
Extending the Body:

A Niche Design For Seamstresses

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Abstract

As consumers, we are faced with a glut of products, the source of which we are dimly aware. Being unaware of the source of products, we are also unaware of the conditions under which they are produced. Designers often have an analogous relation with users. Unless we are directly involved with field research or user testing, we have an indirect relationship with our audience; hence, the conditions under which the products designed are actually used. To add to the gulf between users and designers, we are often tasked with designing mass-produced items meant to serve the needs of a vast population of users. With such an approach, a diversity of users and practices are overlooked. And tools are not always optimized to suit a specific task or audience.

Keywords

User-Centered Design
Activity Theory
Extended Cognition
Local Design
Seamstresses
Equipment Design
Niche Design
Human Factors

As an antithesis to this scenario, this thesis seeks out a local context for design solutions. Research was carried out at a local garment factory, resulting in the design of a work-surface solution for seamstresses. By focusing on a specific local context of user artifact interaction, a niche design process is derived. Traditional product design research methods entailing field work and user-centered design are supplemented with Human-Computer Interaction theories such as Activity Theory, and frameworks borrowed from the interdisciplinary study of extended cognition. A softening of the boundary of the individual is an umbrella idea connecting these various frameworks. Humans are seen as adaptive and plastic systems adopting tools and technologies as cognitive enhancements. The work surface design for seamstresses that is arrived at is evaluated in terms of its potential as a cognitive enhancement. The author seeks to put forth a rudimentary notion of a niche design process that seeks out local contexts and adapts design to specific audiences.

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My parents, for your belief and support.

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Preface

This thesis project began with a concern, not just for the kinds of things we are designing as industrial designers, but also the process by which things get made. Today, as consumers, we are faced with a glut of products, the source of which we are dimly aware.

My response to the situation we face was to produce a design by positively exploiting localized resources and manufacturing. Using this method, I could give a product a strong local identity or vernacular that would connect a consumer to the production of that good. So I began to dig further into this idea by investigating what we produce right here in the Rochester NY area. Being interested in furniture design and household goods, I visited a local furniture factory and was planning to visit to a clothing production facility. Both companies had a long and rich local history in the area, which I thought could add to the local identity of my design. My agenda was to utilize these company's materials and manufacturing expertise, and perhaps the waste materials from their products. At this point in the process, however, I was advised that a specific context for my design process was missing. I had to agree. Designing around a local need would be a stronger way to proceed than by just manipulating the language of a product via local materials and processes.

With this in mind, I visited the clothing manufacturer, Hickey Freeman Inc. My focus was not just on the material processes, but also the people within those processes. Seeing the skilled and tedious work involved in producing these goods, I began to view labor as a vital element in a product; as vital as any natural or material resource. So why not design for an audience that product designers do not often consider.

This change in outlook held two important ideas for me. The first thought was that I had discovered an underserved audience for product design in the worker's of Hickey Freeman. Secondly, by induction, what had allowed me to make this discovery was the notion of beginning the design process by focusing on a specific local context of interaction.

Preface

To summarize this back story of how I got to my topic, what began as a more general concern for manipulating local materials and manufacturing processes, became a concrete design process within a localized context.

Introduction: Other Audiences

Workers in an industrial setting produce the goods designers design and that we consume, but do not necessarily benefit from the solutions of contemporary design within their workplace. The office is the workspace garnering most of the sophisticated workplace solutions of industrial designers. This may be evidence of a cultural value that holds educated office work above skilled labor; white collar over blue collar. It may also be due to the practical reality that a factory is generally thought of as serving design through manufacturing; not the other way around.

Whatever the reasons, the industrial worker remains an underserved audience of industrial design, and the industrial worksite a fertile area for design solutions. This area provides potential opportunities for the industrial designer, the industrialist, and the worker. The industrialists can certainly profit when industrial designers offer solutions improving the contentedness and productivity of his workers. They can also profit from producing the goods we have designed. The worker obviously profits when his work experience can be improved in terms of safety, efficiency, aesthetics, and overall morale. For the designer, an area of research and problem-solving is opened up that is potentially fresher than reinventing or restyling consumer gadgets.



While industrial designers do at times design products or equipment that becomes part of the industrial work site, the relationship is often a more indirect one. Designing specifically for a factory floor and even designing work processes themselves, is more the domain of the industrial engineer.

Human Factors, the discipline of designing human centered systems, is perhaps the domain where industrial design and industrial engineering overlap the most. While the engineer is better equipped to deal with the quantitative side of human factors, the designer is better equipped to put the “human” in human factors by humanizing technology. We are trained to be more empathic, more attentive to the user’s experience of an object. One could say designers operate at the place where aesthetic experience and usefulness conspire against tedium, and what is more tedious than a repetitive task.

Project Context

While beginning my thesis research, I was lucky to stumble upon an interesting user group and cognizant enough to recognize an opportunity when I did. This occurred while touring Hickey Freeman Inc., of Rochester, NY.



The reason for my visit to the garment factory was to better understand the needs of the seamstress. My intention was to design a piece of furniture or equipment around the needs of the garment worker. However, I was open to the formulation of an unforeseen need or problem. During this first visit, I was struck by a group of women sewing the lining of a very expensive men's jacket entirely by hand. They were an intriguing anachronism been that I was in the 21ST century amongst a factory full of machinery.

These women presented me with a chance to design for an underserved population, and offered a rich context for my design process. Just within the United States, the garment worker is certainly an underserved population. Of the 6,000 garment factories in California, the majority are considered sweatshops. According to the same study, 94% of California garment workers faced health and safety violations (Harrison MD 2000, 10).

Hickey Freeman could serve as a testing ground and a place to do first-hand research to better understand the needs of the garment worker. My research there has fulfilled this criteria as well as providing me with a niche to study that is even more overlooked than that of the sewing machine operator. So the industrial hand sewer, and those working at Hickey Freeman Inc. in particular, became the subject of my design process and interventions.

A Note on Methods

In the first phase of my research I followed a human-centered approach to my design process. The term, user-centered or human centered design, is a widely recognized approach involving the end user from the very beginning of the design process. The end user is integral to the initial problem formulation and is directly involved in the evaluation of each stage of a design.

There are many user-centered design methodologies; each with their own specific check list of criteria. The international standard (ISO 13407: Human-centered design process) “defines a general process for including human-centered activities throughout a development life-cycle, but does not specify exact methods” (www.usabilityprofessionals.org). For my purposes, I cobbled together my own set of methods; many of which I borrowed from *Human Factors Methods for Design, Making Systems Human-Centered* by Christopher P. Nemeth.

“Hitting the field with notebook and camera in hand was what propelled my project and kept it rolling.”

From the outset, I realized doing human factors analysis that was quantitatively meaningful was beyond my means and interests for this project. For instance, Nemeth suggested that when using a method such as a task analysis, observation is to be carried out until 1,000 distinct operations have been observed (Nemeth 2004, 191). Then of course, one would have to proceed to analyze the data, noting the frequency of each distinct action, and so on. Therefore, many of the methods I adopted for my research were adopted somewhat loosely, although conscientiously.

The information I observed and collected then was qualitative in nature. My methods and the thoroughness of my documentation might not have held up to any rigorous qualitative standard. Nonetheless, they were the practical methods of someone juggling the role of researcher and designer. They provided me with information essential for understanding my audience, and evaluating and justifying my design decisions.

A Note on Methods

Methods I employed throughout my research and design process were as follows;

- Qualitative Task Analysis
- Passive Observation
- Conversational Interviews
- Photo and Video Documentation
- User Testing and Evaluation

Ergonomic considerations are always essential to successfully fitting a product to a user. Although my project would have been unimaginable without addressing issues of ergonomics, I never conceived this thesis as being solely about an ergonomic solution. What did interest me from the beginning was fitting a product, not just physically, but to the specific living culture of a group of users. Hitting the field with notebook and camera in hand was what propelled my project and kept it rolling. The type of primary research and fieldwork essential to this project is often referred to as ethnographic research, and has been widely borrowed by the design community from anthropological practices. Many ethnographic methods overlap the human factors methods I listed above, such as the general notion of passive observation (observing a groups behavior without contact or intervening), as well as photo and video documentation and conversational interviewing.

A Note on Methods

Evaluative Methods

Some design solutions resulting from my fieldwork led me to consider the boundary between a user and an artifact further. The specificity of my fieldwork led me to think about the possibilities of design as a localized niche process, where artifacts were adapted to smaller groups of users in more specified ways.

Another issue that arose was the way in which artifacts became so deeply integrated into our physicality and our image of our selves. Several areas of thought that grew out of Human Computer Interaction proved insightful for furthering these ideas innate to my project. In particular, Activity Theory provided some fascinating perspectives on human artifact relationships, as well as practical methods for evaluating processes and resulting designs. I also borrowed heavily from Andy Clark's ,Natural-Born Cyborg, among other writers.

Activity Theory

If user-centered approaches to design espouse studying the user object relationship as a system, then Activity Theory went further by stating no qualities of the user or object exist beyond their interaction (Kaptelnin, and Nardi 2006, 30). This called for studying users interacting with technology within a localized context. The local context of a particular group of women was central to my design problem solving. The solutions I arrived at were tailored to a particular set of people, who were a minority in their own work place. They were a niche of twelve workers amongst a factory of five hundred.

The needs of these seamstresses could be extrapolated to larger groups of users performing similar tasks, but not without generalizing. Much of the spirit of this project was in opposition to the generalized and to the one-size-fits-all solutions of modernist design. For these reasons, Activity Theory, with its emphasis on the social context of interaction and studying technology in use, provided a relevant framework for the evaluation of my project.

The interaction between subject and object is not seen as

KEY CONCEPTS

- Social Context of Interaction
- Tool Mediation

A Note on Methods

isolated to a task, but rather seen as an activity. An activity is the purposeful interaction of a subject with the world (Kaptelnin, and Nardi 2006, 31). Viewing interactions as activities broadens the scope to include the meaningful social context of an interaction, with the motives of groups and individuals relative to these activities. The localized context of a particular group of women was central to my design problem solving. The solutions I derived were tailored to a particular group of people; a group who were a small minority in their work place. For these reasons, Activity Theory, with its emphasis on the social context of interaction and studying technology in use, provided a relevant framework for the evaluation of my project.

What is also posited by Activity Theory, which goes beyond a typical user-centered approach is the notion that the human mind is a product of the interaction between human and world, emerging to make interaction between organism and the world more successful (Kaptelnin, and Nardi 2006, 42). Activity Theory originated in the 1920's from the work of Russian Psychologist Lev Vygotsky, known as Cultural Historical Psychology. Vygotsky's view that social being determines consciousness challenged the clear subject/object split that dominated psychology of the day. Likewise, Activity Theory de-emphasizes or undermines clear distinctions between external and internal, individual and collective.

If we take Activity Theory's viewpoint that the mind is culturally determined, then external cultural phenomena such as language and tool use are viewed as shaping our internal mental activity.

This emphasis on tool mediation, the notion that tools structure and orient our activities in the world, can be a very useful concept for designers. Understanding that artifacts are deeply integrated into not just our physical activities, but also our mental processes, we can begin to see how without them we could not experience the world as we know it. In fact, our individuality is shaped by learned concepts appropriated from culture. "Elaborate practices of creating, maintaining, and storing tools are the most basic features of mankind" (Kaptelnin, and Nardi 2006, 45). Tools then embody abstract concepts representing individual and collective experience. In this view, tools structure how we experience our world and ourselves.

Model Comparisons

Traditional
User-Centered Model

System
 $(\text{subject}) + (\text{tool}) \rightarrow \text{task}$

Expanded
Activity Theory Model

Social Context
 $(\text{subject} \leftarrow \text{tool} \rightarrow \text{activity})$

*Activity Theory puts special emphasis on studying technology in use. The interaction between subject and object is not seen as isolated to a task, but is an activity set within a social context of interaction. User and tool should not be seen as separate, but subject and object develop and change through their interaction. This diagram is meant to express this relationship.

A Note on Methods

Clark's Natural-born Cyborg

To further understand this notion that tools and technology extend our capabilities and sense of embodiment, I looked to the writings of philosopher and cognitive scientist Andy Clark. His *Natural-Born Cyborgs* is a very accessible account of the frontiers of human machine symbiosis both low and high tech.

KEY CONCEPTS

- Tool As Cognitive Enhancement
- Humans act within a bio-technological matrix

One of our earliest and most ubiquitous technologies, language itself is for Clark synonymous with a technology such as a hands-free cellular head set, that one might more readily imagine as Cyborg-like. What makes both of these technologies Cyborg in nature is the way in which they serve as scaffolding for our thinking and problem solving. Our brains seamlessly integrate these technologies into our lives as extensions of internal thought processes (Clark 2004, 76). They literally extend our thinking beyond ourselves and into our environment.

These “cognitive hybridizations” then are the mark of a Cyborg for Clark. “What we should really care about is not the mere fact of deep implementation of flesh to wire grafting, but the complex and transformative nature of the animal machine relationships.”

Technologies such as the cellular phone and hands-free headsets have become integrated into our lives; transforming our sense of presence and embodiment. In most populated areas in the United States, we can communicate with other people located all around the world at any given time; thus, making our presence felt and receiving the presence of others from afar, to a degree that unimaginable ten or fifteen years prior. The cell phone's ubiquity and ease of use is evidence of its deep cognitive penetration into our lives.

Using Clark's notion of the Cyborg is useful for evaluating how my own design solutions for the seamstresses at Hickey Freeman might result in “cognitive enhancements”. The “transformative nature” of the user tool relationship can change the quality of their work experience; hence, their perception of their work and themselves.

Initial Research Strategy

Before my first information gathering trip to Hickey Freeman, I prepared a loose research strategy. These methods, as mentioned in the previous section, were mostly pulled from Human-Centered Design methods.

Observational Methods

Besides a general observation of the workers activities and an openness and curiosity in understanding their niche, the following supplemental methods were employed. They were documented using photography, written notes, and drawings.

Informal Task Analysis

- Try and remain in the background so workers perform as usual.
- Record all distinct steps in the seamstress activities
- Observe again noting frequency of steps over a given period of time

Work Flow Analysis

- Draw diagrams of the seamstresses work envelope, noting the movements made and where (take photos if allowed)
- Record posture of as many workers as you can
- Record any awkward or strained movements
- Sit at a sewing station yourself.
- Note any adaptations users have made to their equipment
- Make measurements of the table and chair heights.
- Look to see if there are adjustable seating and adjustable height work surfaces.
- Make note of general ethnicity and stature of employees
- Approach workers with an ingenuous attitude

*Interviews were carried out in my initial trip to Hickey Freeman as well as in subsequent visits. An informal conversational approach was used. A set of questions was prepared in advance, but only served as a guideline. I held off on discussing the interviews in detail until Section 3 as a thorough analysis of the interviews did not take place until later in the design process.



Situation Analysis

My first visit to Hickey Freeman was essentially a tour of the factory and operations, and an opportunity to explain my research and intentions at Hickey Freeman. After identifying possible research subjects in my discovery of the hand sewers, I spent about an hour in their section making observations.

Being that my arrival was unannounced to the workers, they were suspicious about my presence. Hence, my interaction at this point was very limited and sufficiently awkward. Even so I was prepared with task analysis diagrams (see following pages), with a profile, and a overhead drawing of a seamstress seated at a work station. This allowed me to conveniently draw and record the posture and actions and work flow of the seamstresses over the top of the diagrams. I also was able to sneak a few photographs in during this initial visit.

From my initial observations and inquiry, it seemed that the seamstresses spent the majority of their time hand-sewing suit jackets, although I was told they were sometimes assigned to other tasks. I was surprised at how rudimentary their tools were. The needle and thread they used as their main instruments changed little in 30,000 years of human history.

posture / work flow / workstation analysis

hand sewing - all female

workers find it best to work on their lap and not - table top.

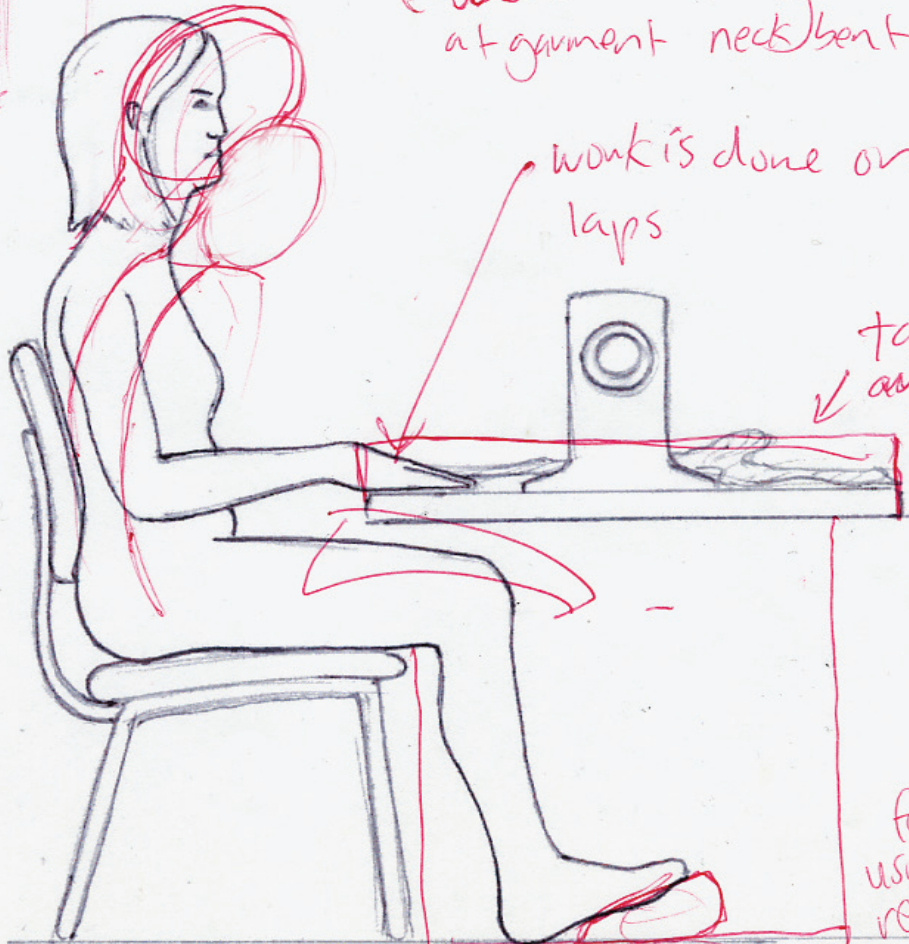


hands need to be close to head 1'-1 1/2' workers looking down at garment neck bent

work is done on laps

tasks available is

Some workers have back pad added to chair, or seat pan



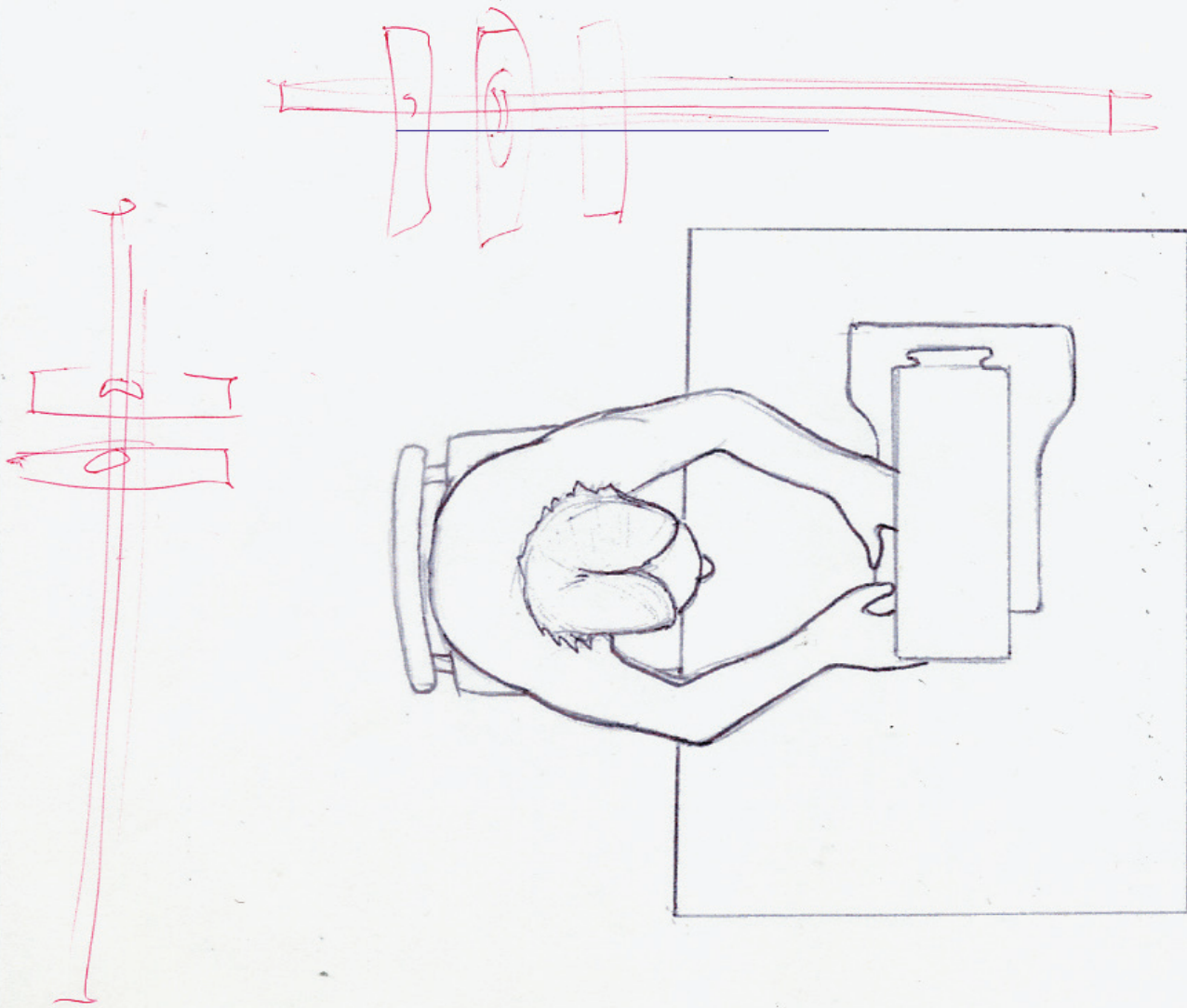
feet usually resting

modified foot rest - piece of wood to hold up feet

on bottom shelf

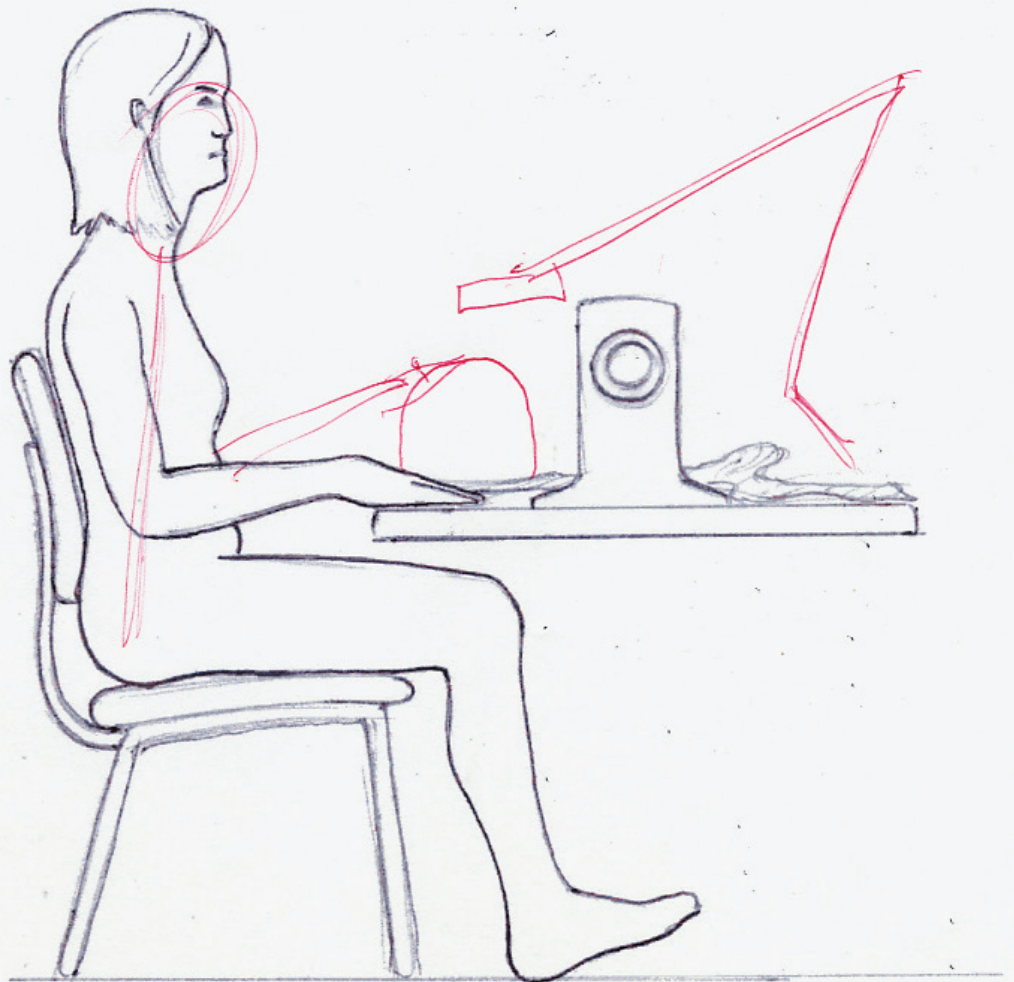
posture / work flow / workstation analysis

- pull coat from rack.
- turning coat inside out to attach sleeves
- sewing various vents
- place back on racks
- take full finished rack to front of room



posture / work flow / workstation analysis *speciality repair/runs
sewers*

work at very close to face to see fine details of fabric,



Situation Analysis

Besides these tools, the seamstresses were equipped with work stations that had a small inset table and a foot bench running across the bottom (see figure below). The seamstresses sat with their feet elevated on the work bench, with the suit jacket draped over their laps. This allowed them to elevate the garment on which they were working closer to their faces.

Ergonomically-speaking, the workers' situation was less than ideal from the outset. The elevation of their feet was creating a closed angle, less than ninety degrees between their trunk and legs. The workers also tend to lean forward with their back and neck to see the fine work they were doing. Sitting in this manner for extended periods is widely considered detrimental to the human body, the back, and especially, the neck. It is also a common problem among garment workers in general. Neck and trunk flexion, as well as repetitive shoulder abduction are major risk factors in sewing table tasks (Harrison MD 2000, 29).

A second major issue was with these worker's posture and the manner in which they held up the garment. The free hand grasped the garment, where it is was being sewn while the dominant hand wielded the needle and thread. This resulted in prolonged contraction of the neck and shoulders, both of which caused static muscle load resulting in fatigue.

Repetitive static muscle load can lead to micro-trauma in the concerned muscle groups. Sustained micro trauma can gradually lead to what is referred to as Cumulative Trauma Disorder (CTDs) of the muscular skeletal system. CTDs manifest themselves as soreness, fatigue, numbness, tingling, and general pain to the affected areas (Karwoski 2003, 123).

I realized there was a large opening in this scenario of the hand sewers for some kind of a work surface solution. Something could be designed to assist them in the task of supporting the garment they were working on, while addressing the human factor concerns associated there with their posture and positioning.



Situation Analysis

Design a work surface solution for hand sewers at Hickey Freeman that addresses negative aspects of worker's stations:

- Neck and trunk flexion (closed angle between the legs, spine and neck)
- Elevated feet, workers are effectively bound to workstation



Situation Analysis



- Prolonged contraction of the neck, shoulders and arms, static muscle load (Karwoski, pg123)



Section 2 Process and Protoypes

User Testing: Overall Results

Extended Context for Testing

My original intention was to do all my testing with the actual users at Hickey Freeman. However, after my second trip to the factory to test my early prototypes, I realized this wouldn't be practical.

I was only granted access to one worker, Venice. Hickey Freeman proved to be challenging as it was a busy company and they were not asking me to be there. I had to be bold in approaching them to do the research in the first place, but there were limits as to the resources they were willing to grant me. My initial feedback was limited as it was with only one worker. As it turned out, she was quite resistant to my interventions. I knew I had to find more test subjects.

Thinking of users who had a similar skill set, I approached local tailors. This worked out very well. They possessed the same high level of proficiency in hand-sewing and some of them had worked with Hickey Freeman in the past.

I also included students in the test. They were unbiased in that they did not have a set of work habits, nor did they have special skills related to sewing. Although their feedback was ultimately less valuable, they provided a neutral perspective which balanced out my testing group.

User Testing: Overall Results

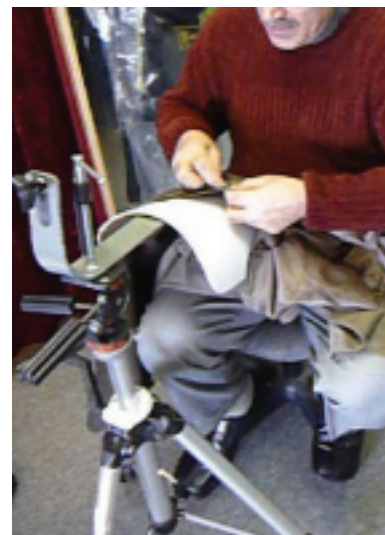
The first round of testing was carried out with the three basic designs pictured below. Testing was performed with a worker from Hickey Freeman and local tailors, as well as with the students pictured. Testing was documented with photo, video, and written notes.



prototype 1
prosthetic work surface



prototype 2
cantilevered work surface
gentle radius



prototype 3
cantilevered work surface
tight radius



Venice was my primary test subject, as I was granted access to her at Hickey Freeman. Venice preferred the early version of **Prototype 2** pictured here. She viewed this prototype with ambivalence and did not prefer it to no work surface at all. The length of time tested was insufficient to determine whether she perceived this intervention as an advantage.

User Testing: Overall Results



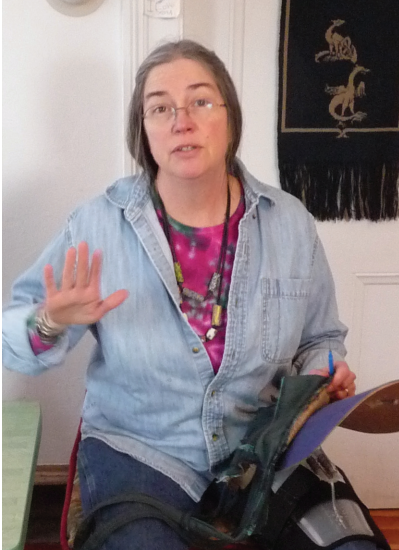
Sasha was a local tailor who emigrated from Turkey. Sasha **preferred Prototype 2** pictured here. She said it was more comfortable than Prototype 1, which strapped to the leg. She had worked for Hickey Freeman previously and felt version 2 was the best for the fast-paced piece work they do there. I viewed Sasha's feedback as biased, as she made the point many times that she was a certified tailor and viewed her own skills as being of a higher level than the factory-trained seamstress.



Ishmael was a local tailor who also emigrated from Turkey. Ishmael **preferred Prototype 1**. He had a very strong affinity for the prosthetic, finding the shape and curve of the work surface much more conducive to the motions involved with sewing seams by hand. In addition, he also seemed to relish the fact that it moved with the body and adjusted as he adjusted. He preferred Prototype 3 over Prototype 2 as it shared the work surface of Prototype 1.

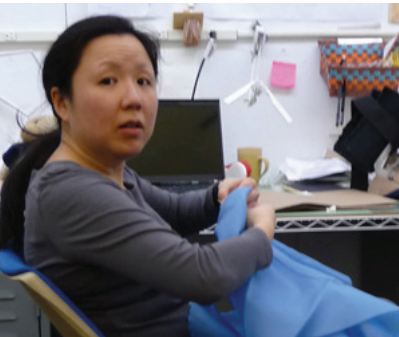


Gullu was a local tailor who also emigrated from Turkey. Gullu also had a very strong affinity for the prosthetic, finding it very convenient. She said it was very comfortable and thought it would be great for a tailor shop environment such as her own. This was in part due to its compact size and the convenience she saw in being able to take it on and off as needed. However, Gullu ultimately **preferred Prototype 2**. As it turned out, she had worked as a hand seamstress at Hickey Freeman and felt this intervention would be the right one for the workers there. One reason is that Prototype 2 accommodated a number of sewing operations. In addition, the batch work the seamstresses perform, sewing one coat after another, requires them to get up and down repeatedly, which could be difficult with equipment strapped to them. Gullu also gave me the excellent suggestion of adding a small tool tray to the front of Prototype 2 to hold miscellaneous tools and items.

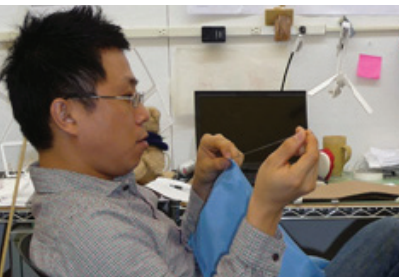
 User Testing: Overall Results


Natalie was a professional Seamstress. Natalie **preferred Prototype 1**. She enjoyed the shape and grade of the convex surface, which afforded the draping of fabric over it. The prosthetic device allowed her to prop one hand on it as she held the fabric and allowed her to work the needle with the other hand. The device brought the work closer into her chest and face, which was necessary in hand sewing.

Natalie had two main points of criticism. Since the prosthetic strapped to one leg, she had to twist her trunk slightly to the left or right to meet the work surface. She felt this twisting would cause pain after prolonged use. Her second point was that because the surface of the prosthetic was covered in soft foam, she thought she might end up sewing the fabric she works on to the work surface itself.



Shen Lin was a student at RIT. Shen **preferred Prototype 1**. The prosthetic allowed her to sit in an upright but relaxed position as she sewed. With the prosthetic attached to her body, it allowed her to easily change positions without having to adjust the work surface. With Prototype 2, she felt she was forced to conform to it, leaning over it like a work table. She said this position would be uncomfortable after many hours of work.



Chong-Yoon was a student at RIT. Chong-Yoon **preferred Prototype 1**. He felt it was more natural to the way he sewed and helped support the fabric. However, Chong Yoon felt it only provided a small advantage to no surface at all. He found prototype 2 to be constraining, making him feel pinned in his chair.



Sarah was a student at RIT. Sarah **preferred Prototype 1**. She also liked the more relaxed work posture Prototype 2 afforded. She stated that women's bodies moved differently than men's, and this model felt intuitive in that regard.

Prosthetic Prototype

As it happened, my contact at the factory had arranged for me to work with just one hand sewer, Venice. She reacted with giggling aversion when I demonstrated how the device worked. She was quite reluctant to try it on. Eventually, Venice relented, but I felt she was only playing along, understanding that I at least needed to photograph her with it on.

The experience was quite discouraging, but given the circumstances, understandable. I was essentially a stranger to her. Further, the device I was offering had a somewhat intimate and unusual relationship with the body. Venice's unfamiliarity with me made her less likely to consider any solution that I might offer, let alone one that breached the boundary of her personal space. Where issues of embodied cognition are concerned, if there is to be true embodiment at all, a certain level of intimacy between human and object or human and system is presupposed. To achieve a level of openness and feedback between myself, Venice and these prototypes, which was necessary for generating the appropriate embodied and transparent solution, more time to build these relationships would be needed. Luckily, over multiple visits to the factory our rapport grew, as well as her candidness and openness to my design interventions. In the end what also added to the development of a solution was the more forthcoming feedback coming from users who had less at stake in the project's outcome.

This photo belies Venice's desire to have the device removed from her as soon as possible.



In-depth Analysis of Process and Prototypes

Prosthetic Prototype

After leaving Hickey Freeman on my first visit, and having identified my possible user group, I had fuzzy notions of a device that would cancel out the closed angle of the worker's body. This seemed a natural and somewhat obvious response; design a device that replaces the function of the worker's elevated leg.



I saw this as something that could attach to the worker's leg, as an extension of the leg, allowing her to work in the manner that was natural to her and natural to hand sewing. This type of work was intimate and was accomplished most effectively by being brought in close to the body. A device such as the prosthetic I was imagining could preserve this aspect of the work.

A cheap plastic pitcher provided a quick and easy platform from which the work surface could be built. When sliced longitudinally in half, the pitcher's cylindrical shape fit snugly around the upper leg. The initial prototype had a work surface which was also cylindrical for simulating the shape of the leg; the work surface the seamstresses were already working over.



After some testing among my fellow students and myself, I decided to refine the prototype further before bringing it to the workers for testing. The next version included a Velcro strap and some added cushioning where the device met the leg. The strap added obvious stability, and kept the device from sliding or rotating around the leg when weight or force was applied to the device off center. The added cushioning and fabric also kept the device from slipping and prevented the rigid plastic from digging into or pinching the leg.

The first testing of this device was on my second trip to Hickey Freeman. I was expecting to test it with several seamstresses, and was prepared to spend the better part of the day at the factory.



Prosthetic Prototype

Natalie (pictured above), my next test subject, was the first of these other users. She was an independently employed local seamstress with at least 20 years of experience. She found this prototype to be potentially quite useful. She did note, however, that the device being on one leg caused her to twist her trunk slightly, which she said she would feel in her back after an hour of work. She also made the excellent observation that having a soft fabric or foam layer as the work surface proved to be problematic in that the tip of her needle was catching it. She felt she would end up stitching the fabric to the soft surface.

Prosthetic Prototype

Ishmael and Gullu, both local tailors (pictured left), responded best to this prototype as well. In particular, they both cited the way the fabric draped over the convex work surface as a positive feature. Ishmael stated, “Design...shape is good. Look how nice,” referring to the quality of seam he sewed using the device. He liked how the device fit to his body, and how it moved when he moved. Given that the prosthetic acted as an extension of the lap, the tailors seemed to adjust to using the device almost instantly.

Gullu felt it would be very convenient. The device is quite compact, which is perfect for a tailor’s shop as they are often quite small. Further, the device could be taken on and off quickly and easily, then stowed away when not in use.

She did, however, have some important criticisms for this prototype. By serendipity, it happened that Gullu had worked at Hickey Freeman for nine years, but had recently quit to open her own tailor shop. She had actually done the hand sewing I was designing for and pointed out that the sewers get up and down each time they finish an operation on a jacket. On a busy day, they may get up and down as often as every 10 to 15 minutes as they return and retrieve jackets from a rack; a fact I overlooked in my enthusiasm for the design. This would obviously be uncomfortable and awkward with a device strapped to your leg.



Prosthetic Testing Summary

Pros

- Is artificial extension of the sewer's knee, allowing for intuitive adjustability
- Transfers closed angle of the body to the prosthetic
- Off-loads holding up of garment from body to prosthetic
- The device preserves a body positioning that is natural to hand sewing, increasing the likelihood of transparency in use
- Curved convex work surface affords draping of fabric



Cons

- Device being attached to the body is inconvenient as workers get up and down every ten to twelve minutes.
- Soft foam covering of work surface is inappropriate material as needle would have a tendency to catch the surface.



Armature Prototype



Developing the prosthetic prototype begged the making of a counterpart not directly attached to the body. These armature prototypes were easily worked up out of a steel armature with work surfaces attached. The steel armature was clamped to a camera tripod, allowing it to be easily deployed and adjusted to various bodies. Based on the feedback of seamstresses, two surfaces were eventually developed; one cylindrical and leg-like and the other with a more generous, gently curving table surface. In the end the leg-like surface won greater favor and was deemed more suitable to the draping of the suit coat over it.

Important, specific feedback for these prototypes came from the tailors. Both Gullu and Ishmael felt the leg-like shaped work surface was the right form for draping the fabric. The shape and size also made it right for pulling in close to the body, and working in a manner close to hand sewing without any surface.

As an aside, I was quite lucky to have come across Gullu as a test subject, because of my limited access to the workers at Hickey Freeman. Even though I had performed a task analysis of the workers at the factory, my time there was limited. I had forgotten about this aspect of their work in my own enthusiasm for the prosthetic device. This incident highlighted for me the importance of being thorough in a situational or task analysis of a design audience. After collecting your initial research, keep your own biases in check by considering as many perspectives of a situation as is reasonable throughout the design process. Perhaps this is stating the obvious, as the widespread use of user testing and tools like interviewing evidences. Collecting information and differing viewpoints, however, is one thing; fully exploiting them is quite another.



Armature Testing Summary

Pros

- Convenient for factory setting where workers get up and down frequently
- Transfers closed angle of the body to the prosthetic
- Off-loads holding up of garment from body to prosthetic

Cons

- In the Device not contacting the body it loses its intuitive and active adjustability



Hybrid Prototype

After the testing of the prosthetic style and armature prototypes with several seamstresses and tailors, it became clear that a third prototype combining the useful qualities of both was necessary.



Many of the tailors and seamstresses found the prosthetic prototype to be very convenient and natural for hand sewing. However, due to the fact that they get up and down every 10 to 20 minutes, depending on their speed and the amount of work waiting, to place the jacket they were working on to a rack and to get the next jacket, a device that attaches to the leg projecting outward from the body would prove awkward in a standing or walking position.

On the contrary, there were two qualities of the prosthetic I wanted to preserve. One was the natural adjustability of the device for which the tailors responded. It moved when they moved, as if it were part of the body. The second was how the positioning of the garment mimicked the intimacy of unassisted hand sewing. The natural technique of hand sewing was minimally disrupted.

Keeping in mind some useful suggestions from fellow students, I quickly developed the hybrid prototype. The device was designed to rest against the lap; thereby, preserving the desirable qualities of the prosthetic without literally being attached to the user. Instead of being cantilevered out like the armature prototype, the device hinged from a desk or tripod. The work surface could then be lifted up and placed against the lap. The device could also rotate on the horizontal plane where it met the table or tripod. This was necessary as the position of a workers chair in relation to the desk would not always be 90 degrees. In effect, having the device pivot on the horizontal plane allowed for a much greater range of positions for the worker.

I returned to Hickey Freeman for a third time to test this prototype with Venice. Through our interaction over the last few visits, our rapport had grown. The suspicion with which

Hybrid Prototype

she first met me no longer lingered. Venice was the biggest producer among the hand sewers, earning a wage well over \$10 an hour. Any change to her work methods would also mean a temporary loss of wages due to the pressure of the piece-work system. It was understandable that she would be particularly resistant to change.

On this third visit, it seemed her co-workers had also warmed up to my presence. When I came over to test the hybrid prototype, they looked on with interest. Some came over to ask questions or make comments. One woman seemed to reassure Venice, stating that the device was good.

I can't say whether in the final assessment I convinced my end user that the device offered advantages over her methods, but she was at least open to the possibility. She commented, "If the management wants to use this, then we have to try it out and get used to it for several weeks." That is as fair an account of the situation as I could expect. I can certainly show through demonstration and analysis that my design intervention showed significant advantage and improvement over the current methods and workstations at Hickey Freeman. To prove it irrefutably would require a prolonged trial and study of the device within that work setting. Obviously, that is beyond my means as a single Industrial Design student, and beyond the constraints of the project setting of Hickey Freeman.

Hybrid Testing Summary

Pros

- Incorporates fluid adjustability and rich feedback of prosthetic with out being literally tethered to the leg
- Longitudinal angle change incorporated into worksurface allows for better draping of shoulder seam and support of the necessary hand postions

Cons

- Setting intial angle and height of worksurface happens at two points resulting in a counter intuitive and overly complicated interface



Precedents and Prototypes

It seemed to me, when starting this project, that I had discovered a rather wide-open niche for the design of a product without much precedent. As it turned out, this was not entirely true. Perhaps in eagerness to pursue my initial design ideas, I hadn't bothered to do a proper market or historical research.

Looking back, though, a little ignorance of a subject can also be liberating. Without preconceptions and existing solutions clouding the imagination, the mind was unrestricted and approached a problem with a fresh perspective. Of course, proceeding with incomplete information one runs the risk of reinventing the wheel.

About half way through my design process, someone made an interesting correlation. After viewing my prototype, this person noted how older tools were brought in and used close to the body, unlike modern day electrical tools which tend to be kept at a safe distance from the body. They suggested I look at old hand tools used in leather tooling and textile crafts.

Doing some digging around, I came across a curious book, *The Tools and Toys of Stitchery*, by Gertrude Whiting, published in 1928. Miss Whiting, a scholar of textile arts and a sewing enthusiast, traveled the world extensively, collecting and documenting sewing tools and documenting techniques.



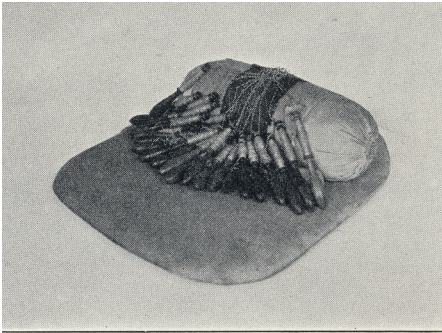
Right: Cingalese women making lace
(image source Whiting1928)

Precedents and Prototypes

I was pleasantly surprised to find a strong precedent for my own designs in the lace-making pillows of European tradition. The pillows were just that, semi-hard pillows which sat in the lap. A few were made of woven reed, quite like an inverted basket. They all, however, had the same function in supporting the intricate lace patterns women were working on. The surfaces were semi soft so the needles and pins could be stuck into them. The forms sat in the lap or very close to the body on a stand called a horse.

There were also modern parallels to my own design that served a similar function, and are mentioned here. There was a device called a sewing ham that was the same size and shape as a cooked ham. The rounded ham served as a supporting form for a section of a garment to be draped over, aiding in sewing, or

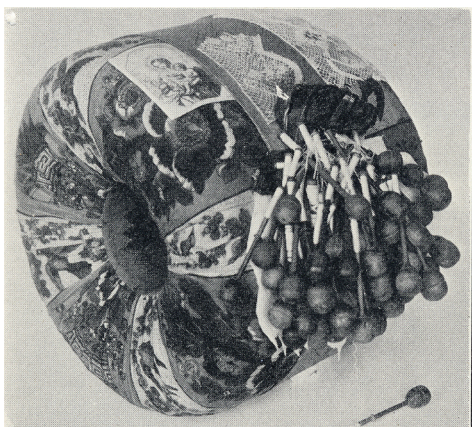
Clockwise from right: Old woman in Tignes, France using wicker lace making pillow, lace making pillow with horse, flat lace making pillow



Precedents and Prototypes

more commonly, pressing. Another commonly used piece of sewing equipment was the dress form, which was in the generalized shape of a human torso sitting vertically on a stand. It was used in garment construction for draping and sizing.

None of the examples I mentioned could stand in for the device I've created without significant alterations; alterations which would basically constitute the design of a new object. However, the lace-making pillows of old, in form and in the technique they afforded, made a strong case for the evolution of the sewing work surface such as the one I have arrived at.



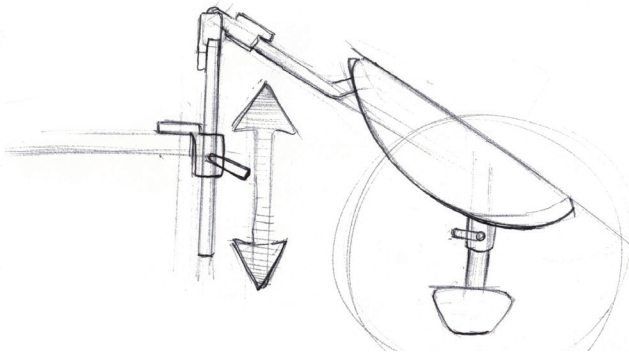
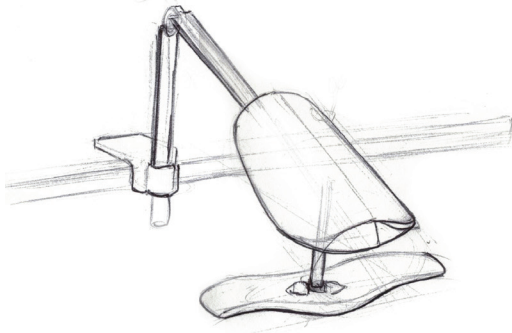
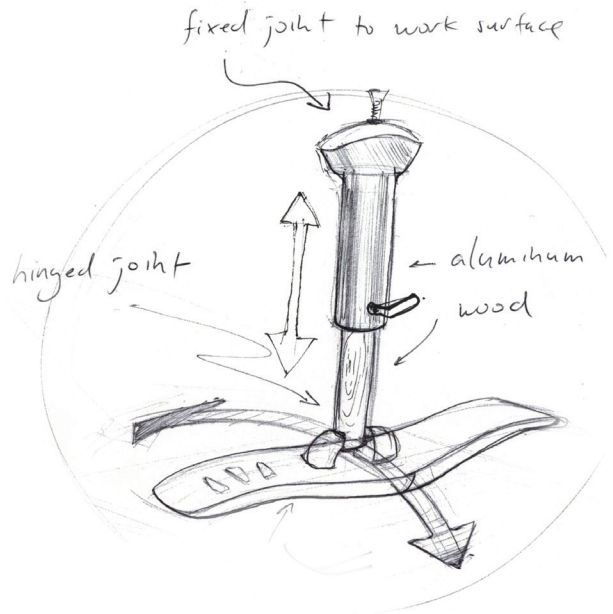
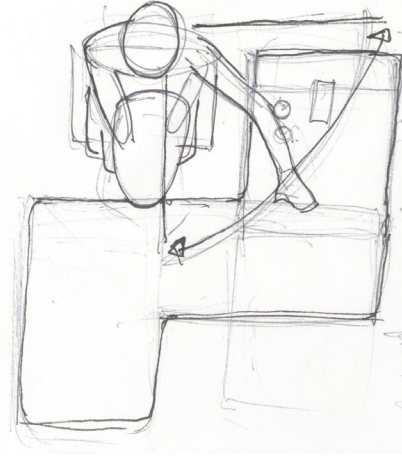
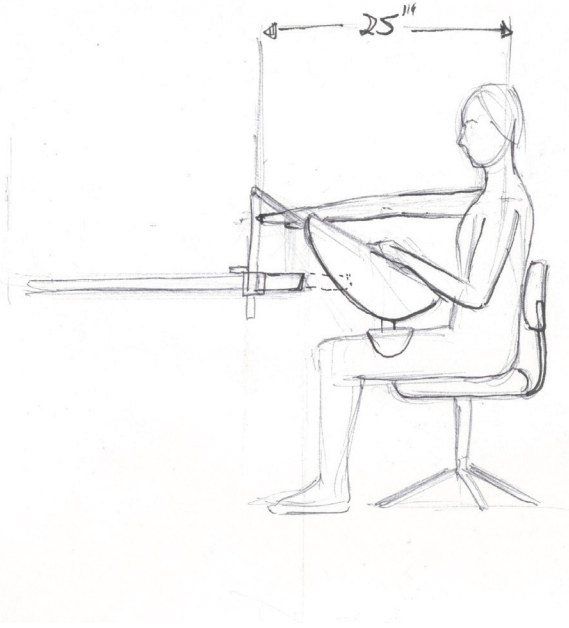
*Above: Cylinder lace making pillow and
Tailor's Ham*

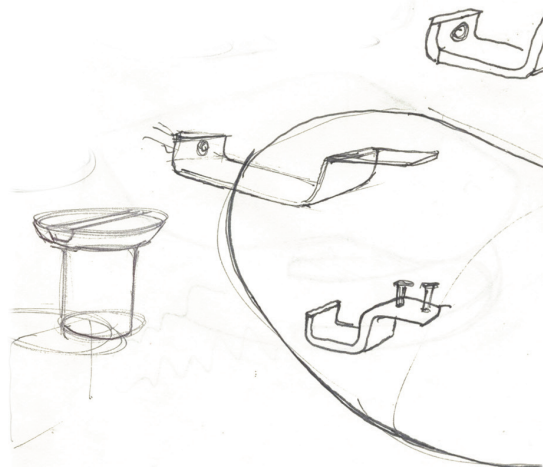
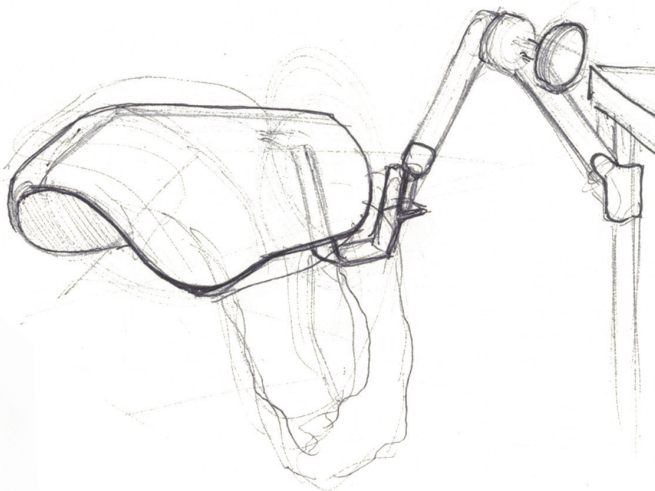
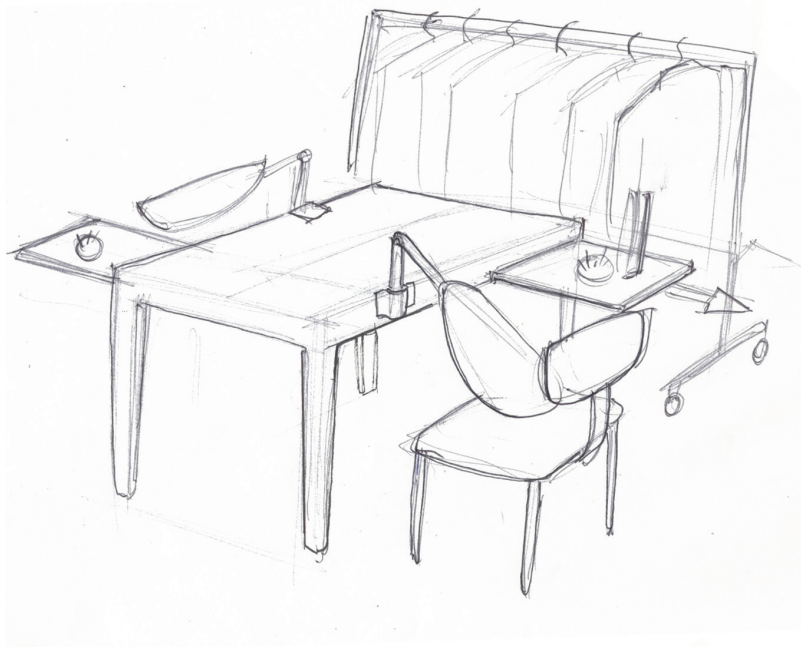
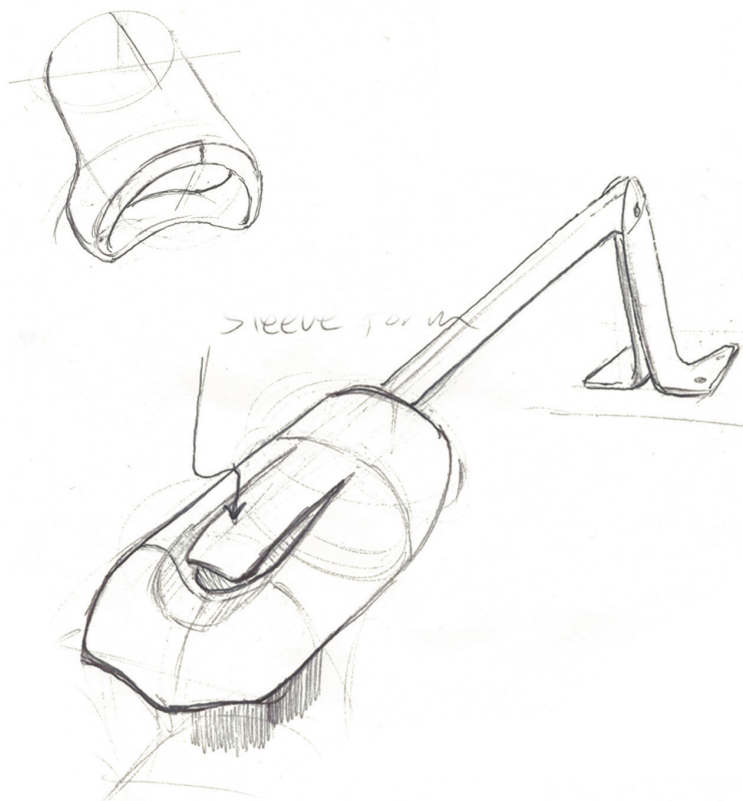
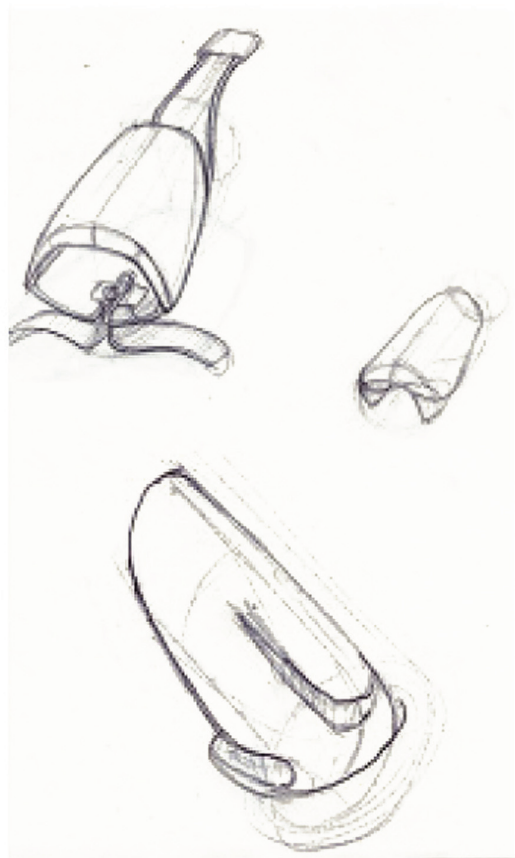


Above: Adjustable dress form

Process Sketches

% women 25" reach





Section 3 Re-evaluating Design Criteria

Excerpts From Interviews and Analysis

As my access to Hickey Freeman employees was somewhat limited, I managed to interview four people. I spoke to two seamstresses, as they were my end users. It was imperative to understand their perspective and their attitude towards their work. I also spoke with two people in management who were directly related to the functioning of the workers on the floor. Speaking to both management and the seamstresses gave me a full scope of the activities that comprise the hand-sewing unit at Hickey Freeman, as well as an idea of the steps taken by all parties involved to ensure productivity, safety and contentedness of the workers. Also understanding how the rapport between the workers as a group contributed to their functioning was a key criteria that gradually emerged. Further, how their current equipment helped to structure and enable their functioning was an issue that informed much of the thrust of this thesis.

Interview Questions

In the actual interviews, these questions were used as a guideline. While I did make sure to hit on important questions, I allowed the interviews to flow casually and conversationally. The darker text marks the questions, which were more important. Interviews were documented with video or voice recorder.

Questions for Management

- How long of a training period do seamstresses undergo?
- Do you look for workers with prior training in garment making?
- Is there a strict sequence of actions a seamstress should follow, or is there some room within the standardized procedure by which they can adapt their own abilities and tendencies to that procedure?**
- Are Human Factors considerations important to how you maintain an efficient and safe work environment?**

Excerpts From Interviews and Analysis

- **What steps do you take to minimize occupational injury among your seamstresses - ergonomic or otherwise?**
- **What is the average length of employment for seamstresses?**
- **What is the longest employment period of any seamstress currently on your line?**
- What Union benefits do workers receive?
- Please tell me more about your worker recruitment program in Turkey.

Questions for Seamstresses

- What is your country of origin?
- **What skill or trade did you practice there before coming here?**
- **Where do you experience (muscle) pain at the end of the workday?**
- Can you identify any particular movements that are difficult or cause you strain?
- **Do you have the freedom to perform your job in a way that best suits your personal work habits or methods? If you could change anything about the tasks you are asked to perform, how would you change them?**
- **If you could make any changes to your workstation, what would they be?**
- **Do you feel like your workstation is your own, and is this important to you?**
- **Is being paid by piece work good or bad?**
- **Do you feel management is concerned for your well-being?**
- **How important is your relationship with your fellow employees?**
- How would you rate your job satisfaction on a scale of one to ten?
- Are there any other ways job satisfaction could be improved?
- Do you feel you have a future with this company?

Mike

Occupational Safety Manager



“When we change something it slows them down and they get upset”

Mike talking about the struggles of implementing ergonomic changes to worker’s equipment or to their techniques and tasks:

“The problem around here is they’re used to doing it one way, and they get payed by piece work, so when we change something it slows them down and they get upset. Even if they are doing it wrong, they don’t want to change. That’s my dilemma”

Analysis

This was a theme I heard from another manager. Many workers including the hand sewer’s are paid by piece work. Any disruption to their methods by well meaning managers can result in lost wages, as they slow the worker down in the short term. Apparently it is difficult to introduce change into this kind of a system.

Key points

Resistance to change due to piece work system and worker’s habits

John

Head of Productions



“There used to be just a long wooden work bench with ten to fifteen metal chairs running the length of it. No foot rest, very uncomfortable.”

John talking about improving equipment on the production lines:

“Prior to the swivel adjustable chairs and the metal work stations with the foot rest, there used to be just a long wooden work bench with ten to fifteen metal chairs running the length of it. No foot rest, very uncomfortable.”

John goes on to say:

“At one point I played around with a special table with a crescent shape cut out of it, and a padded rail to rest their (hand sewer’s) arms against, but they complained that this or that got in their way. You can come up with a solution but try to get it under them (gesturing, under their bodies)”

Analysis

Apparently change comes slowly to some areas of the production line. It took many years just for to get the current work benches and task chairs. Also there is a lack of specialized equipment for what is a very specialized niche of production. If a specific solution to a work station is offered up it may not be readily accepted.

Key Points

Slow change

Lack of specialized equipment

Venice

Seamstress, Hand Sewing



Venice talking about why she likes the hand sewing job and why she has stayed in that position so long:

“I don’t like the machine, when I came here I told my supervisor I’m scared of machine, I can’t control the machine, so I like to work by my hand.”

Venice speaking about her job satisfaction;

“My kids are not at home my husband is not at home, if I stay home I feel sick, I just feel sick. Here (Hickey Freeman) I see the people I work with and I’m... busy. At work I feel good.”

Analysis

Venice much prefers the control over her own actions afforded by the hand sewing work. The machines she encountered remained opaque, unlike the needle and thread which perform as an extensions of her.

Venice values her time at work, she feels productive and seems to enjoy the social aspect.

Key Points

Prefers intuitive easily controlled
(transparent) tools

Importance of work and its social aspect for
her contentedness

“I’m scared of machine,
I can’t control the
machine, so I like to
work by my hand .”

Zahara

Seamstress, machine and hand work



“Like me they all don’t speak english well, so sometimes we use language with the hands to communicate, however we can, because we have to for our jobs”

Zahara in response to the Question “How are your relationships with your coworkers?”:

“Over here (Hickey Freeman) a lot of different people from countries come here, so we don’t always say hi. Like me they all don’t speak english well, so sometimes we use the language with the hands to communicate, however we can, because we have to for our jobs”

Zahara in respond to the question “ You are paid by piecework is that a good system?”:

“Yeeaaaah, at first it is a little scared, you don’t know can I make it or not (the work quota), but after that you just know that you can do it, you do your best. You are used to it and you don’t worry. But then I go home and sometimes I’m doing everything fast fast fast...(laughter)”

Analysis

The social aspect of the work is important for Zahara in terms of cooperative work.

Zahara expresses some stress over the piece work system although she has become accustomed to it.

Key Points

Importance of social aspects for cooperative work

Pressure of piecework system

CHALLENGE



habits of workers
&
pressure of piece work
create **resistance to change**

OPPORTUNITY



habits of workers
&
pressure of piece work
require a **transparent solution**
that worker can easily adapts to

FURTHER OPPORTUNITIES

- 1 create a solution that can enhance social aspect of work
- 2 a lack of specialized equipment

Activity Analysis

An Activity Analysis is a tool I synthesized by bringing a Human Factors task analysis into the context of Activity Theory. A task analysis is a method used to systematically account for all the steps in a particular task. It requires passively observing all the steps a worker goes through in completing an individual task, noting the frequency and order of all actions involved within a given period of time.

Activity Theory, as previously stated, goes beyond user-centered methodologies in that it does not view the user artifact relationship as being isolated to a specific task. Rather, it views the relationship in the large context of an activity. Broadly defined, an activity is the purposeful interaction of a subject with the world. Viewing interactions as activities broadens the scope to include the meaningful social context of an interaction. Activities have motivations, which may not be directly related to immediate goals of someone's actions.

For instance, let's say a man named Bob is a loan officer. Bob meets with clients at the bank all day approving loans. Bob's motivation for the activities comprising a good loan officer may be to represent the interests of the bank. Bob, however, also wants to be a good loan officer to represent his own interest of making money. If we expand the scope of our analysis to include Bob's other personal motivations related to making money, then we can arrive at a deeper understanding of Bob. Looking to Bob's E-bay transactions, we might discover his passion for designer ski-wear circa 1985. Bob is something of a shcuss-meister at the local mountain, and can't be missed whizzing down the slope in his brightly colored ski jackets and jumpsuits featuring asymmetrical geometric patterns.

Suddenly, we find ourselves quite far from the activities of Bob the conscientious loan officer. Nevertheless, Bob's passion for expressing himself through skiwear is a legitimate and important motivation for Bob's good performance as a loan officer, not to mention part of what makes him a colorful and multifaceted human being.

Activity theorists refer to this complexity of human behavior as division of labor. A classic example of this is the scenario of early hunter-gatherer hunting parties (Kaptelinini, and Nardi 2006, 58). The beater is a character who scares up prey by beating or making

Activity Analysis

noise. At first, this seems counter intuitive. If the goal is to catch dinner, then why would someone scare it away? However, if we look at the larger scenario of the hunting party, then we can better understand his role even though it is not directly related to a desired outcome. The beater scares up the prey for the skilled hunters who are waiting ahead to ambush the animal. This scenario expresses the society's capacity to divide labor and an individual's capacity to partake in activities that do not directly benefit their goals or needs.

An activity can be broken down into an action, then an operation. The hierarchy of activity diagram (pictured opposite page) expresses that if an activity has motivations, then an action has goals and an operation has conditions. An action as a lower order step within an activity has its own goals. An action might be Bob goes online to check an applicant's credit scores. This action's goal then is to secure an accurate credit check, which fits into the larger goal of Bob accurately assessing the risk of a loan applicant, which fits within the larger motivation of Bob's doing a good job to secure a paycheck.

An operation, then, is an activity that has become rote, and no longer requires conscious thought. For instance, within the action of Bob checking a credit score, there exist many routine operations such as clicking on a desktop shortcut taking Bob to the appropriate web site. The conditions of this operation might be Bob's routine positioning of his body in relation to his computer and the surrounding physical space.

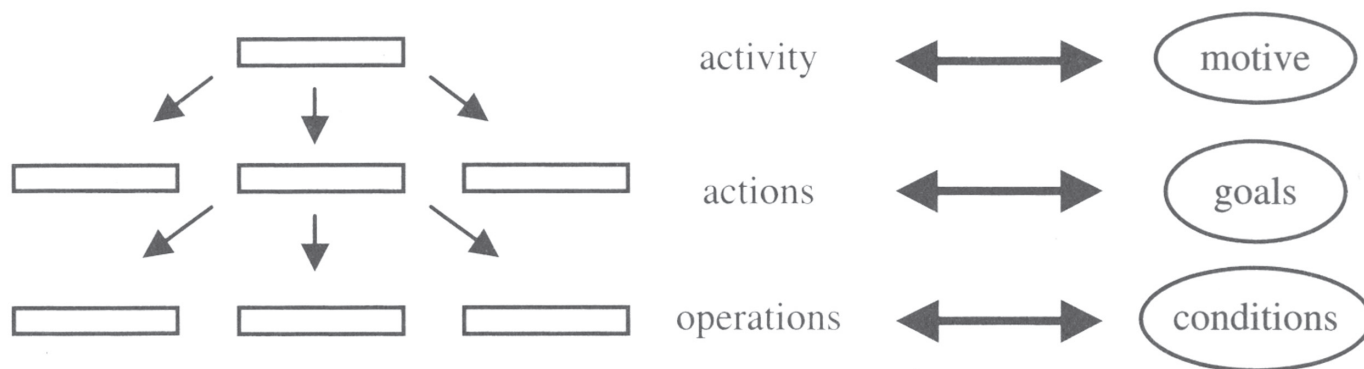
The activity analysis then allows one to explore a task at both a macro and micro level. We can formulate the significance of the task and the tool in light of the larger social context of an activity. Also, the individual steps of the task can be analyzed at a closer scale to determine what actions should be supported as operations.

Activity Analysis

To Summarize creating an activity analysis can be useful in evaluating the hand sewers of Hickey Freeman in terms of:

- Identifying the motivation of users in engaging with a tool. How do immediate goals relate to larger goals and motivations of a user? This can give us a clearer picture of how the user perceives an object; its meaning and importance.
- By distinguishing between actions and operations within an activity, aspects of the tool that should support “transparency” in use can be identified; in other words, what qualities or part of the tool allows an action to become an operation.

Hierarchy of Activity



*Kaptelinin and Nardi,pg64

Activity Analysis: Activity Level

Activity
hand sewing



Motive
Maintaining a job as
a means to a living

Sub-Motives:

- Work as efficiently as possible at a maintainable pace so as to maximize pay
- Maintain social/work relationships
- With co-employees for personal reasons like enjoyment of work environment and practical reasons like cooperative work
- With immediate supervisors as they monitor your performance



Activity Analysis: Actions Level

Actions
hand sewing task



Goal
sewing of suit coat lining
body to sleeve

Steps within overall action:

Step 1 - Coat is retrieved from clothing rack adjacent to the work station.

Step 2 - The worker reads the code associated with the jacket and enters it in keypad terminal at her workstation.

Step 3 - Now seated, the worker drapes the jacket over her lap with the interior exposed. The jacket shoulder is held by the free arm while the shoulder seam is clenched with the free hand. The dominant hand sews the seam with thread and needle. This step is repeated for the other jacket shoulder.

Step 4- Close out the jacket number in the keypad terminal.

Step 5 - The worker returns the coat to the rack and retrieves another.

*This whole process takes 8 to 12 minutes depending on the speed of the worker.

Operations
sewing of seam



Conditions
Routine positioning of the
body, tool, and garment

Step 3

I have categorized finding a comfortable position in the chair; the positioning of jacket in relation to the lap and hand; along with sewing the seam as operations due to their very routine nature. Once a skilled seamstress begins to make their passes with the needle with the thread skillfully finding the path of the seam, a level of thoughtless operation is reached.

Activity Analysis Summary

To summarize, the activity analysis was useful in highlighting two important aspects of a design solution for the hand sewers. It shed light on the motivations of the workers, as well as the type of second nature or operational activity a design might support.

In terms of identifying motivations, it became clear that the activity of hand sewing must be connected to other concerns of the workers not directly evident. By applying the hierarchy of activity one can see how larger motivations of an individual overlap particular and concrete activities. This relationship was highlighted earlier by the example of Bob's love of 80's ski gear as being an indirect motivation for job performance. When I analyzed the motivations connected to the hand sewers overarching motivation of performing their job well, analogous motivations such as social relationships emerged. I saw social relationships as being important for two main reasons.

Good rapport with co-employees, or playing nice with others as it is often called, is necessary for cooperative work. In the context of the hand sewers, cooperative work might entail collective problem-solving, or managing the distribution of work amongst them.

The second reason social relationships with co-employees are important is simply for the enjoyment of work and the morale of the employees. A pleasant work environment, that a friendly rapport with co-employees enhances, is obviously beneficial to the prolonged happiness and productivity of workers.

For these reasons, it became obvious to me that the motivation of maintaining relations with co-employees should be included among the design criterion for my project.

The other main criteria for a design solution the activity analysis highlighted was the importance of the design solution supporting the physical orientation of the body that is best suited to the task. Although this criteria was obvious without the activity analysis it allowed me to explore it in a more nuanced way. By dividing the physical task or activity of the hand sewers into distinct steps we can identify what actions should become operations. To reiterate, operations are distinct actions within an activity that should become automatic or thoughtless through practice.

Activity Analysis Summary

At this thoughtless level of activity, a level of pure practice or doing, the tool involved should be like an extension of the body. In a moment of pure practice the tool is not on our mind, but is of it, and is incorporated into the image of the body. The activity itself and its goal then become the object of attention. In the case of the experienced hand sewer, the needle and thread they are wielding should not be the object of attention. They are instead focused on the path of the seam and the relation of two pieces of fabric being joined. The tool should be silently supporting the task.

By distinguishing between an action and an operation, we can determine the steps of a process where this kind of thoughtless practice is reached. The tool we are designing affords effortlessness on part of the practiced user when performing operations. Another way of stating this is the tool remains transparent at the operational level of activity.

“In a moment of pure practice the tool is not on our mind, but is of it, and is incorporated into the image of the body. The activity and its goal then become the object of our attention”

Activity Analysis Summary

Creating an activity analysis was useful in evaluating the hand sewers of Hickey Freeman in terms of:

1

Identifying the **motivation** of users in engaging with a tool;

- Importance of social relationships to productivity and overall work environment

2

By distinguishing between **actions and operations** within an activity aspects of the tool that should support “transparency” in use can be identified;

- Actual sewing of seam should be supported as an operation



Reevaluating Design Criteria

This design process, although having a loose research strategy from the beginning, unfolded in a somewhat organic way. Not only were some conceptual frameworks added as the project evolved, but information collected in the beginning of the project did not come into focus until later in the design process.

This surely had to do with my inexperience in conducting a research and design project, but was also because of the nature of the creative process. What I mean is that problem-solving is never a linear process that unfolds neatly from problem to possible solutions to final solution. We often have to go back and redefine the problem space as design requirements not foreseen are uncovered.

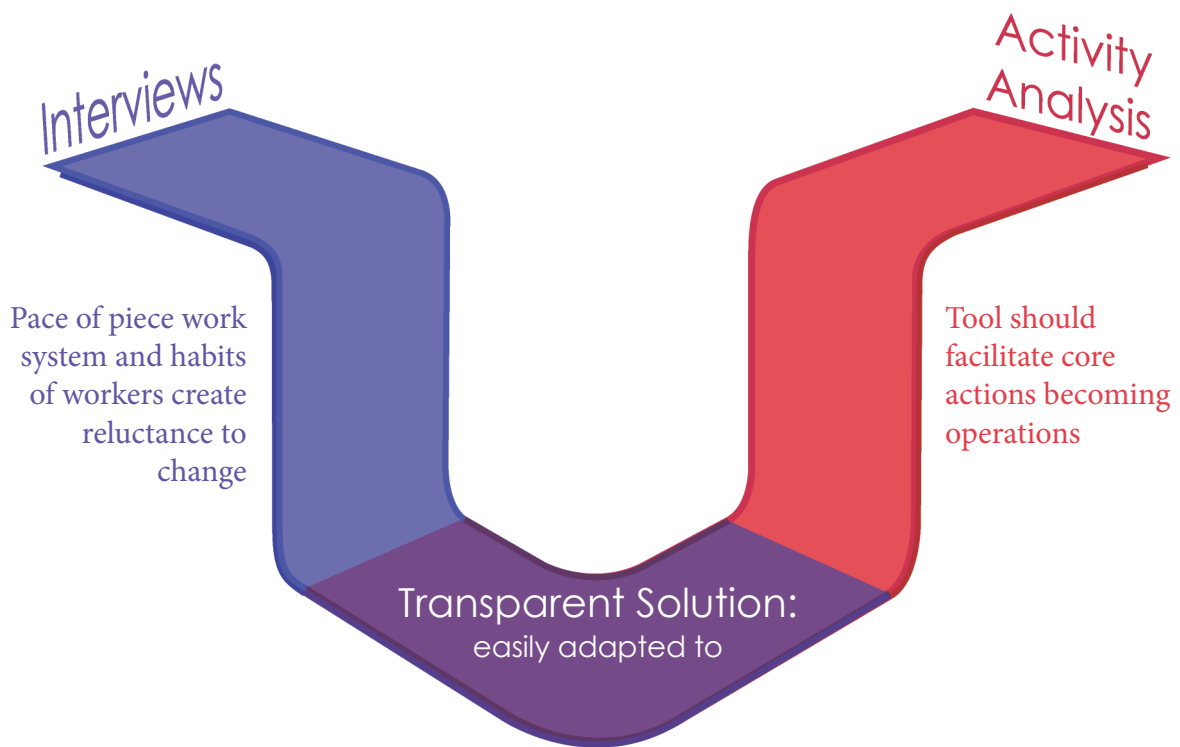


In this project, I was designing a relatively new piece of equipment that was not a direct descendent of any particular design. I could only develop requirements for the design by a process of observation, prototyping, feedback, and prototyping again. User feedback on the prototypes became essential to fitting the tool to that task, and as a real world counterpoint to my designs. Indeed, the checklist of criteria grew and evolved as the project did. I had performed a task analysis in my initial research, and tried to define what needs the object might fulfill. However, it was difficult to consider at all times all the requirements of a work environment to which I had limited exposure. Again, the feedback of expert seamstresses proved invaluable to both reminding me of the oversights and shortcomings of my designs, and in helping to envision what form this new thing needed to take.

In this spirit, I find it necessary here to create an amended checklist of criterion as part of discussing my final design solution. As mentioned, these criteria were informed by my initial analysis of the worker's situation, including interviews, by the users themselves throughout the testing process, and also by evaluative frameworks incorporated during the design process.

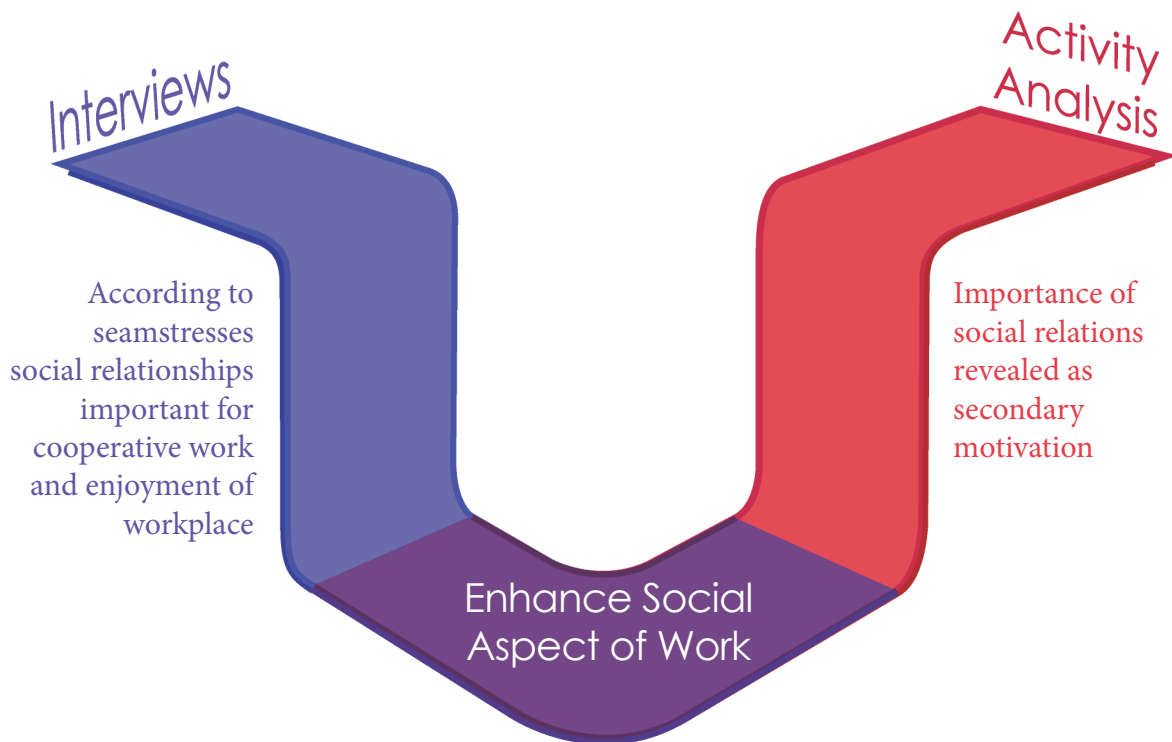
Reevaluating Design Criteria:
Synthesis of Challenges and Opportunities Identified
by Activity Analysis and Interviews

Transparent Solution:



Reevaluating Design Criteria:
Synthesis of Challenges and Opportunities Identified
by Activity Analysis and Interviews

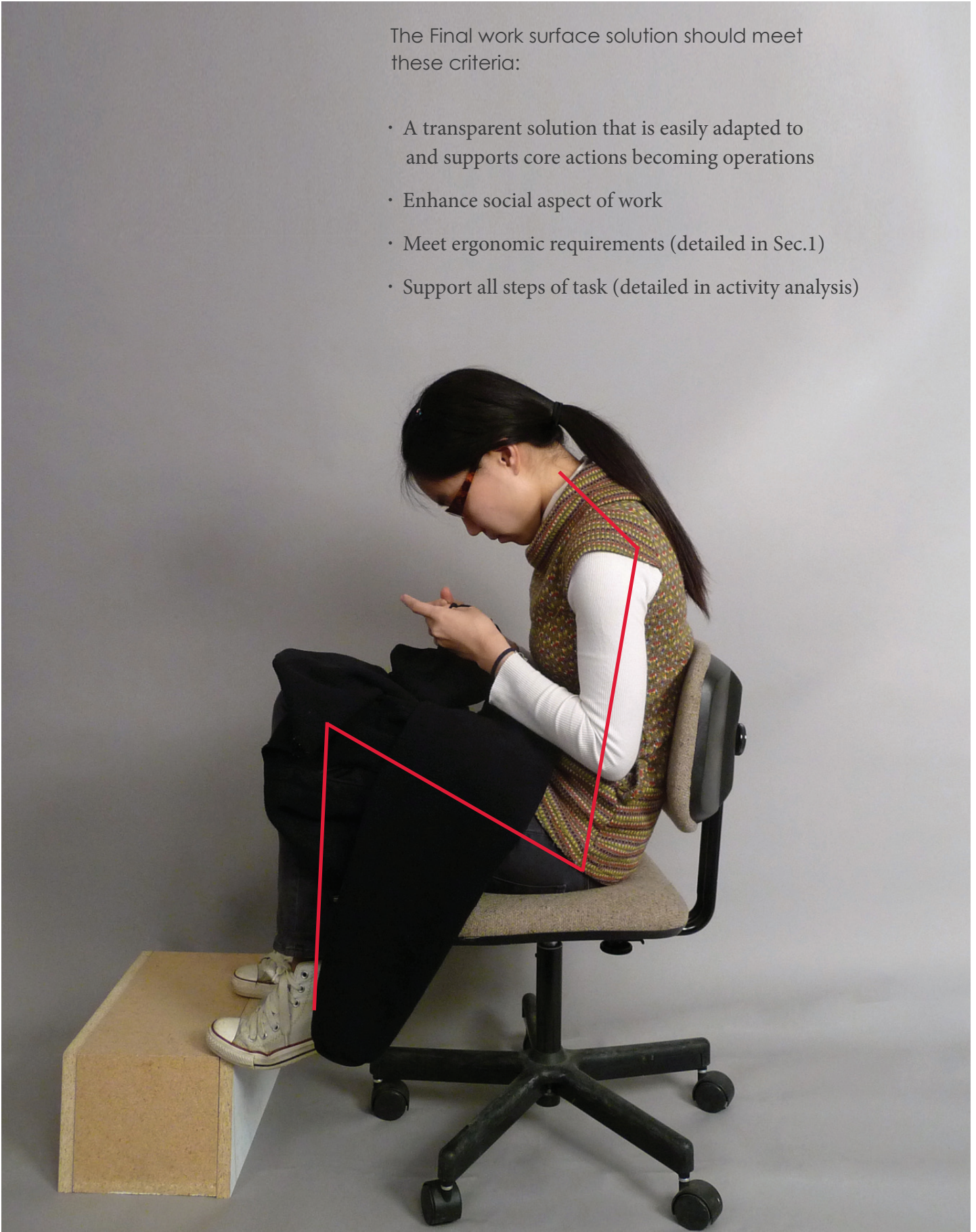
Social Relationships:



Revaluating Design Criteria

The Final work surface solution should meet these criteria:

- A transparent solution that is easily adapted to and supports core actions becoming operations
- Enhance social aspect of work
- Meet ergonomic requirements (detailed in Sec.1)
- Support all steps of task (detailed in activity analysis)



Final Model: A Work Surface for Seamstresses



This final model was a simplified form of the hybrid prototype. The seamstresses would have to work with this tool for long hours. With this in mind, the foot of the hybrid prototype which rested against the lap was removed (pictured below left). I determined it would not provide a significant enough advantage to justify the physical weight it placed against the body. Although the tailors favored the nuanced and intuitive adjustability it provided, it was not justifiable in the factory setting.



The automatic adjustability provided by the foot was made up for with the articulating arm to which the sewing form was ultimately attached. The articulating arm had three points of movement or joints which can all be controlled by a single cam lever or tension adjusting knob; it provided all the adjustment needed for a variety of body types. The movement it provided was fluid and intuitive, unlike the more complicated multi-adjustment points of the hybrid prototype. In ideal circumstances, I feel it would be necessary to test both the Final Model and the Hybrid prototype over an extended period with multiple users to really determine what advantages they each hold.

The design solution I arrived at is a vast improvement on the workers' ergonomic situation, and is justifiable in terms of the enhancement of the task. What is not definitively proved through this project is how well the workers would adapt to my solution over time. The design criteria I defined for the device are fulfilled in terms of the repositioning of the body and the potential for improved posture, work flow, and social enhancement of the workspace, which will be discussed in detail in the following section 4.

It would be gratifying to see how these potentialities would hold up to empirical evidence that would only be possible through a more scientific, prolonged study of the device in use. This kind of testing might be necessary to take this design concept through to a finished product marketable to the garment industry. However, for the scope of this project, I justified my design decisions in a reasoned manner based on real and concrete conditions. Further, I am satisfied with how I've cracked this problem. I won't belabor all fulfilled design criteria here in prose, but will allow the reader to review the design in the images and text in the final design analysis in the following pages of this section.

Final Model



The following ergonomic issues addressed support the transparency of the tool:

- Neck and trunk flexion (closed angle between the legs, spine and neck)
- Elevated feet, workers are effectively bound to workstation
- Prolonged contraction of the neck, shoulders and arms, static muscle load (Karwoski 2003, 123)
- Function of holding up the garment redistributed to the tool

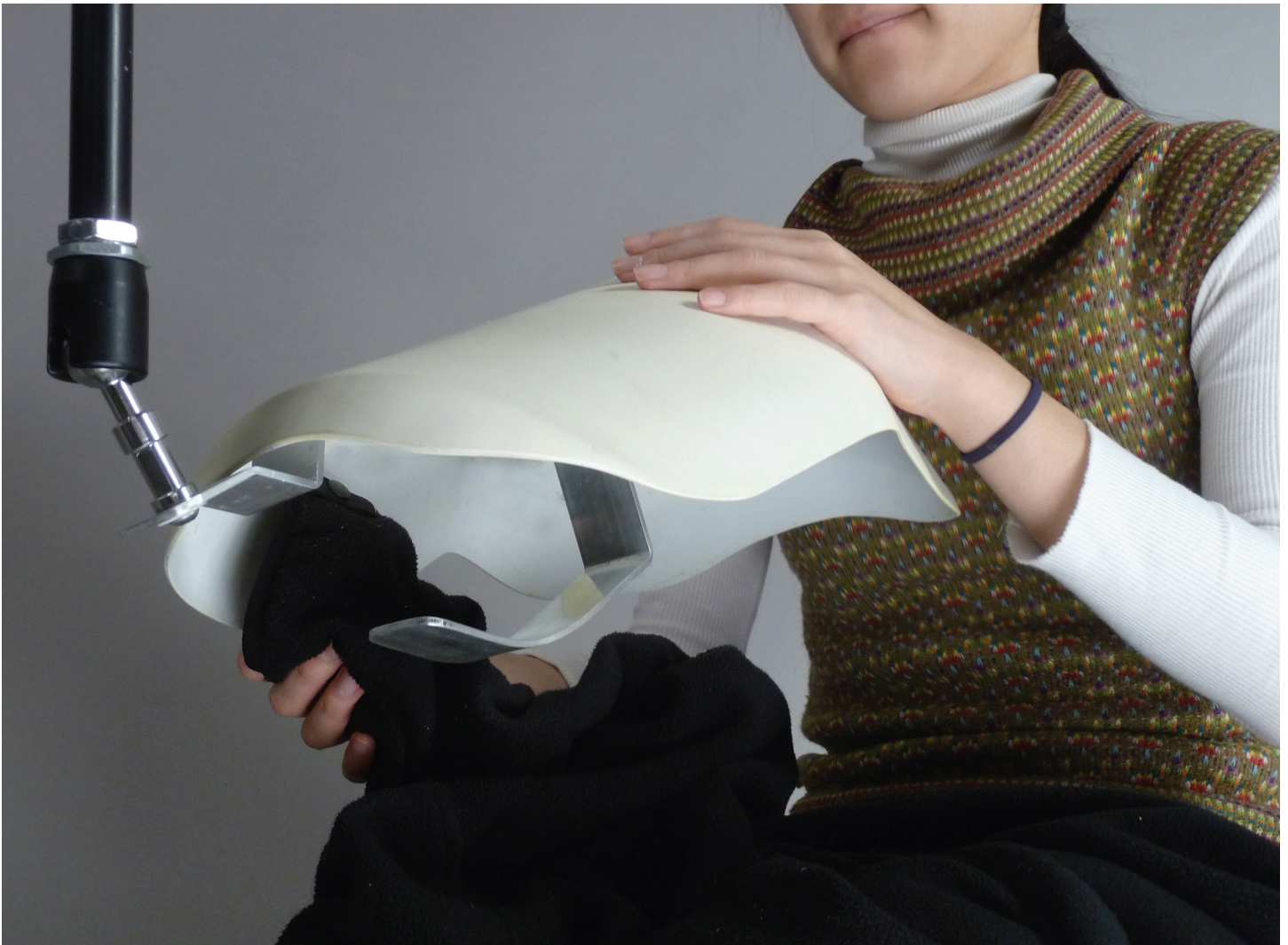


Final Model



Further Features supporting transparency of the tool:

- Easily adjustable to different bodies
- Clip manages excess fabric (dangling coat sleeves)
- Longitudinal angle change of sewing form supports hand positioning that is natural to sewing and is neutral (no ulnar or radial deviation)
- Shape of sewing form fits jacket shoulder



Final Model

The following improvements move towards a cognitive enhancement in the work experience of the seamstresses:

- Workers feet are firmly on the floor (no longer bound to workstation)
- A greater range of postures and positions are opened up to the worker encouraging intercommunication and cooperation between workers; a social and cognitive enhancement
- Having equipment designed to their specific needs, the sewers would have greater control over their task, as well as more opportunities to cultivate their own technique (exactly how my design achieves these ends and how they constitute a cognitive enhancement will be discussed in detail in section 4)
- Having equipment designed around their specific needs, the sewers could perceive an increased value in their skills



Final Model

Visualization of SolidWorks model in use by Shasa, user-testing participant.

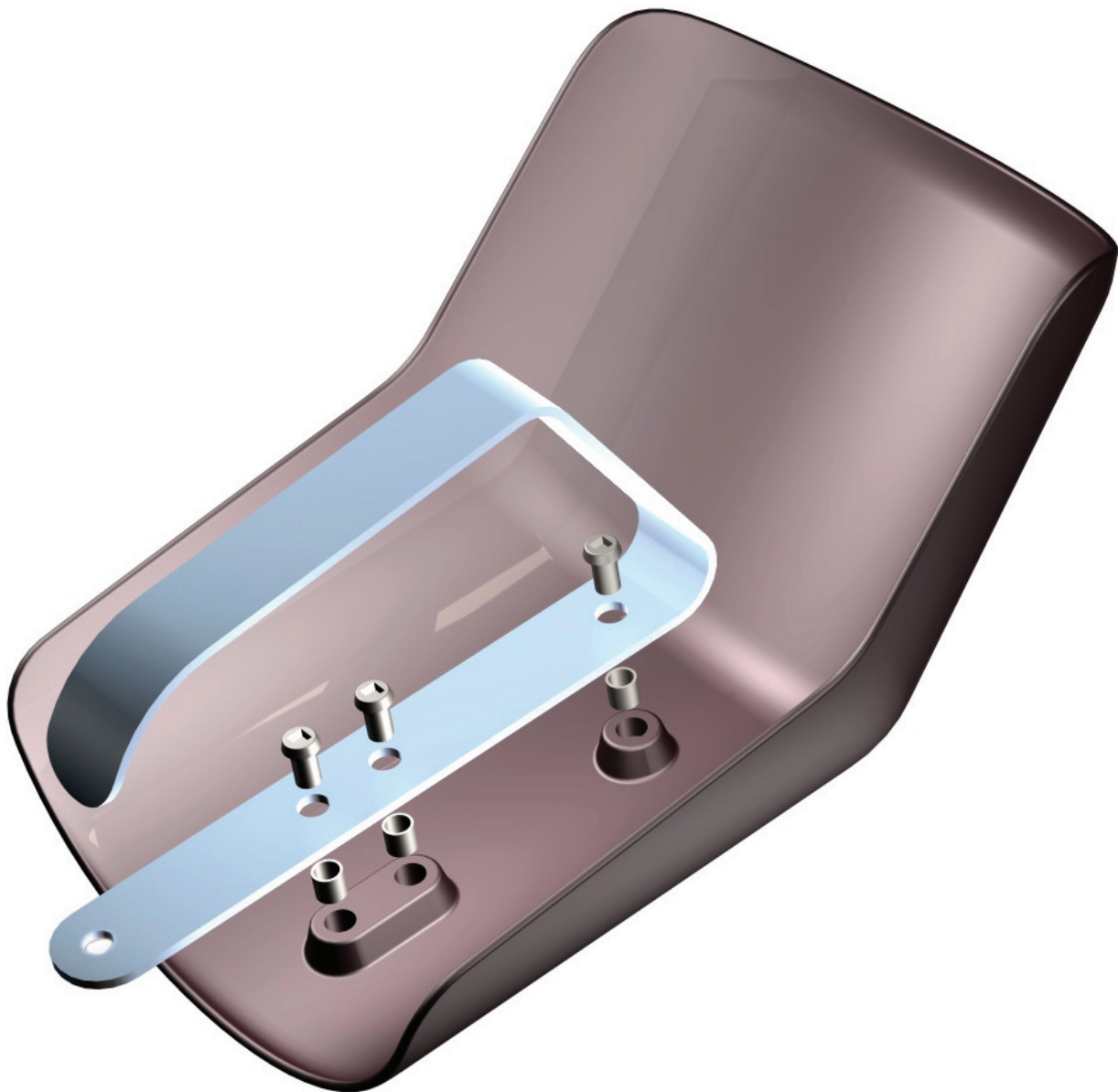


Final Model

Final SolidWorks model exploded assembly view.

Materials:

- Sewing form, injection molded polypropylene
- Fabric clip, 1/8" x 1 1/4" aluminum stock



Section 4
Design as a Cognitive Enhancement

Localized Contexts And Niche Design

Throughout this paper, I've stated the importance of a localized context to my design process. Seeking out a context and doing fieldwork led me to frame a problem and offer solutions I never would have arrived at otherwise.

The kind of concrete observation and collaborative design work doing firsthand user research provides was a vital element in this project. In centering my design process on this niche of local workers, I discovered opportunities that could not have been foreseen. There are many methods of arriving at innovative solutions, but I think starting from the human and their activities and experiences is as good as any. By first seeing the design opportunity as arising from the person and his or her activities, our thoughts are not crystallized around a particular object or existing solution. Another way of saying this is the *problem-space* of a design must be sufficiently defined and considered before latching onto a *solution-form*.

The other important move that was made by starting with a localized context was the specificity of my audience. The apparent novelty of some of my solutions stemmed from the unique situation of this small group of hand sewers. In contrast the predominant way our products were produced in the 20th century was through standardization and mass production. The positive side of this is we could produce products cheaply, thus reaching a mass audience. The negative side effect is that one-size-fits-all solutions are impersonal, can be ill-fitting, and discourage diversity.

In his book, *Our Own Devices*, Edward Tenner states, "One challenge of advanced industrial societies is a degree of standardization that threatens to choke off both new technologies and new techniques. The remedy is a return to the collaboration between user and maker that marked so many of the great innovations, like the shaping of the classic American fire helmet." Seeking out local contexts and user maker collaborations is one way to counter this over standardization of modernism. I think an apt term for this kind of approach is *Niche Design*.

We are starting to see this kind of mentality take hold even within large corporations. Mass customization is a means of

Localized Contexts And Niche Design

flexible manufacturing that can respond to the needs of individual consumers. Companies use platform-based designs which can be customized, giving the consumer greater options and control. This kind of responsive manufacturing has been greatly aided by Computer Aided Design systems, which are directly linked to manufacturing.

When visiting a local furniture manufacturer, Gunlocke, I was able to see this kind of custom manufacturing firsthand. Gunlocke offers a variety of modular furniture system with a generous degree of flexibility. The dimensions of their furniture and the configurations of elements may be tweaked to meet the needs of a specific space. When a customer can collaborate with Gunlocke to tailor their work environment, they are setting the conditions for the kind of human artifact mergers that mark transparent technologies. Sales people can work with customers to arrive at the desired design. These custom designs are then handed over to engineers who program computer-aided milling machines to dutifully carry out the custom cutting and drilling for a specific piece.

Another promising technology that has the potential for responding to the needs of individual users is rapid prototyping. There have already been many small production runs of products which have been 3D printed. Another such technique is laser sintering, which creates a three-dimensional form directly from a CAD model by fusing together small particles of plastic, metal, or ceramic powders.

At the Cornell College of Human Ecology, research is being done to apply three-dimensional body scanning technology for use in the fashion industry (<http://www.bodyscan.human.cornell.edu/scene0037.html>). Again, with the aid of digital technologies, an individual's unique bodily topography can be fed to a computerized pattern-cutting machine. The garment can then be assembled and sent along to the customer, resulting in a tailor-made yet mass-produced item. When manufacturing technology is advanced and inexpensive enough to adapt to the specific needs of individual bodies and persons, then we will have arrived at a true mass customization.

An analogous aspect of localized niche design as I see it would

Localized Contexts And Niche Design

be localized manufacturing. Ideally, both the design process and manufacturing should be flexible and adaptive to ever-changing localized needs and conditions. If designers can work within localized contexts to produce niche designs, then manufacturing could consider localized conditions and resources. As much as possible, manufacturing needs could be met with the materials and resources available and produced within a given geographical region. With wealth and resources circulating within a region, residents would become more responsible for the management and maintenance of their local environment.

From a Prosthetic Prototype To The Prosthetic Notion



A concrete manifestation of the idea of the prosthetic made available by the early prosthetic prototypes spurred me to re-examine the relationship between body and tool, human and machine. By literally being attached to the body, this device was making quite obvious what is often beneath our conscious awareness; that is, how bonded we are with our devices. Our everyday intimacy with the technologies and tools that suffuse our lives can make us quite blind to our deep integration.

When we become so accustomed to a tool, when it does its job so well that it is an extension of the body, it is serving us silently. Why would we question or reflect on the relationship? If, however, we stop to imagine our lives without our innumerable contemporary devices, then it is rather impossible; we always have been, as long as it has mattered, toolmakers and users (Baber 2003, 3).

Transparency is a useful notion that helps to explain our often unexamined relationship with well-designed objects. It is a term often used in the worlds of human-computer interaction and cognitive science. When a tool is being sufficiently and effectively controlled by the user, it can be considered transparent in use (Hollnagel, and Woods 2005, 27). When the tool is transparent, it is appropriate enough to its task and to the body of its user so that it becomes an extension of the user.

From a Prosthetic Prototype To The Prosthetic Notion

An oft-quoted example of this relationship is the common hammer. When one is swinging the hammer to hit the nail, they are no longer focused on it, but rather are seeing through it to the head of nail. However, if a user needs to adjust their grip on the handle of that hammer, their attention is no longer through it but on it, and the artifact is now opaque. Effective tool use involves both modes of use, transparent and opaque (Clark 2004, 49).

“The opening that *the prosthetic* presents, in its transparency is a blurring of the boundary between body and tool, man and environment. The supposed clear boundary between subject and object has been displaced when we get so comfortable with our devices.”

The opening that the prosthetic presents in its transparency is a blurring of the boundary between body and tool, man and environment. The supposed clear boundary between subject and object has been displaced when we get so comfortable with our devices. What we don't always realize is that while we are busy making and using so many devices, these devices are busy remaking us:

“A blurring of identity is produced by all prostheses. They do more than simply extend the body. In a strange way, the body depends on the foreign elements that transform it. It is reconstituted and propped up on the ‘supporting limbs’ that extend it. Indeed, it becomes a side effect of its extensions. The prosthesis reconstructs the body, transforming its limits, at once extending and convoluting its borders. The body itself becomes artifice (Jain 1999, 3).”

The prosthetic offers a powerful dynamic; one that is relevant for product designers whose greatest measure of success may be whether the consumer bonds with their product. It remains to be seen as to the useful methodologies that emerge from the idea of the prosthetic. What might be useful to consider now is the kind of refiguring the things we design present. How do these refigurings of the body effect us physically and mentally? We are creating plastic worlds where the body itself cannot be extricated from this process.

Design as a Cognitive Enhancement

If we regard the relation between a tool and a person as a mere physical event in the completion of a task, we have ignored the individual's volition and self awareness. It seems, in fact, impossible to view the event of a human-tool interaction without considering the cognitive aspect: cognitive aspect meaning the conscious mental activity of the user in question, regarding their encounter with a tool. Even if a task is viewed solely as the coordination of bodily movements in interaction with a tool in order to complete a set of predetermined steps, a thinking and feeling person is presupposed. Any conscious persons then, each with their own set of experiences and their own physical attributes, will experience the same task differently, however subtle or dramatic the difference may be.

Of course, there are many similarities amongst our experiences of a same or similar task. In Activity Theory, these similarities and differences are accounted for by the belief that each human mind is the product of historical and cultural development. That is to say, as an individual develops, she learns and appropriates concepts that already exist in culture. These appropriated concepts are often crystallized around physical objects such as tools. "Elaborate practices for creating, storing, and maintaining tools are the most basic features of mankind" (Kaptelinin and Nardi 2006, 26).

So the use of tools can be thought of as a functional process for the completion of a task, but also as the assimilation of an external set of values into an individual mind. The person then encounters a tool and a process and in learning it they are transformed. Their possibilities for meaningful action are transformed. Let's take for instance learning to drive a stick shift. It requires the familiarization of a complex set of steps, which must be practiced in a certain order. Left foot clutch in, as right hand positions stick in place. Now right foot engages gas pedal while left foot releases clutch fast then slow. Now this set of operations is completed for each gear. As we learn to complete this shifting of gears smoothly and with aptitude, we then integrate a whole number of other behaviors in with these, some necessary to driving, others not. We shift gears as we tackle inclines, round corners, change radio stations, gaze at passing scenery, and carry on conversations with passengers. The brain

Design as a Cognitive Enhancement

handles the coordination of all these events seamlessly, a great deal of it happening beneath our conscious awareness. We are taking an “external set of operations and integrating them deep into our own neural functioning” (CLARK 2004, 94). The car becomes coextensive to our physical bodies and to our brains. It is a marvel how we are able, over and over again, to repeat these processes of integration as we adapt to our ever-evolving environments.

But, what is really at stake for the conscious human subject who reorients himself toward the world via technology? For the car operator there is a greatly increased potential for physical mobility. For the person driving that car, this increased mobility translates perhaps to a new-found sense of freedom and convenience. They can go where they want when they want with speed, comfort, and little physical exertion. They are no longer mere pedestrians, but rulers of the road. The driver experiences an increased degree of control over his environment in terms of his ability to make tracks.

It is easy to perceive and play up the cognitive enhancement of an automobile, in a country like the US where the cult of the car is so robust (Detroit’s current crisis notwithstanding). However, the cognitive enhancement made possible by a tool or technology, is an important aspect of a design to consider. How does a design fit, not just physically to our bodies and to the requirements of a task, but to our sense of self, to our personas? How do our tools extend our capabilities as humans and as individuals?

Project's Potential As A Cognitive Enhancement

If we look at the social context of interaction, uncovering the motivations of users, as Activity Theory suggests, we can begin to paint a profile of meaningful interaction with a tool that goes beyond the physical and mental requirements of an isolated task. Or, to put it in Clark's terms, what kind of meaningful mergers and human-technology hybridizations do the objects we design provide?

To answer this question relative to my own design, I've looked to my analysis of user testing, information gleaned from interviews and the activity analysis, and the actual attributes of the final prototype. I will try to synthesize this information and extrapolate logical conclusions with regard to the type of cognitive enhancements my interventions might provide.

To reiterate, I would like to consider a cognitive enhancement as an amplification of a capability of a human subject, or an addition of a skill or capability previously unattainable, and in this case afforded by a physical device. Moreover, it is not just the amplification of a capability, but how the enhancement may be perceived and exploited by the user. I want to consider how the interaction with a tool may change the seamstress's relationship with her environment. This built environment, the niche of the factory floor in which she operates, affords a certain range of activities, encouraging the ones to which it is best suited. The intervention of a tool or prop into that environment, changes the quality of that individual's relation with the space and the possibilities for action within it. Introducing a tool that mediates the relation of the subject with their environment creates a new world person circuit (Clark 2008, 31). For the seamstress in question, what they think about this tool, and how it has qualitatively changed their experience of their environment, would be of importance in evaluating a device as a cognitive extension. These considerations should lead me to a closer to understanding of the transformative nature of this particular piece of technology.

A good place to start this inquiry will be with an actual person whom the design interventions were created for, Venice. Venice tellingly stated, "I'm scared of the machine, I do not like the machine. I told my boss when I started working here, I can't

Project's Potential As A Cognitive Enhancement

control the machine, so I prefer to work by my hand.” This statement seems made for analysis in the vernacular of human-machine interaction.



For Venice the sewing machine that she was referring to was opaque; she was only experiencing it as an object, rather than experiencing the task through it, the tool amplifying her abilities. One can imagine (if they've had the common experience of being near or operating a sewing machine), how the noisy device with its frantically moving needle and foot voraciously pulled the fabric through its mechanical teeth, with relatively little input from Venice via the foot pedal. Apparently, this was a frightening experience for her. Granted, this isn't a terrifying scenario on the level of Stanley Kubrick's astronaut, Dave, who was systematically shut out of spacecraft operations by the murderous artificial intelligence Hal; but it was off-putting enough that she cared not to become intimate with that machine. Science fiction and everyday human machine interactions are full of these scenarios of a bad fit between human and device.



Donald Norman suggests many of the failed interfaces of human-machine interactions are in part due to it being “a very new discipline with very little past work to guide it.” These relationships need to involve rich interaction, symbiosis, and cooperation for interfaces to be successful in the future (Norman 2007, 173). Of course, Norman is talking about complex digital technologies that provide users with a much wider range of activities and goals. I have just designed a relatively simple analog tool. While my design is obviously not as complex as something like an iPhone with its seemingly endless apps, it is an interface nevertheless. It needed to satisfy an array of movements and actions within the task of hand sewing, while also keeping in mind higher-level activities, such as the interaction of seamstresses. In doing this, it should offer intuitive controls, and rich feedback to enter into a symbiotic relationship with Venice and her work environment. She should feel that she can control the device.

The sewing machine for Venice represented a lack of control. Cognition where work is concerned can be thought of in terms of an operator's or user's ability to control their work and their environment. In the case of the human and artifact interacting

Potential As A Cognitive Enhancement

to achieve an end, they can be thought of as a joint cognitive system (Hollnagel, and Woods 2005, 35). In designing Project's a work surface, I had an advantage over the designer of the sewing machine in that my design entailed no automation of functions; unless one counts the offloading of the holding up of the garment from seamstress to sewing form. In reality, I would consider this more of a relinquishing of one function (support the garment with arms) towards the amplification of another (sewing of the seam). The intervention I was offering also had a more direct and organic relationship to the body than that of a sewing machine; the user is still in total control of the main action which is the sewing of the seam.

The design was not an attempt to disrupt or redesign the hand-sewing method the sewers were so used to. It was more a subtle change to and enhancement of their existing procedures. By offloading the taxing function of holding up the garment onto the sewing form, the design in effect was amplifying their core action, the delicate sewing of the interior shoulder seam of the coat. Taking this advantage into consideration alongside the other secondary actions the design supported, and the ergonomic improvements it entailed, the design was well on its way towards a transparent and symbiotic relation between it, the seamstress, and the environment.

To extend the case for my work surface design constituting a cognitive enhancement, it will be useful to invoke the concept of cognitive niche construction. Philosopher Andy Clark has borrowed this concept from the natural sciences, where it serves to explain how animals actively shape their ecological niche, thus effecting natural selection in further generations of a given species. For instance, beavers create dams that last past their lifetime and are inherited by their offspring. These dams actively construct the larger environment, such as affecting the flow of the river. This changed river flow puts different environmental and selective pressures on the beavers and their offspring. In the case of animals, niche construction creates "feedback cycles that run across evolutionary time" (Clark 2008, 62). In the human realm niche construction has an effect on lifetime learning, where human-built structures and educational practices dramatically alter the landscape of our development.

Clark uses the example of a bartender who arranges his workspace in such a way as to aid his workflow and memory. The bartender inherits an array of different shaped glasses each for

Project's Potential As A Cognitive Enhancement

different kinds of drinks. This array of glass forms can be exploited as visual cues representing the different kinds of drinks he must serve. If the bartender has multiple drink orders, he will often arrange or line up the different glass forms in a way that visually represents the temporal order in which he took the various drink orders. For instance, we can see how an arrangement of pint, highball, and rocks glass, could act as a visual and spatial representation of the order that the bartender took in his head. This visual-spatial array would act much like a cognitive aid to memory such as a written list. The bartender has transformed his inherited cultural practices and the physical structure of his workspace to aid his interaction with his environment, or what we call work. This active exploitation of the built environment brings into being new forms of problem solving and thought, or what can be referred to as “cognitive niche construction.”

To get back to our seamstresses, let us look at how the device I was offering might have aided in a kind of cognitive niche construction. As mentioned before, my work surface afforded greater control over the seam sewing task by offloading the function of holding up the garment onto the form. The design also changed the orientation of the worker towards their larger physical space. With improved posture and greater adjustability in working positions that the device offered, new possibilities for the arrangement of the workspace abound. The seamstress would have new opportunities for exploiting the physical structure of their work environment to suit their individual habits and methods.

Pre-intervention the seamstresses immediate work environment existed as a task chair, work table with foot rest, tools, and garment. The physical orientation they could take was very narrow, as they all faced forward toward their table with legs elevated on the work bench. Post- intervention they now had the possibility of rotating their angle of orientation towards their work tables within an approximately 140° range. Changing their orientation towards their work tables, and towards the work itself, the garment, introduces new options for how the worker might choose to structure the total task.

Workers placed their tools, needles, pin cushion, and strands of thread on the tables in front of them. By changing their angle

Project's Potential As A Cognitive Enhancement

towards the work table, they have new possibilities for how they might arrange the elements on the work table in light of their reorientation. Tools and materials might be arranged in such a way as to aid the pace and workflow of the task. With more possibilities and flexibility between the elements in their work system, more opportunities for individualized practices arise. If a seamstress is actively exploiting this new flexibility of the workspace, creating new arrangements and practices to aid their completion of their task, they would be engaged, in Clark's terms, in cognitive niche construction.

To drive home the claim of cognitive enhancement, let me touch again on the idea of transparency in use. The device I created, in allowing for a positioning that was natural and ideal for hand sewing, in its adjustability to different bodies, and in offering the seamstress enhanced control over the task, was primed for becoming a transparent solution. The scenario I was offering was an improved interface between worker task and environment, from the seamstress's current workstation. I believe the improved orientation of my work surface, through practiced use, would have resulted in a new sense of embodiment. And one in which for the seamstresses the device itself would have faded from view, and they would be left as enhanced agents confronting the world (Clark 2008, 31).

Cognitive Enhancement, Social Aspect

Beyond the advantage to the individual user in performing and structuring their tasks, that the work surface provides, larger motivations interrelated with task performance became important. A repeated theme that emerged from my interviews with the seamstresses was the importance of the social aspect of their work. This same aspect was also evidenced by my activity analysis (as outlined in Sec. 3).

I expanded my analysis of the seamstress's task by applying the hierarchy of activity (Kaptelnin and Nardi 2006, 64). By seeing the worker's goal-oriented actions, their sewing, as nested inside of larger concerns or motivations, such as maintaining relationships with coworkers, a richer picture of the significance of the tool emerges. Motivations which might not seem immediately related to the workers' actions or goals, can be considered as design criteria.

Both Venice and Zahara spoke about the importance of social relations in their interviews. Zahara stated, "Over here (Hickey Freeman) a lot of different people from countries come here. Like me they all don't speak English well, so sometimes we use the language with the hands to communicate, however we can, because we have to for our jobs." It is no great revelation that interaction and communication among co-employees is vital to a productive and creative workplace. In this age of innovation it is a notion we take for granted, but one that is more commonly spoken about in the context of the office.

Concerning workers on a factory line, the importance of intercommunication may seem less vital. From the point of view of scientific management, it was more often viewed as an anathema to productivity. The rationalization of the workplace and increased efficiencies that factories experienced under its principles even extended to the office in the early 20th century. In the office place this meant that all tasks should be standardized to the most efficient method. Under scientific management an office clerk's duties were often reduced to a single task (Forty 1986, 123). Of course, this redesign of work also carried over to the organization of the workspace, and the design of equipment and furniture.

**Taylorian here refers to the father of Scientific Management Fredrick Winslow Taylor, and the work place principles he set forth*

The desk, the most important piece of equipment for the office clerk, underwent a Taylorian* redesign. The high back roll-top desk (pictured next page) was the standard in most offices around

Cognitive Enhancement, Social Aspect

1900. As you can see from the illustrations (featured below), the desk was greatly modernized under scientific management. The pedestal base was removed, then replaced with legs for easy cleaning. The many nooks and drawers of the roll-top desk were removed to keep important documents from been held up or stowed away. And most importantly the high back and roll-top of the desk were removed. This took away the clerk's personal space and ability to personalize his desk.

While this new minimal desk opened up the space between workers and with it the possibility of intercommunication, conversation was seen as a subversion of the principles of scientific management (Forty 1986, 126). Many offices countered this by instituting a silence rule on the office floor. Other offices built wall-like partitions between desks to stem the flow of chatter.

The redesign of the office via scientific management comprised a depersonalizing of the workspace and by extension the worker. Any individuality expressed through a clerk's methods or by organization of his workspace was stamped out. When a clerk's task was reduced to a single activity, such as the typing of a few lines of information on a single kind of insurance form, it seems they were little more than a mechanistic fragment of a person; this at least seems to be the ideal scientific management was promoting. The transformation of the clerk's desk demonstrates how an ideal or an ideology can be embodied in a seemingly benign object.



Cognitive Enhancement, Social Aspect

It may seem like overstating the case, or anthropomorphism, to attribute this kind of significance to inanimate objects. For instance, we may refer to a loved and trusted car as sick, gently patting its dashboard when it expresses audible respiratory ailments (a clogged carburetor). This anthropomorphism is a very human tendency, and perhaps not such a misplaced one. While it is not the objects themselves that should be attributed special properties or made a fetish, the experiences they provide are significant. Our artifacts structure our experiences, and bring new ways of being into being.

To get back to the seamstresses at Hickey Freeman, I would put forth that the design intervention I provided them embodies the inverse of the Taylorian redesign of the clerk's desk. Where the new clerk's desk provided standardization of practice, my work surface is conformable to individual bodies and techniques in its adjustability.

Where scientific management sought to discourage socializing in the workplace, my design seeks to enhance intercommunication of workers on the floor. The clerk's desk can be thought of as constraining the cognition of its audience, where as my design attempts to extend cognition. As outlined in Sec. 3, the importance of the tool supporting the worker's larger personal motivations within the workplace was an important insight in my process. For my design to satisfy a larger set of actions and goals and qualify as a cognitive enhancement, the tool had to do more than just meet the physical and ergonomic requirements of the task.

However, improvements in the worker's ergonomic situation led the way for these additional improvements. Since the workers are no longer bound to their workstations in a limited range of posture, their orientation towards their larger work environment, as well as towards their task, is improved. When using the design intervention, the worker's feet are firmly planted on the floor. The large degree of adjustability of the device opens up a much larger range of postures and orientations towards their co-employees.

Intercommunication is an important aspect of any work environment of multiple operators. We heard this assertion from seamstresses themselves in the interviews I conducted.

Cognitive Enhancement, Social Aspect

Communication between workers is an important feature of the proper functioning of a work system and also for job satisfaction. According to Human Factors expert Martin Helander, to maximize job satisfaction the design of a job should allow workers to (Helander 2006, 221):

- collaborate
- talk to others
- receive performance feedback
- have control over one's own work pace
- use their own judgment and decision making
- be exposed to opportunities to learn new concepts and develop new skills

With a little imagination we can see how any of these criteria might play out via our seamstresses' enhanced workstations. I've established that my device, if implemented, would have set up a more neighborly state of affairs in the seamstresses' section. With their orientation and postures significantly opened up, the above criteria have the potential of being enhanced, especially as they are mutually reinforcing terms. Let's see how that might have worked in terms of receiving performance feedback (third bulleted point).

Venice, one of the better and more experienced performers among the hand sewers, would have been likely recruited to help oversee and mentor newer seamstresses. With a more flexible workspace open to reorientation with the aid of my work surface design, setting up a scenario in which Venice or any other experienced seamstress could monitor fledglings, would happen with relative ease. With leadership responsibilities distributed among the group of workers themselves, the group would become self-monitoring and organically connected as a whole. For the experienced workers like Venice, using their own judgment and decision making would come into play (Helander's 4th term). Confidence and sense of autonomy and worth would spread to other workers as their skills grew and they learned to trust their own judgments. These kinds of changes to the workers' scenario obviously would not just magically spring forth with the introduction of my device. But the object itself could help to engender and reinforce in the workers' environment this new sense of cooperation

Cognitive Enhancement, Social Aspect

and self-regulation. This is not to say cooperation and self-regulating practices don't currently exist among these workers, but just that through my design they could be justifiably enhanced. Like our workers subject to the Taylorian redesign of the office space, this change of equipment for the seamstress could have ushered in a transformed sense of embodiment.

This scenario recalls my earlier discussion of Clark's use of cognitive niche construction. We can see how this device, through practiced use and a conscious shift in collective mindset of the seamstresses might become deeply integrated into their system. Individual workers could exploit the sewing techniques handed down to them alongside the flexibility and enhancements of this new tool to arrive at their own personalized methods. With the possibility of greater intercommunication and cooperation among workers, so too increases the opportunity for the seamstresses to be influenced and benefit from one another's techniques. This cooperative interconnected atmosphere could result in a kind of synergetic niche construction.

In a scenario like this, workers are not regarded as clones enacting the one right method, but instead are enabled as conscious agents; agents who can tailor their environment to enable their own best methods. Many of Helander's principles of good job design would be satisfied. So too would many of the conditions for embodied cognition.

Also, having a piece of equipment designed expressly for them would have a positive effect on the seamstresses' morale and how they perceive their own value as employees. It is not unreasonable that all these changes in the seamstress situation are facilitated by the work surface:

- Improved ergonomics
- Greater control over their task and their orientation towards their larger work environment
- Enhanced worker interaction, enabling seamstresses to influence one another's techniques, and become self-regulating
- Boost in morale from being recipients of a specialized design

Taken together, these comprise a cognitive enhancement.

Cognitive Enhancement Summary



- Workers feet are firmly on the floor, they are no longer bound to the workstation.
- A greater range of postures and positions are opened up to the worker. This coupled with the ergonomic improvements that allow for the core actions of the task to be facilitated, result in greater control of their task and their orientation towards their environment.



Cognitive Enhancement Summary

- Improved posture and orientation towards their environment encourages intercommunication and cooperation between workers; a **social and cognitive enhancement**
- Through enhanced worker interaction, the seamstresses can influence one another's techniques becoming more selfregulating
- Boost in morale from being recipients of a specialized design



Conclusions

Niche Production and Custom Audiences

The foundation for this thesis project was laid by fieldwork. By studying a specific group of users within a localized context, I was able to identify unforeseen contexts for my design intervention; and, as it turns out, an under-served audience as well.

Although a fieldwork-oriented, user-centered approach is an entrenched method in many fields of design, what I arrived at is something a little different. Applying a user-centered method to a highly localized context resulted in a niche approach to design; this supports a greater diversity of potential user techniques, products, and markets. Working free of market constraints allowed me to work with a group that might be considered too small to commercially sustain a product line.

However, I feel a niche approach to design, business, and manufacturing is a feasible paradigm for the future. This is shown in the marketplace by mass customization of products. New technologies that are now in widespread use and development, CAD systems for design and manufacturing, rapid prototyping, and digital imaging technologies such as 3D body scanning point the way to an adaptive and nimble approach to product design and manufacturing. When these technologies reach their potential, we will see companies responding to markets that were traditionally considered too small. In some cases, the products themselves will have the capacity to be personalized down to the dimensions of individual bodies and needs.

Niche Design as Cognitive Design

The future holds a greater merging of physical and cognitive product design. As more and more products become digital interfaces, understanding of the cognitive aspect of design may become a necessity for industrial designers. These ideas, however, extend down to traditional analog products, as all human problem solving and activity have a cognitive element. Industrial Designers would do well to use a cognitive approach in the design of products, especially where interaction with the

Niche Design as Cognitive Design

product has many layers.

The theoretical framework that made way for these considerations entailed incorporating paradigms more commonly associated with field of Human Computer Interaction into the study of industrial design. In evaluating my project I drew upon ideas from Activity Theory, the writings on embodiment and cognitive extension of Andy Clark, and other writings based in Cognitive Science and Psychology. A softening of the boundary of the individual is an umbrella idea which connects these diverse areas. In such a view, cognition is seen as happening in our heads and in the world. Artifacts serve as amplifiers and extenders of our mental activity. They structure our experiences and connect us in our activities. The self in this scenario may be seen as a plastic an adaptive system always reorienting itself towards the world.

The things we design can then be seen as facilitating and structuring the user's interaction with their environment. The devices we design are not just physical tools, but cognitive ones. When they work well they become incorporated deep within our plastic selves.

The concrete realization that this viewpoint allowed in the design of my work surface was the expanding of the scope of the seamstresses' task to include their orientation towards their larger work environment. The inclusion of the worker's larger motivations, such as social relations and cooperative work, became design criteria to be supported by the final solution-form. When the tool is not just seen as supporting an isolated task better and more efficiently, but includes analogous needs and motivations of the user, a more rich and nuanced understanding of the human tool interaction emerges; one that supports the user and tool as an adaptive system enabling enhanced control over their environment. When tools in the seamstresses' environment are exploited in ways uniquely adapted to their context-specific needs, tools become extensions of their cognition. To take this notion further, as these human artifact relationships bring into being new problem-solving structures, the seamstress or given conscious participant, becomes an enhanced agent actively engaging in niche construction.

Niche Design as Cognitive Design

As a final illustration of this point, let us take for instance a case described to me by a local Industrial Designer John Stanton. While employed for a prominent tool manufacturing company, he was tasked with the redesign, both stylistically and ergonomically, of some everyday hand tools, and in this particular case a hammer. When generating ideas for this project, John took a number of steel hammers and physically manipulated the forms by heating and bending their shafts with the use of a blowtorch. In an innovative and intuitive bit of field work, he then took these modified hammers around to construction sites to gather feedback from the workers there. John wanted to see if these distortions to the physical form of the conventional modern hammer held any practical advantage beyond visual pleasure. The responses he received varied depending on the specialty or niche of the worker.



In one instance a construction worker doing roofing work, whom we will refer to as Rob, strongly responded to a hammer shape no one else had. This hammer had been stretched and bent in such a way that its form resembled that of a question mark or perhaps the neck of a swan (pictured left). As it turned out this somewhat random adaptation of the neck of the hammer emerged as an advantage in the niche of this roofing worker. According to Rob the Roofer, the bend in the neck of the tool allowed him to hammer a nail that under normal circumstances would be difficult to reach, or would have caused him to reposition himself. Rob often had to hammer up and around rafters. Negotiating these rafters he might have had to take an uncomfortable grip on the hammer, contort his arm into an unnatural angle, or move his entire body into a new position so that the tool could meet the nail. But with this modified hammer, it was as if it had deformed to conform to the constraints of this particular environment. This swan-necked hammer graciously accommodated the protruding rafters to more easily reach that nail on the other side. In this case we could say this modified hammer had been well suited to the constraints of its environment and performed transparently, as an extension of the user.

Suffice it to say that this particular iteration of John Stanton's hammer designs did not go into production. In the slow-changing industrial order of mass production and mass markets that ruled the 20th century, such a deviation in form, only had

Niche Design as Cognitive Design

been useful to a relative few and had little chance for survival. In the high speed, networked, and digitally empowered manufacturing economies that we are moving towards, this kind of niche adaptation of products will find its place. That is, it will become feasible and profitable to produce things in this manner. It is quite possible it will even become the new norm and what consumers demand.

For designers, on their end, it is obvious that closer relationships between user and maker are necessary to arrive at useful niche innovations. This may even go so far as to consider end users as co-designers, or at least as having significant editorial input. This is not a great leap in ideology, as the design process is already a highly collaborative and user-centered affair.

Lastly, what is the cognitive effect, for Rob the Roofer, or Venice the Seamstress, of a niche design approach? When these users become active participants in the design process, the designs that result are optimized for cognitive adaptation by them. That is, these designs are conceived in such a way that they are well adapted to the needs of specific users. As these designs are shaped by user specifications, they should be optimized for transparency in use, wherein, to use Clark's terms, the person in question is not meeting the world through the lens of an object, but is more like an enhanced agent confronting the world.

Also, as in the example of the bartender lining up drink forms, when artifacts are well suited to the demands of a particular niche, the user is empowered to actively engage in cognitive niche construction. By taking advantage of the affordances of a niche design such as John's swan-necked hammer, new opportunities will arise for Rob to engage his environment that are unique to his techniques and practices. In this sense Rob is incorporating problem-solving structures, that he has inherited and now specified (via the personalized hammer), into his thinking and acting. In this scenario the worker has enhanced control over their environment, and potentially greater self realization as learning, thinking, and adaptive beings. These are the outcomes that really matter for cognitively enhanced users, even if they do not think of it in the terms engaged here.

Niche Design as Cognitive Design

In its sensitivity to localized contexts a niche design approach is well suited to aiding the creation of designs as cognitive enhancements. Thinking of physical product design in light of embodied cognition theory allows us to see how deeply integrated artifacts are into the structure of our experiences and our thinking. If as designers we can begin to understand how we as humans incorporate physical objects into our thought and problem solving processes, and even into the physical image of our bodies, we have arrived at a powerful understanding the relation between ourselves and designed objects. What follows is to allow these ideas to influence the way we practice design and enhance users.

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