5	Sheet 1:1	Aluminum
March 3 2018		ABS
Sam Parker	128	Paperstone



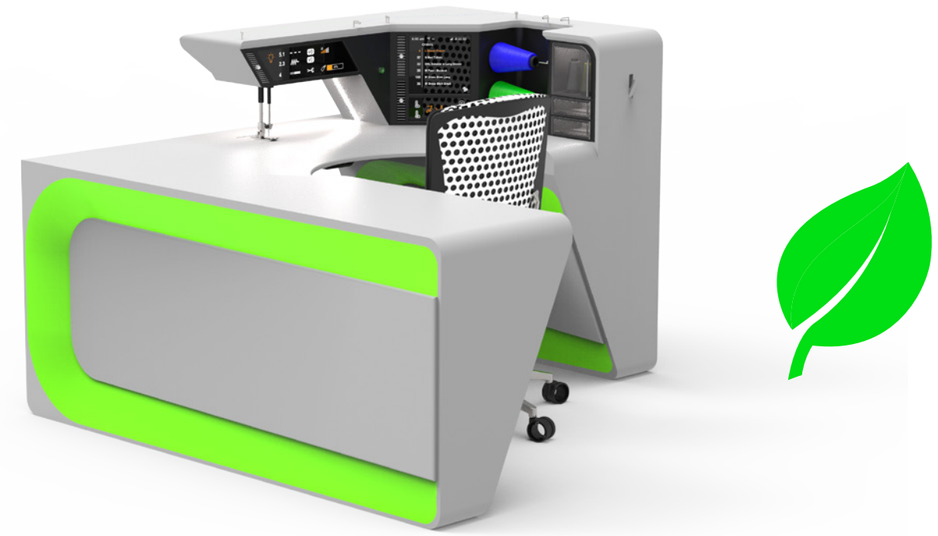
Health

The development of the ergonomic industrial sewing workstation as part of this thesis has been centered around the user. This means that the product must provide a comfortable environment for the user that does not in any way increase the likelihood for users to develop repetitive stress injuries (RSI's). The environment can also adapt the user, and can change over time, to reduce the likelihood of a user developing an RSI.

One major element in helping to reduce RSIs is adaptability of the working position. Because of this, a series of risers and riser motors has been added to the frame of the workstation to allow the user to effortlessly raise and lower the table, primarily to achieve the correct working height, but also to allow the workstation to convert from a sitting workstation into a standing workstation, giving the user the choice of how they would like to work.

While adding that functionality to the workstation has its benefits, the real benefit comes from the reduced sitting periods often endured by the users. To help encourage the use of the sitting and standing functionality, a reminder application has been added to the workstation's notification screen that can create a customized schedule for the user to remind them that they have been sitting for extended periods of time and that they should raise the table and work while standing.

Several other aspects of the design of the workstation have also been altered to better meet ergonomic requirements. These areas are: The organization and layout of storage making it easier to see and reach important tools such as scissors or pencils; the placement of the working spools (of thread) which have been moved closer to the user to allow the sewer to change out new spools and bobbins without having to stand up and bend over the top of the machine; the access to the bobbin case which has been moved to the top of the machine such that the user can change the bobbin without bending over and reaching under the working surface; and the placement and color of lighting, which can be changed over time to reduce the likelihood of the sewer's eyes becoming overstressed.



Environmental

The materials chosen for the workstation in this thesis report have been chosen based on embodied energy values and their ability to be recycled. The lower frame of the workstation is made from recycled aluminum. Using recycled aluminum as apposed to virgin aluminum returns an embodied energy value similar to that of steel. It also has ability to be recycled again in the future, and the reduction in weight of the table which plays a role in total energy needed to lift the table when turning it into a standing desk makes it a good choice over steel.

The work surface is molded from an eco friendly material called Paperstone™ which is a composite material made from recycled paper and natural resins. The material is very strong and durable and has a very low embodied energy value due to its ease of manufacturing and its use of all natural and recycled materials.

The top console, and sewing machine housing are injection molded from recycled glass filled ABS plastic. This plastic was chosen based on its strength and durability characteristics and its resistance to heat and oils. Although ABS plastic is not typically viewed as a green plastic, its durability allows for a long lifespan which reduces the need for units to be repaired or replaced every few years.

Lastly the sound deadening panels are made from CFAB™ cellulose panels manufactured by Stop Noise Acoustical Surfaces Inc. These panels are able to absorb and reduce the sound in the area while resisting mold growth and are both fire resistant and manufactured from renewable and recycled fibers.

Conclusion

6

Form is the ideal solution for reducing repetitive stress injuries (RSIs) in sewing applications. By incorporating several ergonomic elements, Form is able to reduce any unnecessary strain on many of the most commonly used muscle groups. By providing a larger range of adjustment than any other workstation on the market, Form is able to convert between sitting and standing positions allowing sewers to rest muscle groups throughout the day, once again lowering the risk of developing an RSI. Form reaches as broad of a demographic as possible through the use of intuitive, customizable, and universally understood infographics displayed on its three OLED touch screens. Form is also designed to allow for several work flow styles making adoption and integration within current factory settings simple and cost effective. By using Form, businesses are choosing to invest in a sustainable future for their workers, who will have a higher quality of life; and in their businesses which will see returns in productivity and an improved working culture.

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7

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Appendix

8

Information Interview # 1
REPORT

Thesis Topic: Industrial Sewing Work Station

By Sam Parker

Objective: To obtain information from someone with experience /insight into an aspect of the product being designed, in order to better inform design.

Method: Interview, with pre-scripted questions

Thesis Topic: Industrial Sewing Work Station

Description: A sewing workstation that is designed to be more ergonomic and intuitive helping alleviate many of the repetitive stress related injuries that develop from working in the garment and textiles industry.

Expert: PING

Basis of Expertise: Industrial Sewer

Contact information: (519) 579-3131

Date of Interview: October 24th 2017

How interview was conducted: In person interview conducted in the factory.

Was Interview recorded: No video or audio was recorded of the interview, answers were recorded via pen and paper.

Question and Answer Notes

1 What features are a must have? Which aren't?

-the fewer features a machine has the better they usually sew.
-having many features takes away the simplicity and makes it harder to do your job.

2 What is the most frustrating thing about your machine? (the machine/a machine)

-The bobbin tends to get jammed up.
-when you put oil into the machine it tends to drip down onto the working surface so you need to keep cleaning it or else the products will get oily.
-the machine will run smooth and quiet for about two days after oiling then it starts to get noisier.

3 What features break the most often? / What breaks the most often?

-the bobbin tends to tangle.
-needles will break
-the needles and all other moving parts of the machine tend to last longer if you sew at consistent speeds without having to start and stop a lot. Sewing fast and doing long lines is the best for the needle and the machine.

4 What should these machines be able to do that they can't?

-it can be hard to sew tight turns on some of the machines.
-the constant maintenance is always an issue

5 **What movements hurt the most? Does it take a while for it to build up or does it start from specific tasks**.

-cutting things with scissors is by far the worst.
-sometimes holding the fabric down and having to apply a lot of pressure is an issue.
-the pedal position and placement and operating it can cause problems for some people.

6 What do you do to make yourself more comfortable while sewing?

-Listening to music helps me tune out the sounds from the factory and keeps me out of the workplace drama.
-padding on the scissors and making sure that they are VERY sharp helps with the stress on my hands while I'm using them.
-I use a back support and some cushions attached to my chair to help keep my back in a better position while sewing.
-I use a fan to keep the temperature moderate when it's hot in the summer.

7 Describe a normal day of sewing and what you do to make yourself comfortable and keep yourself focused during your shift.

-the chair becomes sore after a while so I use a pillow to help with that
-I use music to keep myself focused and out of trouble (socially – factory drama)

8 Do you know how to use all of the features on the machine?

-yes, the simple machines are better and they tend to break less.

9 What do you like about your machine? (more so than other machines?)

-my machine is over 30 years old, it is very reliable and almost never breaks
-I can make a needle last a whole year on this machine
-I like the lack of features on this machine, it helps make the sewing easier.

10 **What are the most common injuries when using these machines**?

-Hands hurt
-legs can hurt after a day of sewing
-holding the material when hemming can hurt after a while.

Finishing the Interview

1. Is there a question that I should have asked?

-no

2. Is there someone who would be good to follow up with?

-shazada (another sewer on the factory floor)

3. I am going to organize this information. If I have missed a point, would you mind if I quickly followed up for clarification? Could I phone you? What time would be best?

-you can follow up with me here at work when you come in.

Two things that I would do differently next time

1. I would focus my question more around the experience of using the machine and how the user feels and what they do to make themselves happy and comfortable rather than asking about the machine itself. The users seem to fixate a lot less on the machine, they don't really have an idea of what would make a better machine.

2. Conduct the interview not at the sewing machine. I feel that her answers were biased when I asked more general questions about sewing because she just related everything to the machine in front of her.

Key Information from Interview that will Inform Design

#	Design Category	Types of Information	Statements *(if any)*
1	User Needs	Benefits	-cutting things with scissors is by far the worst. -sometimes holding the fabric down and having to apply a lot of pressure is an issue. -the pedal position and placement and operating it can cause problems for some people. -Listening to music helps me tune out the sounds from the factory and keeps me out of the workplace drama. -padding on the scissors and making sure that they are VERY sharp helps with the stress on my hands while I'm using them. -I use a back support and some cushions attached to my chair to help keep my back in a better position while sewing. -I use a fan to keep the temperature moderate when it's hot in the summer.
2	Product	Features	-the fewer features a machine has the better they usually sew. -having many features takes away the simplicity and makes it harder to do your -it can be hard to sew tight turns on some of the machines. -the constant maintenance is always an issue -the bobbin tends to tangle. -needles will break -the needles and all other moving parts of the machine tend to last longer if you sew at consistent speeds without having to start and stop a lot. Sewing fast and doing long lines is the best for the needle and the machine. -my machine is over 30 years old, it is very reliable and almost never breaks -I can make a needle last a whole year on this machine -I like the lack of features on this machine, it helps make the sewing easier.
3	User Profile		
4	User Behaviour	Activities	-Listening to music helps me tune out the sounds from the factory and keeps me out of the workplace drama. -padding on the scissors and making sure that they are VERY sharp helps with the stress on my hands while I'm using them. -I use a back support and some cushions attached to my chair to help keep my back in a better position while sewing. -I use a fan to keep the temperature moderate when it's hot in the summer.
5	Ergonomics	Activities	-cutting things with scissors is by far the worst. -sometimes holding the fabric down and having to apply a lot of pressure is an issue. -the pedal position and placement and operating it can cause problems for some people.
6	Aesthetics / Style		
7	Material		
8	Other		

Information Interview # 2 REPORT

Thesis Topic: Industrial Sewing Work Station

By Sam Parker

Expert: Andrew Gardiner

Basis of Expertise: Textiles Designer

Contact information: 519-998-4322

Date of Interview: October 24th 2017

How interview was conducted: In person interview conducted at a coffee shop.

Was Interview recorded: No video or audio was recorded of the interview, answers were recorded via pen and paper.

Question and Answer Notes

1. **Given my 6 Directions, which do you think would make the most sense for this project?**

-don't make the final a solid block – it's boring from a design perspective
-kneeling chair concept could be a cool thing to incorporate
-I think that designing the table and the machine would make a good thesis project
-movable seating position is key
-stay away from designing the inside of the machine.
-focus more time on designing the table than the machine – there are more ergonomics

2. **How important is versatility with the machine? Is there a market here or should I offer separate machines (hypothetically) that all do one job?**

-stay simple – complexity of the machine won't sell the design.
-your audience won't know anything about these machines so focus your efforts on what they will see and can understand

3. **How important is it that this machine fit into a current factory production line vs having the machine be developed with an entirely new work flow in mind?**

-keep in mind what you want to focus on
-don't focus too much on the work flow aspect – you are already tackling a lot
-work flow stuff is hard to understand for most people who don't know the industry and you shouldn't waste your ID designing time on it.

4. **Would the sewing industry be willing to adopt fully computerized machines? Given the unreliability of partially computerized machines?**

-definitely integrate some aspects but not too much on the machine.

5. **How important is it to stick with the traditional materials in order to uphold consumer perceptions of durability and power?**

-Go crazy
-leave the traditional materials – although the machine should look like it could work – treat it like a concept car – it's the crazy concept that seller the more refined simplistic every day machine.
-take advantage of this opportunity to make something that is very different.

6. **From a project standpoint should I focus on solving a number of issues with the machine itself or creating a machine that is simple and ergonomic? What might give me the best value?**

-again don't bother making a revolutionary machine because they are too complex and people don't really know about them, focus on the ergonomics of the system
-talk about the table and the chair.

7. **From your experience is there more value in having factory workplaces that allow social interaction during work or are focused more on individual work?**

-yeah you could definitely look into promoting the social aspect.

8. **What are key issues with machines currently that if resolved would be major factors in a purchase decision.**

-current machines are super heavy – maybe work on that.
-look into online diagnostics of problems – internet connectivity
-track stitch counts
-collects user data – speed of sewing and how often they start and stop

9. **How should I approach marketing this product? What are the key elements that you see that would help sell this product over others?**

-make it really really cool
-know who you are selling to – make it the tesla of sewing machines
-low maintenance
-oil free

10. **Would companies see more value in a leasing program where maintenance is included on a number of machines as a package, or would companies rather buy these machines outright?**

-lease the machine.
-maybe consider leasing the sewers too!

FINISHING the INTERVIEW

1. **Is there a question that I should have asked?**

-No
-make a list of the typical products that that would be typically be made by that type of machine and bring them in and put them beside the machine.
-sell the idea of the machine by association with other really cool products.

2. **Is there someone who would be good to follow up with**?

-no

3. **I am going to organize this information. If I have missed a point, would you mind if I quickly followed up for clarification?**

-Yes

Two things that I would do differently next time

1. definitely ask more questions, I felt I got some good information from this interview and I could probably have gotten more good info if I had been able to chat for longer and ask more questions.

2. I think that it might have been nice to record some audio of the interview so that I could go back and make sure that I got everything.

Key Information from Interview that will Inform Design

#	Design Category	Types of Information	Statements *(if any)*
1	User Needs		
2	Product	Features	-don't make the final a solid block – it's boring from a design perspective -kneeling chair concept could be a cool thing to incorporate -I think that designing the table and the machine would make a good thesis project -movable seating position is key -stay away from designing the inside of the machine. -focus more time on designing the table than the machine – there are more ergonomics -stay simple – complexity of the machine won't sell the design. -your audience won't know anything about these machines so focus your efforts on what they will see and can understand -leave the traditional materials – although the machine should look like it could work – treat it like a concept car – it's the crazy concept that seller the more refined simplistic every day machine. -take advantage of this opportunity to make something that is very different. -again don't bother making a revolutionary machine because they are too complex and people don't really know about them, focus on the ergonomics of the system -talk about the table and the chair. -current machines are super heavy – maybe work on that. -look into online diagnostics of problems – internet connectivity -track stitch counts -collects user data – speed of sewing and how often they start and stop -know who you are selling to – make it the tesla of sewing machines -low maintenance -oil free
3	User Profile		
4	User Behaviour		
5	Ergonomics	Features	-focus more time on designing the table than the machine – there are more ergonomics -kneeling chair concept could be a cool thing to incorporate -movable seating position is key
6	Aesthetics / Style		
7	Material	Features	-leave the traditional materials – although the machine should look like it could work – treat it like a concept car – it's the crazy concept that seller the more refined simplistic every day machine.
8	Other		

USER PROFILE REPORT SUMMARY

Demographics: Summary

Primary, Secondary, Tertiary Users

Primary User: Sewer
Secondary User: Machines Mechanic
Tertiary User: Business Owner

Demographics of Industrial Sewers.		Reference
Age	16-75 Average : 42.6	Data USA | Miscellaneous textile, apparel, & furnishings workers except upholsterers. (n.d.). Retrieved September 19, 2017, from https://datausa.io/profile/soc/51609X/
Gender	Mostly Female 64.5%	Keane, J., & Willem Te Velde, D. (2008). The role of textile and clothing industries in growth and development strategies. Retrieved from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/3361.pdf
Culture / Ethnicity	White/Mixed	Data USA | Miscellaneous textile, apparel, & furnishings workers except upholsterers. (n.d.). Retrieved September 19, 2017, from https://datausa.io/profile/soc/51609X/
Income	$20-30,000 annually Average: $31,041	Data USA | Miscellaneous textile, apparel, & furnishings workers except upholsterers. (n.d.). Retrieved September 19, 2017, from https://datausa.io/profile/soc/51609X/
Educational Background	Ranging from no post-secondary to university degrees.	Data USA | Miscellaneous textile, apparel, & furnishings workers except upholsterers. (n.d.). Retrieved September 19, 2017, from https://datausa.io/profile/soc/51609X/

Overall, US mountain bikers tend to be younger, male, and white, with higher than average level of income. Overall, US apparel and textiles workers are middle aged, female and white with an average level of income, however within Canada this income is considered poverty line.

Age: Majority <42.6
Income: Between 20,000 and 30,000 annually
Education: More than likely there is no post-secondary education, however, average university degrees usually in the arts would not be uncommon to see.

USER BEHAVIOR: Summary

The table below summarizes the Use Behavior for industrial sewing machine operators

Use Behavior		Comments
Frequency	5-7 days a week	Full time position
Duration	48 hours per week	*Weekends*
Motivation	High	*Most workers are working for a wage they need to live*
Level of focus / exertion	High	
Location	Factories	*Place of work.*

Frequency
Being a sewing machine operator is a full-time job which has been limited by the International Labor Organization to 48 hours per week. Outside of countries that recognize the labor hour limits recommended by the ILO, working hours are often extended well beyond 48 hours per week.

Duration
Shifts are required 5 to 7 days a week with factories in developed countries limiting working hours to 48 hours a week.

Motivation
Many industrial sewing machine operators are working to support their family and children so motivation is high to continue working and producing product.

Level of Focus
Factory workers are required to pay constant close attention to their machines to make sure their sewing meets the quality control specifications, and that they keep their fingers and hands out of the machine.

Location
Sewers are usually required to work in factories in a variety of conditions. The physical location of these factories is spread all over the world with most of the apparel industry cropping up in less developed countries.

USER PROFILE

Primary, Secondary, Tertiary Users

Primary User: Sewer without RSI
Secondary User: Sewer With RSI
Tertiary User: Mechanic

User Profile of Primary User

Demographics		Use Behavior		Personality		Cognitive aspect	
Age	16-65+ Average 42.6	**Frequency of use**	5-7 days a week	'locus of control'	---	Technical Skill	↑
Gender	Mostly Female 64.5 (within USA)	**Duration**	Max 48 hours a week (within developed countries)	Self-efficacy	↑	Pre-req. content knowledge	--
Culture / Ethnicity	Mixed	**Social/Solitary**	Mixed	Changeability	---	Fixation	
Income	Low income: 20-30,000 per year	**Level of Focus**	High	Uncertainty Avoidance	---	Memory	
Educational Bkgd	None – post secondary	**Location**	Factories				

Demographics
Overall textile and apparel sewers tend to be mostly female, 64.5% in the US.

The demographic has an average age of 42.6 and an average income between $20,000-30,000 per year. They work for the income and usually have long days.

Use Behavior
These jobs usually require long hours and long weeks in order to meet set production standards. With work being conducted inside of a factory.

The maximum number of hours workers in developed countries are allowed to work is 48 hours a week.

These jobs usually require high levels of focus and precision while working so talking is kept to a minimum.

Motivation
This demographic is generally motivated by the income. Given the repetitive nature of the work and that it is factory work, it is not usually considered fulfilling work.

Income
Average annual income is between 20,000 and 30,000 dollars.

USER OBSERVATION

Observing the user turning on their machine and changing the thread to the desired color.

About the User

Name	**Shazeda Seecharran**
Age	**52**
Sex	**Female**
Location	**Salus Marine Wear**
Date of observation	**12/05/2017**
Experience level	**Veteran**
Machine Used	**Brother Drop Feed**

Chronology of Observation

Step 1

Positioning Material

- She First changes the thread to the desired color by standing up and leaning over the machine, grabbing a spool and then cutting the thread over the machine and tying the new thread on.
- She then grabs the two pieces of unsewn material and lines them up getting them ready to sew by positioning them in front of the sewing foot.

Sewing the material

Step 2

- She then uses her foot to control the speed of the machine as she sews the two pieces together.
- She has to continuously keep pressure on the pieces and re-adjust them as she works.

"Fingers hurt sometimes when I have to press the material together"

Step 3

Changing the Bobbin

- When the bobbin runs out she has to reach underneath the machine to grab the bobbin out of the case. She has to feel around for the latch.
- She then has to reach to the top of the machine to get the new full bobbin and replace it in the case.

Grabbing the next Piece

Step 4

- She has to turn or twist her body to the side and reach down to grab another piece from the bin.

Step 4

Sewing Tough Fabric

- She has to place more pressure on the fabric when it is thicker to keep good control over the material.
- With stretchy materials she has to push and pull the material through the machine so that the sewing is even.

Step 5

Hemming

- When she hems she has to push the fabric together at the bottom while resisting the pressure of the foam pulling the fabric apart. This puts a lot of stress on her hands.

- Sometimes she has to hold the jacket up near her shoulder to be able to hem it.

"Hemming really hurts my hands especially when the material is thick"

Organizing the Data

Starting the sewing process and gathering materials

- Reaching to change thread is hard
- Lining up material can be hard on the fingers when having to push down
- Turning to Grab pieces mean she has to twist her back

Sewing

- Direct light can be hard on the eyes
- Changing the bobbin means she has to bend down and feel around without being able to see what she is reaching for
- Limited space on the table for laying out other pieces
- Very hard to see into the drawer to find a pencil or scissors

Finishing Sewing and Moving Product

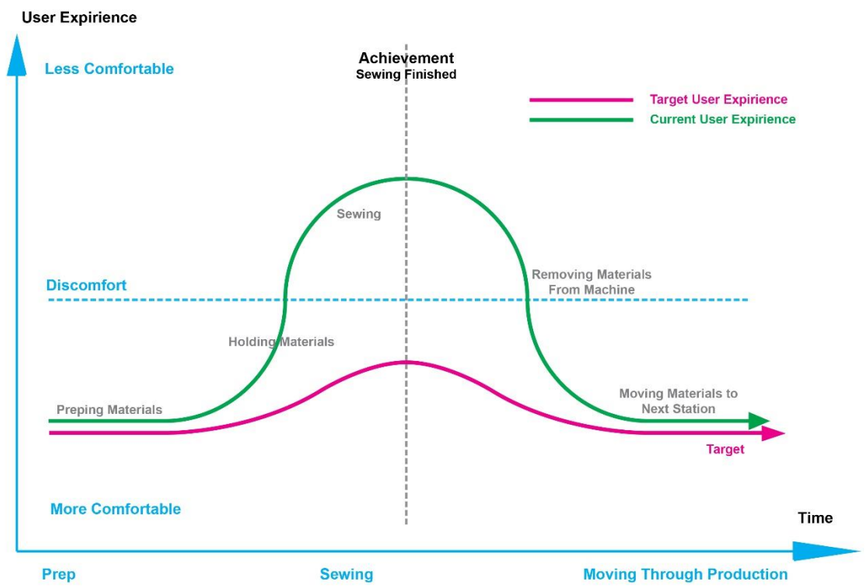
- Hemming is very hard on the hands and fingers
- Stuffing foam is awkward and takes lots of time
- Sewing tough materials requires constant strain from either pushing or pulling of fabric.

Identifying Key Activities Based on this User Observation

Description of Activity

Activities involved in Sewing a garment from start to finish and moving it through the production line.

User Experience Map for User Observation



Key Activities and Potential Improvements

	Steps	Base User Experience	Potential Improvement
Preparing Materials	-Adjusting machine for fabric -Picking up Fabric -Lining up fabric -Holding fabric in front of machine	-Manipulating the fabric can cause discomfort -twisting to pick up fabric can cause back pain	*Reduction of stress on hands* *Reduction of twisting motion*
Sewing	-Hold Fabric as it passes through the machine -operating the foot pedal -Changing the bobbin as needed	-bending over in concentration can cause pain -changing the bobbin is inefficient and repetitive -holding the fabric can cause pain.	*Reduction of bending motion* *Better Bobbin system* *Reduction of stress on hands*
Moving Materials to next station	-Removing the material from machine -placing it into its bin or place -moving the bin to its final destination	-moving material requires lifting -placing material in bin can require twisting	*Reduction of twisting motion* *Reduction of Lifting*

Benchmarking Product I

Comparing Main Features

Approach Taken

The basis for selection of products was to look at the top 5 industrial sewing machines and the top 5 home use industrial machines. This search was done through google, and more in-depth research was gained from the manufacturers websites. These machines were chosen because they are class leaders and make a good comparison between leading tech in the industrial sewing industry and the home use industry. While the home machine market has progressed at a rapid pace, the industrial market has seen less development.

The 10 benchmarked products are shown in the Table below.

Ten Comparable Products	
Industrial	**Home Use**
Juki DDL-8700 Servo Motor	**Singer Heavy Duty 4411**
Pfaff 2081	**Brother THE Dream machine 2**
Brother S-7300A	**Janome Horizon MemoryCraft 15000**
Reliable 31000SD Drop Feed	**Bernina 880 Plus**
Durkopp Adler 261	**Husqvarna Designer Epic**

Appendix I

Promotional literature for those products is shown in Appendix I.

Table

A table comparing the main features for all 10 comparable products was then constructed.
The main features chosen for comparison were:

1. Material Weight Handling Ability
2. Speed in Stitches per Minute
3. Lubrication Method
4. Material Used to Construct the Machine
5. Comfort
6. Utility

The table is on the following page.

Benchmarking Product: Analysis

		Material Weight Handling Ability	Speed Stitches Per Minute	Lubrication Method	Machine Materials	Comfort	Utility / Features	Cost/MSRP	OTHER
1	**Juki DDL 8700 Servo Motor**	Medium	5,500 spm	Auto	Cast Steel	Quiet	Straight Stitch Only	$700-$1000	
2	**Pfaff 2081**	Light - Heavy	5,500 spm	Dry Machine	Extremely Wear Resistant	Quiet Low Vibration	Can Change the bar allowing many stitch sizes	$3300	
3	**Brother S7300A**	Medium – Heavy	4000-5000 spm	Semi-Dry	Cast Steel and Glass Filled Plastic	-More Ergonomic -Quiet	-Electronic Feed Control -LCD Screen	$1825	-Designed to be Easier to Operate and be more ergonomic. -Reduces Birds nests -evens out irregular stitching over lapped seams
4	**Reliable 31000SD Drop Feed**	Medium	5,500 spm	Auto	Cast Steel	Low Noise Low Vibration	Straight Stitch Only	$800	Industry leading reliability?
5	**Durkopp Adler 261**	Light – Heavy	5,500 spm	Minimum Lubrication	Cast Steel and Glass Filled Plastic	Dimmable LED	Integrated Control Pannel Automatic Lifting Food	$1050	-Convincing Price Performance Ratio
6	**Singer Heavy Duty 4411**	Heavy	1,100spm		Stainless Steel		-11 built in stitches -Stronger Motor -Multiple Feet -Changing Needle Position	$153	-Top Drop in Bobbin -4 step button wholer -Drop Feed
7	**Brother THE Dream Machine 2**	Light – Medium	1000 spm		Plastic	-Auto Threading Needle -LED Light mimics the sun -Ergonomic Start Stop Button	Can Perform Thousands of tasks including embroidery -Huge Touch Screen	$14,000	-149 utility stitches -577 decorative stitches -5 sewing fonts and more -
8	**Janome Horizon MemoryCraft 15000**	Light – Medium	1000 spm		Plastic	Auto everything -Instructional DVD	Can Perform Thousands of tasks including embroidery -Huge Touch Screen	$13,000	-510 Built in stitches -480 Built in Embroideries -13 one step button wholes -WIFI
9	**Bernina 880 Plus**	Light – Medium	1200 spm		Plastic	Removable extension Table	Can Perform Thousands of tasks including embroidery -Huge Touch Screen	$12,500	-1764 Total stitch Options -400 Embroidery Designs -12 fonts -20 button whiles -touch screen -2 USB Ports -
10	**Husqvarna Designer Epic**	Light – Medium	Fast?		Plastic	-120 step by step tutorials -large working area -Market Leading Light	-30% larger bobbin -relatively quiet?	$15,000	-Uses the “cloud” -WIFI -over 1200 stitches -6 alphabets -over 650 embroideries -

Benchmarking Product II

Comparing Pairs of Features

Feature Comparison X-Y Graph

Pairs of these features were chosen to create an x-y graph.
The two features were assigned either the x or y axis, and images of each of the comparable products placed on the graph.

The intent was to see if a pattern emerged which could indicate a particular neglected market niche.

Axis Chosen

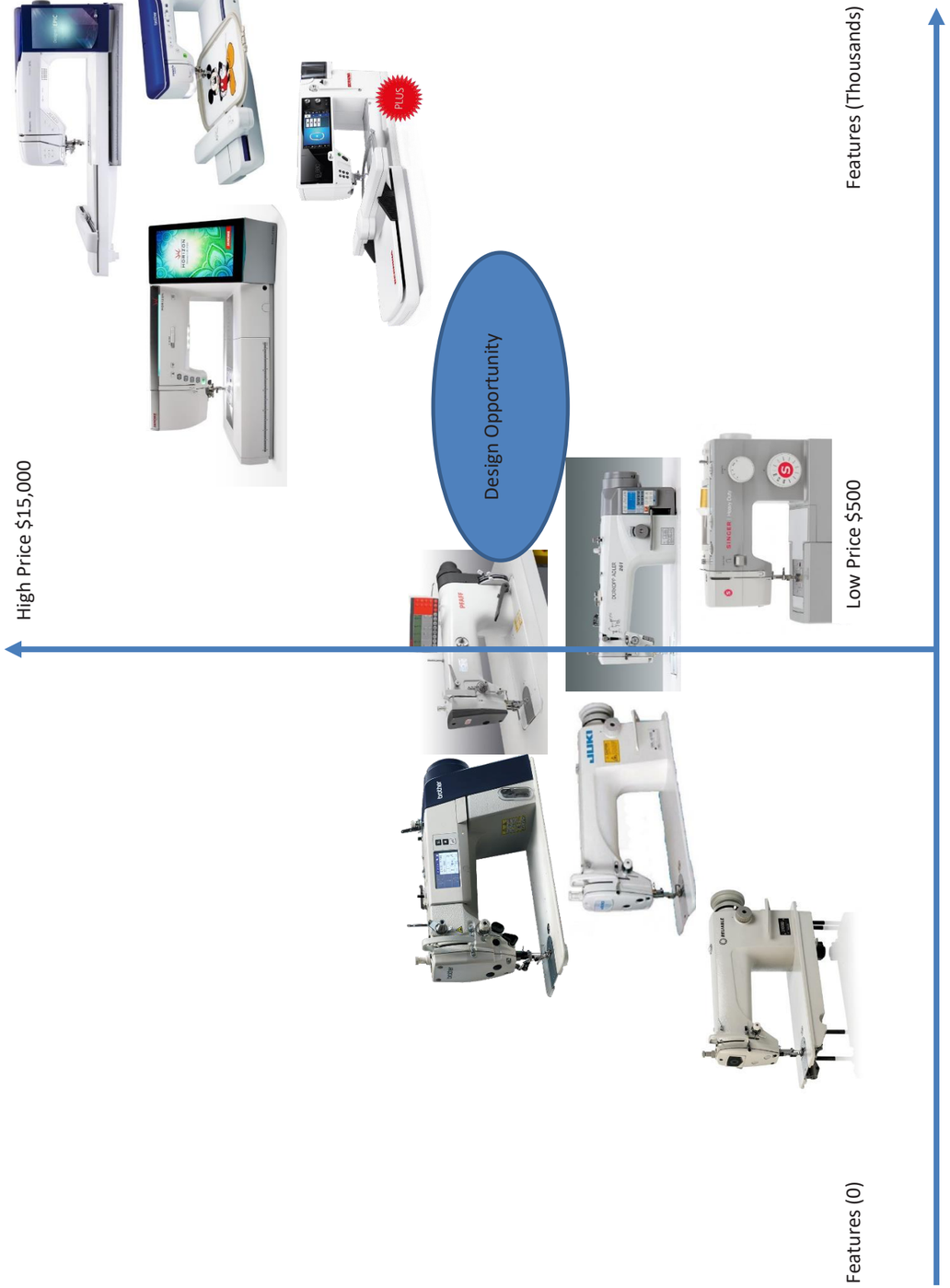
Y-axis: Cost
X-axis: Number of Features

Results

X-Y Graph I is shown on the following page.

Summary and Conclusions

1. Sewing machines are a competitive market with many of the machines having similar features within their categories
2. Major key features are durability, types of stitches, speed of sewing, and utility.
3. Features specific to some brands are not taken into account in this analysis however they do often play a role in the buying decision.
4. There is a general trend between cost and number of features
5. Most industrial machines fall in the $500-2500 range
6. Most Home machines observed fall within the $10-15,000 range (noting that smaller cheaper units were not analysed in this analysis)
7. **Based on the cost vs feature analysis a design opportunity was identified ($1,500-$3000 price range with a larger range of ergonomic features)**



Benchmarking Product III

Determining Main Benefits and Features of Comparable Products

Benefits

Determining the features and benefits for a product (or related product) is key to informing design.
It is best done at the start of the design process.

Benefits are the hooks that catch the customers and makes them want your product over your competitors. Benefits are how your features will help the user conduct their tasks in an easier, faster, less frustrating or more exciting way.

Where to find benefits: Advertising (promotion / sales pitch) emphasize the Benefits.

Features are line after line of unique characteristics that your customers may need,

Where to find features: Technical Specifications list the Features.

Method

The technique used was to select promotional material for 3-5 products which are related to the thesis topic.
From this promotional material, the words describing **features** were colour coded one colour, the words describing **benefits** were colour coded another colour.
The frequency of these words was determined, and the most common identified.

Results

Results are shown in Appendix 2a

Conclusions: Key *Benefits for Industrial Sewing Machines*

The top 4 words associated with benefits and features, as determined from promotional literature, are listed in the following table.

Key Benefits of Comparable Products	
9	Quality
6	Comfort
2	Speed/Power
1	Utility

Features

Determining the features and benefits for a product (or related product) is key to informing design.
It is best done at the start of the design process.

Benefits are the hooks that catch the customers and makes them want your product over your competitors. Benefits are how your features will help the user conduct their tasks in an easier, faster, less frustrating or more exciting way.

Where to find benefits: Advertising (promotion / sales pitch) emphasize the Benefits.

Features are distinctive attributes or aspect of something.

Where to find features: Technical Specifications list the Features.

Method

The technique used was to select promotional material for 3-5 products which are related to the thesis topic.
From this promotional material, the words describing **features** were colour coded one colour, the words describing **benefits** were colour coded another colour.
The frequency of these words was determined, and the most common identified.

Results

Results are shown in Appendix 2.

Conclusions: *Key Features for Industrial Sewing Machines*

The top 5 words associated with features, as determined from promotional literature, are listed in the following table.

Key Features of Comparable Products	
11	Material
7	Lubrication
7	Machine
6	Sewing
3	Speed

Competitor Benefit Assessment

Method

Two products close to the 'Design Opportunity' were assessed on how they met customer needs.

The two products selected were:

1. Pfaff 2081
2. Brother S7300A

Results

Results are seen in the Table below. Benefits are the ones identified for this product. Possible Niche Markets are deficits in current product offerings (A & B in this case).

BENEFITS Customer Needs	BENEFIT COMPARISON		
	Pfaff 2081	Brother S7300A	*Possible Niche Market*
Quality	Good	Good	
Comfort	Low	Fair	X
Power/Speed	Excellent	Excellent	
Utility	Fair	Good	X

Conclusions

Possible niches for design in terms of benefits were determined to be comfort and Utility.

References: See Appendix 1

Product Research Which Informs Design

Benchmarking

1. Sewing machines are a competitive market with many of the machines having similar features within their categories
2. Major key features are durability, types of stitches, speed of sewing, and utility.
3. Features specific to some brands are not taken into account in this analysis however they do often play a role in the buying decision.
4. There is a general trend between cost and number of features
5. Most industrial machines fall in the $500-2500 range
6. Most Home machines observed fall within the $10-15,000 range (noting that smaller cheaper units were not analysed in this analysis)
7. **Based on the cost vs feature analysis a design opportunity was identified ($1,500-$3000 price range with a larger range of ergonomic features)**
8. Possible other niches for design in terms of benefits were determined to be comfort and Utility.

Key Benefit and Features

Top benefits and features for comparable products, as determined from promotional literature were:

Key Benefits of Comparable Products
1. Comfort
2. Utility
3. Power/Speed
4. Quality

Key Features of Comparable Products
1. Material
2. Lubrication
3. Machine
4. Sewing
5. Speed

BENEFITS Customer Needs	BENEFIT COMPARISON		
	Pfaff 2081	Brother S7300A	*Possible Niche Market*
Quality	Good	Good	
Comfort	Low	Fair	X
Power/Speed	Excellent	Excellent	
Utility	Fair	Good	X

Competitor Benefit Assessment

A comparison of benefits for two products close to the potential market niche determined from the X-Y graph.

Needs Statement

An industrial sewing work station that is affordable while also being durable, more comfortable, ergonomic and provides more utility to the sewer.

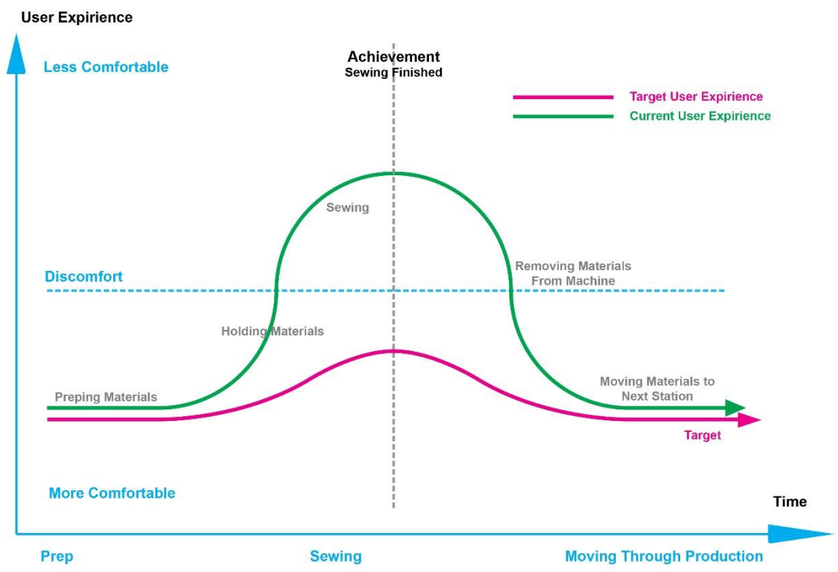
NEEDS REPORT SUMMARY

4 The User Experience Map

The previous exercises addressed general benefits of using a similar product to the thesis topic.
But where should the design focus be placed.

The User Experience while using the product for a specific task will **identify the specific benefits/needs for specific activities.** These are displayed on a User Experience Map.

This was carried out for the activities of the user for this thesis topic.



Activities and Potential Improvements

	Steps	Base User Experience	Potential Improvement
Preparing Materials	-Adjusting machine for fabric -Picking up Fabric -Lining up fabric -Holding fabric in front of machine	-Manipulating the fabric can cause discomfort -twisting to pick up fabric can cause back pain	*Reduction of stress on hands* *Reduction of twisting motion*
Sewing	-Hold Fabric as it passes through the machine -operating the foot pedal -Changing the bobbin as needed	-bending over in concentration can cause pain -changing the bobbin is inefficient and repetitive -holding the fabric can cause pain.	*Reduction of bending motion* *Better Bobbin system* *Reduction of stress on hands*
Moving Materials to next station	-Removing the material from machine -placing it into its bin or place -moving the bin to its final destination	-moving material requires lifting -placing material in bin can require twisting	*Reduction of twisting motion* *Reduction of Lifting*

Statement of Need ***Derived from the User Experience***

To design a sewing workstation that reduces the amount of discomfort the sewer experiences by reducing the amount of time they are handling the material in an uncomfortable manner.

5 Summary of Needs

1 Initial Needs Statement

To create a machine that can perform all the sewing functions while reducing stress on the user, enhancing their quality of life.

2 Linking Benefits to Fundamental Needs

	Benefit	***Possible Corresponding Fundamental Human Needs (FHN)***	***Relationship between Benefits and FHN***
9	Quality	Subsistence, Protection, Abilities, Creation	Moderate
6	Comfort	Subsistence, Health, Safety, Protection	Strong
2	Speed/Power	Creation, Work, Esteem, Ability, Skills	Moderate
1	Utility	Ability, Skills, Build, Work, Creation	Moderate

Statement of Need ***Industrial Sewing Machine***

Sewing is a **Creative** activity that has its core appeal based on it being a **skilled** task that accomplishes **work.**

Subsistence is realized through the machine providing a **safe** environment where the worker can **work** and **create.**

Summary of Needs (cont.)

3 Linking Fundamental Needs to Benefits

Industrial Sewing Machine

Needs	Benefits Underlying Needs	Importance		
Basic Needs	*Mazlows Hierarchy of Needs*			
Control over one's environment	Sewer has control over the machine and the material			**High**
Social Belonging	*Effort / resources to belong to a 'tribe'*			
Fear of the enemy	Fear of being fired for not producing enough	**Slight**		
Tribal Identity *Belonging to the winning team*	Part of the team of sewers	**Slight**		
Peer Pressure / Social Expectation (direct and indirect *'Everybody else has it'*)	Need to sew to a specific standard and produce a set quantity of product	**Slight**		
Social Expectation	Need to work fast and long hours	**Slight**		
Social Status *'The elite have it…I want to be like them'*	Sewers with more experience get first pick of the machines.	**Slight**		
Social Recognition	Sewer with more experience get more respect	**Slight**		
Convenience	*Product (tool) that amplifies human abilities*			
Ease of Use	Understanding controls, Operating foot pedal, Threading the machine, Changing the Bobbin			**High**
Speed (fast, less time)	The faster the machine can sew the more can be produced			**High**
Control (precision, responsiveness, power)	Good foot pedal, well-lit work surface, low vibration,			**High**
Value	*(optimization of limited resources)*			
Price	Should be cheap-affordable for business owners		**Moderate**	
Reliability	Machine should not break down (would reduce production)			**High**
Next Generation	*(longer term / less immediate)*			
Health/care/education of children	Should not cause RSI – this would limit the sewers ability to perform day today tasks such as taking care of their children			**High**
Pleasure				
Senses (see, hear, feel taste, smell)	Less noisy machines are more pleasurable		**Moderate**	
Aesthetically Pleasing	Could be more aesthetically pleasing	**Slight**		
Emotional Response				
Empathy	Is this machine too powerful? Will it hurt me?		**Moderate**	

Statement of Need

A sewing workstation that quickly and efficiently performs the task of sewing while is reliable, comfortable and provides a sustainable working environment for the sewer.

CAD MODEL Reference 5.3

All cad model renders and photos of progress can be found in chapter 4, 5, and 6 of the thesis report.

HARD MODEL PHOTOS Reference 5.4

All hard model build photos and final photos can be found in chapter 4 and 5 of the thesis report.

TECHNICAL DRAWINGS Reference 5.5

Technical drawings of the workstation can be found in chapter 5 of the thesis report.

MANUFACTURING COST REPORT Reference 5.2.3

Manufacturing cost and business report can be found in chapter 5 of the thesis report.

SUSTAINIBILITY REPORT

ABSTRACT

In this report, elements of sustainability will be evaluated and analysed in relation to the ergonomic industrial sewing workstation being developed as part of a thesis project by Sam Parker. This report will look at sustainability in two areas, the first being health, safety and the environment, and the second being materials, processes and safety. The former will be a broader look at sustainability and how it impacts the user and the environment while the ladder will be a more in-depth review of the impacts of specific process and how the manufacturing and development of this product might be streamlined in order to increase the sustainability of the product. To better understand the value of sustainability in the creation of this product and in its use, the lifecycle of the sewing workstation will be analysed and methods of recycling and reusing will be evaluated to gauge for possible application within the products lifecycle.

1. INTRODUCTION

Industrial sewing machines are products and tools that have been around for over one hundred years. First being used effectively to sew French soldier's uniforms, sewing machines quickly became a house hold item allowing clothing to be made and repaired within the home. However, their real value to society has been in the manufacturing industry where industrial sewing machines are used to create all of the worlds clothing, and textiles for a diverse selection of industries. Every day millions of workers head to work where they sew clothing for international business that sell their products all over the world. One element of this business that has not been addressed effectively at any level, is sustainability. Often industrial sewing machines are designed with one key trait in mind: durability. Although this if fantastic for business owners, the users of the machines themselves are seldom accounted for leading to sever repetitive stress injuries and long lasting muscular problems. An in depth look at increasing sustainability for the user as well as amplifying the benefits of modern technology into this product is conducted in this report which will lead to the final development of a machine that is more sustainable for the worker, the business owner, and the environment.

2. LITERARY REVIEW

The following information in this report has reference to several safety guides developed by workers safety boards, as well as research papers and documents the outline improved methods for textile and clothing manufacturing and suggestions for businesses to improve the ergonomics of their current workstations to better serve the needs of their workers.

3. SUSTAINABILITY

3.1 Sustainability – Safety, Health, and Environment

Research was conducted on the health, safety and environmental realms in relation to this product and a detailed list was made of changes that can be made to improve the design industrial sewing workstations. These changes range from user needs and functionality to environmental initiatives and material sourcing and selection.

3.1.1 Sustainability – Safety

The primary functionality of industrial sewing machines and the workstation being designed in this thesis is to sew fabric quickly and reliably. The physical action of sewing fabric on its own however, poses several risks to the user, such as impalement by the needle, fingers getting crushed by the presser foot, and many other stress related injuries that might develop over time. While reducing all risk entirely is not

possibly at this time, design features have been added to address the risk and mitigate the likelihood of injury.

These design features include a guard in front of the needle and presser foot and adjustable lighting used to help illuminate the work area.

3.1.2 Sustainability – Health

The development of the ergonomic industrial sewing workstation as part of this thesis has been centered around the user. This has been characterised as meaning that the product must provide a comfortable environment for the user to work in, that does not in any way increase the likelihood for users to develop repetitive stress injuries (RSI's) while looking to create an environment that can also adapt the user, changing over time, to reduce the likelihood of a user developing an RSI.

One major element in reducing RSI's is adaptability of the working position. Because of this, a series of risers and riser motors has been added to the frame of the product to allow the user to effortlessly raise and lower the table, primarily to achieve the correct working height, but also to allow the workstation to convert from a sitting workstation, into a standing workstation. Giving the user the choice of how they would like to work.

While adding that functionality to the workstation has its benefits. The real benefit comes from the reduced sitting periods often endured by the users. To help encourage the use of the sitting and standing functionality, a reminder application has been added to the workstations notification screen that can create a customisable schedule for the

user to be reminded that they have been sitting for extended periods of time that they should raise the table and work while standing.

Several other aspects of the design of the workstation have also been altered to better meet ergonomic requirements. These areas are: The organization, and layout of storage making it easier to see, and reach important tools such as scissors or pencils. The placement of the working spools (of thread) which have been moved closer to the user to allow the sewer to change out new spools and bobbins without having to stand up and bend over the top of the machine. The access to the bobbin case which has been moved to the top of the machine such that the user can change the bobbin without bending over and reaching under the working surface. And the placement and color of lighting, which can be changed over time to reduce the likelihood of the sewers eyes becoming overstressed.

3.1.3 Sustainability – Environment

Perhaps one of the better features of industrial sewing machine is their durability. These machines are built tough to last through many years of service which in turn means that they have exceedingly long lifecycles. However, these machines do need regular oiling, and with the introduction of computerization into the industry, there are still a handful of areas that can be improved upon to help reduce the impact these machines have on the environment.

First and foremost, the largest consumable these machines have, aside from thread, is the oil they use to lubricate all of their hundreds of moving parts. Machines are usually

oiled every night and excess oil wiped up in the morning. With the introduction of self oiling machines, oil is often kept in a sump underneath the worksurface, but needs to be changed at regular intervals. The workstation being designed in this thesis will use an ecofriendly lubricant derived from various plant-based oils. This impacts the design of several other components in the machine, as seals and other rubber and plastic parts will need to be specified to not degrade over time with exposure to the natural lubricants. The materials and processes used to build and recycle the machine have also been selected based on their ability to reduce the impact on the environment and will be discussed in the materials and processes section of this report.

3.2 Sustainability – Materials, Processes, and Technology.

Although there are many impacts these workstations have on sustainability during their use. There are equally as many impacts made during their production relating to material choice, the processes used to create the machine, and the technology added to the machine to add features and functionality. These impacts will be discussed in the following sections.

3.2.1 Sustainability – Materials

Traditionally, industrial sewing machines have been cast from steel, with their internals being machined and mounted inside the cast shell. These machines are then mounted onto a melamine or particle board desk, and then attached to a bent steel

frame. This has traditionally worked well for the industry because the cost of casting steel is low, and the end result is a machine that is very durable and can last many years, allowing it to return its invested value many times over through the thousands of products it will make.

The materials chosen for the workstation in this thesis report, have been chosen based on embodied energy values and their ability to be recycled. The lower frame of the workstation is made from recycled aluminum. Using recycled aluminum as apposed to new aluminum returns an embodied energy value similar to that of steel, plus the added bonus of it's ability to be recycled again in the future and the reduction in weight of the table which plays a role in total energy needed to lift the table when turning it into a standing desk makes it a good choice over steel.

The work surface is molded from an eco friendly material called Paperstone™ which is a composite material made from recycled paper and natural resins. The material is very strong and durable and has a very low embodied energy value due to its ease of manufacturing and its use of all natural and recycled materials.

The top console, and sewing machine housing are injection molded from recycled glass filled ABS plastic. This plastic was chosen based on its strength and durability characteristics and its resistance to heat and oils. Although ABS plastic is not typically viewed as a green plastic, its durability allows for a long lifespan which reduces the need for units to be repaired or replaces every few years.

Lastly the sound deadening panels are made from CFAB™ cellulose panels manufactured by Stop Noise Acoustical Surfaces Inc. These panels are able to absorb

and reduce the sound in the area while resisting mold growth and are both fire resistant and manufactured from renewable and recycled fibers.

3.2.2 Sustainability – Processes

Due to the modular nature of the workstation in this thesis, assembly of the workstation, as well as upgrading of parts and performing maintenance is easy. Through the selection of environmentally conscious materials, the processes for production of the various parts of the workstation are also low energy and have a reduced environmental impact when compared to similarly manufactured products.

3.2.3 Sustainability – Technology and Power

With the introduction of computers into the sewing machine industry, it was not long before touch screen appeared on many home machines and computer boxes with dozens of buttons appeared on industrial machines. While screens are a great tool for effectively communication and interfacing with the user, often the glow of a screen can cause fatigue on the user's eyes after many hours of use.

To improve the simplicity of interfacing for users as well as to allow for upgrades to be made via software changes, OLED screens have been fitted to the workstation being developed in this thesis. OLED screens use very little power and do not cast a glow because they only turn on the pixels that are needed to display a particular image, where black is a turned off pixel and white or any other color is turned on. This, along

with the incorporation of a energy star rated direct drive motor reduces the amount of power used to run the workstation making it a smart choice for business owners looking to reduce their monthly energy bills.

3.2.4 Sustainability – Safety

While safety is addressed in many areas of the design of this work station. One major safety concern when using any powered machinery is that the machinery must be kept in good working order and that users do not attempt to operate broken or worn out machinery. Through the use of durable materials and the addition of computers that are able to keep track of the workstations maintenance schedule, the workstation is able to provide a safer environment for sewers to work in.

4. CONCLUSION

Through the assessment of sustainable initiatives, and the evaluation of several sustainable material options, design decisions can be made with relation to improving sustainability for the workstation being designed and for its manufacturing. By improving the sustainability in areas related to the user, their health and safety, and the environment, a product can be created that improves the lives of the users and business owners and minimizes harm on the environment.

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PANEL ON
RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Sam Parker

has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **6 September, 2017**

"Humber Institute of Technology & Advanced Learning
Bachelor of Applied Technology – Industrial Design
IDSN 4002 Senior Level Thesis 1

School of Applied Technology
Fall 2017
Dennis Kappen, Bruce Thomson

THESIS TOPIC APPROVAL

NAME(S)
Sam Parker

TOPIC TITLE:
Ergonomic Industrial Sewing Station

TOPIC DESCRIPTIVE SUMMARY:

How might we use design to create an industrial sewing work station that is both easier for the user and easier on the user helping improve the quality of life for sewers while also improving product quality and output. Today there are millions on workers of all ages and ethnicities working in textiles and apparel factories world wide who are slowly developing serious repetitive stress injuries to much of their upper body making simple day to day tasks painful compromising their quality of life. In ~~this research paper,~~ THIS REPORT ~~I will do my best~~ AIMS to understand the users and their needs. ~~I will conduct~~ an ergonomic STUDY AND analysis of current workstations on the market and look at how I might be able to improve them to reduce the risk of repetitive stress injuries. I will also look at the interface of the machine and how I can simplify the controls making the machine easier to understand and safer to use for a large very diverse demographic of users. Lastly, I will look at new tech in an attempt to integrate new technology into an age-old profession. At the end of my study I hope to have found a solution that improves the lives of the sewers, improves the quality of textiles and apparel manufactured, and potentially increases production line efficiency.

Student Signature(s)

Date Sept 25th 2017

Instructor Signatures

Date Oct. 4 2017

HUMBER

Informed Consent Form

Research Study Topic : *Ergonomic Industrial Sewing Station*
Investigator : Sam Parker
Course : iDSN 4002-0NA

I, ANDREW GANDNER, have carefully read the Information Letter for the ergonomic industrial sewing station project. A member of the research team has explained the project to me and has answered all of my questions about it.

I understand that if I have additional questions about the project, I can contact Sam Parker via email sam1996parker@gmail.com at any time during the project. I understand that this project has been approved by the Humber Research Ethics Board.

If I have any questions about my rights as a research participant, I can contact Dr. Paul Griffin, REB Chair, 416-675-6622 ext. 3226, paul.griffin@humber.ca.

- ☑ I hereby give consent to have my voice recorded
- ☑ I hereby give consent to have photographs taken with the proviso that my identity will be blurred in reports and publications
- ☑ I hereby give consent to have videos taken with the proviso that my identity will be blurred in reports and publications

Consent for Publication: Add a (X) mark in one of the columns for each activity

Activity		Yes	No
Publication	I give consent for publication in the Humber Digital Library which is an Open Access platform	☑	☐
Review	I give consent for review by the Professor	☑	☐

Withdrawal:

- ☑ I also understand that I may decline or withdraw from participation at any time without negative consequences.

Privacy:
All data gathered is stored anonymously and kept confidential. Only the researcher

Mr. Sam Parker, Prof. Dennis L. Kappen and Prof. Bruce Thomson may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

HUMBER

My signature below verifies that I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Signature : _____

Participants Name : ANDREW GANDNER

Verification of having read the informed consent form:

☑ I have read the informed consent letter

I, ANDREW GANDNER *(First Name, Last Name, Signature)*, have read this document and give consent to the use of the data from questionnaires and interviews in research reports, publications (if any) and presentations with the proviso that my identity will not be disclosed.

Signature : _____

Participants Name : ANDREW GANDNER

Humber Research Ethics Board

This project has been approved by the Humber Research Ethics Board.

If you have any questions about your rights as a research participant, please contact Dr. Paul Griffin, REB Chair, 416-675-6622 ext. 3226, paul.griffin@humber.ca.

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more, please contact me at Ph: 519-781-9049, email: sam1996parker@gmail.com

My supervisors are:

Prof. Dennis L. Kappen, dennis.kappen@humber.ca , 416 675 6622 xt 4832,

or Prof. Bruce Thomson, bruce.thomson@humber.ca, 416 675 6622 xt. 4673

2017-18 Industrial Design Thesis Project HUMBER

- I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- My identity will be masked
- I understand that the data from this study may be published.

I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.

ANDREW GARDNER
Name of Participant (please print)

Signature of Participant

DEC 18TH 2017.
Date

Project Information
Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more, please contact me at Ph: 519-781-9049, email: sam1996parker@gmail.com
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2017-18 Industrial Design Thesis Project HUMBER

Informed Consent Form

Research Study Topic : *Ergonomic Industrial Sewing Station*
Investigator : Sam Parker
Course : iDSN 4002-0NA

I, Sharada Seecharran, have carefully read the Information Letter for the ergonomic industrial sewing station project. A member of the research team has explained the project to me and has answered all of my questions about it.

I understand that if I have additional questions about the project, I can contact Sam Parker via email sam1996parker@gmail.com at any time during the project. I understand that this project has been approved by the Humber Research Ethics Board.

If I have any questions about my rights as a research participant, I can contact Dr. Paul Griffin, REB Chair, 416-675-6622 ext. 3226, paul.griffin@humber.ca.

- ☑ I hereby give consent to have my voice recorded
- ☑ I hereby give consent to have photographs taken with the proviso that my identity will be blurred in reports and publications
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Consent for Publication: Add a (X) mark in one of the columns for each activity

Activity		Yes	No
Publication	I give consent for publication in the Humber Digital Library which is an Open Access platform	☑	☐
Review	I give consent for review by the Professor	☑	☐

Withdrawal:
- ☑ I also understand that I may decline or withdraw from participation at any time without negative consequences.

Privacy:
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Mr. Sam Parker, Prof. Dennis L. Kappen and Prof. Bruce Thomson may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

My signature below verifies that I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Signature : S. S.

Participants Name : Shazeda Seecharran

Verification of having read the informed consent form:

☑ I have read the informed consent letter

I, Shazeda Seecharran *(First Name, Last Name, Signature)*, have read this document and give consent to the use of the data from questionnaires and interviews in research reports, publications (if any) and presentations with the proviso that my identity will not be disclosed.

Signature : S. S.

Participants Name : Shazeda Seecharran

Humber Research Ethics Board

This project has been approved by the Humber Research Ethics Board.

If you have any questions about your rights as a research participant, please contact Dr. Paul Griffin, REB Chair, 416-675-6622 ext. 3226, paul.griffin@humber.ca.

Project Information

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or Prof. Bruce Thomson, bruce.thomson@humber.ca, 416 675 6622 xt. 4673

- I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- My identity will be masked
- I understand that the data from this study may be published.

I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.

Shazeda Seecharran
Name of Participant (please print)

S. S.
Signature of Participant

12-5-2017
Date

Project Information
Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more, please contact me at Ph: 519-781-9049, email: sam1996parker@gmail.com
Prof. Dennis L. Kappen, dennis.kappen@humber.ca , 416 675 6622 xt 4832,
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Work 41 (2012) 1670-1676
DOI: 10.3233/WOR-2012-0369-1670
IOS Press

The risk of developing repetitive stress injury in seamstresses, in the clothing industry, under the perspective of ergonomic work analysis: a case study

Melo Junior, A. S.
Superintendência Regional do Trabalho na Paraíba, Ministério do Trabalho e Emprego, Praça Venâncio Neiva, 11, Centro, 58010-011, João Pessoa, Paraíba, Brasil, Phone:55 83 93420596

Abstract. This study presents the sewing task with the approach of the ergonomic analysis of the work, in the seam activity in a clothing industry to identify the relationship between the use of different sewing machines and the activity of sewing pants and blouses, which brings larger risk for the development of work related musculoskeletal disorders. It was done a study of transverse and exploratory cut, in that was used a methodology control of multiple analysis of variables. The population objective was the workers that exercise the activity in the section of makings, with 93 workers, being 54,8% sewing auxiliary and 45,2% dressmakers. Most is single (75,3%), has the 2nd complete degree (58,0%) and the medium age was 25 years old. As results were observed that the machines serger, zig zag and traveti are classified as of high risk of developing work related to musculoskeletal disorders, that the postures assumed during the execution of the tasks were classified as bad or terrible, and that the workstations were just classified as reasonable. It was concluded then, that a relationship exists among the task of sewing pants and blouses, and the risk of the development of work related to musculoskeletal disorders.

Keywords: repetitive stress injury, seamstresses, clothing industry, ergonomic work analysis

1. Introduction

With the advent of the new model of flexible production clothing industries, from the 80's, a new rhythm of work was imposed seeking productivity and product quality. There was thus an increasingly tense labor, generating uncertainty and promoting the emergence of new diseases. Technological developments and new management approaches are important issues for ergonomic research in this new millennium.

Under this approach the working conditions offered to workers they have generated in many companies, physical and mental discomfort, and consequently the increase of various illnesses, among them the work-related musculoskeletal disorders (MSDs), which currently are also related modernization. The consequences of increasing the number of cases of MSDs have been the source of many of the concerns of business organizations, in addition, are causes of physical and psychological suffering for the workers.

For organizations are direct consequences, as with the removal of the operators of jobs by injuries, has reduced productivity, increased absenteeism, increased the final cost of the product, the company's negative image in society, the expected delay in delivery of products and an uncomfortable environment in the sector of work, because these lesions makes removal by a climate of doubt and anxiety among operators, which directly reflects the other [13}.

The main causes of MSDs are the biomechanical factors and organizational work, which can be categorized into four groups, namely: (1) strength, (2) poor posture of the upper limbs, (3) repeatability, and (4) vibration and mechanical compression. They are part of the groups most likely to have symptoms and develop this disease, workers whose functions have

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Focus on IFA's work

Edition 2/2013 617.0-IFA:638.81

Ergonomics at sewing workplaces

Problem

Elevated sickness rates and levels of the corresponding absenteeism have been observed for years in the German sewing industry. The main group of diseases observed in this area are those of the musculoskeletal system, particularly of the spine and the upper extremities. Under their prevention mandate, the then BGs responsible for the leather industry and for the textile and clothing industry (now the BG ETEM) therefore launched a research project with the aim of developing an ergonomic sewing workplace and a practical guide to setting up ergonomic sewing workplaces.

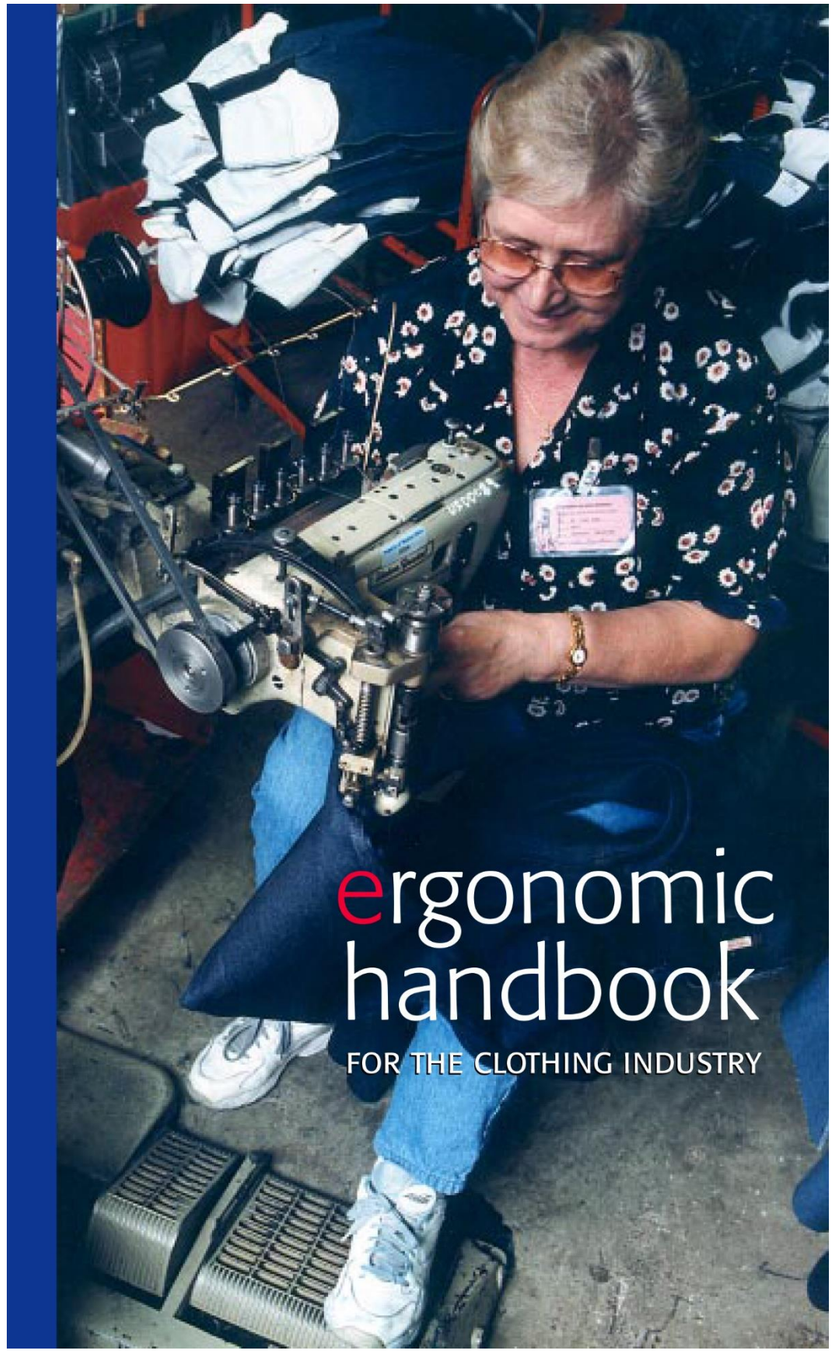
Activities

The project, which was funded by the DGUV, was conducted in collaboration with the Munich University of Applied Sciences and the Schwan engineering office in Frankfurt. In eight selected sewing businesses, physiological strain parameters such as pulse rate and electrical muscle activity were measured in conjunction with body postures and movements during typical sewing tasks. The body postures and movements of the upper extremities, head, spine, and lower extremities were recorded continuously by means of the CUELA measurement system developed at the IFA. In addition, environmental conditions such as lighting, noise and climatic conditions were measured. The subjective impression of the strain for the sewing operatives involved and their disorders and diseases were documented. Based upon the measurement results, an ergonomically improved model sewing workplace was developed, which was then installed in a number of sewing businesses.

The newly developed ergonomic sewing workplace; sewing operative fitted with the CUELA measurement system

Results and Application

It was possible to demonstrate and quantify for the first time the typical stress situations at sewing workplaces, such as the performance of work in extreme joint angle positions, static postures, continually repeated movements, and the application of high forces. These results were incorporated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