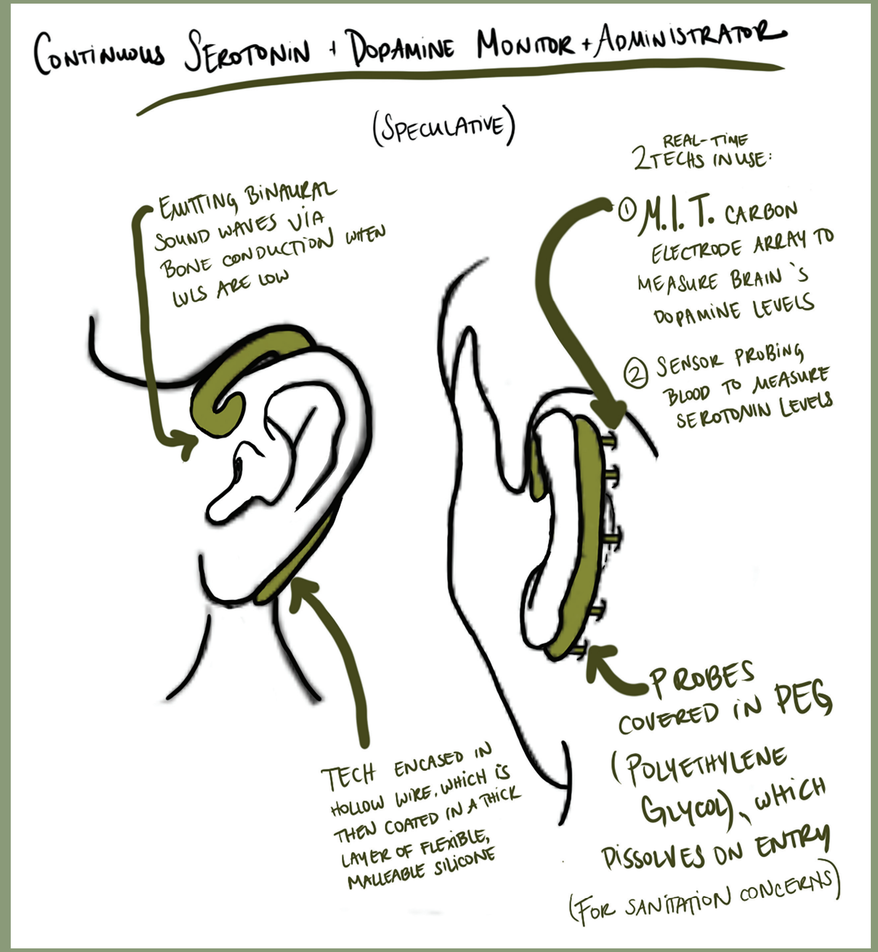


IV. How do speculative & all-digital designs change the user's access to the technical artifact as a vehicle for human knowledge & connection?

A Possible Future for Medical Data Collection Devices

Course: Thesis Studio I with Fred Wolflink & Tim Scholl

Introduction

Since the advent of the computer in and around the 1950's, and accelerated by the invention of Ethernet and the World Wide Web in the 1970's and 1980's, a whole new realm of technical artifacts have become accessible to the designer: hybrid and fully digital artifacts. In ye olde 2024, digital designs are so ubiquitous and commonplace that one has to read the description of a 'Designer' job posting to know if the work will be entirely digital; the digital realm dominates even disciplines that create physical objects, like Industrial Design. Having built my whole technical artifact theory based on the creation of physical objects, I knew it would be important to include a project that contained even a fraction of the digital aspects of modern product design.

Since we have now reached the exploration of the forefront of the evolution of the technical artifact, we must also acknowledge that even functional digital artifacts are but speculative prototypes; executions approximating experiences we *would like* to design using current technology. We touched on the topic briefly in *A Possible Future for Sustainable Living*, but **Speculative Design** is a large driver in the evolution of technology, specifically for deciding the direction of its development.

The overlap between the two design subdisciplines is so large that, since the advent of the Futurist Art movement, we have been using fiction (**fantasy, science fiction, and design fiction**) to imagine possible futures of humanity, proximate or distant. Examples that come to mind include Alan Kay's Dynabook (imagining the portable computer), several science fiction depictions of video calling, or Dick Tracey's or the Jetsons' visualizations that are eerily similar to today's smartwatches. They imagined so we could create.

For me, the ultimate frontier for speculative digital design is the medical device industry; the reasons are twofold.

The incidence of health problems is only rising, even if our knowledge about the body and its health is at a historic high. Part of the problem is the access to that knowledge; the topic itself could span its own 200+ page book. The other part, the one on which I would like to focus on with this chapter, is the one of a more technological nature: personal data provisions and access and control of one's health.

There's an enormous difference between knowing the type and magnitude of a particular metric (say, blood sugar levels, for example)

Speculative Design -

"a design practice concerned with future design proposals of a critical nature"

Fantasy vs. Science fiction vs. Design Fiction - In my work, the distinction between fantasy, design fiction, and science fiction is down to the scientific and physical (as in physics) possibility.

Fantasy departs from the verifiable physics of our world, although some features of culture in fantasy literature may be based or inspired on real scientific phenomena

Science Fiction is the creation of a rule-based world that is either inspired by IRL Earth science or an extension / extrapolation of our own scientific system.

Design Fiction is the creation of an object in a fictional world that shows an experience of that object and inspires people in our real world to bring it to life.

that cause serious detriments to one's health, and knowing in real time your personal blood sugar level and being able to have a say in its levels and preventing an illness, such as diabetes.

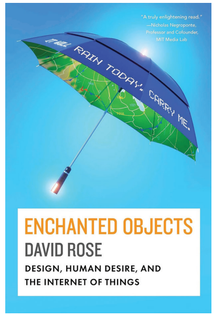
This experience is a very personal one; I've had ever more health issues as time goes on, and have found that the most difficult aspect of quotidian health care is having access to accurate, dynamic data on the metrics inside my own body that could inform me about my health and provide quantifiable feedback regarding the health impacts of any changes I make in my behavior. One of the reasons I pursued this path was that I desired access to more, better quality health data in the progression of our technology and devices.

Secondly, health-related scientific R&D is very well funded, rigorously tested, and the application of this research is often highly sought after in our society. In particular, medical technology R&D gets an opportunity often not present in most commercial industries in that it favors speculative-style research in design of technologies and devices for medical applications.

A Possible Future for Medical Data Collection Devices (APF: MedDevs) is intended as a 3-for-1 examination of both speculative design and digital design as methods and/or mediums for the creation of medical and health-related technical artifacts. Specifically, to continue the train of thought from the previous project and examine the impact these methods of artifact creation have on the user's access to the information contained within them. APF: MedDevs is also an extension of APF: Sust, just within the context of medical devices. I hope to speculate upon and explore the possibilities in form & function of wearable medical devices in the world I imagined in previous projects.

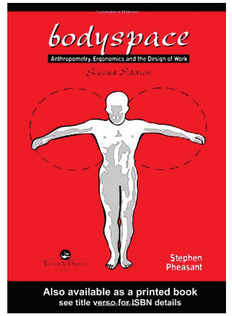
Contexual Research

Enchanted Objects: Design, Human Desire, and the Internet of Things - David Rose



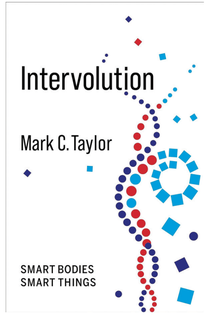
The Best Interface is No Interface - Golden Krishna

Bodyspace: Anthropometry, Ergonomics and the Design of the Work - Stephen Pheasant

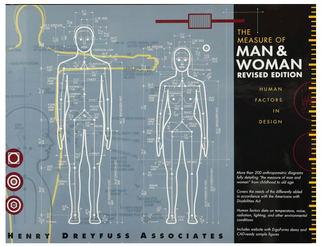


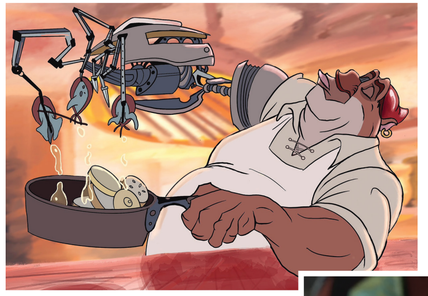
Speculative Everything - Anthony Dunne & Fiona Raby

Intervolution: Smart Bodies Smart Things (No Limits) - Mark C. Taylor



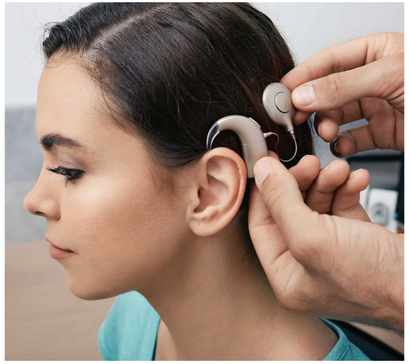
The Measure of Man and Woman: Human Factors in Design - Alvin R. Tilley





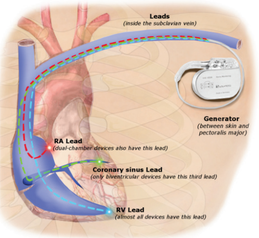
Fashion-based wearable health devices

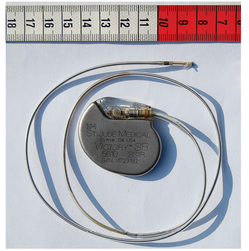
- Oura Rings
- smartwatches



Already extant medical devices

- Pacemakers
- Pulse Oximeters
- Continuous Glucose Monitors
- Cochlear Implants

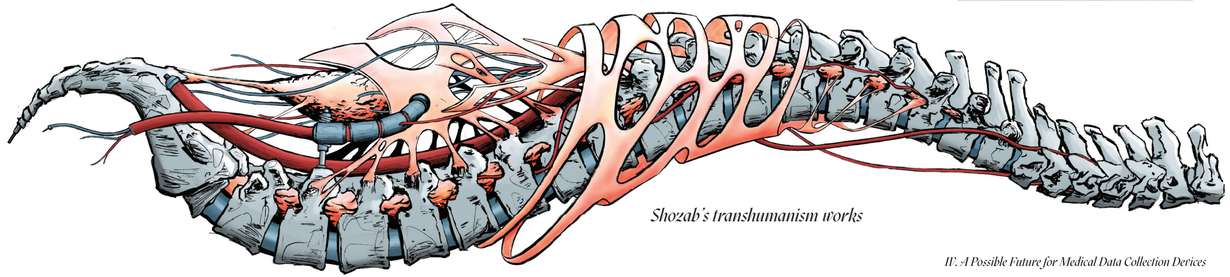




Visual & Content Inspirations:

Devices found in science fiction which have health data-related functions.

- Kimoyo beads from The Black Panther and Wakanda Forever
- Enhanced contact lenses from any number of sc-fi films and books
- The Enhanced arm and eye from the cook in Treasure Planet
- Alastor Moody's eye in Harry Potter



Shozab's transhumanism works

Conceptual Development

First I tried to ideate on the range of medical device experiences, without being limited by the present. What could a medical device look like? I landed on 3 Categories that the experience of medical wearables to fall into and that I will use to organize my exploration:

The Clinical Experience

A device created for the Clinical Experience is a device we come to once over a regular period of time (once a day, week, month, etc) for a check-in. Features of this experience include:

- Wanting to be able to leave the data behind once the experience is over
- Wanting to be able to have an intentional moment of awareness of their body's health

There are three contexts in which we might devise a medical device with a clinical-style experience: Daily, weekly, or monthly interactions or touchpoints. Below are some ideas of interactions that we already engage with that might serve as such touchpoints:

- Daily Interactions / Touchpoints
  - Mirrors
  - Scales
  - coffee mug
  - coffee machine
  - Toothbrushes
  - Water bottles
  - (for dancers) ballet barre
- Weekly / Monthly Interactions / Touchpoints
  - Weight scales

The Fashion Wearable

A device whose user experience is that of a Fashion Wearable is one that is constantly monitoring the user's health and behavior, and which the user is actively interacting with constantly.

- The aesthetics of this device are very important
- Multiple locations/accessories are an option

I could think of two general categories of wearable fashion items that we habitually adorn ourselves with that could serve as vehicles for a medical device with a fashion wearable style of experience: objects that don't break the skin, and objects that do break the skin. Below are lists of wearable fashion items that I was considering as candidates for a medical device upgrade:

- Don't break the skin:
  - Watches
  - Bracelets
  - Necklaces
  - Earrings / cuffs
  - Headphones / earbuds
  - Rings
  - Headbands
  - Belts
  - Nail polish / acrylic nails
  - Wallets / handbags
- Break the skin:
  - tattoos
  - Skin grafts
  - Skin-embedded superficial devices (inspired by glucose monitors)
  - Sub-dermal or inter-dermal devices (inspo: Nexplanon chips, pet chips)
  - Other piercings

The Long-Term Health Study

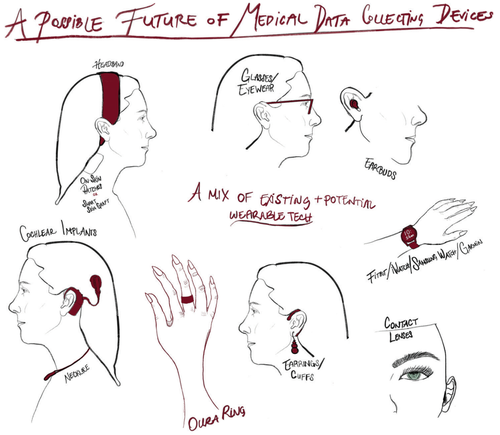
The last category of medical wearable experience I named the Long-Term Health Study. This User Experience involves a device that is constantly monitoring the user's health and behavior, but is not visible/perceptible to the wearer, and whose data is being transmitted to another person (ex. Your doctor)

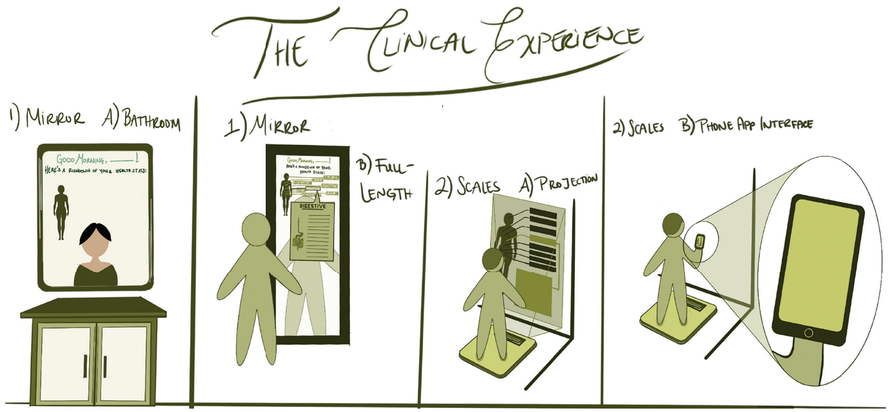
- Important: Device must be removable if/ when study comes to an end.
- The user is only notified for two reasons:
  1. It's an annual check-in / analysis of their year-long data acquisition
  2. The thing being monitored is reading a dangerous magnitude, or is in a dangerous range and the wearer needs to make a move to manage this, such as seeking emergency care

Only cybernetic implants come to mind as candidates for this type of medical device experience. In my head they fall in two general categories: skin grafts/patches (that can be an organic matter and sensor / tech hybrid and can be incorporated into the greater skin organ but locatable for removal later) and subdermal device implants (like cochlear implants).

To a lesser extent, piercings and tattoos are also candidates for the Long-Term Health Study user experience, but have a few difficulties. Piercings fall a bit short because, although they can be worn in the skin for an extended period of time, the inside heals and does not have internal body access for sensors and data collection, and they are often (though not always) on the periphery of the body. Tattoos have similar limitations – the tattoo is a scar whose ink has been isolated in the dermis and has no access to the inside of the body for data collection; also, they are permanent and removing them would require either excision or advancement in laser removal to include any sensor/technological elements to a "medical device tattoo." They can, however, function as circuits, if getting tattooed with body-safe conductive ink (assuming such a thing exists); however, this possibility does not get explored in this project.

I spent some time mulling over these exploratory medical device contexts, and tried to visualize a few; I sketched some form / function / placement ideations, to see if there was a context that spoke to me and I found interesting to explore. I was deciding between the Fashion Wearable and Clinical Experiences.





I also ideated specifically on the clinical experience, trying to visualize something new. This process reminded me of the chapter "Terminal World: The Domination of Glass Slabs" that David Rose discusses in his book Enchanted Objects. In short, he opens the book by discussing the four general categories in the trajectory of object design development technological but I fell into the trap of only designing screen-based experiences, whether these were on a digital-backed glass screen or as projections onto a wall.

I am personally not a fan of screen-based technologies; anyone in my life will tell you that I am perpetually leaving my phone behind and forgetting about it; I cannot be in front of a computer for extended periods of time without going outside and seeing the sun; and I don't like watching television for more than an hour or my head gets fuzzy. Reading about Rose's Terminal World was a very terrifying portent; as we all know by this time, screens are the very antithesis of what is healthy to humans, and more of that does not seem the right move. So, for the sake of time, I abandoned the Clinical Experience path.

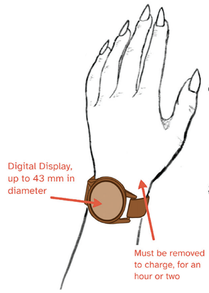
Where the Long-Term Health Study experience is concerned, some of the elements appealed to me, like the idea of a cybernetic element. A nod towards Shozab's transhumanism works (go read his book, *Low Resolution Humans*!), I do not fear or oppose moving towards an integration of technology with the body; I simply worry about all the usual moral and ethical quandaries... but not in this book!

However, I am not a fan of not having access to the data collected. So my sketch and ideation inclinations pointed me towards a hybrid of the physical, cyborg-like implemented aspects of the Long-Term Health Study-style experience, but with the personalized, quality, quantifiable data of a Fashion Wearable-style user experience in the device's form and function.My sketch inclinations showed me that I was biasing towards a Fashion Wearable-style user experience of the device's form and function.

My ideations, sketches, and other work narrow their scope to this style of experience moving forward.

Market Research

While I contemplated the specifics of the form my speculative medical device would take and its associated user experience, I also decided to better inform myself regarding the extant wearable devices on the market. Namely, I wanted to note exactly which medical elements they recorded, for the functional aspects of my design that would come at a later date. Subsequently you will find my notes, examining 4 of what I've seen are the most popular fashion wearable devices on the market at present.



Samsung Watch

General Features:

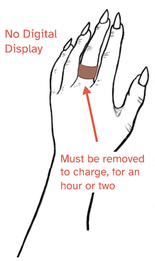
- Phone Call/Text
- Music/Audio control
- Workout & Step tracking
- Sleep coaching & tracking
- Fitness Tracking
- Vitals

Security:

- Emergency SOS
- International emergency calling
- Fall Detection

- Advanced Sleep Coaching
- ECG / Irregular Heart Rhythm Notification
- Personalized Heart Rate Zones
- BIA (Bioelectrical Impedance Analysis)
- Skin Temperature / Cycle Tracking
- Blood Oxygen

- Water-resistance in 50m deep water as described by the international standard ISO 22810:2010
- Dust-resistance as described by classification IEC 60529 IP6X)



Oura Ring

Features:

- Workout & Step tracking
- Sleep tracking
- Vitals

Security:

- Emergency SOS
- International emergency calling
- Siren
- Crash Detection
- Fall Detection

- Blood oxygen
- Heart rate
- Heart rate variability (HRV)
- Temperature monitoring
- Activity, and sleep monitoring
- Sleep stages
- Body Temp
- Sleep Staging Algorithm
- Waterproof
- Water temp
- Ambient light sensor

Apple Watch

Features:

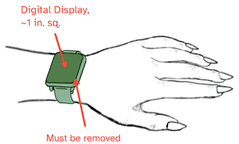
- Phone Call/Text
- Music/Audio control
- Workout & Step tracking
- Sleep tracking
- Vitals

Security:

- Emergency SOS
- International emergency calling
- Siren
- Crash Detection
- Fall Detection

Sensors:

- Blood oxygen
- Electrical cardiogram
- 3rd-gen optical heart sensor
- H & L heart rate
- Irregular HR rhythm
- Sleep stages
- Body Temp
- Depth gauge ±1m accuracy
- Water temp
- Compass with Waypoints and Backtrack
- Always-on altimeter
- High-g accelerometer
- High dynamic range gyroscope
- Ambient light sensor



Fitbit

Features:

- Workout & Step tracking
- Sleep tracking
- Vitals
- Up to 10 day battery
- Call, text & app notifications
- Always-on display mode
- Do not disturb & sleep mode

- Daily Readiness Score
- 24/7 heart rate
- Active Zone Minutes
- Cardio Fitness Score
- Connected GPS
- Exercise modes
- Automatic exercise tracking
- Steps, distance & calories
- Swimproof

- SpO2 (blood oxygen) tracking
- Skin temperature variation
- Heart rate variability
- Breathing rate
- Wellness Report
- Blood glucose tracking (in app only)
- Resting heart rate
- High & low heart rate notifications
- Irregular heart rhythm notifications
- Menstrual health tracking
- Stress Management Score
- Mindfulness sessions
- Reflections
- Relax breathing sessions
- Sleep tracking & sleep stages
- Sleep Score
- Sleep Profile
- Smart Wake alarm

Security:

- Emergency SOS
- Siren
- Fall Detection

I got to thinking about their commonalities, and about what I am often hoping for in a device that informs me of what is going on inside my body so I can take better care of it from the outside. One particular detail, commonality they shared, that I thought peculiar: their placement on an appendage rather than on the core of our body.

Peculiar not for being logical or useful, but rather about what it says about our society and its views. I noted that choice, of flirting with a possible future, of that possible relationship with technology, as if we

That being said, I know that these proclivities are slowly evolving, what with the new trend of apparently healthy people wearing continuous glucose monitors to monitor their blood sugar.

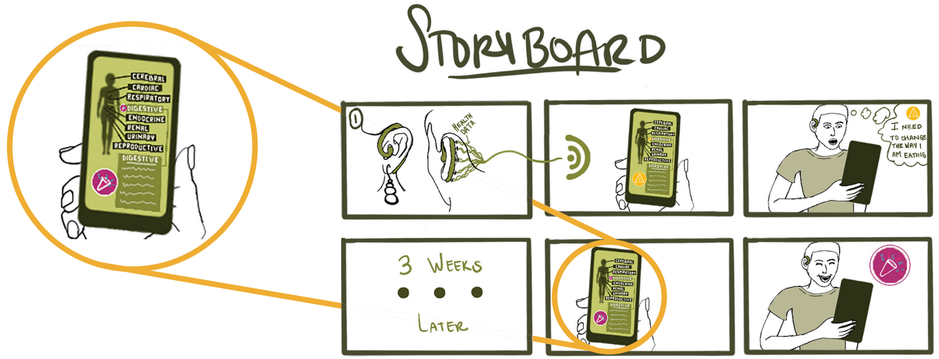
were dipping our toes in the ocean, marveling at the sensation and enjoyment it brings, and hoping that we would somehow rid it of all its horrors, when the ocean's horrors . Having this proximity to the technology that could help us, but separated from the integration that could make it function by being outside the skin, current wearable medical devices suit the current proclivities of the preferences we have due to our sensitivity to the idea of technology penetrating our skin, as if it were a rather impermeable membrane.

Still, I understand that there is something appealing to be acknowledged about the ability to remove or swap the device, if only for fashion purposes. I kept that tidbit in mind.

Brainstorming/Initial Ideas

Final context:
Fashion: Ear Cuff Med Device

Now, dear reader, we get to the all important question - what did I decide on when it came to form factor? After much thought, I decided to go with an ear cuff, with some sort of an implant element. This is how I envision the user experience of the cuff to be like:

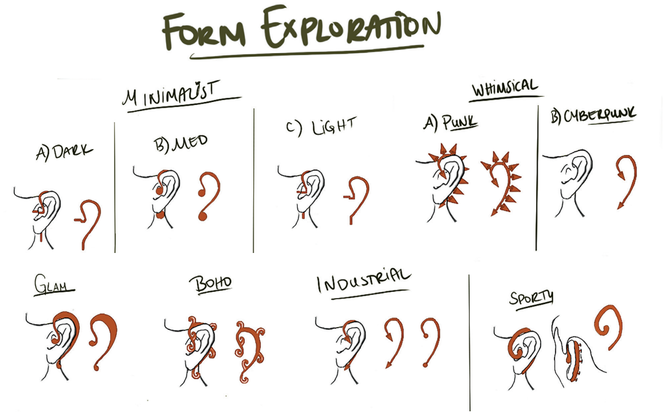


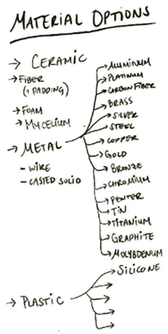
Iterations

Form Ideation

I chose this form factor and style of experience for a few reasons:

1. With our current affinities for over the ear headsets for music and phone call purposes, it's not an accessory or location that would be untoward to our current fashionable sensibilities
2. It pushes us more towards a cyborg future without triggering our current moral dilemmas about technology in the body
3. It's relatively One Size Fits All – ears only come in so many sizes
4. The ear cuff design is well located to incorporate developing technologies only accessible by probing the subdermal, intravenous, and intracranial fluids – some metrics can only be measured intravenously, and in some cases, like with dopamine and serotonin levels, require intercranial fluid from the head; the technology for this is only now being developed by MIT.
5. Last, but certainly not least, is the user experience for Long-Term Healthcare. Due to the device's implantation into the skin, it should be designed to last for a very long time, years, and uptakes continuous, dynamic health data, and deposits it directly into the hands of the user.





With these motivations and design requirements in mind, I began ideating on the specific contours of my speculative Ear Cuff Med Device.

One appealing feature of the Fashion Wearable experience is the seemingly endless customizability of the primary form factor to appeal to a wide range of users' aesthetic preferences. I tried to ideate a form factor for all the more popular aesthetics, pictured above. I also tried to keep in mind the form of the ear and not add any features that might interfere with the anatomy and give the user discomfort. I also tried to account for the necessary electronics that would go inside, trying to maintain a minimum width for wires to pass through and sensors to be stored; with middling success, I think.

I also explored my materials options. I knew I needed a material that was:

→ Biologically inert

→ Itself was not a conductor of electricity, or could be isolated from the electronics

→ That would be stiff enough to protect the electronics

→ Flexible enough to be manipulated by the user to be put on and off, slept on, and otherwise disturbed, with minimal discomfort to the wearer

→ "Warm" to the touch, that would bring the wearer comfort in its presence

→ Reasonably recyclable, repurposable, repairable, and/or replaceable as to be sustainable

→ Of ethical sourcing and fabrication

→ With minimal emissions in its production

I devised the list of materials you see here, and determined that each aesthetic's model in the series would need to be assessed to determine their ideal material of fabrication. For now, I decided to move forward with a looks-like prototype, and I decided for the sake of time to model only the Glam, Boho, and Medium Minimalist forms for human factors testing.

The final 3 I set aside to determine later, should I get to a "feels-like" prototype or a Cradle-to-Cradle or Life Cycle Assessment in the development of this project; though no less important and so included here.

Looks-Like Prototype:

I created some extremely quick prototypes, made from wrapping a thick sculpting wire with some polymer clay which I quickly set in the oven. I devised the contours by wrapping the wire around my own ear, and tested the forms on myself as well as my younger sibling, Audrey.

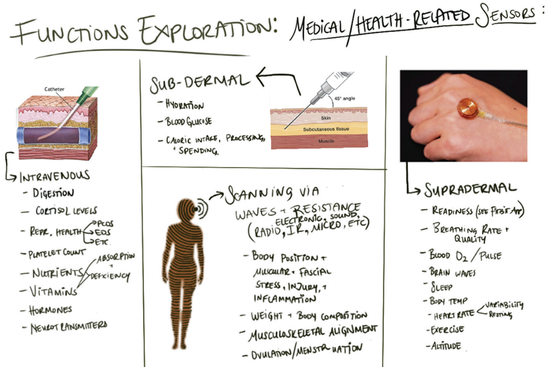
Problems with Looks-Like

Most of our difficulties with the form were actually due to the clay and wire as prototyping materials as opposed to the forms themselves. After baking the clay was much too stiff and brittle, and it made it difficult to don the cuffs, requiring us to contort our ears quite uncomfortably to get them on and off. Furthermore, after a few wear attempts, parts of the clay began to crack, as you can see in the Minimalist form prototype.

I definitely intend to remake the cuffs with a more suitable material (perhaps a 3D printed TPU?)for further form tests; however, this is as far as time allowed me to progress on this project, so this is the final prototype to display here.

I did, however, spend some time detailing the medical functions I imagined for this device; including ones that are not strictly possible based on the current state of technological development, but not unlikely to soon follow. I included all features that the placement of the cuff facilitated, such as wave scanning (inspired by the smart scales on the market) to determine body position, composition, and alignment; and those facilitated by the subdermal and intravenous access like cortisol levels, and dopamine, serotonin, and blood glucose monitoring.

I did give some thought to how I might do a works-like prototype, obviously only modeling those functions that are actually possible with today's technology, and not breaking the skin. Although I have not yet arrived at the opportunity to prototype a look-like, I did do some brief testing and found that I could make a quick prototype by attaching a fitbit to some wire to make a cuff that would have the fitbit sit on the area of the ear where I pictured the sensors of my design to go.



Next Steps

The next steps for this project are relatively endless, but I've listed a few for you below:

1. First, and foremost, a re-do of the "looks like" prototype, with a material that is more comfortable and responds to the handling the object will go through

2. I did give some thought to how I might do a works-like prototype, obviously only modeling those functions that are actually possible with today's technology, and not breaking the skin. Although I have not yet arrived at the opportunity to prototype a look-like, I did do some brief testing and found that I could make a quick prototype by attaching a fitbit to some wire to make a cuff that would have the fitbit sit on the area of the ear where I pictured the sensors of my design to go.

3. I would like to run an extensive survey to determine the precise target user for this object; I was modeling it after what I need, as someone with many health issues, some of which are chronic. However, I am a firm believer in preventative healthcare, so I would want to create a version for the average, fairly healthy person with a simpler set of functions.

4. A fascinating direction for the conceptual development of this project would also be a conversation surrounding the elements of sustainability discussed in the A Possible Future series of projects (there are two others not featured in this book) which seem incompatible with the medical field (namely, the repurposing of "trash" artifacts and how it combats with the idea of sanitation and sterility).

5. I'd like to continue developing the implant aspect of the design; already I want to ideate on a version even more similar to a cochlear implant, with a piece that exists permanently subdermally and a separate piece that connects magnetically, rather than having permanent punctures from needle probes.

6. Lastly for now, I would love to take this investigation into the realm of designing medical and health-related objects with the express purpose of having a publicly purchase-able version and a version for people with severe or chronic conditions that require specialized features; especially, how to design for health insurance coverage and serving a population that has to fight for ever scrap of life-saving care they ever receive.

Conclusion: How do speculative & all-digital designs change the user's access to the technical artifact as a vehicle for human knowledge & connection?

I also did not want to miss the opportunity to address a question I have always wondered: (Assuming making stuff is innate to humans,) Is our current digital world natural? Are digital artifacts natural? (Note: Natural does not necessarily beget healthy, but that's a discussion for a very different book)

I felt compelled to include this project in the MVP version of this book because digital and postdigital artifact design and fabrication dominates our current reality and our anticipated future; I knew it would be important to the robustness of my technical artifact conceptual framework to address how designing digitally affects the resulting artifact and the relationship between the user and said artifact, as well as that of the user and the people involved in its ideation and creation.

As the project progressed, I did a few things differently to emphasize my findings. You will notice that every aspect of the design process was done digitally - all of my research, sketching, planning, ideations… Even my CMF (color, material, & finish) ideation and research was done digitally, in stark contrast to the rest of the projects in this book, and to my preferred design practice.

Building on the previous chapter, where we discussed the additional layer of removal that is established by mass manufacturing an object, digital designing takes it even further. My findings from this experiment are twofold:

1. Firstly, the experience as a designer was extremely difficult: we design for users, and users are people. When we are not making objects in a physical space, we lose access to the temporal nature of the artifact; there are no details to the digital process to tell us when or where we are.

   Furthermore, once I was in need of feedback on my ideas on the direction of development, it was difficult to communicate what I was thinking. When I tried to do user testing, using digital drawings or 3D printed parts, I felt an impediment to understanding how people use their objects.

   When we are making something in our hands, there is something really personal about the marks we make on the page, the fingerprints, the asymmetry of something bilateral. When sketching in the physical space, for example, the marks made are immutable, and one may make several in pursuit of the line that gets featured. In the digital space, tools such as the "undo," "mirror" or "copy" or "resize" streamline the creation process, at the expense of the individual gesture of the designer; the sketches, prototypes, and ideations get streamlined, and rather than knowing specifics about your maker, you are lucky if you even knew there was a person present in the process.

   Especially in comparison to *What's in a Wallet?*, where I worked intimately with Shozab and Janhvi on what they needed, wanted, and their personal style aesthetics, here there was no opportunity for the development relationship between myself as the maker and the user.

2. Secondly, even without a final prototype, I could tell the user experience of the object would be very impersonal and superficial, and for one simple reason: digital objects do not contain artefacts. For the person using such an object, there is no awareness but of a vague understanding of its materiality; no understanding of technique of fabrication, and no sensation of the people that were involved in creating and fabricating it, even less likely anything about the state of the greater species populus.

By exiting the physical realm, digital design creates more separation between ourselves, the people, and the information that is stored in objects; even than those that are mass produced.

This disconnect is particularly concerning for the medical space, where so much of care is about interpersonal connection. I watch the designers in my life (Cédric, mostly) working on medical robots and machines that address some of the infinite tasks RNs take care of, and look so cold and intimidating, and I worry. I worry that in improving the mechanics of healthcare, we are worsening the emotional connection in that care. There are countless examples that show that the medication or procedure would not have worked if not for the emotional support and proximity that a patient receives from their loved ones and their medical staff. We're talking about life-saving care.

And then there is the matter of the speculative aspect of the design. In my role as a designer, I always cherish a speculative design project. I enjoy the freedom to not be so bound by the realities of our world, and the challenge of trying to have truly original thought. I also enjoy learning about complex problems and trying to solve them. It is possible to get farther removed from our humanity, especially as, due to the primarily theoretical, imaginary nature of the inquiry, we are working very seldom with physical manifestations of these ideas beyond sketches.

I will say, digital and speculative design are not going *anywhere*; if anything, my goal with this chapter is about acknowledging the ways in which these processes pull away from human-ity, and fighting for the human-ity to keep up with digital artifacts as technology evolves.