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Enhancing Habit Formation Through a Wearable Vibrotactile Device

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Master’s Thesis Strategic Product Design

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Old habits die hard.

Acknowledgements

When I began my master's education at TU Delft, I often heard the adage, "If you want to go fast, go alone. If you want to go far, go together." Although this thesis bears my name as the author, it is not solely a reflection of my efforts.

Although at times I have grappled with some of the aspects ingrained in the institution of academia, it is undeniably through its framework that I have been able to create this space for exploration and intellectual growth.

On that note, I'd like to express my gratitude to my mentor, Gijs Huisman, and chair, Rebecca Price. Thank you for creating space for me and my dreams and thank you for your servant leadership along the way. And most importantly, thank you for knowing when I needed that extra push and for challenging me to step out of my comfort zone. It's through those moments that I have grown most as both a human and a designer.

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Thank you to my dad. Dad, thank you for always making me feel like I could be whatever I wanted when I grew up. Your own professional journey has always been a source of inspiration for me and undoubtedly led me here. I hope to turn all your support, love, and investment into real, positive change in the world.

With heartfelt gratitude,

Victoria

Executive Summary

As our society becomes increasingly ill, healthcare systems are failing to support us. People are actively seeking products and services that make leading a healthier life easier.

This thesis details the development of Abit, a wearable device that uses vibrotactile feedback to aid habit formation and modification.

Through extensive research, concept design, and user testing, this project presents a product service system aimed at facilitating long-term behaviour change.

Abit enhances the habit formation process by offering real-time cues and rewards, reinforcing healthy habits, and empowering individuals to take control of their health and well-being.

Glossary

HABIT
Context-dependent behaviour patterns that are enacted automatically and make up over 40% of our everyday actions.

HAPTICS
Haptic feedback uses the sense of touch to communicate with users in a wide variety of contexts.

VIBROTACTILE
Vibrotactile feedback is a form of haptic feedback that employs vibration to communicate with the user.

WEARABLE
A term used to refer to wearable technology which encompasses a broad variety of devices that are worn on the body.

Contents

Part 1

The Groundwork

A Comprehensive Introduction to the Project

Part one of this report aims to provide a comprehensive introduction to the project diving into the context, scope, and research question and concluding with an outline of the structure applied through this project. This section lays the groundwork for the subsequent research, design, and strategy sections.

1.1 PROJECT INTRODUCTION

PROBLEM DEFINITION

Year after year, the general population is growing sicker and sicker (Callaghan et al., 2021; Sleeman et al., 2019) and unhealthy lifestyle choices are in large part to blame. Designed to treat instead of prevent, healthcare systems are failing to meet individuals' needs and people are taking charge of their health, seeking out products and services aimed at improving well-being.

Wearable devices like the Apple Watch, Fitbit, and Oura ring cater to this shift, offering biomarker measurements that empower users to make informed lifestyle choices. Despite the proven effectiveness of these devices, individuals still struggle to make long-term behaviour changes.

> **"In the most health-obsessed society ever, all is not well.**
>
> - Gabor Maté (2022)

The answer may lie in reforming our habits. They make up 43% of our everyday actions (Mazar & Wood, 2018) and the saying "old habits die hard" holds true for many. Researchers have found that existing habits are one of the primary impediments of people adopting and sticking to healthy behaviour (Wood & Neal, 2016).

So how do we make these old habits die? In the habit formation cycle, cues and rewards play a pivotal role, signalling our brains to perform these automatic context-behaviour associations (Gardner et al., 2012). However, effectively interfering in this cycle poses a considerable challenge (Gardner & Lally, 2018; Mazar & Wood, 2018; Neal et al., 2012).

Image 1

A poster designed by Marie-Joëlle Lemire with the French expression "Métro Boulot Dodo" conveying the routine of everyday life (2017)

SCOPE

This project explores how vibrotactile feedback, as compared to other communication modalities, can accelerate habit formation and retraining processes. It culminates in the design of a wearable device that can measure, monitor, and provide vibrotactile feedback within the habit cycle. The resulting product is designed to aid consumers in both forming new habits and reshaping existing ones to improve their overall health and well-being. In support of the concept, the final section presents a strategic business plan, launch strategy, and high-level marketing campaign.

RESEARCH QUESTION

This report is aimed at answering the research question:

How can a wearable device intervene in the habit formation process to make building and changing habits easier for individuals so that they can achieve their long-term health goals?

Each section of the report approaches this question from a different perspective. To start, The Research section dives deep into the current research on the topics of habits, wearables, and vibrotactile feedback complemented by user research on the same topics. In The Design section, insights are turned into a cohesive product service system that brings the idea for the device to life. Finally, in The Strategy section, a business strategy, go-to-market roadmap, and campaign plan envision how to take the concept from idea to reality.

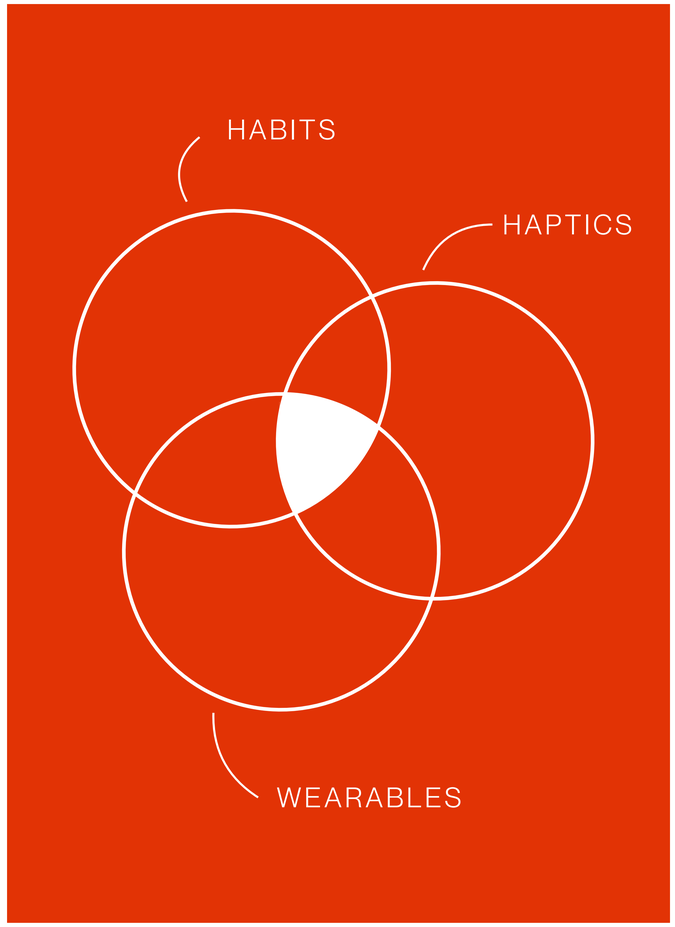
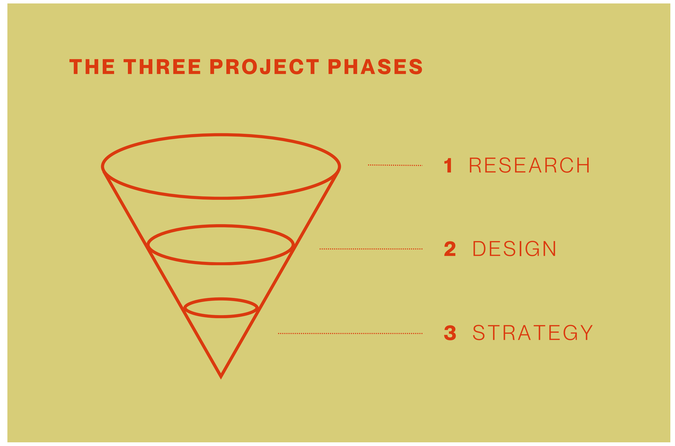


Figure 1

This project happens at the intersection of three topics

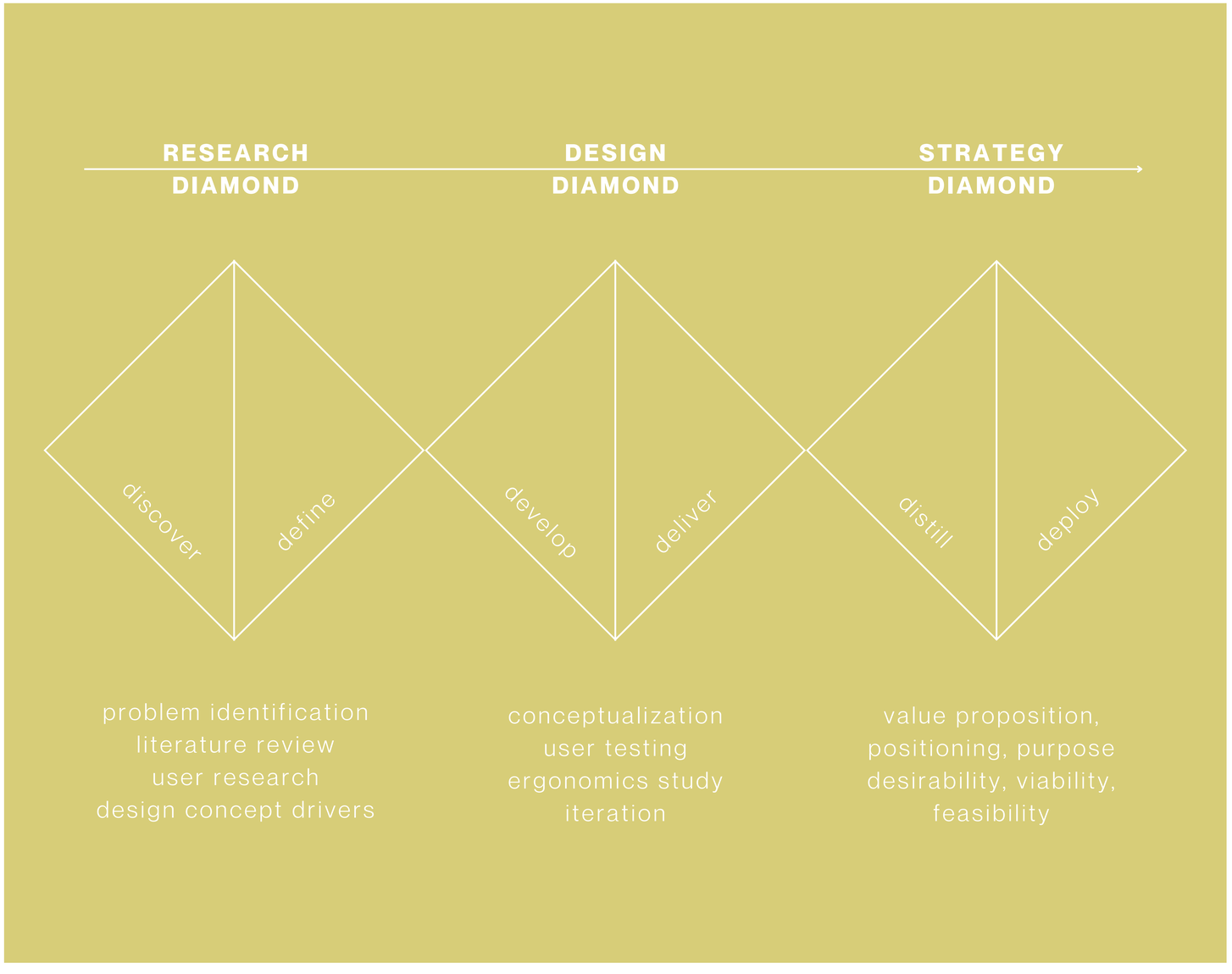
Figure 2

The three primary phases of the project narrow toward the solution



GROUNDWORK

Figure 3
The double diamond approach adapted to a triple diamond for this thesis (Design Council, 2005)



1.2 THE STRUCTURE

This thesis is structured in a way that combines both theoretical and user research with practical application, all centred around the development of a wearable device designed to enhance the habit formation process. The process and thus report is composed of three primary phases: (1) the research, (2) the design, and (3) the strategy.

THE RESEARCH

This section covers the existing research on habits, wearables, and haptic technology which lays the foundation for the following user research. A combination of a survey and in-depth interviews explore individuals' experiences with these topics. The goal of this section is to introduce the main insights and find the points of intersection between the areas of study.

THE DESIGN

In the design phase, the goal is to transform research findings into a cohesive, tangible solution. This section begins with direction-setting activities including the development of a vision statement, user personas, and journey maps. With customer needs in focus, it moves into the conceptualisation of the digital and physical product through wireframes, sketches, and 3D models. To conclude this phase, we return to the user with usability testing and concept validation which guide the iterations that lead to the final concept design.

THE STRATEGY

Finally, in the strategy section, we set a roadmap for taking the concept from idea to reality. In this phase, we detail the value proposition, positioning, and purpose. This is followed by an in-depth market and competitor analysis, a technical feasibility report, and finally a launch roadmap including the business model, go-to-market plan, and marketing campaign strategy. Together these components make up some of the key ingredients for building the business behind the product.

Part 2

The Research

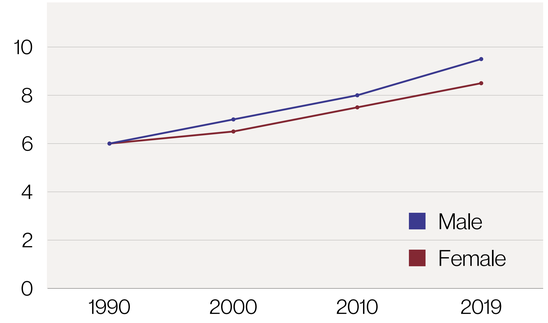
An Introduction to Habits, Wearables, & Haptics

In part two, we will first introduce the topics of habits, wearables, and haptics, finding the points of intersection between them. This is followed by user research which dives deeper into individuals' experiences with habit formation and their perceptions of wearables and vibrotactile feedback.

2.1 THE PROBLEM

The general population is growing increasingly ill (Callaghan et al., 2021; Sleeman et al., 2019) and unhealthy lifestyle behaviours are responsible for much human disease. For example, cardiovascular disease, a disease greatly affected by lifestyle risk factors, has been steadily rising across the globe and is responsible for one-third of deaths worldwide as of 2020 (Roth et al., 2020).

Figure 4
Cardiovascular Disease Deaths 1990-2019 (Roth et al., 2020)



Reducing or replacing such unhealthy behaviour is an important strategy for improving the health of the general population. In the case of cardiovascular disease, daily habits and actions, such as regular physical activity, sound nutrition, weight management, and not smoking cigarettes, can reduce risk by as much as 80% (Rippe, 2018). And in the case of type 2 diabetes, similar lifestyle interventions can lower the incidence of the disease by 51% (Li et al., 2008). In fact, nearly half of all health burdens in the United States can be attributed to modifiable risk factors (Mokdad et al., 2018).

Despite the potential benefits, individuals often struggle to sustain long-term behavioural changes. While motivation and willpower may drive short-term changes, maintaining them is challenging (Dombrowski et al., 2014). Research indicates that most individuals who succeed in short-term behaviour change struggle to sustain it in the long run (Hunt et al., 1971, Hughes et al., 2004, Kirshenbaum et al., 2009).

"Daily habits and actions, such as regular physical activity, sound nutrition, weight management, and not smoking cigarettes, can reduce risk of cardiovascular disease by as much as 80%" (Rippe, 2018).

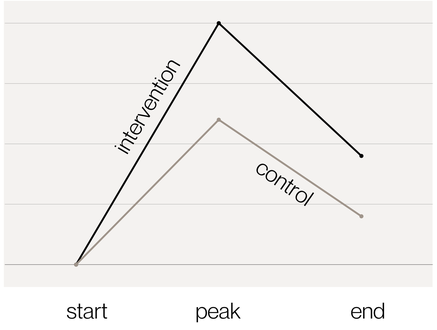


Figure 5

The Triangular Relapse Pattern in healthy behavior change over time (Wood & Neal, 2016)

This can be seen in the all-too-common triangular relapse pattern which describes the phenomenon that although willpower is an effective tool for short-term change, in the long-term it is limited and once exhausted, people return to old patterns of behaviour. Wood and Neal illustrate this pattern through a visualisation of results from health intervention studies on topics including weight loss, gym visits, quitting smoking, and exercise (2016).

One of the driving factors is that habits, or automatic behaviours, make up 43% of our everyday actions (Mazar & Wood, 2018). Many of these behaviours have damaging (e.g., eating fatty foods, cigarette smoking) or promoting (e.g., taking the stairs, eating vegetables) effects on health (Orbell & Verplanken, 2010). Breaking or changing these automatic actions, so that they ladder up to long-term goals, requires an understanding of how habits are acquired and controlled.

Image 2

A depiction of a common habit, toothbrushing. show me ur teeth by Felix Chesher (n.d.)

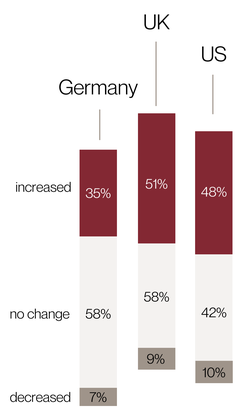
Habits are learned responses to situational cues developed through a history of repeated action and reinforcement (Hull, 1943) that lead to a degree of automaticity and are thus enacted with little conscious awareness (Gardner, 2014). The creation of healthy habits is done through repeating rewarding actions in stable contexts. Thus, the key to successful interventions is disrupting or reprogramming the cue and reward stages of the habit formation process (Gardner & Lally, 2013). Without changing external variables, tools for making these changes are limited.

Interest in using behaviour change as a tool for preventative medicine is growing in both the public sector and with individual consumers. For instance, in the US, more than a quarter of healthcare spending was due to preventable illnesses, which is estimated at more than $730 billion in 2020 (Galea & Maani, 2020). The Institute of Medicine (IOM) estimates that missed prevention opportunities cost the country $55 billion per year (Batarseh et al., 2020). This creates a large financial incentive for policy changes. In line with the increased focus on behaviour change, anti-smoking campaigns in the United States have found greater success in targeting cigarette purchases and smoking habits compared to those focused on willpower and self-control (L. M. Wilson et al., 2012).

Image 3

The implementation of smoke-free laws is associated with a 3.4% decrease in tobacco use (CDC, 2024).

Additionally, year-over-year, consumers are prioritising their wellness, purchasing products and services aimed at helping them become healthier, accounting for a $1.5 trillion global wellness market with an annual growth rate of up to 10% (Callaghan et al., 2021). A proliferation of wearable devices, facilitating the monitoring and measurement of various lifestyle aspects, indicates a growing interest in personal accountability for health-related behaviours. Wearables, through their ability to offer real-time data and personalised insights, are uniquely positioned as tools to empower individuals to actively engage in their well-being and foster lasting behaviour change.



The success of these devices relies on their ability to communicate with and engage the user. Increasingly haptic feedback has become a common communication modality due to its discrete nature (Hermsen et al., 2016), serving functions such as notifications and alerts, guidance and navigation, experience enhancement, and more. The technology presents an immense area of opportunity that is still widely underutilised in the consumer electronics space.

Figure 6

Change in wellness prioritisation compared to 2-3 years ago (Callaghan et al., 2021)

“

Virtues are formed in man by his doing the actions.

Aristotle, 2002

2.2 THE LITERATURE REVIEW

The following section dives deeply into the research, exploring the topics of habits, wearables, and vibrotactile feedback. It lays the foundation for the following user research which aims to give context and find the links between the topics.

2.2.1 HABITS

The concept of habits can be traced back as far as ancient Greece with the etymology of the word stemming from the Latin term habitus composed of the Greek words: ethos (ἔθος) and hexis (ἕξις) (Barandiaran & Di Paolo, 2014). Aristotle, a prominent philosopher of the time, characterised habits as dispositions that can be acquired to achieve desired goal states.

The notion of habit recognised today is primarily derived from the seminal work of psychologist and philosopher, William James. In “The Principles of Psychology” (1890), James describes habits as automatic, learned behaviours formed through repetition that become ingrained in an individual's routine. His work emphasised the automatic nature of habitual behaviours. Though we’ve learned much about habits over the past century, contemporary definitions remain largely the same.

Habits have been defined and redefined for decades. Based on the research shared here, the most simple yet all-encompassing definition is as follows:

“Behavioural patterns, based on learned context-behaviour associations, that are elicited automatically upon encountering associated contexts...acquired through context dependent repetition” (Gardner et al., 2012).

Key aspects of the definition include the idea of a habit being a behavioural pattern and one that is specifically linked to a cue-based association. This link creates an automatic response where the brain becomes trained, through repetition, to perform the behaviour without conscious thought.

THE HABIT FORMATION PROCESS

Habits make up about 43% of everyday actions, in the sense that they are repeated almost every day in the same context and are usually performed while people are thinking about something else (Mazar & Wood, 2018). They include a variety of activities from brushing one's teeth, to food and nutrition choices, to picking up one's phone throughout the day.

A key component of habits is that they are formed through repetitive action. When a new action is performed, a mental association between the situation and action is created, and repetition reinforces and establishes this association in memory (Wood & Neal, 2009). The habit formation process can be divided into four stages as seen below.

Figure 7
Habit formation process (Gardner & Lally, 2018)

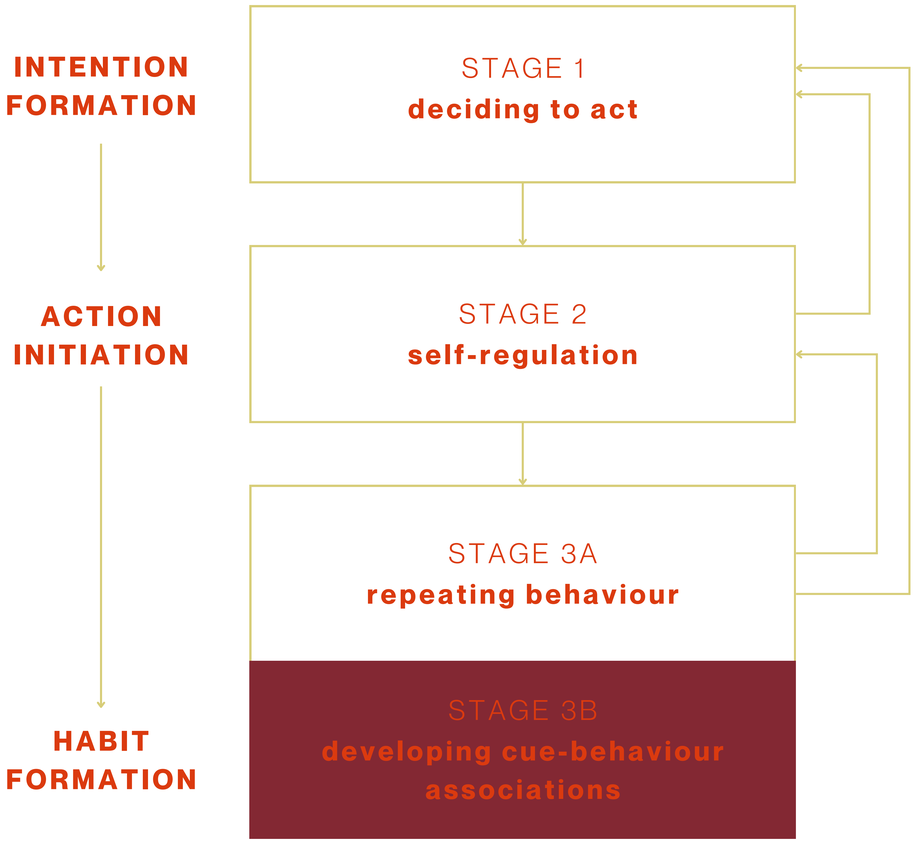
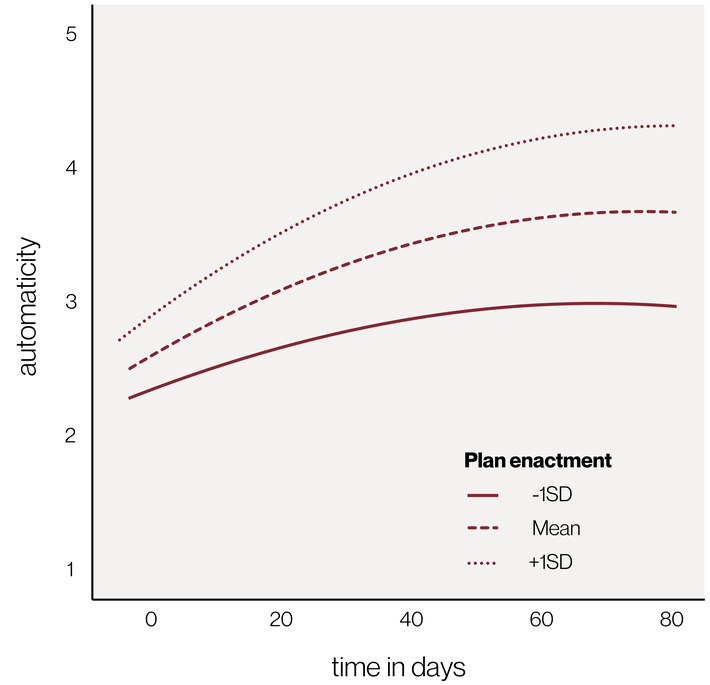


Figure 8
Automaticity curve (Lally et al., 2009)



Although most empirical data regarding habit formation has arisen from animal-learning studies (Dickinson, 1985; Thorndike, 1911; Tolman, 1932), one human-based study explored the relationship between behavioural repetition and habit formation (Lally et al., 2009).

Over twelve weeks, ninety-six participants were instructed to repeat a self-chosen physical activity or dietary behaviour daily in response to a self-identified cue. The data was mapped against an asymptotic curve model to show automaticity gains. The curve showed an initial rapid increase leading to a plateau over time. The median time for each participant to reach their personal habit plateau was 66 days, though this ranged from 18 to 254 days. This demonstrates that from the start of a behaviour change to the point of automaticity, or the point where the behaviour becomes habitual, is on average 66 days, though it varies greatly per individual.

THE ROLE OF INTENTIONS & GOALS

Several scholars have studied the role of intentions and goals in the habit formation process. Most researchers agree that habits often originate from a goal given that people are most likely to repeat actions that are rewarding or yield desired outcomes (Consolvo et al., 2009; Neal et al., 2012; Lally & Gardner, 2013). However, as a habit forms, behavioural regulation is transferred from a conscious, deliberative information-processing system, to an impulsive, association-driven system, which triggers action rapidly (Gardner & Lally, 2018).

What sets habits apart from other behaviours is that control shifts from goal dependence to context dependence. Once a habit is formed, it guides behaviour even when people intend to do something else (Mazar & Wood, 2018). Therefore, the role of a context cue is more influential in the habit cycle than the original goal or intention (Neal et al., 2012). Studies that assess naturally occurring context changes find that participants continue to perform habits with minimal influence from goals, but only so long as they continue to live in the same context and so are exposed to cues that activate the behaviour (Neal et al., 2012). Additionally, habitual behaviours persist even where they no longer serve the goal that motivated initial performance (Wood & Neal, 2007). Therefore, habitual behaviours are shielded from motivational changes and therefore exist even when conscious motivation to perform them is missing.

The role of a context cue is more influential in the habit cycle than the original goal or intention (Neal et al., 2012).

THE THREE CENTRAL COMPONENTS OF HABIT FORMATION

There are three central components of habit formation. Each forms an essential factor in the formation and maintenance of habitual behaviours (Wood & Neal, 2016).

1 **AUTOMATICITY**
2 **CONTEXT CUES**
3 **REWARDS**

1 AUTOMATICITY

For habit learning, greater task repetition speeds performance, reduces thought and attention, and increases activation in certain brain regions leading to automaticity, the idea that a behaviour is performed automatically without conscious thought (Knowlton & Patterson, 2016). In the context of cognitive psychology, a habit falls into the System 1 category, meaning that it makes minimal demands on the working memory, in contrast to System 2 which uses executive function (Mazar & Wood, 2018). This illustrates the idea that a habit is a direct response to a cue with no need for a reflective process.

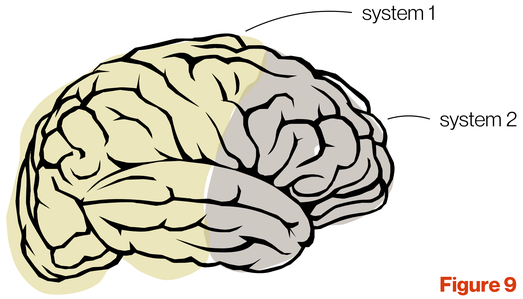


Figure 9
Visual representation of System 1 & System 2

2 CONTEXT CUES

The second component of habit formation is associated context cues. As previously noted, habits are triggered automatically by context cues with minimal influence from goals (Neal et al., 2012). Successful habit formation depends not only on repetition but also on the presence of these stable context cues, which can include times of day, locations, prior actions in a sequence, and even the presence of other people (Wood & Neal, 2016). Cues that are more distinctive and novel are more salient, and therefore more effective (McDaniel & Einstein, 1993). Strategies to change habits are more successful when they target specific contextual cues rather than relying on goals or internal motivation (Neal et al., 2012).

3 REWARDS

Lastly, rewards play a powerful role in habit formation. Behaviours that are pleasurable or intrinsically motivating, may become habitual after fewer repetitions than those that are not, as pleasure and intrinsic motivation act as rewards, which accelerate habit formation (Judah et al., 2018). In addition, cue–behaviour associations may also be more quickly learned for rewarded behaviours (De Wit & Dickinson, 2009).

Uncertain rewards, ones that do not always occur upon completion, are the most powerful motivators (DeRusso et al., 2010).

HOW HABITS INFLUENCE HEALTH

For most people, intentions to change health behaviours have limited success because interventions typically result in limited short-term changes but fail to become long-term behaviour patterns (Dombrowski et al., 2014). Beyond that, existing bad habits are a significant obstacle to people adopting and sticking to healthy behaviours (Wood & Neal, 2016). Fortunately, just as these bad habits impede behaviour change, good habits can promote it. Consistent action of healthy behaviours is the only way to achieve long-lasting health and longevity. This is achieved through establishing positive habits and breaking existing unhealthy patterns. Research shows that people who consistently act in healthy ways in daily life do so out of habit (Wood & Neal, 2016). Although willpower is limited and can easily be exhausted, habits guide behaviour from a cue-response association – meaning that they activate behaviour in the absence of awareness, conscious control, and cognitive effort – circumventing internal urges to act in unhealthy ways (Adriaanse et al., 2014; Galla & Duckworth, 2015). In fact research has shown that when intention is weak and habit strong, behaviour corresponds with habit, not intention (Gardner et al., 2011).

“Research shows that people who consistently act in healthy ways in daily life do so out of habit” (Wood & Neal, 2016).

Image 4
A depiction of a woman biking to church.
At Prayers on a Solitary Pursuit by Sophia Oshodin (2022)

HOW TO CHANGE HABITS

Habits are stored in memory and familiar contexts and routines will bring unhealthy cues to mind and potentially trigger old patterns. Erasing bad habits requires neutralising the context cues that trigger the habit performance (Wood & Neal, 2016). Though this is possible, behaviour change is more easily managed by substituting undesirable habits with more desirable ones (Gardner & Lally, 2018).

According to Wood and Neal (2016), there are three main strategies to reduce the impact of existing cues: (1) cue disruptions, (2) environmental reengineering, and (3) vigilant monitoring or inhibition.

1 **CUE DISRUPTION**
Habit discontinuity interventions leverage context shifts – such as moving to a new house, starting a new job, or having a child – as an opportunity to be no longer exposed to cues that trigger old habits.

2 **ENVIRONMENTAL REENGINEERING**
Altering the performance environment can add additional friction for unhealthy options while making healthy options easier.

3 **VIGILANT MONITORING**
Increasing awareness of cues that trigger unwanted behaviours allows for vigilant monitoring, using conscious thought to control automatic processes.

THE ROLE OF TECHNOLOGY IN THE DISRUPTION OF HABITS

Technology presents a possible intervention in the habit cycle to enhance the process of replacing unwanted actions with more desired alternatives. In fact, in a review of 72 studies, a vast majority found digital technology to be an effective way to disrupt habits, regardless of target behaviour or feedback technology used (Hermsen et al., 2016). Digital technology can aid in: (A) providing instant feedback and gratification, (B) supporting awareness and self-monitoring, (C) accelerating automaticity through enhancing cues and rewards and, (D) disrupting the cue-response association (Lally & Gardner, 2013).

> The terms wearables, wearable devices, or also wearable technology refer to **small electronic and mobile devices**, or computers with wireless communications capability that are **incorporated into gadgets, accessories, or clothes**, which can be **worn on the human body**, or even invasive versions such as micro-chips or smart tattoos.
>
> Ometov et al., 2021

2.2.2 WEARABLE TECHNOLOGY

"Wearable" is a colloquial term to describe wearable technology which encompasses a broad variety of devices that are, simply put, worn on the body.

The main value proposition of most wearable devices is that they provide users with a seamless, integrated, hands-free solution that is less disruptive than traditional computers and smartphones (Ferreira et al., 2021). They can provide various monitoring and measuring features, including fitness tracking and biometric sensors, that are fed back to the user to incorporate into their daily life. The most commonly measured data include vital signs such as heart rate, blood pressure, body temperature, and blood oxygen saturation, posture, and physical activities (Mu & Luo, 2019).

Wearable devices take many different forms and can be attached across the body as bands, belts, rings, glasses, shoes, jewellery, clothing, and as skin-attachable devices. Recent technological advances are also allowing for the advent of smart tattoos, ingestibles and insertables.

To date, the primary aim of most devices falls into one of the following categories: fitness tracking, AR and VR, and medical or close-to-medical devices.

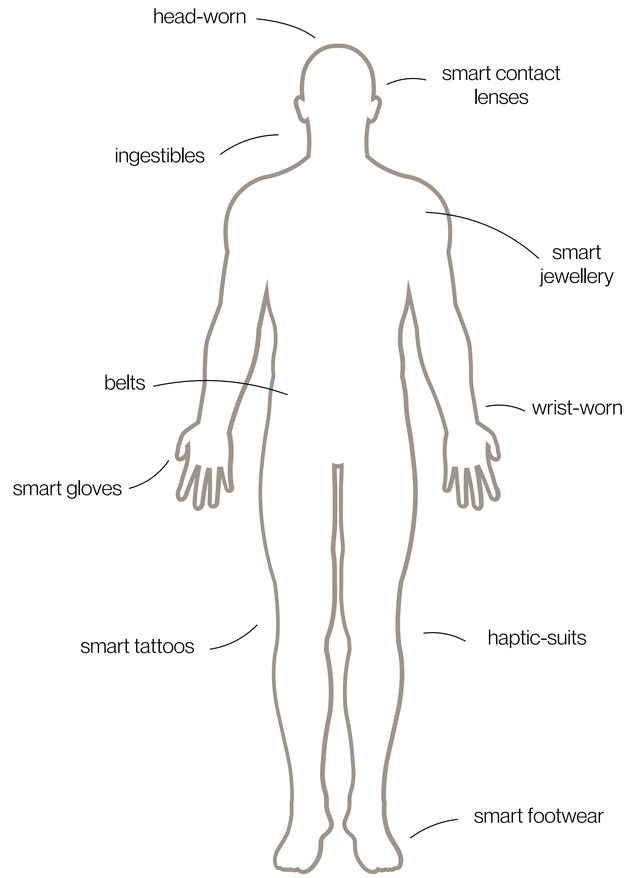


Figure 11
Common and emerging wearable device types

THE RISE OF WEARABLE TECHNOLOGY

Most broadly defined, wearables can be seen as a worn piece of technology including glasses and watches which were invented as far back as the 13th century (James, 1923). However, the technological revolution of the mid- to late-20th century brought the advent of “smart” devices and the modern definition of wearable devices emerged as worn technology with computing capabilities.

The rise of the wearable market, as we know it today, started with the introduction of the Fitbit in 2007. Since the late 2000s, Apple, Google, Microsoft, and Meta have all released consumer wearables making them commonplace in society today with more than one-third of Americans using a smartwatch or band to track their health and fitness (Dhingra et al., 2023).

One-third of Americans use or have used a smartwatch or band (Dhingra et al., 2023).

Most recently, wearables have started to enter the healthcare space, offering constant health monitoring and communication between patients and doctors. Spurred by the COVID pandemic, increased interest in health monitoring has led to rapid development and advancements in this domain (Channa et al., 2021).

Image 5
Praxa Sense’s Afi device that allows for remote monitoring of cardiovascular health (praxasense.com)

THE WEARABLES MARKET

The global wearables market is well established with hundreds of options available to consumers and from a monetary perspective, is expected to keep growing exponentially in the coming years. In fact, it is forecast at more than a 20% annual growth rate with the market expected to reach more than 150 billion euros per year by 2028 (Ometov et al., 2021).

The wearables market is predicted to grow to 150 billion euros in yearly revenue by 2028 (Ometov et al., 2021).

Many have predicted a major shift in the industry, with a transition from wristbands and fitness trackers to a greater focus on augmented and virtual reality. One of the most promising value propositions of wearable devices is their ability to relieve people from constantly holding and checking their smartphones. Wearables open up opportunities for integrated displays and non-disruptive interaction. As we move toward creating a hyper-connected society, wearables also play the role of integrating real and virtual worlds, connecting people, things, and spaces (Lee et al., 2016). In this context, wearable devices permeate new industries such as eHealth, workers’ safety and efficiency, as well as gaming and sports.

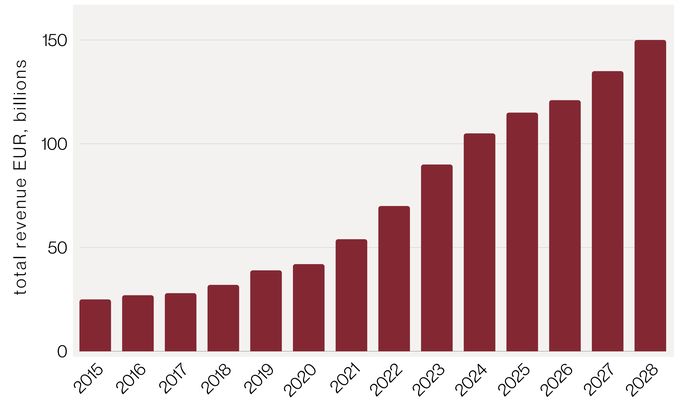


Figure 12
Wearables market growth forecast (Ometov et al., 2021)

THE IMPACT OF WEARABLES ON HEALTH & WELLBEING

Technological innovations, including wearables, often encourage customer empowerment and focus on leading a healthy lifestyle (Spanakis et al., 2016). A key component of health management is self-monitoring (Payne et al., 2015). Many products aim to track and provide insights into various behaviours, giving users the knowledge to self-monitor and make health-promoting decisions in everyday life.

When focusing specifically on wearables targeting health and wellbeing, they have a proven positive impact in promoting healthy behaviour changes and improving outcomes in areas such as cardiovascular disease, weight loss, physical activity, stroke, and general quality of life (Wortley et. al., 2017). One of the major mechanisms is the potential to increase physical activity (Hickey & Freedson, 2016; Lewis et al., 2015; Bort-Roig et al., 2014; Stephens &. Allen, 2013).

Physical inactivity is a major public health problem, with 23% of adults worldwide not meeting recommended levels of daily physical activity (McCallum et al., 2018).

Physical inactivity is a major public health problem, with 23% of adults worldwide not meeting recommended levels of physical activity (McCallum et al., 2018). Many illnesses such as cardiovascular disease, obesity, and type 2 diabetes can be improved through simple lifestyle changes such as increased movement and proper nutrition choices (Rippe, 2018). Even simple activity trackers and step-counters offer enough awareness and motivation to create impactful positive change.

CHALLENGES & LIMITATIONS

Issues including user acceptance, security, ethics and big data concerns still need to be resolved to support the growth of the wearables industry. When it comes to user acceptance, the majority of people are open to the idea of wearable devices with 70% of early adopters and 60% of elderly people showing interest in next-gen wearables (Ometov et al., 2021; Mu & Luo, 2019). However, one of the challenges facing the market is that one-third of American consumers who have owned a wearable product stopped use within six months.

Donald Norman, a cognitive scientist, notes that “much of what is being done with wearable devices is happening simply because it can be done,” (Norman, 2013). His perspective is that wearables act as a distraction in everyday life, contributing to the loss of focus and efficiency on the task at hand. In order for the technology to become fully ingrained in the user’s life, it must augment experiences and focus attention rather than take away from it.

> **“Much of what is being done with wearable devices is happening simply because it can be done.**
>
> - Don Norman, 2013

In a similar vein, Dave Evans, Cisco’s chief futurist, has said that the future of wearables lies in the idea of “aware-able,” where functionality shifts from a simple tracking role to one of meaningful and appropriate, context-aware solutions. Research shows that 90 to 95 per cent of people are not motivated by looking at data (Schüll, 2016). Deeper, more personalised insights can be delivered through data analysis technologies such as signal processing, pattern recognition, data mining, machine learning, and other artificial intelligence methods (Perera et al., 2014), creating a shift toward smarter, more feature-rich products.

Another major concern surrounding the industry is that of security and data protection. Because wearable devices collect a huge amount of highly personalised data, the issue of data security requires further attention and research. There are data privacy laws in most countries designed to protect the rights of their citizens. However, despite protocols to keep data private, most wireless solutions are exposed to privacy threats from attackers who either intend to steal data for their own use or install malicious hardware and software (Ometov et al., 2021). Since the majority of wearables rely on device-to-device communication, a more secure solution is needed to ensure the data security of users.

Derived from the Greek verb “haptesthai,” meaning “to touch,” haptics is the science of sensing and manipulating through touch.

Eid & Osman, 2016

2.2.3 HAPTICS & VIBROTACTILE FEEDBACK

In the realm of habit formation, the integration of vibrotactile feedback has the potential to enhance processes and make long-term behaviour change more achievable on an individual level. Leveraging haptic technology’s capacity to provide subtle tactile cues and rewards in the form of vibrotactile feedback presents a promising avenue to enhance cue-response association, reinforce learned behaviours, and accelerate the automaticity of habits.

UNDERSTANDING HAPTIC FEEDBACK

The sense of touch is one of the most important ways humans perceive the world around them. Derived from the Greek verb “haptesthai,” meaning “to touch,” haptics is the science of sensing and manipulating through touch (Eid & Osman, 2016). In modern human-computer interaction, haptics refers to the study of human touch and force feedback (Culbertson et al., 2018). Haptic sensations offer a subtle and private way to provide feedback that is easily engaged with or disengaged from (Umair et al., 2021) making them a promising technology in the wearables space.

The sense of touch is typically divided into two modalities: kinesthetic and tactile (Culbertson et al., 2018). Kinesthetic sensations involve forces and torques sensed in muscles, tendons, and joints typically from movement of the body. Tactile sensations include pressure, shear, and vibration sensed by mechanoreceptors embedded in the skin, typically from feeling or holding objects (Culbertson et al., 2018). Understanding these distinctions is crucial for developing wearable devices that effectively utilize haptic feedback to enhance user experiences and improve interaction quality, ultimately leading to better user engagement and satisfaction.

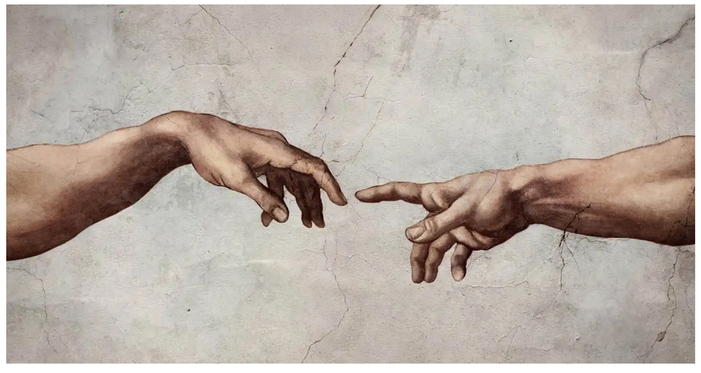


Image 6
The Creation of Adam by Michelangelo (1508-1512)

To date, three main types of tactile feedback have been established in technology and electronic devices. They can be distinguished by the type of actuator used in each system (Islam & Lim, 2022):

1 **ELECTROTACTILE FEEDBACK**
Delivers haptic sensations to the user's skin using electrodes placed on the surface of the skin (Pamungkas and Caesarendra, 2018).

2 **THERMAL FEEDBACK**
Uses actuators to move heat around the skin, enhancing both visual and nonvisual feedback, and providing an additional sensory channel (Islam & Lim, 2022).

3 **VIBROTACTILE FEEDBACK**
Acts as a sensory substitution, offering by sending alerts through vibration (Lindeman et al., 2005; Vichare et al., 2009; Jones and Sarter, 2008; Ho et al., 2005).

Figure 13
Examples of graspable, wearable, and touchable haptic systems (Culbertson et al., 2018)

TYPES OF HAPTIC DEVICES

Utilising the three types of tactile feedback, there are also three main types of devices that encompass the landscape of haptic systems and offer a diverse range of applications. The categories show the breadth of modalities used across both kinesthetic and cutaneous stimulation.

These are the foundational elements in which most haptic systems are designed. They employ one of the three haptic feedback mechanisms, electrotactile, thermal, or vibrotactile, and take form as either a graspable, wearable, or touchable device. Of course, this does not include every device designed to date. The depth of the field is ever-expanding with new innovations released constantly.

For the purposes of this research, we will focus solely on vibrotactile feedback due to its subtle and discreet nature combined with its ability to communicate semi-complex information, making it ideal for daily use in various environments.

1 **GRASPABLE SYSTEMS**
These systems involve kinesthetic mechanisms and are typically grounded, providing users with a sense of physical interaction. They allow the user to push on them (and be pushed back) through a held tool.

2 **WEARABLE SYSTEMS**
Designed to be worn on the body, wearable haptic systems provide users with subtle vibrations, lateral skin stretch, and normal skin deformation. They also include exoskeletons that create a reaction force on less sensitive body parts.

3 **TOUCHABLE SYSTEMS**
This category includes displays that allow the user to interact with the surface. They can be fully cutaneous or hybrid cutaneous and kinesthetic, changing shape and mechanical and surface properties (Culbertson et al., 2018).

HUMAN VIBRATION SENSING & SKIN SENSITIVITY

Humans have two different types of receptors that sense vibration, each responsible for different frequency ranges. The first, Meissner corpuscles, sense lower frequency vibrations in the 5-50 Hz range and exist in glabrous (non-hairy) skin. While Pacinian corpuscles, which are found in hairy skin, sense higher frequencies in the 40-400 Hz range (Culbertson et al., 2018).

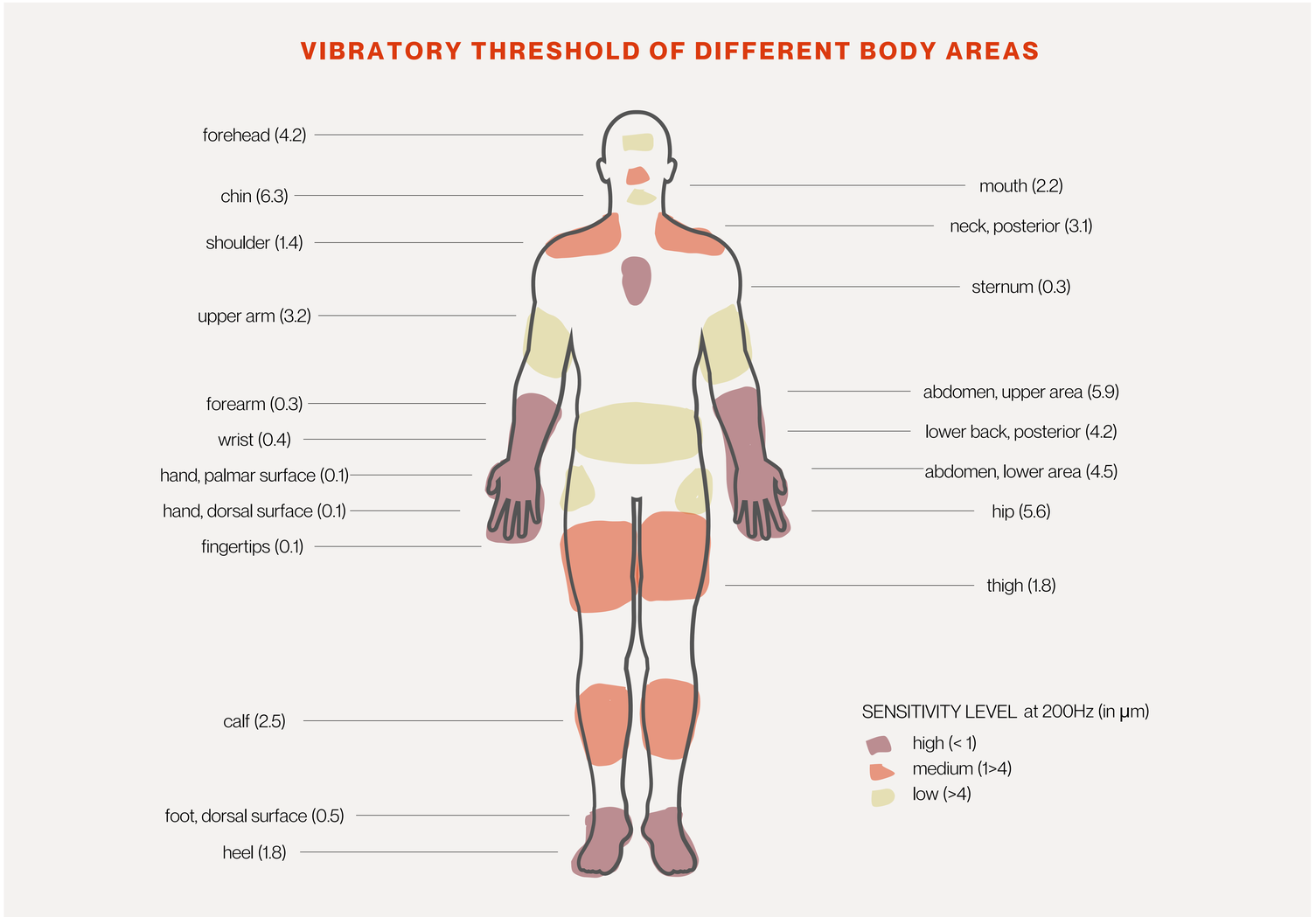
Skin's sensitivity to vibration varies across the body and relies on two primary factors, vibration frequency and stimulus intensity (Choi and Kuchenbecker, 2012; Jones and Sarter, 2008). Contact area, stimulus duration, skin temperature, and age all play roles as well. Thresholds for detecting vibration at various body sites vary greatly with fingertips being the most sensitive (0.07 μm at 200 Hz), and abdominal and gluteal regions being the least (4–14 μm at 200 Hz). Overall the optimal sensitivity is achieved at 200 and 450 Hz across all body sites (Wilska, 1954).

The most common vibrating actuators typically produce vibrations above 100 Hz. These frequencies are better sensed in areas with hairy skin that contain Pacinian corpuscles (Culbertson et al., 2018). This is an important consideration for the form-giving of wearable devices.

Beyond that, the somatosensory system has a lower capacity to distinguish variations in vibrational patterns than the auditory system, making waveform another important variable. Because both glabrous and hairy skin are more sensitive to higher frequencies, waveforms with larger amplitudes and higher frequencies are easier to identify (Azadi & Jones, 2014).

Although easier to identify, high-frequency vibrations can also be perceived as stressful, increasing self-reported anxiety. Vibrations delivered with a frequency lower than the average heart rate, in contrast, helped to decrease heart rate and lead to feelings of less anxiety (Umair et al., 2021). Umair et al.'s 2021 study explored frequency preferences for the downregulation of stress. The majority of participants preferred frequencies of around 30 bpm (2021). This is consistent with Israr and Abnousi's findings that low frequency (<40 Hz) at low amplitude is felt as pleasant while at high frequency, high amplitude is biased toward unpleasant (2018).

Figure 14
Vibratory Threshold by Body Area (Islam & Lim, 2022)



THE POTENTIAL OF VIBROTACTILE FEEDBACK IN WELLNESS DEVICES

The continued exploration and incorporation of vibrotactile feedback in habit-formation wearables presents significant potential to enhance the way individuals engage with health and habit formation. This technology, when integrated into wellness devices, offers a variety of unique opportunities to encourage behaviour change.

As previously noted, the presence of cues and rewards play significant roles in the habit formation process and are key to long-term behaviour change. However, it is challenging to control these variables in day-to day life. Vibrotactile feedback has the potential to provide immediate, tangible cues and rewards that can complement or replace traditional visual and auditory cues. The tactile nature of this type of feedback can increase the speed of automaticity of behavioural responses in a user's routine aiding in the transition from conscious to unconscious effort, while the immediacy helps to reinforce the habit formation process which is ultimately the key to long-term change.

Vibrotactile feedback has the potential to provide immediate, tangible cues and rewards that can complement or replace traditional visual and auditory cues.

In addition to offering real-time cue and reward enhancement, vibrotactile feedback, by nature, is subtle and discreet allowing for a private relationship with the product service system. Health and wellness can be incredible personal aspects of an individual's life that they will experience different levels of comfort in sharing or externalising. While visual and auditory feedback can often be seen or heard by others, vibrotactile feedback is delivered only to the user.

A variety of variables also become highly personalizable components of the design. Different behaviour patterns and habits can be matched with a highly personalised training program. Different waveforms can be personalised to match the user's comfort and perception to encourage adherence to the program. All of these factors combined, make vibrotactile feedback a promising communication modality in the pursuit of enhancing the habit-formation process.

Image 7
Somnox mimics breathing rhythms to help users sleep (somnox.com)

Image 8
Quell uses tactile feedback to turn home fitness into a game (playquell.com)

LITERATURE REVIEW SUMMARY & CONCLUSION

In this analysis, we took an in-depth look into the existing research related to habit formation, wearables, and haptic feedback, looking for design opportunities. To begin, we explored the topics of behaviour change and habits and their impact on health and wellness. Then we dove into the landscape of wearable technology, focusing particularly on its growing relevance for consumers and effectiveness in encouraging healthier lifestyle choices. Lastly, we zoomed in on haptic technology, specifically vibrotactile feedback, approaching it as an innovative solution to enhance the habit-formation process. In conclusion, a high-level summary of key insights and the research limitations are provided before moving on to the user research sections.

Image 9
Depiction of a woman running, a common healthy habit. Female Rummer II by Willi Baumeister (1925)

SUMMARY

To summarise the key findings from the literature review, at the intersection of habits, wearable technology, and vibrotactile feedback, we found that:

1. Daily habits have a profound influence on overall health, in fact, good habits around physical activity and nutrition can play a huge role in preventing some of the most common diseases like cardiovascular disease and diabetes.

2. Wearable technology has already proven its ability to influence health-related behaviours in the short term.

3. Vibrotactile feedback, with its discrete and subtle nature, emerges as a pivotal tool in reinforcing behaviour change, turning short-term healthy choices into long-term healthy habits.

LIMITATIONS

This research is not without limitations. Despite decades of investigation in the individual domains of behaviour change and haptic feedback, there are notable gaps, particularly concerning vibrotactile feedback's role in habit formation. The existing literature focuses on short-term experiments and pilot studies, which do not help to provide a holistic picture of this topic area. In particular, it's constrained by a lack of long-term longitudinal studies. Longitudinal studies would help us to better understand how users respond to vibrotactile cues over extended periods and how to prevent desensitisation of the feedback modality.

In addition, these findings are highly context-specific, and their utility may vary across different populations and cultural contexts. This leads us into the next phase of research where we will uncover deeper insights into individual experience and preferences as well as perceptions of wearables and vibrotactile feedback.

2.3 USER RESEARCH

To complement the literature review, we explore user perceptions of habits, wearables, and vibrotactile feedback through a two-part user research program. The first part includes a short survey sent to 14 participants to collect general data on personal experiences and preferences. The main aims of the survey are to gain some initial insights into user perceptions and further define the target group. In the second part of the research, we will dive deeper with longer format qualitative interviews with four participants. These interviews pull from the selected target group defined through the survey analysis and are an in-depth exploration of the topics covered in the survey.

PRELIMINARY SURVEY

To begin the user research phase of this project, a preliminary survey was sent out to the broader target demographic to better understand their relationship to health management, wearables, and vibrotactile feedback. The insights from this survey were used to craft the in-depth interviews that followed.

AIM

The aim of the survey is to get a better understanding of different customer groups and their preferences and to start to narrow down the specific customer group to design the product for, we've constructed and distributed a short survey to a diverse sampling of 14 participants.
The aims are to:

1. Understand different types of users' experiences with habits in the past
2. Rank habits from most important to least important
3. Uncover existing perceptions about wearables
4. Collect insights into past interactions with vibrotactile feedback

METHOD

The six-part survey is composed of twenty-two questions ranging from short-form answers to Likert scales and ranking activities (See Appendix A for the full survey.) It can be completed in fifteen minutes or less making it easy to collect data from a broad variety of participants. A snowball sampling strategy was used, starting with the researchers' friends, family, and colleagues, who were then asked to share the survey within their circles. This strategy resulted in 14 participants ranging in age, gender, occupation, and location.

Table 1
Overview of Survey Participants

VARIABLE	PARTICIPANT REPRESENTATION
Gender	64% Female / 36% Male
Age	29% 20-30, 36% 30-40, 7% 40-50, 28% 60-70
Occupation	Including Marketing, Architect, Student, Entrepreneur, Retired and more
Location	The United States, the Netherlands, Germany, and Norway

To analyse the results, a mixed-methods approach was used, integrating both quantitative and qualitative techniques. Cross-tabulation was used to explore correlations between different variables, such as demographic information, and specific habits. For the open-ended questions, thematic analysis was applied to form insights that will later be used to construct design concept drivers.

RESULTS

The results of the survey data will be broken down into three parts. Part 1 will describe basic learning from the survey such as average health prioritisation and starting familiarity with wearable technology. Next, we will look into the habit insights around which habits are prioritised and which are not. Last, we will explore insights related to perceptions of wearable and vibrotactile feedback.

Based on the entire data set, the average rating for health prioritisation was 5.3 out of 7 indicating that the sample population places a high level of importance on making health-based decisions in daily life. Younger age groups such as those in their 20s and 30s rated an average of 5 out of 7. Those in their 50s, 60s, and 70s rated health as a

slightly higher priority with an average of 5.75 out of 7. Men gave an average score of 5.6 of 7 while women gave an average score of 5 of 7.

When rating their familiarity with wearable technology, the average score was 4.2 out of 7, suggesting a moderate level of familiarity among participants. People in their 20s gave the lowest rating with an average of 3.3 and 30s with an average of 3.8, while participants in their 60s gave an average rating of 5 out of 7. The male participants averaged 4.6 while the females averaged a score of 4 out of 7.

When asked to rate:

How much they prioritise health...
The average score was **5.3/7**

<60	**5.0/7** ↓		♂	**5.6/7** ↑
>60	**6/7** ↑		♀	**5.0/7** ↓

How familiar they are with wearable technology...
The average score was **4.2/7**

20s	**3.3/7** ↓		♂	**4.6/7** ↑
60s	**5/7** ↑		♀	**4.0/7** ↓

High-level questions about past experiences with habits and habit formation were asked. All participants indicated that they have attempted to form a new habit or break an old one at some point in the past. When asked which habits they are currently trying to form or have worked on in the past, the most common responses included exercise (mentioned 9 times), diet or eating healthy (mentioned 6 times) and meditation or mindfulness (mentioned 6 times.) Other frequently mentioned habits included journaling, drinking less alcohol, consuming water, and reading.

When asked which tools they've used in their habit-making, reminders

was the most commonly mentioned tool (4 times). This was followed by some kind of accountability, including an accountability partner, a paid experience, or social support. Each of these was mentioned once. One participant wrote, "I started changing my eating habits at the same time as another friend. It was good support." Other commonly mentioned tools include to-do lists, goal setting, scheduling, and tracking including with the use of wearables or app-based products.

Participants mentioned the following tips for forming habits: goal setting, accountability, reminders, and tracking. Three participants also indicated that they did not have any tricks.

"The most important trick has been to remind myself of what it is I want, and then be willing to make incremental steps toward that."

When asked about the challenges faced, participants mentioned consistency, willpower, motivation, and forgetting most, each mentioned four times. One participant wrote that they struggle to maintain "motivation over [a] long period, changes in circumstances make it easier to forget." They also mentioned losing track of their goals, getting frustrated, and falling back into old patterns of behaviour.

Participants were asked to rank the goals most important to them as well as rank negative habits that they would like to change. A pre-selected list of 8 habits was provided along with a free-form option to fill in any habit not included on the list. The average ranking of these goals is:

1. Regular exercise
2. Getting enough sleep
3. Eating healthy foods/following a diet
4. Adequate hydration
5. Social connectivity
6. Limiting alcohol and/or avoiding smoking
7. Stress management
8. Meditation or mindfulness practices

Habits added in the free-fill option included dog walking, reading, and hard cardio.

When ranking habits that they would like to change, participants were provided with a pre-selected list of 10 habits with an additional option to fill in as they please. They were asked to leave out any habits that they did not participate in. Based on this, the average ranking of these habits is:

1 Skin picking
2 Excessive screen time
3 Poor sleep habits
4 Procrastination
5 Lack of physical activity
6 Excessive alcohol consumption
7 Poor stress management
8 Overeating or unhealthy eating
9 Nail biting

The habit not included in any ranking was smoking either because participants do not participate in the activity or do not wish to change it.

Habits added in the free-fill option included “slouching” and “inner jaw biting.”

In part 4 of the survey, participants were asked about their experiences with wearable devices. 65% said that they, currently or in the past, have worn a wearable device. For them, the most commonly worn devices include the Apple Watch, the Fitbit, and the Oura ring. One participant also had experience with medical devices including an insulin pump and continuous glucose monitor.

65% of participants wear or have worn a wearable device in the past.

The features they found most useful are heart rate and HRV tracking (mentioned 6 times), exercise tracking (mentioned 4 times), and sleep tracking (mentioned 3 times). Other features mentioned were reminders, goal setting, notifications, fall detection, and menstrual cycle tracking. When asked which features they didn’t like or found useless most did not provide specific answers but three participants mentioned that they found the device distracting.

When asked if they had any concerns regarding using a wearable device, comfort and battery life were both mentioned 4 times. Privacy was mentioned twice and durability and integration with existing devices were each mentioned once.

Moving on to perceptions about vibrotactile feedback, 71% of participants indicated that they had used some kind of device with vibrotactile feedback in the past. Of these participants, when asked about their experience, six mentioned that they like it with remarks like, “less irritating than audible notifications,” “feels engaging,” and “I like it!” Three participants mentioned that they found it annoying or disruptive, noting, “annoying and distracting,” and “can be disruptive.” They also mentioned two unique use cases for the feedback one being that it signals an event or notification and the other that it acts as a confirmation of an action.

DISCUSSION

These survey results provide a look into the user perspectives on habit formation, wearable technology, and vibrotactile feedback. These insights will guide the design process for a habit-forming wearable device through their translation into key design concept drivers.

GENERAL INSIGHTS

Health Prioritization: Among this sample, there was a general inclination toward health-conscious decision-making. The slight increase in health prioritisation among the older demographics could reflect a growing awareness and need for health management later in life.

Wearable Technology Familiarity: There is a moderate level of familiarity with wearable devices among participants, despite age, occupation, and location variances. The slightly lower scores among the younger age brackets could reflect either a lack of access to wearable technology, potentially due to their often higher price points, or differing priorities. Conversely, the higher scores among the older demographics suggest an openness to technology-assisted health management.

HABIT FORMATION INSIGHTS

Popular Habits: Frequent mentions of exercise, diet, and mindfulness either indicate that these are highly prioritised habits or that they are the most commonly referenced habits and therefore easiest to recall.

Tools, Tricks, & Challenges of Habit Formation: The common mentions of willpower, motivation, and falling back into old patterns of behaviour all reflect the research insights from the literature review section. Tricks such as reminders, accountability, and to-do lists all align with existing knowledge on behaviour change strategies.

WEARABLE DEVICE EXPERIENCE & VIBROTACTILE FEEDBACK PERCEPTIONS

User Experiences with Wearables: There was a diverse range of features that users found most useful from their past experiences with wearables with a high focus on units of measure (heart rate) versus more generalised insights (stress scores). However, users also expressed concerns regarding comfort, battery life, and distractions.

Vibrotactile Feedback: Reactions toward vibrotactile feedback were mixed with the majority of participants feeling positive, especially in the context of replacing auditory feedback. Some participants also expressed that they found it distracting or intrusive.

IMPLICATIONS FOR DESIGN

The insights gathered here are instrumental in shaping the coming design process. The data highlights a need for opportunities for personalisation to fit individual users' needs. The next phase of user research will delve deeper into these insights, particularly focussing on uncovering deeper insights into which habits are most important and most targeted for change by the target group. This exploration will aim to uncover nuances in user experiences and expectations for wearable technology.

IN-DEPTH USER INTERVIEWS

Building on the initial results of the survey, in-depth user interviews were conducted with a small set of participants with a range of ages, locations, and occupations. These interviews went deeper on the topics of health prioritisation, changes in approaches as one ages, successes and challenges of habit formation experience in the past, and perceptions of wearable technology and vibrational feedback.

AIM

The survey results offered valuable high-level insights into how users prioritise their health and habits. The primary aim of the in-depth interviews is to gain an understanding of the emotional and psychological processes associated with habits and wearables. The interview guide is broken down into multiple sections including (1) prioritisation of health and changes with time, (2) associations, emotions, and psychological processes underlying habit formation, (3) perceptions and experiences with wearables and vibrotactile feedback.

METHOD

The in-depth interviews formed the qualitative investigation component of this research. A semi-structured interview format was employed to allow for deep investigation and flexibility, enabling participants to express their thoughts comprehensively (see Appendix B for the full interview guide and informed consent form.)

Four participants were recruited using a purposive sampling technique, ensuring a diverse representation across demographics including age, gender, occupation, and geographic location. The interviews were conducted both in-person and online and each lasted about 60 minutes to allow for in-depth storytelling and detailed response.

Table 2
Demographics of participants

	Gender	Age	Occupation	Loc.
P1	Male	25 y/o	Student	NL
P2	Female	31 y/o	Marketing	USA
P3	Male	46 y/o	Start-up Founder	NL
P4	Female	64 y/o	Advertising	USA

The interview guide was structured into four main sections: background information, habit formation associations, success, and challenges, past experiences and perceptions of wearables and vibrotactile feedback. This organisation allowed for a logical flow of questioning that started with high-level general information and progressively delved deeper into emotions and thought processes.

Each interview began with a brief introduction to the study's purpose, informed consent, and an explanation of confidentiality. All interviews were audio recorded with consent from the participants, ensuring no personally identifiable information was included in the recordings. The data were then transcribed and the recordings destroyed to maintain confidentiality. The analysis of the transcripts employed thematic analysis, identifying patterns and themes related to habit formation and the role of wearable technology. This method provides rich, detailed insights used in the development of user personas, journey mapping, and design concept drivers.

RESULTS

Analysing the interview transcripts using thematic analysis, generated five core themes on the topics of habits and wearable technology. The main findings are summarised below and provide a foundational understanding of the target audience's needs and experiences. They follow the structure of the interview guide, touching on each section.

1 HEALTH AND WELLBEING PRIORITISATION

Though the participants displayed a variety of attitudes towards health prioritisation, all scored themselves at least five out of seven and as high as seven out of seven. This illustrates the importance of health and well-being in the daily lives of these participants who treat health as a major factor in their decision-making. All four participants mentioned that balance, and not going to any extreme, is also a priority. They all strove to make healthy choices but not so much that it would lead to obsession, rigidity, or negative associations.

"I would say it's 6, but it's not a 7 because I am not obsessed. I can have some breaks sometimes I just treat myself."

Three of four participants also mentioned that health has become more important to them as they've gotten older, often from wanting to stay healthy for longer. Some cited personal experiences such as life changes or illnesses that led to a reprioritisation of health. One shared that they wanted to stay healthy for their child while another noted that watching their parents age motivated them to build health now. In addition, taking care of one's mental health became more important to participants as they grew older.

2 HABIT ASSOCIATIONS

When asked to free-associate based on the word "habit," participants provided a variety of responses from habit definitions to types of habits themselves. It's clear that this group, views exercise, diet, and sleep as the main categories. Other habits that were mentioned frequently included socialising, alcohol consumption, and stress management. They all recognized that habits can be both positive and negative by mainly focusing on the development of good habits versus reducing or eliminating bad habits. When asked to rank the habits that were most important to them to least important, participants gave the following responses:

Participant 1

1. Sleep
2. Exercise
3. Eating
4. Social

Participant 2

1. Hygiene
2. Grocery shopping
3. Exercise
4. Cleaning

Participant 3

1. Sleep/rest
2. Eating
3. Exercise
4. Stress management

Participant 4

1. Sleep
2. Hydration
3. Exercise
4. Social

Three of the four participants ranked sleep as their highest priority habit. When asked to explain their sleep habits, they spoke of the activities they do and do not do leading up to sleep Several mentioned that they avoid screens such as televisions and phones and instead relied on tea, meditation, and reading to relax and prepare for sleep.

“Sleep is very important, put that at the top because without sleep, then everything else doesn't work.”

All four participants included exercise on their list of top four habits, though it did not take the first position for anyone. Two participants mentioned social habits such as spending time with family and friends, and two participants also mentioned eating habits on their lists.

3 ENABLERS & BARRIERS OF HABIT CHANGE

Participants identified several enablers of behaviour change including reminders, tracking, different types of accountability, combining with existing habits. They shared personal tools and experiences building and changing habits in the past using tools such as digital reminders, accountability partners, and making small changes over time. Conversely, barriers including external factors, such as environmental changes and time, and internal factors, such as mental fatigue and laziness, proved obstacles for habit formation and maintenance. Many participants talked about times when their lives changed, such as moving or changing jobs, and how it impacted their habits. They often sought out mindful and conscious ways to replace habit cues in order to maintain the behaviour, though not without some struggles and failures. Two participants also explained how starting a habit from a stagnant place is more difficult than doing it after another activity. For example, going to the gym after resting at home versus going to the gym directly after school.

“I don't play water polo anymore, so that kind of prompting was gone.”

“[It’s harder to] go from a stagnant position to being more active. I think of it like the law of inertia, an object in motion stays in motion.”

One of these participants compared this to the law of inertia. In addition, the “cost” of a behaviour was referenced, describing that sometimes the cost of a behaviour change is bigger than the reward which makes the habit difficult to build. For example, the cost of stopping alcohol consumption is perceived as higher than the benefit to one’s health therefore the change is not prioritised.

4 EMOTIONAL & COGNITIVE ASPECTS OF HABITS

It's clear that emotions play a strong role in the development and maintenance of habits. Several participants talked about their inner dialogue in the lead-up to completing a habit. They shared that though at first, they feel positive and even excited, when the time comes, they enter into a back-and-forth conversation with themselves, jumping from I will do it to I will skip it. One participant personified these two voices as two people: two different versions of themself. When the voice telling them to do it won, it often used the strategy of reminding them of the feeling they will have upon completion, one of confidence, pride, and accomplishment. This feeling served as a reward that they were able to use as future motivation to keep the habit going. One participant mentioned that they consciously think about a specific, highly motivating reward, in their case, it was the idea of skiing with their son until he reaches 18 years old. On the other hand, when they did not complete the habit, participants spoke about the importance of not being too hard on oneself to avoid developing a negative association in the future.

“The person who's setting the goal the night before is super optimistic and enthusiastic and remembers how nice it felt the day before. But the person hitting the alarm is not always as convinced by that voice from the night before.”

On the topic of wearable technology, participants talked about the features that also helped to strengthen the reward for completion such as the Apple Watch’s daily rings. While features such as heart rate tracking made the experience of working out more fun, several participants noted that the daily goals were what drove consistent action.

5 TECHNOLOGY INTERACTION & DEPENDENCY

All four participants used wearable devices, specifically the Apple Watch, to support their health goals. Users appreciated features such as activity tracking, heart rate monitoring, and setting daily goals. However, they all remarked on feeling distracted by the constant notifications. They had all customised the settings to turn off text and email notifications while only enabling health alerts.

“I don't get texts or anything like that. I just felt, I felt all that was just too distracting.”

Overall, these themes illustrate a deeper view of the complexity of habit formation and the mix of personal, social, and technological factors at play. Participants shared a range of attitudes toward health prioritisation, habits, and wearables. The data revealed that habits such as exercise, diet, and sleep are commonly targeted for improvement with participants speaking to the challenges of long-term behaviour change due to time, motivation, and consistency.

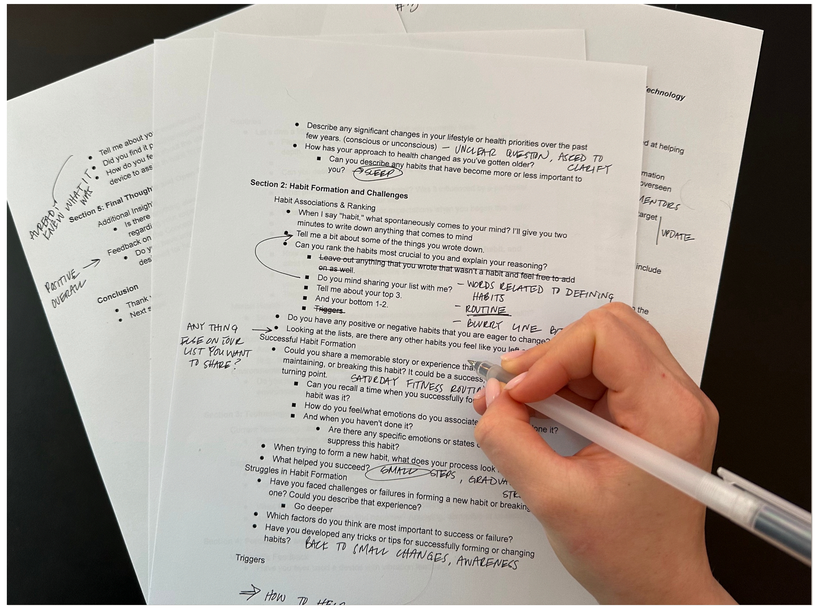


Image 10
A marked-up copy of the interview guide

DISCUSSION

The above themes provide deeper insights into the participants' emotions, cognitive processes, and perceptions of habits and wearable technology. These themes serve as the basis for the creation of concept drivers -- insights that will be used to guide the design process and narrow the solution space.

From these five themes, the following concept drivers were developed. They will be explained in more detail in the following section.

1 WHEN LIFE CHANGES, SO DO HABITS

2 BALANCE OVER OBSESSION

3 THE INNER DIALOGUE OF MAKING GOOD CHOICES

4 DAILY GOALS LEAD TO CONSISTENCY

5 IMAGINING FUTURE YOU

6 ENGAGING VERSUS DISTRACTING NOTIFICATIONS

2.4 THE CONCLUSION

This section explores the key topics of this thesis: habits, wearables, and haptic feedback. The two-phased approach first looked at existing research on the topics then validated and added depth to those findings through qualitative feedback from potential users. It is clear that habits have long been an area of fascination for researchers, with connections back to Aristotle and the ancient Greeks. The challenge of the next section is to take these multifaceted perspectives and turn them into a unified design solution that can solve problems and meet user needs.

Part 3

The Design

Transforming Insights Into a Solution

The Design, part three of this project, takes the learnings and insights from the research and transforms them from problems into a unified solution, manifested as a digital and physical product. This section outlines the design process, starting with a vision statement and concept drivers and moving toward conceptualization and testing.

3.1 THE DESIGN APPROACH

The design phase of this project adopts a three-part process. The first phase focuses on translating insights into direction by developing a design vision statement, personas, and user journey maps. In phase two, the initial design concepts are explored through an iterative process using traditional and digital tools. Then in phase three, the concepts are tested through a validation process that includes usability and ergonomic testing. Insights from the tests are incorporated into the final design concept.

Phase 1 **SETTING THE DIRECTION**
- design vision statement
- user personas
- user journey mapping

Phase 2 **CONCEPTUALIZATION**
- digital concept & prototype
- physical concept & prototype
- haptic design

Phase 3 **TESTING & VALIDATION**
- usability testing
- ergonomics study
- iteration of concept

3.2 SETTING THE DIRECTION

In this section, we take insights from the research phase and build on them to create a design direction including a design vision statement, a recap of the design concept drivers, user personas, user journey maps, and the brand identity for the product-service system.

THE DESIGN VISION

The design vision statement acts as a guiding north star for the project, articulating a clear and structured objective in three distinct parts, each addressing the what, why, and how of the project.

> Empower individuals to **seamlessly integrate healthier habits into their daily lives** by making the habit-formation process **more engaging and effective** through **a smart wearable device** that provides **intuitive and personalised vibrotactile cues** that enhance the cue and reward stages of the process, **speeding time to automaticity** and **reducing the likelihood of falling back into old behaviour patterns.**

THE DESIGN CONCEPT DRIVERS

The design concept drivers distil the insights gathered in the research phase of the project into actionable design goals. Each driver is created based on a compilation of facts and insights from the literature review and user research. Together they function as guideposts, helping to refine the solution space and ensuring the design remains attuned to user needs.

concept driver 1

WHEN LIFE CHANGES, SO DO HABITS

It's clear from the interviews that life is constantly in flux. From moving to becoming a parent, to schedule changes, life is full of surprises and that has a big impact on one's habits. Given that habits are always linked to some type of cue, and cues are subject to change, it can be difficult for individuals to maintain their habits when their environment and schedules change. Several participants shared stories of losing a habit and looking for a new cue in order to return to their old behaviour. Giving users the ability to easily adjust their targeted habits with a wide variety of available cue events will result in a device that can adapt to the flexibility of everyday life instead of being cumbersome to use or restrictive in functionality.

concept driver 2

BALANCE OVER OBSESSION

Though all participants acknowledged that health is a driving factor in their decision-making, they also remarked that balance is preferred to rigidity and obsession and, in fact, extreme mindsets and behaviours are consciously avoided. Though this group is constantly striving to make better decisions regarding their health, they acknowledge that finding their own happy medium between stagnation and obsession is the most important factor. Negative associations can easily become linked to healthy behaviours when an individual engages in self-reproach. Today, many people lead busy lives packed full of activities, from work to parenting, socialisation, hobbies, fitness, and much much more. In order to do so in a way that is conducive to maintaining a well-adjusted mindset, it's important to treat each priority with a degree of flexibility and lightness. Though holding oneself accountable is essential to personal growth, being overly rigid can lead to a suite of negative effects such as increased stress, heightened anxiety, and potential discouragement from setting future goals. In the design of a habit-enhancing device, this consideration must be taken into account, helping people to meet their goals without encouraging obsessive behaviour.

concept driver 3

THE INNER DIALOGUE OF MAKING GOOD CHOICES

Participants described the inner dialogue, the duel of the good and bad voices in their head, either telling them to take action or take the path of least resistance. The experience of talking oneself out of a previously made decision is one we are all familiar with: the ping-ponging back and forth between the devil and angel on each shoulder. So how can we quiet the dialogue or at the very least get the ‘angel’ to more consistently get the final word? The design of the device will incorporate features that reinforce positive self-talk and support good decision-making. For instance, motivational prompts and affirmations could serve to give the ‘angel’ a louder voice. Real-time positive feedback, by way of key data indicators that directly link to desired behaviours, gives small but effective dopamine hits and keeps the momentum and motivation going.

concept driver 4

DAILY GOALS LEAD TO CONSISTENCY

When asked about their experiences with the Apple Watch, users often brought up features that they liked. For example, monitoring one's heart rate during a workout can make the activity more engaging. Or setting a timer to track the length of one's gym session can hold them accountable. However, it was Apple’s three rings, each representing a daily goal, that were cited as motivating long-term changes most effectively. Through this, we learn that although metrics and data play an important role, it’s daily goals that keep people engaged and lead to long-term changes. This insight emphasises the need for the device to not just collect data but also enable the setting and tracking of achievable daily goals. This device can utilise a customizable goal system where the user can set objectives that can be broken down into smaller, daily achievements to encourage frequent reinforcement and sustain long-term motivation. Integrating feedback that both cues and rewards daily victories will keep their goals top of mind and serve as a constant source of encouragement.

concept driver 5

IMAGINING FUTURE YOU

When describing this inner back-and-forth dialogue, participants spoke to this idea of forecasting the future version of themselves that's filled with pride and confidence for completing the task at hand. The anticipation of future satisfaction is a strong motivator, but it can often be overshadowed by immediate discomfort or reluctance. To harness the power of this motivational tool, the design of the device can feature visualisation tools that help the user connect to this feeling of their future self. Or it can offer suggestions for more specific highly-motivating reasons for action such as the example of skiing with one’s 18-year-old child that one participant shared. Integrating goal-tracking functionality that illustrates progress over time can bridge the gap between present actions and future results, making the abstract concept of ‘future you’ more tangible in the present.

concept driver 6

ENGAGING VERSUS DISTRACTING NOTIFICATIONS

Several participants noted that it's hard to ignore the vibrational notification of an Apple Watch. One cannot help but look. They also noted that they preferred the discreet and private nature of a tactile cue versus an auditory or visual one. All participants had turned off the notifications for text and email communications while leaving them on for movement and activity alerts. The effectiveness of a vibrotactile cue is clear, though it can quickly become distracting or disruptive. It is key to allow the user to personalise their experience and limit the total amount of alerts, especially during the times of day that require focus such as during work hours and meal times. The device should aim to be there when you need it and invisible when you don’t. This is no easy task but by approaching the design with a user-centred approach and employing smart algorithms and customization options, the device can learn from the user’s behaviours and intelligently decide when to send alerts and when to remain quiet.

DESIGN

USER PERSONAS

This section presents user personas aimed at humanising the data and providing a clear framework for aligning the project outcomes with the needs of the target audience. Each persona is crafted from a blend of user data, behaviour, and psychographic profiles obtained in the research phase. They serve as archetypical users around whom the design is tailored, ensuring the product resonates with users' expectations, preferences, and needs.

Image 11
AI-generated headshot from unrealperson.com

TECH-SAVVY TARA

Demographics:
Age: 32
Gender: Female
Occupation: Marketing Manager
Education: Master's in Business Administration
Location: San Francisco, CA, USA

Psychographics:
- Fancies herself a 'cool hunter' and enjoys staying up-to-date on the latest technology
- Values efficiency and productivity
- Engages in weekly yoga sessions to relieve stress

Goals & Motivations:
- Always trying her best to maintain a healthy work-life balance
- Motivated by tech that helps her to simplify her life and enhances personal efficiency
- Aims to improve her sleep because her go-go-go days leave her wide-eyed and restless at night

Frustrations & Pain Points:
- Struggles to maintain consistency in her exercise and sleep habits
- Feels overwhelmed by her busy life & finds it difficult to sustain motivation for long-term health goals
- Finds it difficult to disconnect and focus on her physical and mental health

Tara's Story:
Tara lives a fast-paced life which often feels at odds with much-needed rest and relaxation. She used to struggle to fall asleep, laying in bed with her eyes wide open and her mind scrolling through her endless list of to-dos. She saw an Instagram ad for a habit-enhancing wearable device and decided to give it a shot. It allowed her to hone in on a couple of small changes she could make throughout the day to reduce her restlessness at night. Since she started wearing it, she's developed the habit of turning off all screens at 10:00 and taking a hot shower instead. At first, it was difficult to unglue herself from her phone but through some moments of encouragement from the device, she was able to change her behaviour, and now it feels totally natural and she actually looks forward to her nightly routine.

DESIGN

Image 12
AI-generated headshot from unrealperson.com

ACTIVE ALEX

Demographics:
Age: 44
Gender: Male
Occupation: Software Engineer
Education: Bachelors's in Computer Science
Location: Berlin, Germany

Psychographics

- Constantly in pursuit of bettering himself through small daily optimizations
- Actively seeks out ways to integrate technology into his health and fitness routines
- Enjoys outdoor activities like cycling, hiking, and skiing

Goals & Motivations

- Aims to stay fit and healthy as a way to manage stress and maintain high energy levels
- Is motivated by technology that provides data and insights into his outdoor hobbies
- Seeks to manage work-related stress effectively despite his demanding job

Frustrations & Pain Points

- Concerned about the accuracy of health data tracking, especially for stress management
- Struggles to integrate stress management practices into his daily routine
- Often frustrated by the clutter of multiple apps and devices that do not synchronise seamlessly

Alex's Story:
When Alex took his first computer science class, everything clicked. He felt like his highly logical brain was more similar to the computer than to most of his peers. He's motivated by efficiency and self-improvement and lives by the motto, "1% better every day." He puts pressure on himself to perform at work and sometimes struggles to manage his stress. He tried things like meditation but found it hard to stick to them. Since he started wearing his new habit device, he's finally made some longer-term changes. Unlike times in the past when he tried to build new stress-management habits, he's been able to keep up with them and finds completing his daily goals rewarding and satisfying. Plus, he loves collecting data about his activities and looking for other areas to improve his life.

DESIGN

USER JOURNEY MAPS

These user journey maps illustrate how individuals experience the process of building new habits or changing old ones. This section charts the entire arc starting from intention and through to automaticity, mapped along Gardner and Lally's model (2018). It includes challenging moments and the associated emotions along with Abit's opportunities to intervene. This exploration serves as a tool for understanding the user's end-to-end experience and how the concept aims to solve some of the embedded problems.

Figure 15
User journey map for forming a new habit

FORMING A NEW HABIT

GARDNER & LALLY'S MODEL	stage 1 **INTENTION FORMATION**	stage 2 **ACTION INITIATION & SELF-REGULATION**	stage 3a **REPEATING BEHAVIOUR**	stage 3b **DEVELOPING CUE-BEHAVIOUR ASSOCIATIONS**
USER ACTION	The user identifies a desire or need to develop a new habit for reasons like health improvement or skill acquisition and seeks out information needed to plan their future action. They set some kind of goal framework for a certain period of time.	The first actions are taken, such as purchasing equipment or setting a dedicated time and space for the activity. The first repetition of the new behaviour is carried out.	The user begins to find success in establishing a routine with their new activity and starts to begin consistent action. Occasional setbacks may occur but are managed with increasing commitment. The rewards of their behaviours are self-motivating and perpetuate consistent action.	The action starts to become a habit through the strengthening of the cue-behaviour association. It starts to become more ingrained, less conscious, and a regular part of the user's life. They may plan future enhancements and related goals.
EMOTIONS	*positive* deciding to make a change overwhelm of realising it's not easy taking the first steps continuing when it gets hard facing obstacles to staying consistent it starts to get easier & progress is seen life changes challenge routines behaviour becomes ingrained *negative*			
THREATS	Absence of goal setting	Inability to translate intention into action due to forgetfulness or time management issues	Loss of willpower or failure to refine strategy when facing obstacles	Inability to see results leads to lack of interest in maintaining change
ABIT'S OPPORTUNITIES	**Structured goal setting** **Prompted planning & guidance**	**Defined small daily goals** **Presence of automatic real-time cues**	**Consistent cues** **Built-in reward system** **100-day goal cycle**	**Pre-defined, customisable cues that can be adapted to a changing life**

DESIGN

Figure 16
User journey map for maintaining a habit

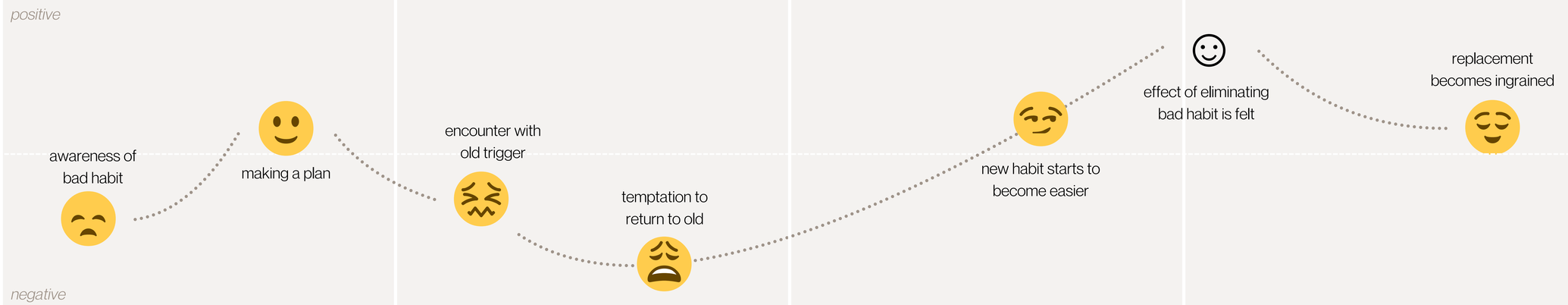
MAINTAINING A HABIT THROUGH LIFE CHANGES

GARDNER & LALLY'S MODEL	stage 1 **AWARENESS OF THREAT**	stage 2 **ACTION INITIATION & SELF-REGULATION**	stage 3a **REPEATING BEHAVIOUR**	stage 3b **DEVELOPING CUE-BEHAVIOUR ASSOCIATIONS**
USER ACTION	The user has established a habit that is a part of their ongoing routines. A cue-behaviour association exists that triggers an existing habit but a life event occurs that disrupts the established routine and changes or eliminates the cue that the habit was formed on.	The user struggles to maintain the habit without the presence of the cue which may cause stress or frustration, They experiment with new strategies to reintegrate the habit into their new lifestyle. They may fail once or twice before they find a cue that works and are able to reestablish their routine.	Over time and repetition, the user finds a new routine that cues the habit within the context of their new lifestyle. Automaticity begins to develop again and the cue-behaviour association strengthens. The internal or external rewards of their behaviours are self-motivating and perpetuate consistent action.	Automaticity takes over and the behaviour once again becomes a habit in its new modified form.
EMOTIONS				
THREATS	Lack of awareness that the habit has been discontinued	Inability to identify a new cue that prompts the habit	Loss of willpower or failure to refine strategy when it doesn't work	Instability in life becomes a constant threat to healthy routines
ABIT'S OPPORTUNITIES	**Habit tracking and awareness of cues**	**Guided programs and suggestions**	**Tracking and built-in rewards system**	**Pre-defined, customisable cues that can be adapted to a changing life**

DESIGN

Figure 17
User journey map for replacing a bad habit

REPLACING A BAD HABIT

GARDNER & LALLY'S MODEL	stage 1 **AWARENESS & INTENTION**	stage 2 **ACTION INITIATION & SELF-REGULATION**	stage 3a **REPEATING BEHAVIOUR**	stage 3b **RE-DEVELOPING CUE-BEHAVIOUR ASSOCIATIONS**
USER ACTION	The user becomes aware of a detrimental habit and makes a conscious decision to replace it with a healthier alternative. They make a plan for how to phase out the bad habit while introducing the replacement The user sets a clear objecting and support mechanisms.	The user encounters the old habits triggers and faces urges to revert back to their old behaviour, challenging their resolve. They acknowledge the trigger and consciously replace old behaviours with the desired new ones through direct replacement, distraction, or seeking social support.	The behaviour replacement starts to become more natural and the temptation to fall back into old behaviours lessens.	The new habit cue-behaviour associate strengthens and the new habit begins to take precedence, becoming more automatic and the desire for the old habit begins to lessen.
EMOTIONS				
THREATS	Lack of desire to change the habit	Inability to turn intention into action	Loss of willpower or failure to stay consistent	Falls back into old habits before automaticity is reached with the new behaviour
ABIT'S OPPORTUNITIES	**Step-by-step guidance and expert strategies**	**Accountability and social support**	**Tracking and built-in rewards system**	**100-day habit formation goal with small daily goals**

THE BRAND IDENTITY

The insights from the user personas and journey maps help to inform the brand identity work to follow. This work bridges the gap between understanding the customer on an emotional level to designing with them in mind.

THE BRAND NAME

In conceptualising the brand name, several different naming approaches were explored from compound naming to experiential naming and acronymic naming.

Ethos and hexis, two ancient Greek words that harken back to the origins of the concept of habits were explored in great detail. The two words were combined in different combinations and used to invent new words. However, all combinations gave a feeling of rigidity and masculinity.

Image 13
The brand name and tagline

Ultimately, Abit was created by removing the ‘h’ from ‘habit.’ The resulting ‘Abit’ is close enough to the original word that it describes what the product does while still carrying subtle underlying meanings.

One associative meaning is that when spoken it sounds like the expression ‘a bit’ which describes a small amount, alluding to the idea that small steps can lead to big changes – the essence of building better habits.

Abit, and the similarly pronounced Abbott, are also men’s first names that confer personality traits such as intellectualism, wisdom, and leadership. These traits are well aligned with the user personas developed above and resonate with the user's desires for self-improvement, efficiency, and life optimization. This alignment underscores the brand’s aim of encouraging users to progressively evolve toward their best selves.

Lastly, Abit is simple and phonetically clear making it easily pronounceable and memorable across languages. Its short, catchy nature makes it

versatile and easy to adapt without limiting the brand to a specific niche allowing for future expansion and growth.

At the time of writing this, Abit.com is an available domain for purchase and no other apps exist under the name.

THE VISUAL IDENTITY

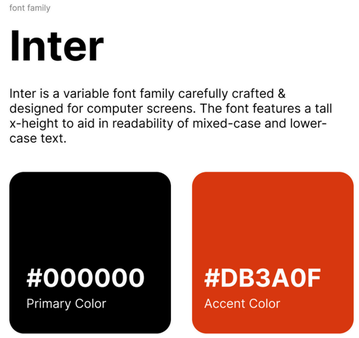


Image 14
The logomark

Image 15
The colour scheme and font family

LOGOMARK

The logomark represents the first letter of the brand name “A”. It is an abstraction of a ubiquitously understood symbol to blend recognisability with novelty and strike a balance between accessibility and innovation. The app’s signature dashboard dial becomes the second symbol in the composition, further embedding the brand's purpose.

COLOUR SCHEME

The bold and focused palette primarily uses black and white accented with a bold red-orange shade. The dominant use of black creates a sleek, modern backdrop while the intentional red-orange accents energise and draw attention to interactive elements. White and greys balance the visual composition and round out the simple and modern aesthetic.

The choice of red-orange is driven by my past experience as a brand and digital marketer. This colour is striking and attention-grabbing which are both valuable in the use of marketing materials. In addition, I have tested this shade of red-orange against over 100 variants and this specific value encourages interaction more than any other.

3.3 CONCEPTUALIZATION

In the conceptualisation phase, insights and direction become tangible with visualisation and prototypes of the digital and physical components of the product-service system. In the final subsection, a high-level visualisation of how the user interacts with the product brings the concept to life.

THE DIGITAL PROTOTYPE

The prior guiding information is used to create a prototype of the digital experience within the product-service system. This manifests as an app prototype that includes user onboarding, daily goal setting, the main dashboard, and sub-goal management pages.

The development of this prototype forces decisions to be made around the scope of the concept and is the first stage in which the user interaction is considered in greater detail.

THE ONBOARDING FLOW

New users move through an onboarding flow which guides them through habit selection, goal setting, and device connection. Based on insights from user research, people tend to think of habits as routines or small groups of habits. For example, one might reference their sleep habit to describe a set of actions and behaviours leading up to falling asleep at night. In this flow, the user is asked to select a habit from a short list of options. From there, they pick three daily goals that all help build toward the broader habit. These daily goals are developed based on the insight that Apple Watch users find the three daily rings the most motivating and engaging feature in the long term. Once the goals have been selected, users are prompted to set up a cue for each action. Abit uses vibrotactile feedback to cue users to perform their desired habits so this step is essential to the product-service system. Cues can be based on three factors: time, place, or event. For time and place, users can select a specific value such as their home address, work address, or any time in the day. The event-based cues build on the idea that habits are most easily performed when coupled with other actions.

In this example, Tara has chosen to receive a cue reminding her to avoid screen time upon getting into bed. In combination, the device and the app pick up on a variety of factors such as phone use, television sounds, and body position to determine Tara's action. Based on these factors, it will send a rewarding vibrational pattern if it believes the goal was successfully carried out.

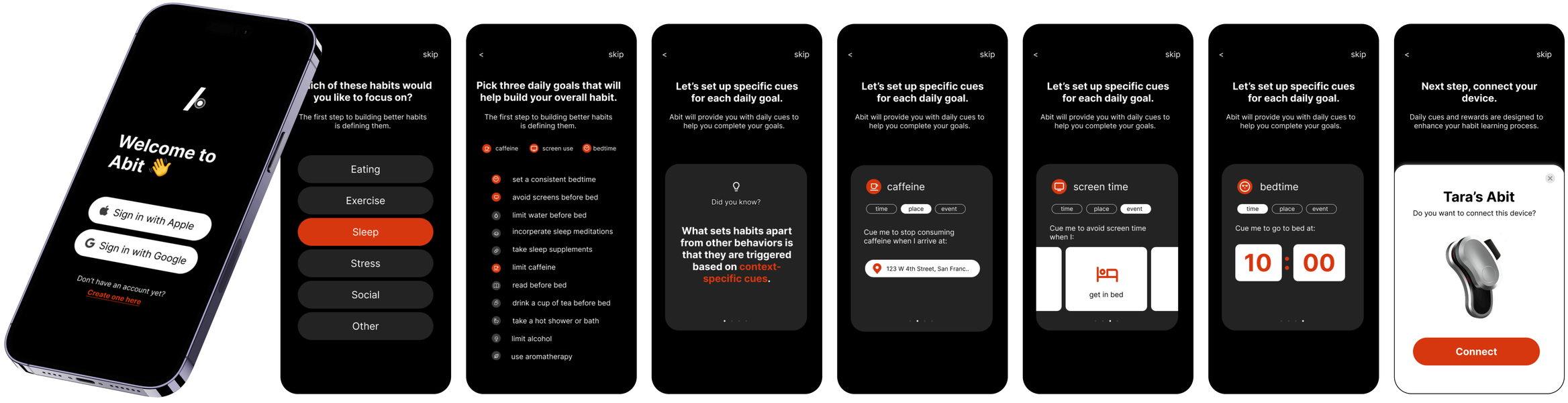
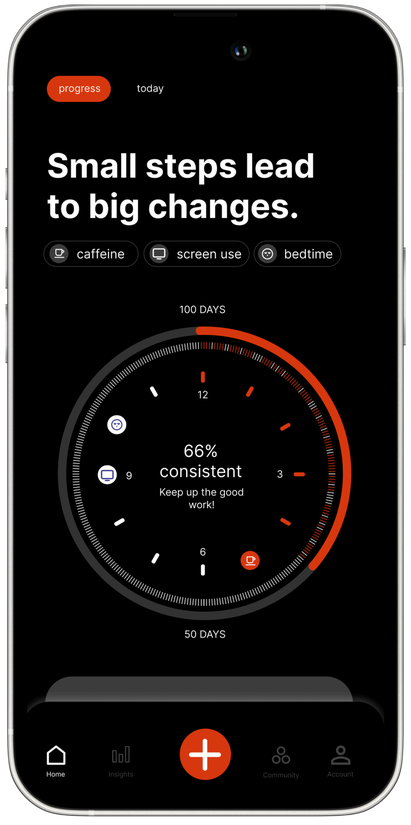


Image 16
Abit's App Welcome Flow

THE DASHBOARD

The dashboard is the main point of interaction for onboarded users. Here they get an overview of their progress toward building their desired habit.

Image 17
Abit's primary dashboard



The centre dial has three rings each representing a different element of habit building. The outermost ring shows their progress in days toward the goal of 100 days, which is the amount of time the app suggests to build a new habit. Inside that ring is a circle composed of 300 radiating lines. Each line represents one of the daily goals for each of the 100 days. When orange, the line indicates that the daily goal was successfully completed. When white, it indicates that the goal was not completed. Together they give a graphical representation of consistency. On the inside, there's a clock with each of the daily goals charted. This clock updates in real-time to show goal completion within a 24-hour time span. In the centre, rotating stats such as consistency percentage offer additional insights. Above, a motivating phrase keeps the user engaged and inspired.

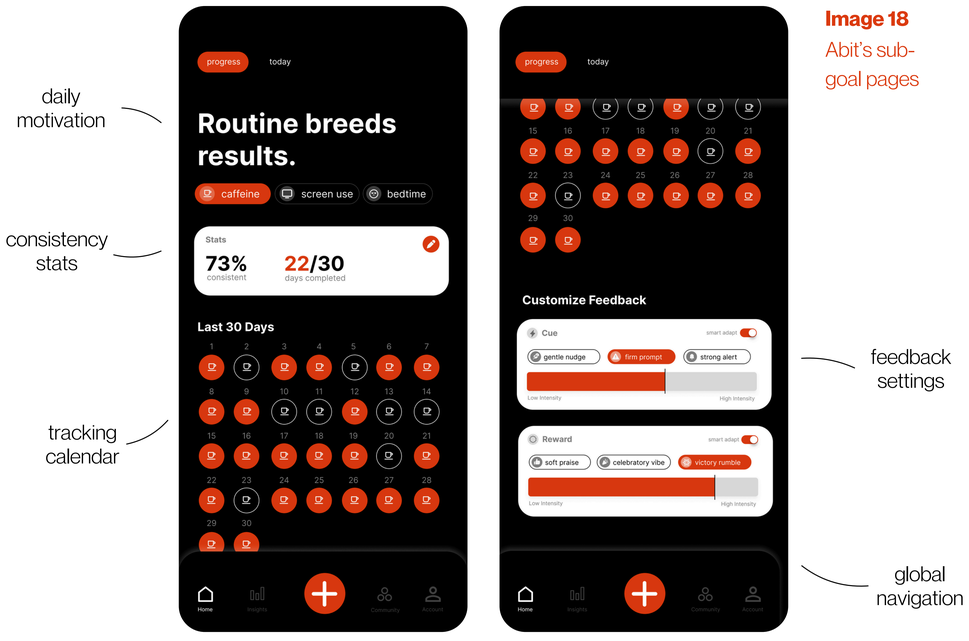
At the bottom of the screen, users can access the main pages of the app. The Insights tab offers personalised trends and tips to increase habit learning. The Community tab connects them to the apps social hub with such as challenges and accountability features. The Account tab opens up account details as well as customisable settings.

In the centre of the navigation bar, the plus button allows the user to perform a variety of tasks such as adding a real-time note to their data, changing or adjusting a daily goal, or logging an action that the wearable may not be able to detect.

From the main dashboard, users can take a deeper look at their three daily goals. Here you can see Tara's goal of limiting caffeine intake after returning home after work. At the top, her consistency stats are displayed along with a button to open the goal editing flow. Below, a calendar of the past 30 days shows which days the goal was successfully completed and which days it was not. This gives a graphical representation of the above high-level consistency stats.

Upon scrolling down, Tara can adjust both the cue and reward vibrotactile feedback for this goal. She can choose from three patterns, each with a different attitude as well as adjusting the intensity.

Image 18
Abit's sub-goal pages



THE SOCIAL HUB

During the research phase, in-depth interviews revealed the power of accountability in the habit formation process. Accountability takes many forms from goal setting to tracking and measurement. However, social accountability is one of the most powerful tools. Several participants mention involving other people in their habit formation process -- either to simply verbalise their ambitions or to rely on someone else to keep them on track.

“Having someone to keep me to it is helpful. When it is just me, it usually fails.”

- quote from user interviews

Because of this, Abit’s digital experience also includes a social hub, featuring both a challenge function and an accountability experience. The challenge page allows users to explore a wide variety of competitions related to their goals. These competitions are open to join for all users and are designed to add a competitive element to the experience.

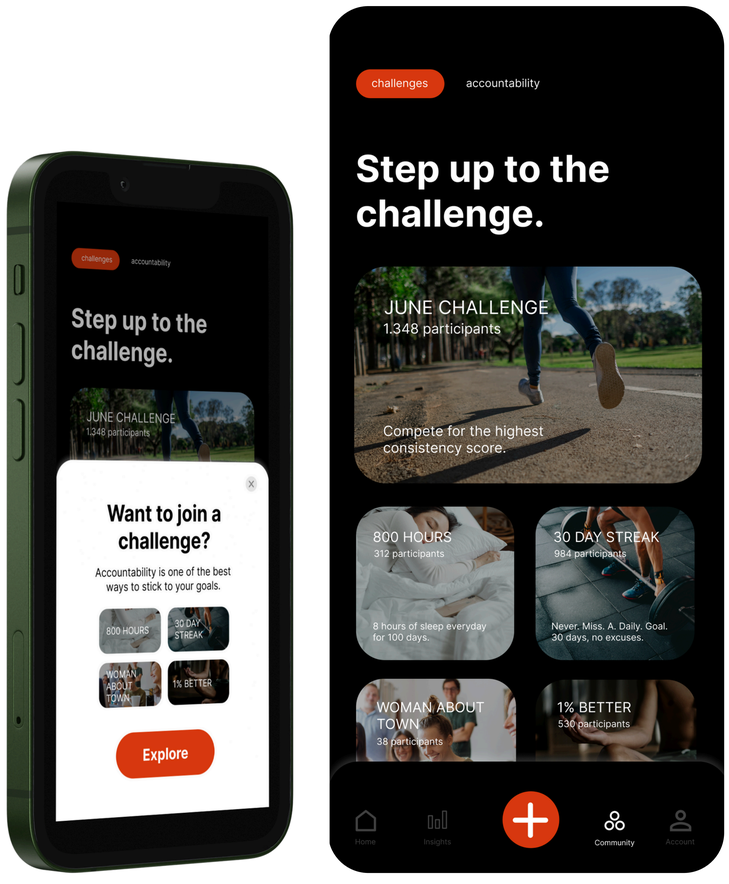


Image 19
Abit’s “challenges” pages

The accountability page encourages users to create a support circle of friends that can offer encouragement and support. Friends can be people that the user already knows or they can find people on the app with similar goals.

Once they’ve created a support circle, they receive automatic updates on each other’s successes and milestones. These updates appear in the in-app messenger where users can message each other in a secure, private environment. Groups can also choose to align their 100-day and daily goals for a synchronised experience.

Together these social accountability features encourage users to make their personal healthy journey a shared experience by competing with fellow Abit users or by joining support circles for a more personal approach. Not only does this enhance the habit formation process, but it also makes the process of habit formation more engaging and fun by adding an additional layer of interaction, fostering a sense of community and mutual support.

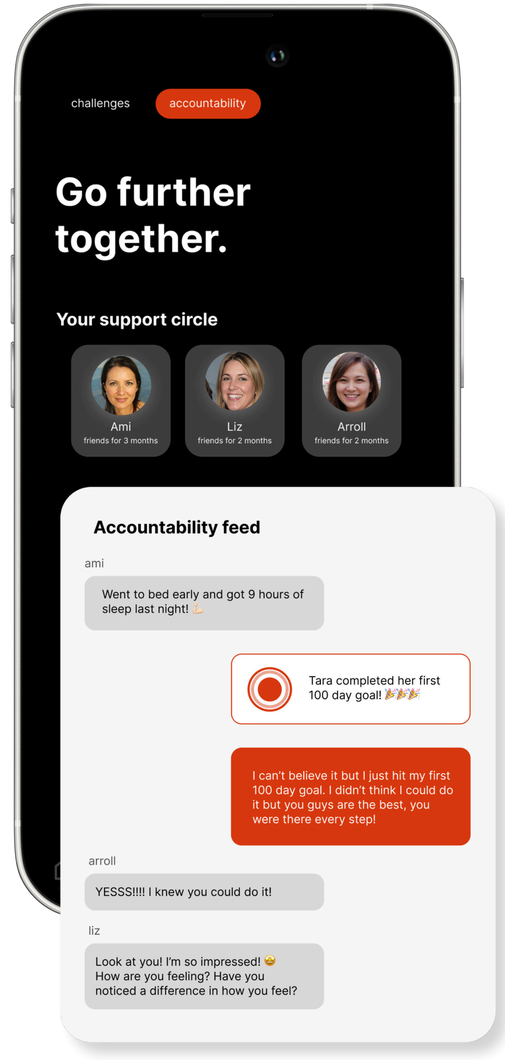


Image 20
Abit’s accountability page

THE PHYSICAL CONCEPT

The app prototype informs the functionality required of the physical device and helps to narrow the design space. From here, we detail out necessary components and make design decisions such as body position. Then, the design process moves from rough sketches to a defined form which is rendered to show a high degree of detail.

COMPONENTS

The Abit device includes a wide range of functionality that allows it to both measure and interact. The following table breaks down the main functions of the device, which component(s) are needed to support it, and a short description of how it works. This serves to inform the device's design. See Appendix C for a full breakdown of components.

Table 3
Key Functions of the Abit Device

FUNCTIONALITY	COMPONENT	DESCRIPTION
Haptic Feedback	Haptic motor	Provides vibrotactile sensations for notifications and alerts through vibrations.
Activity & Biofeedback Sensors	A mix of sensors	Measures activity, location, and biofeedback markers such as heart rate.
Audio Output & Input	Speaker & microphone	Enables voice commands and noise detection as well as delivers audio feedback.
Visual Notifications	LED light	Used to show power status and battery levels.
User Control Button	Mechanical button	Used to power on and off the device as well as other simple commands.

DEVICE PLACEMENT

The current landscape of wearables offers a wide array of choices offering various functions, designs, and intended wear locations. In conceptualising the Abit device, various potential body locations were considered, comparing advantages and disadvantages. This culminated in the selection of an ear-worn device, due to its ease of access, functionality, and resemblance to existing technology that consumers have already accepted. The decision balances a desire for innovativeness and alignment with market preferences ensuring user adoption.

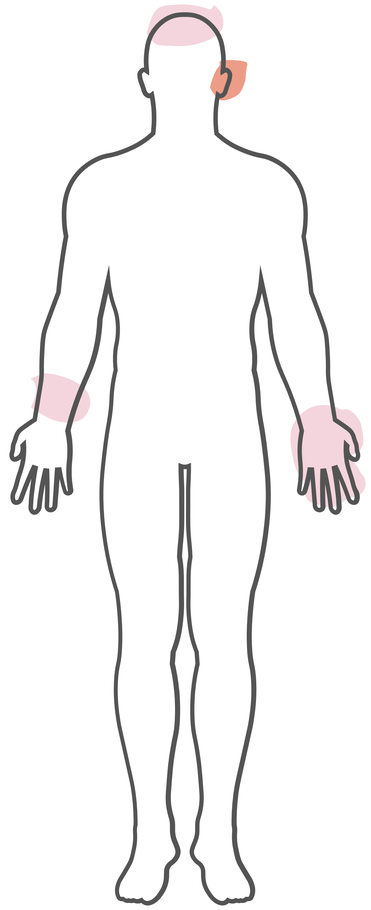


Figure 18
Body Position Comparison Chart

FOREHEAD

+
- High visibility for displays
- Possibility to integrate augmented reality
- Potential for brainwave monitoring

-
- Could be uncomfortable or socially awkward
- Potentially intrusive to daily life
- Possibly interrupts natural facial expressions and human-to-human communication
- Low vibratory threshold

EAR

+
- Stable placement for sensors
- Culturally accepted with introduction of wireless headphones
- Good for hearing-related functions
- Easily moves with body
- Easily accessible for interaction
- High vibratory threshold

-
- Limited surface area for device
- Ear shape variability
- May be uncomfortable for side sleepers

WRIST

+
- Convenient for glanceable information
- Established market acceptance
- Diverse sensor placement possibilities
- High vibratory threshold

-
- Already saturated market
- Can be bulky, some people prefer not to wear things on wrists and hands
- Frequent movement can affect sensor stability

HAND/FINGERS

+
- Allows for high tactile interaction
- Fine motor control for detailed interaction
- Easily accessible
- High vibratory threshold

-
- May interfere with daily activities
- High risk of impact damage
- Sensors exposed to damaging conditions
- Some prefer not to wear things on their hands

INITIAL CONCEPT SKETCHES

Based on the selection of the ear as the intended wearing location, initial concept sketches explore different form factors for the device. Concepts range in fidelity and aim to demonstrate a wide variety of design directions.

Image 21
Initial concept exploration sketche

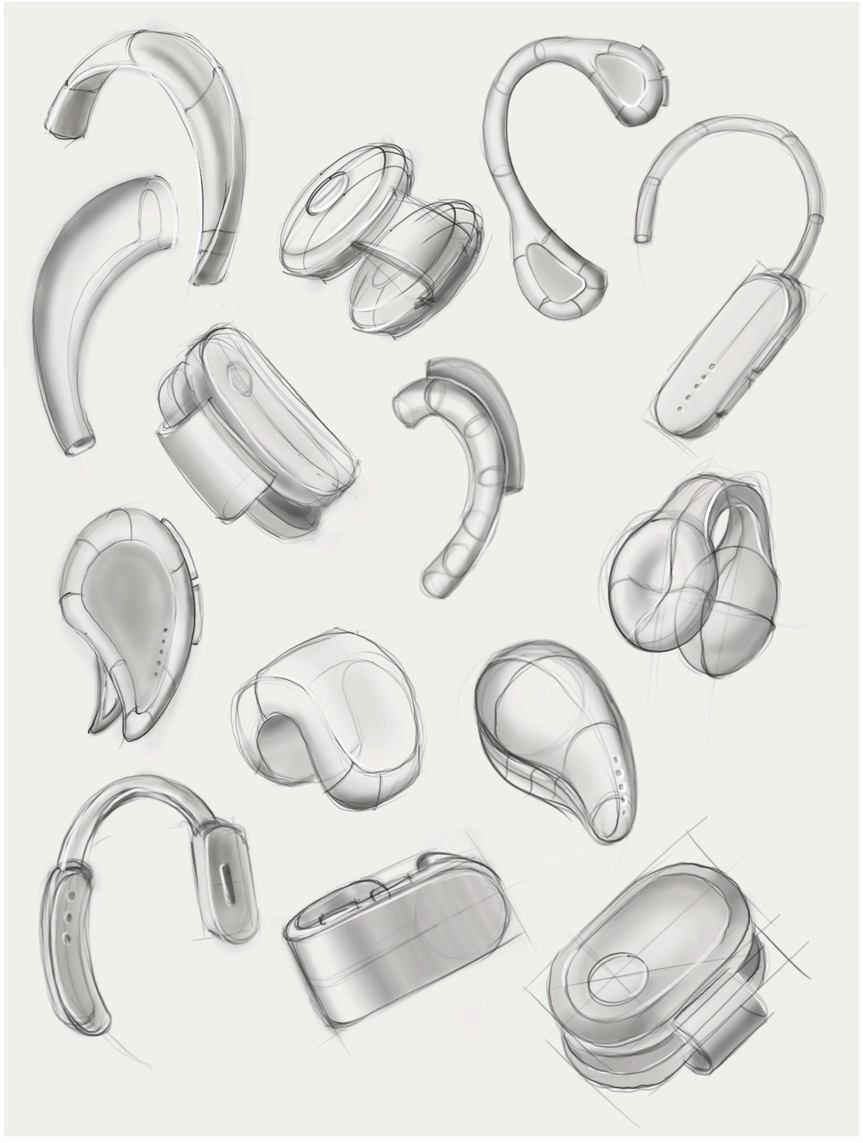


Image 22
Render of Abit device concept

CONCEPT DEVELOPMENT

From the form study, one concept was chosen for further development. It features a two-part device with a front and a back piece connected with a small fabric strap. The two pieces are held together around the ear with magnets. The front piece houses the sensors and various electronics while the back encloses the battery. It is intended to be worn on the upper ear lobe, on the soft part of the ear but above the lower lobe that is often pierced and where earrings are typically worn. It features a small action button that will be used for a variety of functions such as turning the device on and off. It also has a built-in speaker that can be used for secondary feedback.

PROTOTYPING

Once the chosen concept was designed and modelled, it was essential to build a prototype and test the concept with users. Two prototypes were made, the first was a to-size 3D-printed model that would house the vibration motor and magnets and be clipped to participants' ears in the usability test. The second prototype was also a 3D printed part, but this one was printed three hundred per cent bigger to show the finer details such as the action button and speaker holes.

> **The best way to learn about a problem and potential solutions is to start making things — prototypes, in the language of design thinking. Prototypes are not about being perfect; they're about being cheap, fast, and informative.**
>
> - Tim Brown, CEO of IDEO (2009)

Both parts were resin printed to best display the details of the design. They were then lightly sanded to remove the remaining support material.

For the to-scale model, four magnets (two on each side) were glued into place. The vibration motor was left free so that it could be added and removed as needed during the usability testing.

The vibrotactile feedback was prototyped through an Arduino board set-up. The following components allowed for unique vibration patterns to be delivered to the user through the haptic motor embedded in the 3D-printed part.

1. Seeduino Lotus Board
2. DVR2605L Haptic Driver
3. Mini Disc Vibrating Motor
4. Two Arduino Buttons
5. Compact Power Bank

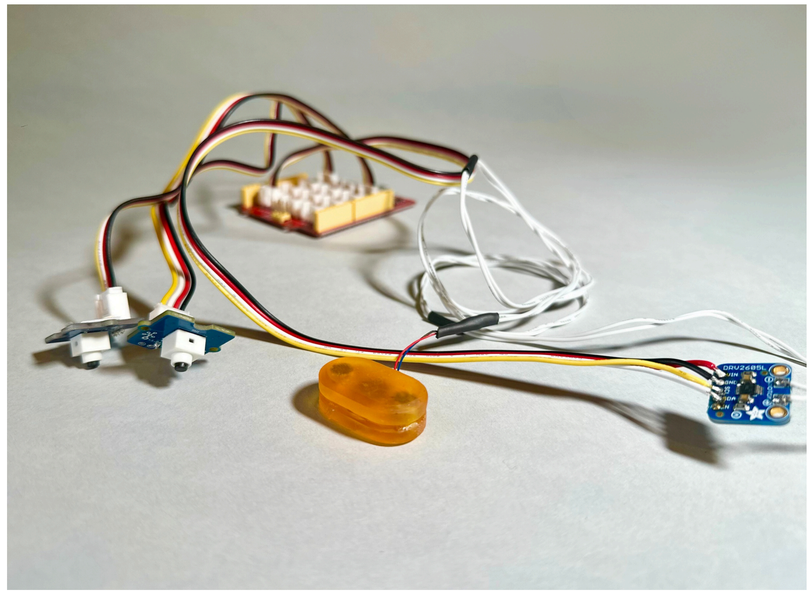


Image 23
To-size prototype with magnets and haptic motor

Image 24
3x model to show design details

HAPTIC DESIGN

A key component in the design of Abit is the vibrotactile feedback delivered to users as both cues and rewards in the habit formation process. To test user perceptions and the perceived utility of this functionality, the prototype was equipped with a haptic motor that delivered vibration patterns directly to the user's ear.

The goal of the haptic design was to create two distinct patterns that each communicated their own intended effect: either to cue the user to behave in a certain way, or to reward them for the desired behavior change.

The DVR2605L Haptic Driver used in the prototype comes equipped with about 150 different vibration patterns. Using Arduino IDE, these waveforms can be strung together with varying intensities to create distinct patterns.

PATTERN DEVELOPMENT

Two different patterns were developed to communicate both a cue and reward in the habit formation process. Insights were taken from earlier literature review, however, there is a greater need for research into haptic design principles that can be broadly applied to projects like this one. The pattern design was done primarily through trial and error and personal preferences.

Cue Pattern

The cue pattern was created with a clear and short sequence of waveforms that could be easily understood as a prompt for action, a notification that was neutral, not positive or negative. It needed to be both effective at calling attention without being aggressive or disruptive. The resulting waveform is a triple-pulse pattern with three short vibrations separated by three pauses. Each repetition is evenly spaced and of equal intensity and duration. The design of this pattern ensures that it is noticeable without being intrusive, providing a gentle yet unmistakable alert. The consistency and simplicity of the triple pulse helps in building a reliable and recognizable cue for the user, aiding in the habit formation process.

PATTERN VISUALISATION

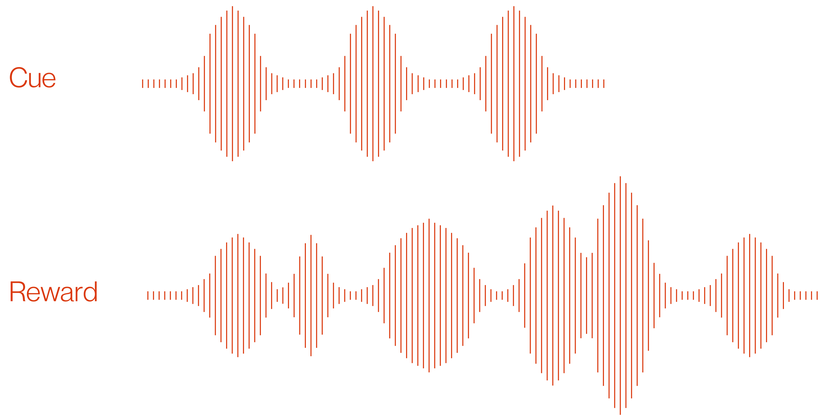


Figure 19
Visualisation of the two vibration patterns

Reward Pattern

The reward pattern is designed to provide a more elaborate and satisfying sensation, clearly distinguished from the cue waveform. This pattern aims to provide a sense of accomplishment and positive reinforcement, enhancing the user's experience and encouraging them to continue the desired behaviour.

To do so, a series of vibrations were strung together to create a longer-lasting overall pattern. It's composed of five unique parts. It starts with a medium-intensity pulse to get the user's attention. That is followed by a short pulse to create a moment of anticipation. Then, a third pulse kicks off the body of the pattern. Combined with the fourth double pulse, these two patterns grow in intensity, evoking a sense of excitement. The final fifth pulse aims to provide a short gratifying end to the pattern. All together the pattern is almost a bit melodic like a comforting song.

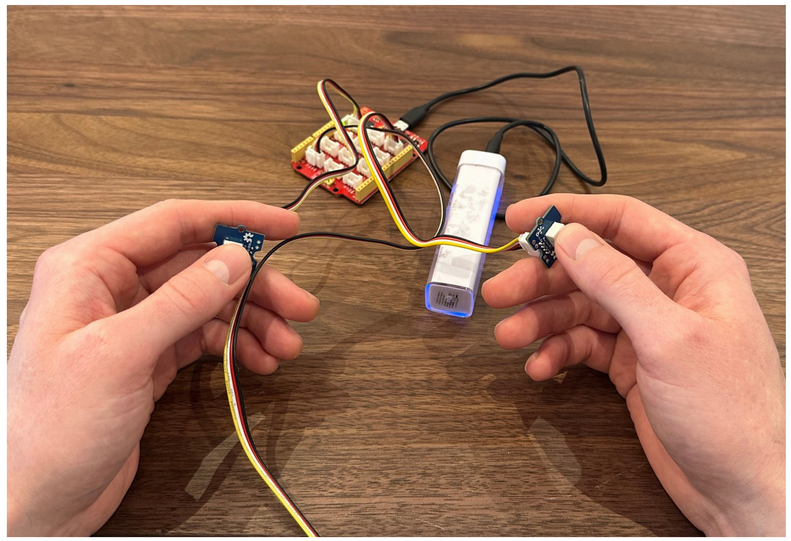
These patterns were developed through an intuitive iterative process that also considered the principles learned through the literature review on vibrotactile feedback. The following usability testing aims to gather feedback from multiple individuals to validate that the patterns are communicating the intended effect.

3.4 TESTING & VALIDATION

Image 25
Usability testing session (staged)

Image 26
Participants used buttons to play the vibration patterns

From the initial exploration, a concept was selected for further development. This concept takes the form of an earlobe-worn device. To test and validate the idea, two studies were carried out. The usability test involved user sessions to gather insights on acceptance, ergonomics, and perceptions around the vibrotactile feedback. The second study focused purely on the ergonomics of the ear.



USABILITY TESTING

To test and validate the Abit concept, usability testing was conducted on a small set of participants. These sessions aimed to gather direct insights from potential users on aspects such as perceived utility, ergonomics, and functionality. Using a low-fidelity prototype, users were able to hold, wear, and interact with the form and most simple vibrotactile functions of Abit.

AIM

The concept design was heavily informed by insights gathered through literature review and user research. However, the usability study offers an opportunity to gather direct feedback on the tangible aspects of the product such as form and aesthetics as well as the vibrotactile feedback mechanism. This study's primary goal is to inform potential refinements to enhance the device's usability and overall utility.

The overarching research question is, "How do potential users perceive the utility, ergonomics, and functionality of the Abit wearable device?" with the aim to cover aspects including:

1. Placement & comfort
2. Aesthetics
3. Intention to use/adoption
4. Functionality of vibrotactile feedback

METHOD

Study participants were recruited through the researcher's personal network to represent the target demographic, with diversity to ensure a range of perspectives. The four participants each engaged in a session lasting between 30 and 40 minutes. A simplified 3D-printed model of the device was equipped with vibrotactile feedback.

Each session was divided into two parts. The first part focused on gathering participant's perceptions and attitudes toward the physical design and ergonomics of the prototype. Participants were asked to interact with the prototype and asked to perform a series of tasks such as walking and bending over to evaluate the comfort and device stability. This part of the session concluded with a short semi-structured interview addressing topics including initial impressions, comfort, aesthetics, and perceived utility.

The second part of the session tested the functionality of the vibrotactile feedback. Participants were exposed to various vibration patterns, delivered through the prototype, to assess the clarity and effectiveness of the feedback. Participants were asked to respond to vibrational cues and give feedback on

the different patterns. This part of the session ended with another short semi-structured interview with questions regarding their experience and their suggestions for improvement.

Data was collected via audio recordings and observational notes. The audio was transcribed and analysed using thematic analysis to give an understanding of user perceptions of the device's usability and potential for enhancements. These insights were used to further refine the design of the device.

RESULTS

For this test, the method of thematic analysis revealed common themes in each studied area: initial perceptions, ergonomics, vibrotactile feedback, and perceived utility. The core themes are summarised below.

Initial perceptions

Participants generally had positive initial impressions of the device and its body placement. They typically found the ear placement appealing but were eager to understand aspects such as comfort and stability When asked if they have any concerns regarding social acceptance of wearing the device, they did not. Several remarked that it would be similar to wearing an Airpod. One participant commented that it "looks very cool and futuristic."

Ergonomics

When wearing the device, all participants found it comfortable for short-term wear. They all expressed concerns about long-term comfort. During the stability tests such as head shaking and bending over the device stayed in place and participants remarked that it felt secure. Button placement felt natural to participants as well.

"[It's] very comfortable...I think it feels natural to the ear somehow, like an extension."

When attaching the device to the participants, issues with the ergonomics were clear. Although it could be attached to all four ears, it did not fit all ears well. Earlobe sizes vary greatly and the device was too large for some.

Vibrotactile feedback

In regards to the vibrotactile feedback, participants had positive comments to share. They remarked that the vibration intensity was subtle with an average rating of 2 out of 10. Several participants commented that it felt like a nudge, that it got their attention without being overly disruptive. One participant said "I think it's very mild, like a nudge or something. So it feels, yeah, it feels really good. Like someone like giving a super soft tap on your shoulder."

"It's much more natural than I thought it would be. I prefer it because it kind of catches my attention without being disruptive."

When asked about the two vibration patterns specifically, participants had generally positive perceptions about the cue pattern. Several remarked that it felt like a notification. One participant explained, "I mean it feels like some form of notification. Like driving attention or urgency on something...It's not like it's trying to gain my attention above everything else. Like, it's not irritating." Another participant noted, "To me, I guess it feels positive because it is soft and gentle and just like a little tap."

The reward pattern had a more negative connotation with descriptions like "more intense," "aggressive," "confusing," and "feels like an alarm clock." Several participants noted that vibrotactile feedback in general feels like a notification and that it could be difficult to make that feel positive and not like something that requires immediate action.

"That feels a bit more intrusive to me, a bit long, a bit too long."

Two participants also suggested that the cue could be delivered multiple times with increasing intensity so that if the user ignored the first cue, they would have another chance.

Perceived Utility

In the final section of the session, participants were asked to imagine a scenario where the device would help them form a new habit. They were asked if thought the device would be effective. Most participants noted that they thought the device would effectively communicate a cue and reward which would be motivating and effective in the short-term. Some participants mentioned that they might find the notifications distracting and would be tempted to take the device off instead of modifying their

behaviour in the moment. One participant explained that they thought it would definitely work in the short term but that it would become distracting which would detract more from their life than the benefits gained.

[In past experiences], I end up turning off the notifications or deleting the app because it interrupts my day-to-day too frequently or too inconveniently.

Two participants also mentioned that if it was integrated with the functionality of headphones, they'd be more likely to wear it in the long term because it would have an essential function attached to it.

When asked if they would like to own the device if it was available on the market, two participants expressed interest. One was most interested in using it to change some of their habits while the other explained that they love trying new tech, no matter what it is. The other two participants expressed some level of hesitation around the possible level of distraction the device could cause.

DISCUSSION

The insights gathered in the user sessions provide many opportunities for improvements to the design as well as first-hand perceptions of the acceptance and perceived utility of the device. The main takeaways are organized into things to maintain in the next iteration of the design and things to improve upon. In the final section, we will discuss further usability testing needs.

The following positive notes will be factored into the revised design:

1. Generally positive perceptions of ear placement with high remarks for short-term comfort and stability
2. The aesthetic styling of the device was well-recieved
3. Vibration feedback delivered on the ear feels "natural" and communicates effectively
4. Integration of speaker functionality improved the utility of the device

The key areas for improvement are summarized in the list below.

1. Change the position of the ear placement from lobe to upper cartilage
2. Further ergonomics research is needed to improve the fit for many ear shapes
3. Maintain the vibration intensity and cue pattern but revisit the reward pattern. Possibly integrate multiple cues with increasing intensity.

To further validate the concept, several additional tests should be carried out with users. Several participants remarked on the short-term comfort of the device but were unsure if it would be uncomfortable after several hours of wear. This should be tested and magnet strength should be fine-tuned to meet both needs for comfort and stability.

Participants expressed concerns about the distracting nature of the vibrotactile feedback and thought they may prefer to remove the device instead of changing their behaviour. This should be further tested with the full product service system. In the context of this study, participants only engaged with the physical device and did not interact with the app experience of setting their own goals and working toward consistency and achievement. This could have a significant impact on their perceptions of the device.

Lastly, ear shapes vary from person to person. This needs to be studied in greater detail and taken into account for future design iterations. The following section of this report will explore the shapes and sizes of several ears to inform the ergonomics of the next design iteration.

ERGONOMICS STUDY

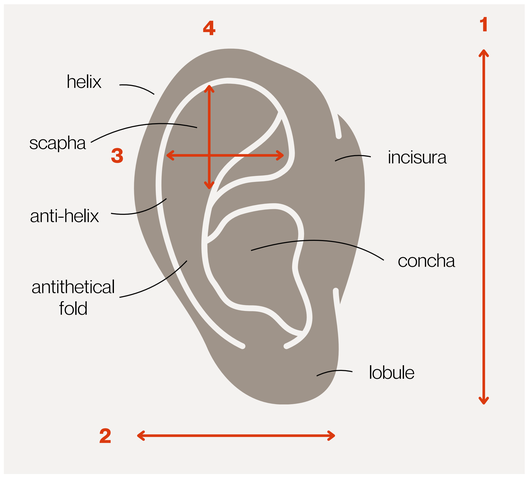
To further investigate the ergonomics of an ear-worn device, this study will assess different ear shapes and sizes with the goal of designing a device that will fit all or the majority of those included. It begins with the measurement and cataloguing of ten unique ears. These measurements are then averaged and considered in the redesign.

The second iteration of the device will be tried on to the ear first virtually using 3D modelling programs and then physically with a 3D printed piece.

MEASUREMENT

In this phase of the study, ten ears were measured, photographed, and catalogued. Participants were recruited on an ad hoc basis and randomly selected to ensure a diverse sample. First, a photo of their ear was taken with a ruler for scale. Then several measurements were taken including the total length and width of the ear, the depth of the upper cartilage, the distance between the outer helix and incisura, and the distance between the concha and upper helix.

Figure 20
Diagram of an ear



These measurements were recorded and analysed to find the average values. These values were then considered in the redesign of the device. The images taken were also referenced throughout the design process to incorporate considerations around shape that could not be easily measured, such as curvature, irregularities in anatomy, and the presence of piercings. By taking these steps, the design could better accommodate a wide range of ear shapes and sizes, ensuring both comfort and functionality for the users. This approach was essential to create a device that is not only effective but also ergonomic and user-friendly.

AVERAGE MEASUREMENTS

54mm	total length	**20mm**	outer helix to incisura
34mm	total width	**16mm**	concha to upper helix
4.4mm	depth of upper cartilage		

ASSESSING FIT

Next, the model of the redesigned device was virtually fit to the catalogued ears as an initial assessment of fit. The images were brought into the 3D modelling software and scaled to the correct size. Then, the device was moved to the appropriate position and visually assessed for fit. This was an iterative process that allowed for micro-refinements before proceeding to 3D printing the model and assessing the fit physically.

Once the model was adjusted to best fit the majority of the ears, it was 3D printed to scale and tried on participants in person. This hands-on testing phase was crucial as it provided direct feedback on the comfort and ergonomics of the device, yielding several findings that will be further detailed in the coming sections.

Image 27
Images of ears catalogued during the study (virtual and in-person try-on)

3.5 THE REFINEMENT

The ergonomics study informed a second iteration of the concept, designed to fit better on most ears. The average measurements were used in the updated design resulting in a similar form but with different proportions.

Image 28
A composite image showing how the device is worn

Image 29
Render of concept idea in two color ways

The redesigned device follows the same basic forms with some ergonomic updates. First, the device placement is moved from the lobe to the upper cartilage. Secondly, the pill shape is curved to follow the curve of the helix. Lastly, the front piece becomes smaller while the back piece becomes larger, balancing the need to fit the electronics with the limited real estate of the ear. The updated design uses the same magnet mechanism to clip to the ear, as this proved a stable and comfortable mechanism during the usability testing. Based on the virtual and in-person try-on process performed in the ergonomics study, the updated design fits most ears well. Further tests and refinements can help to optimise the ergonomics of the design.

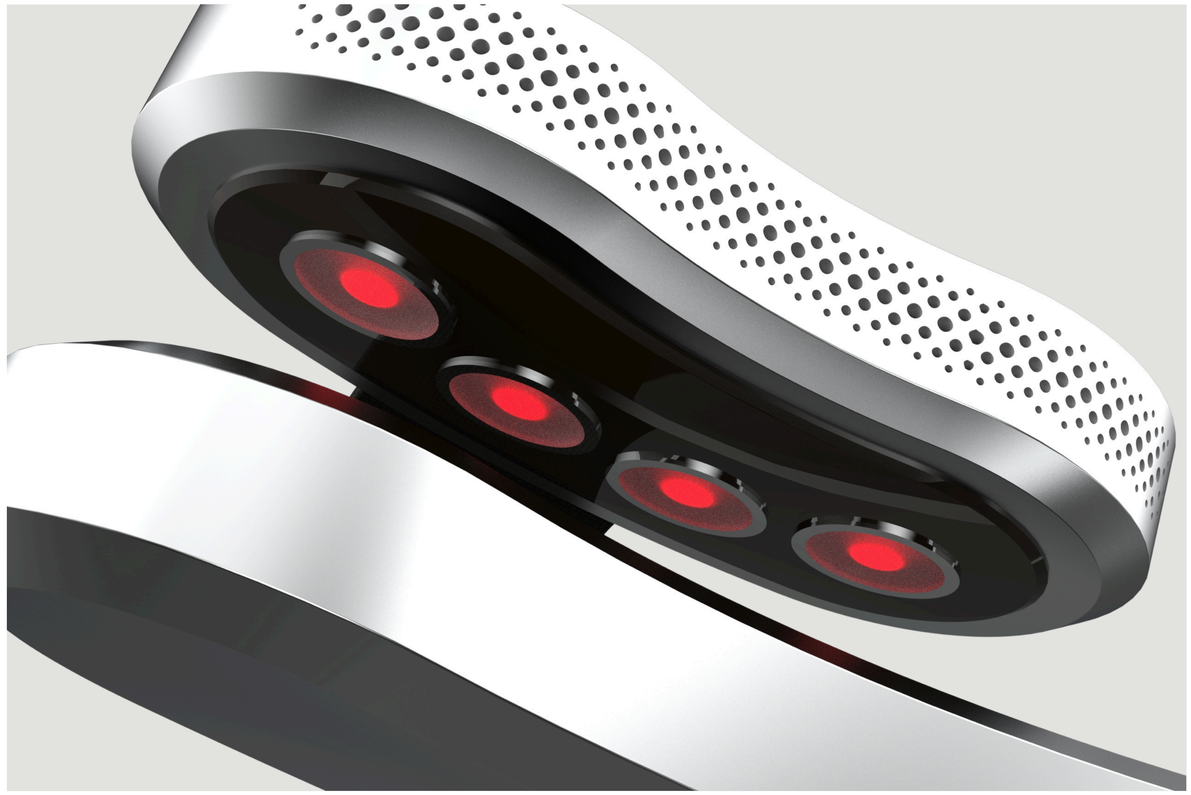


Image 30
Render of the Abit device

3.6 THE CONCLUSION

The design section explored the process of designing a digital and physical product aimed at helping people form habits more effectively. The section started with a deep dive into the user experience with the development of user personas and journey maps. This understanding of the consumer informed the brand design which explored the brand's name, logo, colour palette, and typography. Upon this foundation, the app was prototyped to articulate the functionality and experience of the digital experience. Lastly, the physical device was conceptualised in a two-part process. An initial design was tested with users to gain feedback on both the aesthetics and the vibrotactile feedback. A small ergonomics study was also carried out to better understand how to design the device to fit a wide variety of ears. Insights from the two tests were used to iterate on the initial concept and present a second version of the design.

FUTURE TESTING

The second iteration of the concept is not intended to represent a final design. In the scope of this project, it represents a jumping-off point from which to begin the research and development process. The technological aspects were not covered in great detail because they require the involvement of specialists in the engineering, computer programming, and AI domains. Further testing and development will be critical in refining the device and ensuring it meets the needs of users.

The next steps in bringing this concept to market involve several key areas of focus:

1. **Technological development:** Collaborate with specialists to develop the hardware and software components of the device.

2. **User testing & feedback:** Conduct extensive user testing with a broader and more diverse group of participants.

3. **Iterative design optimisations:** Use constraints from technological development and insights from user tests to improve the design.

4. **Ergonomics studies:** Continue conducting ergonomics studies to ensure the device fits comfortably on a wide range of ears.

5. **Regulatory compliance:** Begin the process of ensuring the device meets all regulatory standards for safety and efficacy.

Moving forward, the focus will be on refining the technological aspects, conducting comprehensive user testing, and ensuring regulatory compliance. By continuing to iterate on the design and incorporating feedback from a diverse range of users, we can develop a device that effectively helps people form and maintain healthy habits, ultimately improving their overall well-being.

Part 4

The Strategy

Taking the Idea to Market

Transitioning from the design phase, we now turn our focus to the supporting business strategy that will take the concept to market. This section covers a comprehensive analysis ensuring that Abit aligns not only with user needs but is also strategically positioned within the competitive landscape. A product launch roadmap provides a clear path for Abit's market introduction.

INTRODUCTION

This section will cover some of the core building blocks of a business strategy. It is broken into four main sections. The first section covers the value proposition, positioning, and purpose. Together these elements further define the brand DNA and articulate how Abit taps into customer needs. The following three sections follow IDEO's desirability, feasibility, and viability framework. Within each section, different strategies and rationales make the case for the product service system's market fit.

Image 31
Portrait of Chess Players by Marcel Duchamp (1911)

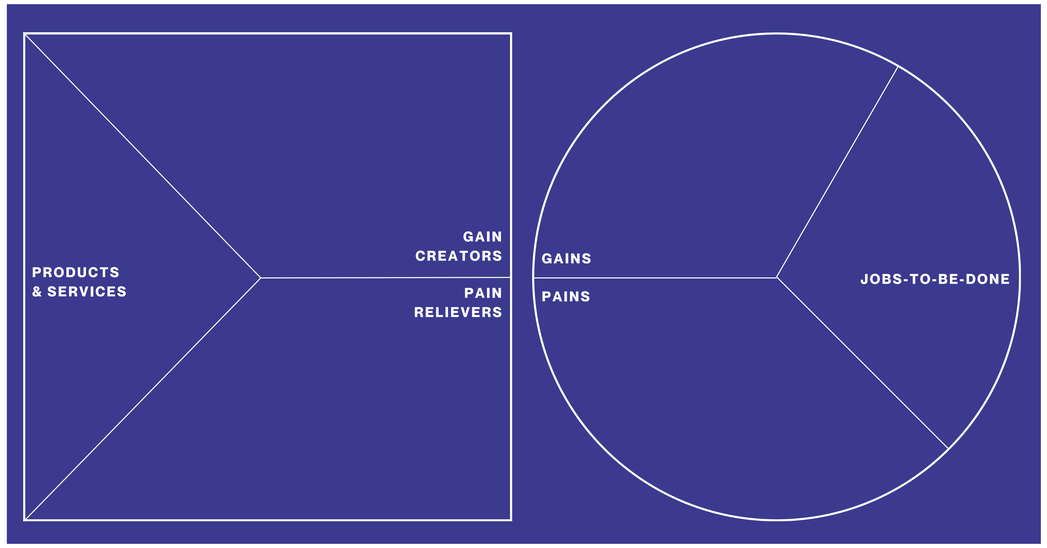
4.1 THE VALUE PROPOSITION, POSITIONING, & PURPOSE

To create market desire for Abit, defining a clear and compelling value proposition, positioning, and purpose is essential. Together, they are the brand's DNA, guiding all communications to the customer and anchoring brand messaging in the product's raison d'être.

THE VALUE PROPOSITION

To craft a powerful and resonant positioning, The Value Proposition Canvas has been employed. This method is used to deeply understand customers and map out the benefits that a product uses to address these needs (Osterwalder, 2014). It looks at who the customer is, what they want, and how the product can help them achieve it. Here we refer back to our user personas, Tech-Savvy Tara and Active Alex.

Figure 21
The Value Proposition Canvas (Osterwalder, 2014)



Each section highlights the main problems that Abit can solve for the user whether it be to relieve a pain or or create some type of additional gain. Product features directly map back to this canvas to ensure alignment between the user's biggest needs and the product service system. Doing so helps to ensure that the value proposition resonates clearly with our target audience, driving both adoption and satisfaction. The full value proposition canvas can be found in Appendix E.

POSITIONING STATEMENT

Identifying connections between the target customer's needs and the gains and pains that Abit can address is the foundation for developing a succinct positioning statement to guide all internal and external communications. It explains the product's benefits to potential customers and clearly illustrates the problems it solves and its advantage over competitors.

Based on the insights developed in the Value Proposition Canvas and using a common framework, the resulting positioning statement is:

target audience

Go-getters and every-last-drop-of-life drinkers...

Abit's target customer highly values health and sees it as a mechanism for living a full and rich life. They are constantly seeking to improve and refine their daily routines to optimise their physical and mental health. Two things that are important to them because they enable them to achieve their goals in all other areas of their life.

product category

a wearable device and supporting digital app experience...

Abit is a product service system consisting of a small wearable piece of technology and a supporting app that serves to visualise their behaviours, set goals, and adjust settings and notifications.

product attributes

advanced goal-setting, alongside intuitive real-time cue and reward feedback mechanisms...

Abit offers a variety of product attributes but on the highest level, they are distilled to goal setting and vibrotactile feedback delivered in real-time through the device.

functional benefits

makes building better habits easy...

Together, these main attributes serve the purpose of enhancing the habit formation process targeting early goal-setting stages and maintaining long-term commitment through daily cues and rewards.

emotional benefits

inspire a sense of control and well-being, reducing stress and enhancing everyday happiness...

The deeper emotional benefits of building better habits is that the user gains a sense of control and autonomy over their health which leads to a reduction in stress and an increase in daily happiness.

self-expressive benefits

to actualize their potential and proudly become the best version of themselves.

The resulting effect on the user's identity is that they are able to embody the best version of themself, the healthiest and most confident version.

The statement reflects the user's desire to embody the best version of themself, the healthiest and most confident version.

POSITIONING STATEMENT

For **go-getters and every-last-drop-of-life drinkers**, Abit offers **a wearable device and supporting digital app experience** that utilises **advanced goal-setting, alongside intuitive real-time cue and reward feedback mechanisms** to **make building better habits easy** and **inspire a sense of control and well-being, reducing stress and enhancing everyday happiness**, enabling them to **actualize their potential and proudly become the best version of themselves.**

It will serve as a foundational guide for all marketing and communication efforts for Abit. articulating the unique value proposition of the device, clearly defining its target audience, key benefits, and differentiation from competitors. By providing a consistent and focused message, the positioning statement ensures that all branding, advertising, and promotional activities are aligned with Abit's core identity and objectives. This helps in building a strong, recognizable brand that resonates with the target market and effectively communicates the benefits of Abit, fostering trust and engagement with potential customers.

PURPOSE STATEMENT

The final component of the brand DNA discussed here is the purpose statement. This declaration summarises the company's raison d'être or reason to be. Particularly for internal communications, the purpose statement has the important job of acting as a rallying cry and inspiring employees to carry forward the company's mission.

In the case of Abit, the purpose statement taps into the ultimate self-expressive benefit to the customer, the idea that the customer can actualize their highest potential. This insight harkens back to one of the key learnings from the user research, that – when motivating themselves to perform a healthy habit – people visualise the future version of themself that's already accomplished the task at hand.

To empower people to build the best version of themselves through small healthy habits.

We can all relate to the feeling of not living up to our full potential, to the self-criticism we inflict when we fail to align our actions with our goals and intentions. The resulting emotions can include feelings of frustration, disappointment, and a sense of inadequacy that can weigh heavily on our confidence.

This purpose statement speaks to the opposite experience. It's about actualizing the best version of yourself by making small and big choices that will ladder up to one's greater goals and ambitions. Abit enables people to make the better choice more often and feel a sense of pride, accomplishment, and bolstered self-esteem which results in less stress and more daily happiness.

Together the value proposition, positioning statement, and purpose statement set the groundwork for all future brand communications. Each anchored in the needs of the customer, they speak to the deep-seated desires and pains of the target audience. They guide all future marketing efforts ensuring alignment with the market through their roots in the needs of the audience.

> **Where you innovate, how you innovate, and what you innovate are design problems.**
>
> Tim Brown, CEO and president of IDEO (2016)

4.2 DESIRABILITY, FEASIBILITY, VIABILITY FRAMEWORK

According to IDEO, a good product must be desirable, viable, and feasible for long-term growth and success (IDEO Design Thinking, n.d.). They have developed a methodology for reviewing these three components to determine whether an idea is worth pursuing. Below, we will assess each of the three focus areas for the Abit concept to pinpoint strengths and weaknesses and prepare the concept for market launch.

DESIRABILITY

To determine the desirability of a concept, we evaluate the market, industry trends, and competitors in the space to better understand whether the solution is something the customer needs or wants. In this section, we focus on the market surrounding the product and use these insights to understand how current customers' needs and desires have created opportunities for similar products and competitors.

MARKET ANALYSIS

To understand Abit's potential we must first identify its relative market and understand the growth opportunities within the health wearables sector. To do so, we define three key metrics: Total Addressable Market (TAM), Serviceable Available Market (SAM), and Serviceable Obtainable Market (SOM). Together they provide a clear understanding of the core customer base at different levels of market penetration. Finding accurate estimates for market sizes is difficult, therefore we will approach this section only with the goal of demonstrating that the market is large enough to have plenty of growth potential.

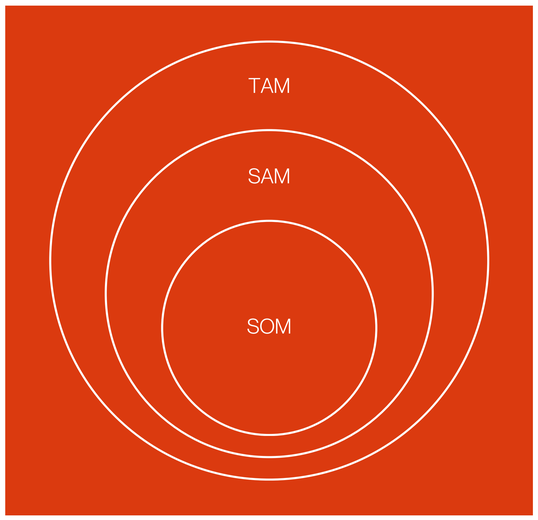


Figure 22
Visualization of TAM, SAM, and SOM

TOTAL ADDRESSABLE MARKET (TAM)

The entire global demand for the product category

Although it can be difficult to accurately measure the size of specific markets, and few reliable and open-access data sources exist, we will compare estimates from several sources to estimate an approximate range for the monetary size of the health wearables market.

- According to Ometov et al., the global wearable market is forecasted to reach nearly 120 billion euros by 2025 (2021). This estimate is not specific to health wearables so we can assume the value to be some fraction of this figure.
- Similarly, Grand View Research's recent report puts the total wearable technology market size at USD 61 billion in 2022 with forecasts that it will reach USD 186 billion by 2030 (2023).
- MarketsandMarkets, a market research provider, estimates the Wearables Healthcare Devices Market at USD 40.7 billion in 2023, and reaching USD 69.2 billion by 2028 (2024).

Based on the data available in these three sources, we can estimate that the health wearables market TAM is less than USD 120 billion and likely somewhere around USD 40 to 50 billion in 2025.

To avoid overestimating the potential market, we'll take the smallest value of USD 40 billion to continue our projections.

The same sources estimated the compound annual growth (CAGR) between 11.2% and 20%. We'll also assume the lowest value of 11.2%.

→ TAM estimated at USD 40 billion

SERVICEABLE AVAILABLE MARKET (SAM)

A portion of the TAM considering business constraints

From here, it is very difficult to make accurate estimations without access to reputable market research reports. In their absence, we choose to keep things high-level by making broad assumptions. The aim is not to provide specific and accurate values but rather to show that the addressable market is substantive enough for Abit's long-term growth.

For Abit, we narrow the total addressable market (TAM) down by targeting health-conscious adults in North America and Europe. These regions are chosen because of their high disposable income levels and general focus on health and wellness (Household Disposable Income, 2023; Callaghan et al., 2021).

We will start by making the assumption that the health wearables market already consists of primarily health-conscious adults and therefore we will only look at narrowing the market by region.

Grand View Research estimates that North America is the largest market, and accounts for 33.8% of overall wearable revenue, closely followed by Europe (2023.) Although they do not provide a specific value for Europe's share we will make the assumption that together, they represent 50% of the global wearables market, or USD 20 billion based on the prior TAM estimate.

→ SAM estimated at USD 20 billion

SERVICEABLE OBTAINABLE MARKET (SOM)

An estimate of a portion of SAM that can be captured over a period.

The Serviceable Obtainable Market is the part of the market that a company believes it can capture within a given timeframe. One to five per cent of the total target market within one to three years is a common benchmark for start-ups and small businesses.

Taking this benchmark, Abit has a SOM between USD 200 million and 1 billion.

→ SOM estimated between USD 200 million and 1 billion.

Although these estimations are based on broad assumptions and cannot be accurately calculated based on reliable data, they paint a picture of the scale of the health wearable market and the growth opportunities within the sector. Even with highly conservative estimations, the obtainable market size is in the hundreds of millions to dollars up to a billion dollars. This presents the large scale of the opportunity space for Abit.

STRATEGY

INDUSTRY TRENDS

The wearable health technology industry and adjacent general consumer wellness industry have witnessed substantial growth and change over the past decade. Fueled by technological innovations and a shift in customer behaviour toward proactive health management, the sectors are in constant flux, shifting in reaction to the dynamic nature of health, wellness, and technology trends. Below, we highlight some of the most interesting and relevant trends.

REPRIORITIZATION OF HEALTH

Following the COVID-19 pandemic, many individuals have reprioritised their health. According to the World Economic Forum, 62% of Americans now value health more and are ready to embrace lifestyle changes (2022). This increased focus on wellbeing contributes to the industry's high growth forecasts.

INCREASED SPENDING ON HEALTH AND WELLNESS PRODUCTS

82% of US consumers now consider wellness an important priority in their lives (Callaghan et al., 2021). This translates to an increased spending on health and wellness products. The consumer wellness market has grown to USD 1.8 trillion and over 40% of research participants had purchased a health product or service in the past 12 months.

RENEWED FOCUS ON SLEEP

Mckinsey found that sleep ranks as the second-highest health and wellness priority for consumers (2021). 37% of their US consumers expressed a desire for sleep and mindfulness products that address cognitive functioning, stress, and anxiety management. There is an opportunity for products that improve sleep holistically, through addressing multiple contributing factors.

THE CONVERGENCE OF WEARABLES & AUGMENTED REALITY

As the AR and VR industries continue to expand, so does their convergence with wearable tech. As demonstrated by Apple's latest product launch, Apple Vision Pro, there is a growing market for AR wearables and consumer spending to match, indicating a real demand for these types of products (Tillier, 2024).

GROWING AWARENESS ABOUT LIFESTYLE MANAGEMENT

As consumers continue to prioritise health and wellness, awareness about lifestyle management increases as well. Individuals are becoming more conscious of the controllable day-to-day factors that build long-term health and are therefore more proactive in their health management (MarketsandMarkets, 2024).

A NEW ERA FOR WEARABLES

More than 75% of surveyed consumers indicated an openness to using a wearable in the future and half of all consumers surveyed had purchased a fitness wearable at some point in the past (Callaghan et al., 2021). Although the market for fitness and sleep trackers is fairly saturated, there are more opportunities in the nutrition, weight management, stress, and mindfulness spaces.

In all, the wearable technology and wellness markets are facing rapid changes as they converge in new and unique ways meeting customers' desires for proactive health management aided by smart products. Both industries are experiencing rapid growth as global priorities shift toward health. This creates fertile ground for products like Abit to meet consumer needs outside of the traditional healthcare industry, which isn't meeting consumer needs As technology continues to advance at an ever-increasing pace, the possibilities for these types of devices continue to grow, pushing the current market of fitness wearables forward into new domains.

COMPETITOR ANALYSIS & MAP

In the rapidly evolving health tech space, understanding the competitive landscape is highly important for positioning the Abit device effectively. This section provides a detailed exploration of key players in the industry, highlighting their unique positioning, strengths, and weaknesses and illuminating points of differentiation for Abit.

TOP HEALTH & WELLNESS WEARABLES (INDIRECT COMPETITORS)

A couple of devices currently dominate the health wearable technology space. Apple Watch and Fitbit have the majority market share while Oura Ring and Whoop offer comparable products that are gaining popularity. By comparing the value proposition, functionality, and use cases of these devices, we can begin to understand which customer needs they serve and which they do not.

Table 4
Current Wearable Devices in the Health Space

DEVICE	VALUE PROP	FUNCTIONALITY	USE CASES
Apple Watch  *apple.com*	**The ultimate device for a healthy life.** An all-in-one health and fitness smart watch.	Fitness tracking, heart rate monitoring, ECG, sleep tracking, GPS	Fitness (counts every move) Health (knows you by heart) Connectivity (the right call for staying in touch)
Google Fitbit  *fitbit.com*	**Smart technology to help you transform your health.** Stay motivated and improve your health by tracking your activity, exercise, and food.	Activity tracking, sleep analysis, heart rate monitoring, guided workouts, water tracking.	Keep a closer eye on health metrics Manage your body's response to stress See what's going on behind the ZZZs Get more out of workouts
Oura Ring  *ouraring.com*	**Smart ring for fitness, stress, sleep, and health.** Oura translates your body's most meaningful messages — sleep, activity, stress, and heart health — to transform how you feel every day.	Sleep tracking, heart rate monitoring, menstruation and temperature tracking, activity and readiness score.	Get better sleep, live healthier, accomplish fitness goals, monitor your heart, understand women's health, monitor stress
Whoop  *whoop.com*	**Unlock your potential.** Monitor sleep, strain, recovery and health.	Heart rate monitoring, strain tracking, sleep monitoring, recovery analysis.	Get better sleep, push your athletic limits, quantify recovery, track habits, manage stress, monitor health markers

CURRENT WEARABLE PRODUCTS IN THE HABIT SPACE (DIRECT COMPETITORS)

The mentioned wearables represent the market leaders. However, they are all indirect competitors as they focus more broadly on health and wellness. Below, we've employed the same framework to compare devices in the habit space in particular.

Table 5
Current Wearable Devices in the Habit Space

DEVICE	VALUE PROP	FUNCTIONALITY	USE CASES
Pavlok  *shop.pavlok.com*	**Change your habits, change your life.** Pavlok helps you get rid of bad habits and replace them with good ones – one zap at a time!	Electric shock for bad habits, haptic feedback to reinforce good habits	Wake up alarm, work out more, stop eating junk food, increase productivity, quit smoking, spend less time on social media, stop nail biting
Sensea *no product image available* *sensea.com*	**Reveal hidden emotional connections.** Use deep insights into the body and mind to uncovers hidden emotional patterns and the complex web of human behaviour.	Creates a psychological map of emotions and a personalized intervention plan with exercises and reflections	User research, corportate trainings, one-on-one coaching
Revibe Tech  *revibetech.com*	**The Future of ADHD Treatment.** Digital therapy for the treatment of attention and focus in kids with ADHD.	Vibration reminders, attention span tracking	ADHD for children and adults
SleepCogni  *sleepcogni.com*	**Putting the power of a good night's sleep back in your hands.** SleepCogni provides insomnia sufferers with a handheld sleeping aid that breaks cognitive cycles that prevent sleep.	Sleep environment optimization, biofeedback sleep onset monitoring	Managing insomnia, improving sleep quality, sleep pattern tracking.
HabitAware  *habitaware.com*	**A smart bracelet for Trichotillomania treatment.** Break the trance of hair pulling, skin picking & nail biting.	Helps the user to gain awareness and provides behaviour change resources, community support, ecourses, and virtual peer coaching	Treatment for trichotillomania, dermatillomania, and onychotillomania

ABIT'S UNIQUE SELLING POINTS

Table 6
Competitor Comparison Chart

The competitor analysis helps us to gain a clear understanding of the customer needs competitors meet and my proxy which needs Abit is specifically able to meet that others do not. To lay out the differences, we've created a high-level comparison chart below. This would serve to show customers how Abit is different from other devices.

	ABIT	PAVLOK	APPLE WATCH	WHOOP
Wearable device and supporting digital app experience	X	X	X	X
Real-time biofeedback monitoring	X		X	X
Activity tracking	X		X	X
Haptic feedback mechanisms	X	X	X	X
Habit tracking functionality	X	X		X
Automatic habit sensing and measurement	X			
Scientifically-proven focus on the cue and reward stages of the habit cycle	X	X		
Real-time cue and reward interference	X	X		
Long-term and short-term goal setting for a wide variety of habits	X			
Focus on rewarding positive behaviour instead of punishment for negative behaviour	X			
Designed to be non-intrusive and seamlessly integrate into day-to-day life	X			

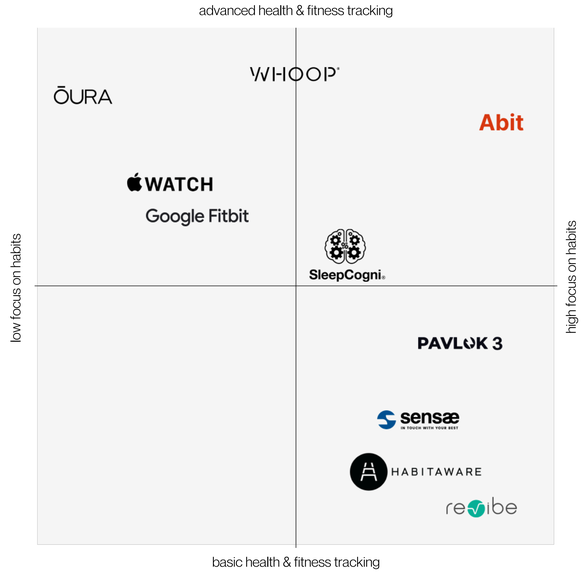
As made clear from this comparison chart, Abit combines the biofeedback and activity tracking of traditional wearables with a focus on habit formation, the cornerstone of building long-term health. Although it speaks to a similar customer group as Pavlok, it works in different ways, focusing on positive reinforcement and automatic habit sensing to make for a seamless, non-intrusive user experience.

COMPETITOR MAP

By plotting all the presented competitors onto a two-axis map, we can start to envision the unique space that Abit holds. This allows us to further tailor messaging and clearly communicate to customers the value the Abit brings that other products do not.

Figure 23
Competitor map

The competitor analysis shows that there are two main areas where Abit can differentiate from competitors. In the broader health and wellness market, Abit stands out for its focus on habits and long-term behaviour change. While other devices focus on general health primarily through step counters and heart rate monitors, Abit works a level deeper by asking users to choose a 100-day habit goal with three daily sub-goals. After completing the 100 days, users will have formed new habits and achieved long-term behaviour change.



Within the small but growing habit-focused space, Abit stands out because it focuses on a broad array of habits, it doesn't target a limited set of behaviours. Unlike competitors, it utilises a full suite of health monitoring and tracking sensors which enable automatic habit sensing and seamless integration in day-to-day life. While other devices require manual logging of data points, Abit tracks them automatically to provide the user with personalised insights into their health and well-being through the lens of their behaviours.

STRATEGY

STREGTHS	WEAKNESSES
Innovative Technology: Abit combines health monitoring with a user experience focused on habit formation, leveraging cue and reward mechanisms to foster positive habits and long-term behaviour change. **Comprehensive Health Tracking:** Tracks a variety of metrics to offer a holistic view of one's health. **User Experience:** Focuses on seamless user interaction that is integrated into day-to-day life with minimal disruptions. **Customisable Discreet Feedback:** Personalised real-time vibrotactile feedback can be adjusted to suit user preferences increasing overall user satisfaction.	**Market Penetration:** Abit might face challenges breaking into a market with well-established competitors. **Cost Implications:** Advanced sensors and technology increase production costs and could make the device unaffordable to the average consumer. **Battery Life:** The use of real-time monitoring and biofeedback could lead to significant battery drain. Coupled with its small size, the device could require frequent charging.
OPPORTUNITIES	**THREATS**
Growing Health Consciousness: The growing interest in personal health and wellness creates a ripe market for these kinds of devices. **Data-Driven Personalisation:** Machine learning can analyse user data can provide increasingly advanced health insights and recommendations, improving the overall value of the product. **Technological Advancements:** Advancements in technology enable Abit to shift form factors to become even more integrated into the user's life. **Subscription Services:** Adjacent subscription models that offer premium features could enhance revenue streams.	**Competition:** A growing market means lots of competition. Abit will need to stay ahead of the competition to stay competitive. **Technological Obsolescence:** Rapid technological innovation could make Abit quickly outdated if it doesn't continue to evolve. **Regulatory Challenges:** Compliance with global regulations faces significant hurdles and could delay or restrict market entry. **Privacy Concerns:** Consumer concerns regarding privacy could inhibit Abit's adoption and growth if it doesn't take robust privacy measures.

Figure 24
SWOT analysis for Abit

SWOT ANALYSIS

A SWOT Analysis is a strategic tool used to analyse the strengths, weaknesses, opportunities, and threats involved in a business or project (Gürel, 2017). It serves as an assessment model that can aid in the decision-making process for new business ventures. By breaking down the business into these four categories, we can capitalise on strengths and opportunities while addressing or mitigating weaknesses and threats. The insights gained through this analysis will guide further strategic planning for Abit.

By analysing the market, industry trends, competitors, and performing a SWOT analysis, we've examined desirability from multiple angles. The market is growing rapidly, projected to reach 120 billion euros by 2025. Industry trends show consumers prioritising health and seeking products for long-term wellness. Competitor analysis reveals opportunities for innovative solutions. The SWOT analysis highlights strengths, weaknesses, opportunities, and threats. This comprehensive analysis underscores the unique customer needs Abit can address, differentiating it from the current competition.

FEASIBILITY

In the feasibility section, we will cover aspects of technological and economic feasibility. We make the case for why the Abit concept is feasible with today's technology and resources. However, we will also cover future possibilities for the device as new technologies are brought to market and make further advancements possible.

TECHNICAL FEASIBILITY

In order to understand whether Abit is technically feasible with today's technology, we will start by examining the main functionalities and comparing them to other devices on the market that provide these features. Given that these other products are able to perform in these ways, we will make the assumption that with the right parts and right team, Abit will also be able to do so.

Table 7
Functionality of Abit compared to competitors

FUNCTIONALITY	ABIT FEATURES	COMPARATIVE PRODUCTS	NOTES OF FEASIBILITY
Haptic Feedback	Customisable vibration patterns for real-time feedback	Pavlok, Apple Watch, Whoop	Well-established in the wearables industry.
Activity & Location Tracking	Location tracking for activity mapping and habit detection	Apple Watch, Fitbit	Standard for activity wearables.
Biofeedback Tracking	Heart rate, temperature, activity tracking	Fitbit, Apple Watch	Common in current wearables, proven technology.

A detailed breakdown of each component needed to support Abit's functionality is provided in Appendix C. It serves to specify how the device would work and to demonstrate that the desired functionality is possible with today's technology. As seen in the table above, Abit's main functionality relies on standard parts that are commonly used in the wearables industry to meet similar customer needs in different ways. Abit combines features from different existing wearables in a unique way to target habit formation as the vehicle for healthy living. From this we can deduce that the current concept for Abit is technically feasible.

FUTURE TECHNOLOGICAL EVOLUTION

The form of Abit's device being a small ear-worn wearable is designed for today's technology and today's customer. As the wearable industry continues to innovate, Abit's form will change as well. There are many advancements in the field such as smart tattoos, smart contact lenses, and micro ingestibles that show promise in meeting customers' needs in increasingly advanced and discreet ways. As this technology improves and consumers begin to accept such innovations, Abit will take advantage of new form factors to better meet customer needs.

ECONOMIC FEASIBILITY

Abit relies on components commonly used in other wearable devices. These devices work in similar ways to Abit and therefore, prove that the functionality already exists and can be implemented in this new concept. The table below details available devices along with their prices. From these retail costs, we can estimate the cost of goods sold (COGS) based on the average consumer electronics industry gross profit margin, which is approximately 32% (Margins by Sector (US), 2024). This information gives us a rough estimation of the manufacturing cost and therefore retail cost of Abit.

Table 8
Estimation of COGS for similar devices

DEVICE	RETAIL COST	EST. COGS (with a 32% margin)
Apple Watch	€250-€800	€170-€544
Google Fitbit	€200-€400	€136-€272
Oura Ring	€329	€224
Whoop	€264	€180
Pavlok	€140-€190	€95-€129
HabitAware	€180	€122

Overall, given that Abit will use similar components to existing devices, we can approximate a similar manufacturing and retail cost for the device. Future, more accurate, projections of costs require building high-fidelity prototypes and working with component manufacturers to get cost estimates for specific parts based on order quantities. This information is necessary in the further development of the concept.

At this point in the design process, we will assume that Abit can be made for loosely the same cost as similar products, €200 (average estimated COGS). Following the industry-standard margin of 32%, Abit is priced competitively at €264. Given that some of these products, such as the Apple Watch and Fitbit are hugely popular, we already know that customers are willing to pay these prices. Market trials and further consumer demand testing are needed to further validate these estimations.

€200
average estimated cogs for comparative products

32%
industry-standard margin

€264
Abit's estimated retail cost

VIABILITY

This section covers the viability of Abit, and explains how the product service system will become profitable. First it outlines the overall business model and explains how Abit plans to generate revenue. Then a launch strategy will present a plan for introducing Abit to market. This strategy will include a roadmap with three development horizons along with a marketing strategy.

THE BUSINESS MODEL

A foundational element to Abit's success is its ability to reach a wide audience of customers and help them achieve real change in making their lives healthier and happier. In order to do this, Abit must have a plan for reaching those customers and, in turn, generating revenue that allows the business to continue to grow and expand. In looking at the business model, we will focus on the revenue streams and pricing strategy. Together these form an overview of the profit-generating activities of the companies. Often business plans also include information about target customers and value propositions. As those have already been covered in prior sections, they will not be repeated in this section.

REVENUE STREAMS & PRICING STRUCTURE

Initially, Abit will have a straightforward revenue model composed of app subscriptions and device subscriptions. This simple strategy is designed to keep the resources focused and customers clear on the product offering.

APP SUBSCRIPTIONS

The Abit App experience is designed to be used alone or with the Abit device. This strategic decision allows for greater reach and acts as a marketing channel for the device. Alone, the app cannot track habits automatically or provide real-time feedback, but it still serves as a manual habit tracking experience where users can set goals and keep track of their successes. The friction involved with manually tracking habits acts as motivation for users to upgrade to the device experience.

In addition, this strategy allows Abit to test and trial the app experience while the device is still in development. Not only does it allow for app improvements and optimizations, it also becomes a revenue channel to supply some cash flow before the device is launched to market.

2 MONTH FREE TRIAL

Customers are offered a two-month free trial. Compared to other apps which offer one week to one month, this longer trial has greater appeal and helps get customers 60 days into their habit formation process. They start to feel successful and see the impact. Their 100-day goal is approaching and will encourage them to convert to paid customers.

→ low barrier to entry

THEN €14,99 / QUARTER

After the two-month free trial is over the customer must upgrade to a paid subscription to continue use. At this point, they are asked to pay for three months at a time, increment that align with the 100-day habit-formation goal. The price of €14,99 is set competitively among similar apps.

→ €60 annual revenue per app subscriber

DEVICE SUBSCRIPTIONS

Abit's competitors operate with several different pricing models. The two most common are full device purchases (Apple Watch, Pavlok) or device purchases plus a monthly subscription fee (Whoop, Oura). Unlike these devices, Abit will be offered for a monthly subscription cost which will cover access to both the device and the app.

A subscription model has been selected because it lowers the barrier to entry for most consumers. As demonstrated by the popularity of Apple's iPhone subscription plans, the majority of customers prefer to pay for higher-priced items in small monthly payments versus paying the full cost upfront (Orr, 2023).

When customers begin their subscription, they will pay the first and last month's fee for their device and will be asked for a three-month commitment. This initial revenue provides extra cash at the upfront which will help the business with cash flow in the early phases. Then the customer will be charged the subscription fee on a monthly basis. If they decide to cancel their subscription, they will need to return their device which can then be refurbished and reused, reducing tech waste. As the product continues to improve and new models are released, older models will command a lower monthly subscription cost.

Initially, we will assume a 12-month average customer subscription length. This is purely an assumption and will need to be further tested. Based on this assumption, we can work backward to arrive at the monthly subscription cost.

SUBSCRIPTION PRICING BREAKDOWN

€200	Estimated COGS
€264	Projected Retail Cost (with 32% profit margin)
/ 12	Month Assumed Ave. Customer Subscription Length
= €22	Month Subscription Cost
→ €24.99	Monthly Subscription Cost (rounded up)

With this pricing model, Abit generates about €300 in revenue per device subscriber (not including app revenue or insurance sales) which comes out to about a 50% profit margin with a €200 cost of goods sold. Abit maintains a very healthy profit margin while customers pay a competitive monthly subscription amount of 2€4.99 which is an accessible price point for a large segment of consumers.

INITIAL PAYMENT (FIRST & LAST MONTH)

€49.99

Customers pay first and last month at the onset of their subscription with a commitment of three months.

MONTHLY SUBSCRIPTION COST

€24.99

After the first month, customers are charged their first monthly subscription cost which they will be charged every month until they choose to cancel and send back the device.

SUPPLEMENTARY YEARLY INSURANCE

€24.99

Customers are given the option to purchase supplemental yearly insurance at the onset of their subscription and each year thereafter. This insurance protects customers against theft and damage and serves as additional cash flow in the early stages of launching Abit.

THE LAUNCH STRATEGY

Abit's launch strategy is designed to establish and grow the brand within the ever-evolving market of wearable technology. The go-to-market roadmap breaks down the approach into multiple phases, each with distinct objectives and target outcomes. Given the need for customer acquisition across the horizons, a high-level marketing strategy is provided to paint a clear picture of messaging, tactics, and positioning.

Figure 25
Abit's launch roadmap

GO-TO-MARKET ROADMAP

A go-to-market strategy is a detailed plan that takes a business from initial concept to market launch and beyond. It sets the direction, timelines, and key milestones for the first phases, or horizons, of the business. The roadmap breaks down the first ten years of Abit into five horizons. Horizon 0 and Horizon 1 serve as the go-to-market strategy for both the app and the device. While Horizons 2 through 4 see the company's development through the following 7+ years.

	0	1	2	3	4
HORIZONS	**CAPITAL FUNDRAISING** today - 2025 *(pre-launch)*	**MARKET ENTRY** 2025-2026 *(years 1 to 2)*	**GROWTH & EXPANSION** 2027-2029 (years 3 to 5)	**MARKET PENETRATION** 2030-2032 *(years 6 to 8)*	**FUTURE INNOVATIONS** 2033+ *(year 9 and beyond)*
VISION	**Raise sufficient capital to launch the product and sustain the business until it reaches the breakeven point.**	**Build brand awareness and begin to establish Abit as a credible brand in the wearable tech space.**	**Expand market reach and establish a solid customer base.**	**Become a key player in the wearables market and command greater market share.**	**Leverage emerging technology to further innovate cutting-edge products.**
REVENUE TARGET	**€0**	**€500K**	**€2M**	**€10M**	**€20M+**
FOCUS AREAS	initial app development fundraising	launch Abit app develop and launch Abit device customer acquisition	learn & innovate on product experience scale up production expand market terriroties & enter new markets	explore new sectors integrate emerging tech	
BUSINESS MODEL	traditional fundraising	acquire 3000 yearly app subscribers *(€200K yearly revenue)* acquire 1000 device subscribers *(€300K yearly revenue)*	grow app customer base to 10k users *(€600K yearly revenue)* grow device customer base to 5k *(€1.5M yearly revenue)*	generate €2M yearly from app subscriptions generate €7M yearly from device subscriptions generate €1M yearly from premium subscription upgrades	generate €4M yearly from app subscriptions generate €14M yearly from device subscriptions generate €2M yearly from premium subscription upgrades

MARKETING STRATEGY

Given that customer acquisition is essential for the success of Abit, this section focuses more specifically on the campaign strategy to support the launch of the Abit device. The campaign is designed to generate awareness and initial sales with early adopters in the United States. Given that regulation compliance is simpler in this region, it has been selected for the initial launch, with expansion to the European market to follow.

CAMPAIGN OBJECTIVE

The launch campaign will take a highly targeted approach, focusing on a few key objectives within a small targeted audience.

1. **Build Brand Awareness:** Introduce the Abit brand and device and begin to build brand equity.
2. **Drive Initial Sales:** Target the acquisition of 300 device subscribers within the first 3 months.
3. **Establish Market Credibility:** Focus on providing early adopters with a positive experience to build up positive reviews and testimonials to pave the way for further market expansion.

TARGET AUDIENCE

For the initial introduction of Abit, we will focus on the core target audience including tech-savvy millennials who are already proactive about their health and wellness, and value the integration of technology into their everyday lives. Given the emphasis on digital marketing that this campaign will employ, we will target individuals who are known as the early adopters in the wearable tech space and niche down to specific interests and hobbies outlined in Tech-Savvy Tara and Active Alex's personas. Prior to the device launch, the app will have acquired a small customer base. This base will also be a primary target group.

Image 31
User personas developed in the design phase

KEY MESSAGING

At its core, the desire to be healthy is a desire to live a full and rich life. Abit's messaging will speak to those who are looking to proactively level up their health and transform their life. To start, the brand will lead with a simple message and tagline to ensure consistent brand awareness creation and avoid confusing consumers. The message will be something along the lines of:

From Good To Great

Transform your habits, transform your life.

Abit

The Habit Device for a Healthy Life

CHANNEL STRATEGY

To reach Abit's target audience, the campaign will employ an omnichannel approach with a focus on digital marketing. The selected channels offer the ability to highly target users based on their location, interests and past purchases, helping to keep advertising costs low.

Digital Marketing

Digital ads across a variety of platforms including Google, Instagram, Facebook, and Tiktok can target specific demographics based on interests and behaviours. These channels also become key areas for testing messaging, components, colours, and positioning to learn what resonates and converts best.

Email Marketing & In-App Promotions

Given the existing customer base of app subscribers, email marketing and in-app promotions can encourage users to upgrade to the device subscription plan.

Content Marketing

Content marketing and search engine optimization (SEO) are long-term strategies and starting early is key to their success. Abit will strive to become a leader and information hub for all things habits and health aiding in customer acquisition in the long term.

Influencer Partnerships

Micro influencers in the tech and wellness space have loyal followings of people who share similar interests. Influences are a great way to build trust and credibility for a new brand and product.

TIMELINE

The first six month's of a product's launch are critical to its success. For Abit's release, the campaign starts with an early bird offer to app subscribers who can try the device for no additional cost for one month. This helps to build credibility through positive reviews and testimonials. In months two and three, the campaign activates a media lightning strike across all channels. The goal is to touch each targeted consumer multiple times to build up initial awareness and promote purchase among early adopters. In the final three months, digital marketing tactics are maintained while a micro influencer campaign is introduced to build trust and loyalty for the product.

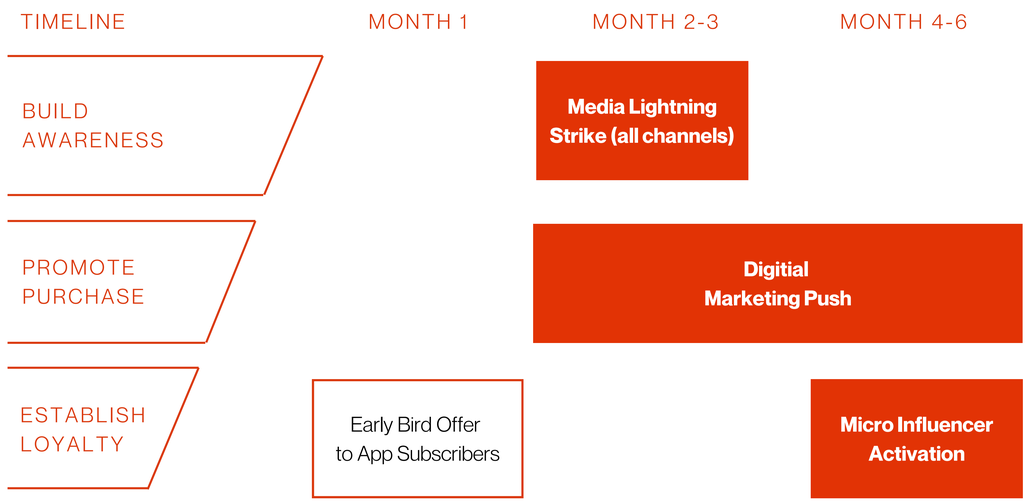


Figure 26
High-level channel strategy

This strategic launch campaign is designed to reach and engage with a highly targeted audience to build brand awareness, drive sales and establish a market presence. Through the outline tactics, the campaign can be both effective at reaching its desired goals but also stay within a relatively low budget while the company begins to generate revenue.

4.3 THE CONCLUSION

The strategy section has outlined a plan for bringing the Abit device to market, ensuring it remains aligned with customer needs while still standing out from the competition. Through a detailed process of defining the value proposition, positioning, and purpose, we have articulated a clear and compelling brand narrative that resonates with the target audience's needs and desires. The market analysis and competitor mapping paint a picture of the broader industry, illuminating gaps that Abit can fill.

The business model and pricing strategy have been created to articulate how the product can support a sustainable company, poised to grow with the industry in the next decade. Through employing a subscription model, the barrier to entry for customers is lowered while simultaneously promoting long-term use and engagement. Additionally, the feasibility analysis has explored the technical and economic viability of the product, while emphasising the need for continued development and iteration.

The go-to-market strategy, with a phased roadmap and targeted marketing campaign, sets a path forward for launching Abit. Starting with growing its user base while developing and manufacturing the physical device, the plan takes a phased approach, breaking the next ten years into five horizons. The framework lays the groundwork for future innovations and market expansion. By following this strategy, Abit is well-positioned to make an impact in the wearables market, aiding users in achieving their health and wellness goals through effective habit formation.

Part 5

The Wrap-Up

Final Conclusions and Reflections

This section provides a general discussion of the results, synthesising the findings from each phase of the project. It also includes a personal reflection on the entire process, highlighting key learnings, challenges, and the overall journey of developing the Abit device from concept to comprehensive strategy.

5.1 DISCUSSION & CONCLUSION

The journey of developing Abit has yielded many insights and opportunities as the intersection of habits, haptics, and wearable technology. Starting from the initial research phase, it was clear that there was a research gap in studying how technology can enhance the habit formation process. Throughout the process, we endeavoured to keep the results connected to the user through user-representation techniques at every stage in the process.

The design phase highlighted the importance of direct user feedback. The brand identity, including the name, logomark, colour palette, and typography, was all deeply connected to the user personas and designed to resonate with users and convey the product's unique purpose. The app prototype showcased the envisioned functionality while the physical device highlighted the need for ergonomic considerations. The two-part testing and validation phase was critical in refining the design, leading to a second iteration that better meets user needs.

IMPLICATIONS OF THE RESEARCH

The findings of this project demonstrate that vibrotactile feedback could be an effective tool for enhancing the habit-formation process through cueing and rewarding users. This insight requires further long-term study but could be valuable in the field of habits and also potentially in adjacent fields such as addiction, obesity, and chronic illness.

For users, Abit represents a possible shift in how they approach habit formation. By providing real-time feedback and support, the product service system could help users develop healthier routines and effectively maintain them in the long term. This has the potential to improve individual health and well-being, laddering up to a higher overall quality of life.

STRENGTHS & LIMITATIONS

One of the strengths of this project was its comprehensive, multi-discipline, approach. It combined academic research with practical, hands-on applications. The iterative design process was informed by user feedback at multiple points, ensuring that the final product was both aligned with user needs and effective.

However, there were also many limitations. The scope of each study was relatively narrow with small sample sizes. More extensive studies would provide a deeper understanding of the variety of user perceptions. In particular, a longer-term study is needed to evaluate the effectiveness of the proposed vibrotactile feedback within the habit formation process. Without it, the concept operates on the assumption that it would be a successful intervention, without data to back it up.

The scope of this project was highly limited due to its reliance on the researcher's own skill sets. Being that it is a thesis project, the involvement of third-party specialists, such as engineers and programmes, was limited. The technological aspects of the device, such as the integration of sensors, require further development and testing to prove their viability in this context. These limitations, and others not discussed here, highlight the need for additional research and development to bring the Abit device to market.

FUTURE DIRECTIONS

Looking ahead, several steps are needed to further develop and refine the presented concept. First, the involvement of software and hardware developers is necessary to confirm the technical viability. This will provide a comprehensive understanding of the technological aspects of the product and better inform the research and development costs required to bring it to market.

Second, an expanded ergonomics study with a larger and more diverse sample size is essential in ensuring that the device can be comfortably worn by all or most of the targeted user group. This study will provide a more representative dataset to inform subsequent iterations.

Next, a more extensive testing and validation program is needed to ensure the device is effective and accurate. This includes further usability testing and trials to measure the impact of Abit on habit formation and health outcomes in the long term.

Lastly, the development of a more robust go-to-market strategy is critical. It should also include a detailed plan for fundraising to secure the capital needed to support the path to market.

In conclusion, this project has laid the foundation for the development of a wearable device designed to enhance how individuals form and maintain healthy habits. While there are challenges and limitations that need to be addressed, the insights gained throughout this project lay the groundwork for future development. Continued iteration of the design, leveraging technological advancements, could lead to the potential of Abit becoming a valuable tool for many in the quest for better health and well-being.

5.2. PERSONAL REFLECTION

Over a decade ago when I was in the process of applying for bachelor programs, my heart called toward design education. At that moment, I let my head take me to New York University to study business. For many years after I graduated, I wondered if I had made the right decision. Deep down my heart still called toward a formal education in a creative field. In the depths of the COVID-19 pandemic, the voice became louder and led me to the Strategic Product Design program at TU Delft.

I have faced a near-constant feeling of imposter syndrome in the last two years and have struggled to identify with the word designer, despite finally gaining the education to prove it. Looking back at my first few weeks at TU Delft, I can see this black-and-white thinking of being a designer or not was also reflected in the rhetoric of the education.

But what does it *even* mean to be a designer? With the rise in popularity of design thinking, anyone and everyone is a designer. However, this poses a threat to the design education system. If everyone is already a designer, why would anyone need a special education? So we are taught the things that set us apart from others: our ability to think abstractly, our innate ability to empathise with the user, or some special way we think in loops.

I have to admit that I have struggled to resonate with these ideas and I have spent a lot of time dwelling on the question of what sets designers apart. I don't have any big revelations or marketable frameworks but I will say this.

During my time at NYU, I noticed that, in general, my fellow classmates seemed most interested in using their education to further themselves, whether it be to make a lot of money, to become famous, or to gain power and prestige. In contrast, my recent classmates dream of changing the world for the benefit of others. Whether that be to make the world a more sustainable place, a more inclusive place, or perhaps just a more beautiful place, my fellow classmates are driven by altruism.

And in reflecting on the past two years, I think, perhaps, that's what makes a designer...the ability to see the problems in the world and a selfless desire to solve them and make the world a better place.

I have been constantly inspired by my classmates' determination to make an impact in the lives of others. And that is what I will most take away from my education, the feeling of gratitude toward all the creative problem-solvers out there.

Over the past twenty or so weeks, I have had the opportunity to use my various skills, whether they make me a designer or not, to envision ways that I can help people live healthier more full lives. At its core, this project is an exploration of how technology can make life easier and more enjoyable for many by making healthy choices easier and more rewarding.

In reflecting on the result, the perfectionist in me will never be fully satisfied. However, in reflecting on the process, I can so clearly see all the ways that I have grown as a person and a designer. Aspects of this project fell squarely into my comfort zone and allowed me to fall back on skills I've spent years developing. Other aspects presented all new challenges and required me to move through discomfort, struggle, and to fail and then try again.

In the end, I am so grateful for this opportunity to spend time putting my ideas to the test. I could not have done it alone and am grateful to all the people that pushed me forward along the way. Thank you to my chair and mentor for challenging me to do more than I thought I was capable of. Thank you to Chris, my partner, who often lent a patient ear. And most of all, thank you to my fellow classmates for inspiring me to design in pursuit of a better world.

5.3 REFERENCES & APPENDICES

In the following sections, you will find the references and appendices. The appendices include additional research as well as extra documentation of the studies carried out over the course of the project.

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APPENDIX

APPENDIX A: USER RESEARCH SURVEY

Habit Formation Wearable Device Survey

Hello! Thank you for taking 15 minutes to complete this survey for my master's thesis project. Your responses are highly valuable to me.

All responses are totally anonymous and will be stored on a secure drive and deleted upon aggregation of the results.

Thanks!
Victoria

victorialouiseholbrook@gmail.com Switch account

Not shared

PART 1: DEMOGRAPHICS & BACKGROUND INFORMATION

Age

Choose

Gender

Your answer

Occupation

Your answer

On a scale of 1 to 7, how much do you prioritize health in your daily life?
(1 being you never consider it, 7 being that it guides every decision you make)

	1	2	3	4	5	6	7	
not at all	○	○	○	○	○	○	○	every decision

One a scale of 1 to7, rate your familiarity with wearable technology?
(1 being not familiar, 7 being very familiar)

	1	2	3	4	5	6	7	
not familiar	○	○	○	○	○	○	○	very familiar

PART 2: HABIT FORMATION

Have you ever attempted to form a new habit or change an old one in the past?

- ○ Yes
- ○ No
- ○ Other:

If yes, list any habits you are currently trying to form or have worked on in the past:
e.g., exercise, meditation, healthy eating

Your answer

What methods or tools have you previously used to form new habits?

Your answer

Have you established any tricks to help in forming or changing habits?

Your answer

What challenges have you faced in forming new habits?

Your answer

Any challenges in maintaining new habits?

Your answer

PART 3: MOTIVATION & BEHAVIOR

Rank these goals on most important to you to least important to you.

1. Regular exercise
2. Eating healthy foods/following a diet
3. Adequate hydration
4. Getting enough sleep
5. Meditation or mindfulness practices (breathwork, journalling, etc.)
6. Stress management
7. Limiting alcohol and/or avoiding smoking
8. Social connectivity
9. Other _____ (please specify)

Example answer:
9 (daily steps), 2, 6, 3, 4, 7, 8, 1, 5

Your answer

APPENDIX

APPENDIX A: USER RESEARCH SURVEY CONT.

Please rank any of the habits below that you engage in and have would like to change. Put them in order from your highest priority to lowest priority.

Leave out any habits that you don't engage in or would not like to change.

1. Smoking
2. Excessive alcohol consumption
3. Overeating or unhealthy eating
4. Lack of physical activity
5. Poor sleep habits
6. Poor stress management
7. Procrastination
8. Excessive screen time
9. Nail biting
10. Skin picking
11. Other _____ (please specify)

Example answer:
4, 6, 11 (slouching), 5

Your answer

PART 4: DEVICE PREFERENCES

Do you currently, or have you in the past, worn a wearable device?

Wearable device: smart wearable device such as a Fitbit, Apple Watch, Oura Ring, Snap Glasses, etc

- ◯ Yes
- ◯ No
- ◯ Other:

If yes, which device(s)? Describe your experience with it/them.

Your answer

What are some features you liked or found useful?

Your answer

Were there any features you didn't like or found useless?

Your answer

Do you have any concerns regarding wearable devices (e.g., comfort, privacy, battery life)?

Your answer

PART 5: VIBROTACTILE FEEDBACK

Have you ever used a device with vibrotactile (vibration) feedback (e.g., vibrating smartphone, gaming controller, Apple Watch)?

- ◯ Yes
- ◯ No

Describe your experience with the vibrotactile (vibration) feedback specifically.

Did you like it? Dislike it? Find it useful? Find it annoying/disruptive?

Your answer

PART 6: ADDITIONAL INSIGHTS & SUGGESTIONS

List any features or functionalities you would desire in a habit formation wearable device:

Your answer

Please share any additional thoughts, concerns, or suggestions regarding a habit formation wearable device:

Your answer

Thank you for participating in this survey. Your feedback is invaluable.

Submit Clear form

APPENDIX B:
USER RESEARCH IN-DEPTH INTERVIEWS

INTERVIEW GUIDE

Introduction

- Welcome and thank you
- Explain the purpose of the interview
- Confidentiality and consent
- Questions

Section 1: Background Information

- Personal Introduction
  - Could you please tell me a bit about yourself (e.g., age, occupation, general lifestyle)?
    - Age
    - Occupation
    - Location
  - Tell me about your general lifestyle, health, wellness, diet, fitness, etc.
- Health Prioritization
  - On a scale of 1 to 7, how much do you prioritise health in your daily life? (1 being you never consider it, 7 being that it guides every decision you make)
  - Describe any significant changes in your lifestyle or health priorities over the past few years. (conscious or unconscious)
  - How has your approach to health changed as you've gotten older?
    - Can you describe any habits that have become more or less important to you?

Section 2: Habit Formation and Challenges

- Habit Associations & Ranking
  - When I say "habit," what spontaneously comes to your mind? I'll give you two minutes to write down anything that comes to mind

  - Tell me a bit about some of the things you wrote down.
  - Can you rank the habits most crucial to you and explain your reasoning?
  - Do you have any positive or negative habits that you are eager to change?
  - Looking at the lists, are there any other habits you feel like you left out?
- Successful Habit Formation
  - Could you share a memorable story or experience that revolves around forming, maintaining, or breaking this habit? It could be a success, a challenge, or a turning point.
    - Can you recall a time when you successfully formed a new habit? What habit was it?
    - How do you feel/what emotions do you associate when you've done it?
    - And when you haven't done it?
      - Are there any specific emotions or states of mind that trigger or suppress this habit?
      - When trying to form a new habit, what does your process look like?
      - What has helped you succeed?
- Struggles in Habit Formation
  - Have you faced challenges or failures in forming a new habit or breaking an old one? Could you describe that experience?
  - Which factors do you think are most important to success or failure?
  - Have you developed any tricks or tips for successfully forming or changing habits?
- Routines
  - Let's dive a little deeper on one specific habit you currently have.
    - Please identify one specific habit you're comfortable discussing in more depth.

        - Can you describe this habit and how it fits into your daily or weekly routine?
        - What prompted you to start this habit? Was it influenced by a particular event, person, or need in your life?
        - What were your initial goals or expectations when you began this habit?
        - What goes through your mind before, during, and after engaging in this habit?
        - How do you mentally prepare (inner dialogue) for this habit, and what thoughts help you maintain it?
        - Have you made any modifications to this habit over time? If so, what prompted these changes?
- Mental Health
    - Do you have any goals related to maintaining or improving your mental health? Which habits do you think play a role (either negatively or positively)?
- Productivity and Personal Development
    - Are there any productivity or personal development habits you're working on (e.g., time management, learning a new skill)?
- Environmental and Social Habits
    - Do you have any goals related to forming habits that positively impact your environment or social life?

Section 3: Technology Usage and Experience

- Current Technology Use
    - Regarding health, wellness, or personal development, what technology do you currently use? Could be devices, apps, etc.
- Experience with Wearable Devices
    - Have you ever used wearable devices like the Apple Watch, Fitbit, or Oura Ring
    - Can you describe your experience?
        - Go deeper
    - What features did you find most useful or appealing in these devices?
    - Are there any features you find negative? Annoying, disruptive or useless?

Section 4: Perceptions and Needs

- Vibrotactile Feedback
    - Have you ever used a device with vibration feedback?
    - Tell me about your experience?
    - Did you find it positive/negative?
    - How do you feel about the idea of using vibrotactile feedback in a wearable device to assist in habit formation?

Section 5: Final Thoughts and Open-Ended Questions

- Additional Insights
    - Is there anything else you would like to share or think is important for us to know regarding your experiences with habit formation and wearable technology?
- Feedback on the Concept
    - Do you have any initial thoughts or feedback about a vibrotactile wearable device designed for habit formation?

Conclusion

- Thank you
- Next steps

APPENDIX

APPENDIX B: USER RESEARCH IN-DEPTH INTERVIEWS, INFORMED CONSENT

Informed Consent Form:
Enhancing Habit Formation Through Vibrotactile Design

You are being invited to participate in a Master's thesis research study titled Enhancing Habit Formation Through Vibrotactile Design. This study is led by Victoria Holbrook and overseen by Gijs Huisman PHD and Rebecca Price PHD.

The purpose of this research is to understand more about the specific target audience, how they view habits, their success & challenges, and their experiences with wearable devices.

This interview will take approximately 45 to 60 minutes and will be fully anonymous. Audio recordings will not include any personally identifiable information and will be transcribed and then destroyed. Any photos and videos will be blurred before use and originals will be stored securely and deleted before the completion of the project.

As with any activity, the risk of an online data breach is always possible. To the best of my ability, your data will be kept confidential. I will minimize any risks by collecting the data anonymously and saving all files on a secure server.

Your participation in this study is entirely voluntary and you can withdraw at any rime. You are free to omit any questions.

Contact details:
Victoria Holbrook (v.l.holbrook@student.tudelft.nl)
Gijs Huisman (g.huisman@tudelft.nl)
Rebecca Price (r.price@tudelft.nl)

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated 01/03/2024, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: - 45–60-minute face-to-face interview - Audio recording of interview, transcribed to text then destroyed - Photos and video taken during interview, anonymized/blurred then originals destroyed	☐	☐
4. I understand that I will not be compensated for my participation.	☐	☐
5. I understand that the study will end 29/06/2024.	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves minimal risks but that some participants may experience mild mental strain. I understand that these will be mitigated by the ability to stop the interview at any time.	☐	☐
7. I understand that the data collected during this study will be anonymous but that there is always a risk of data breaches related to the photos and videos collected during this interview.	☐	☐
8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: - anonymous data collection - anonymization/blurring of photos and videos - secure data storage - transcription then destroying of audio recordings	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
9. I understand that after the research study the de-identified information I provide will be used for a Master's Thesis Report.	☐	☐
10. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
11. I give permission for the de-identified quotes, photos, and videos that I provide to be archived in TU Delft Master's Thesis repository so it can be used for future research and learning. I understand that access to this repository is unrestricted.	☐	☐

Signatures

_____ _____
Please write "Yes" if you agree Date

_____
Participant Number

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____
Researcher name [printed] Signature Date

Study contact details for further information:
Victoria Holbrook
06 25 29 29 62
v.l.holbrook@student.tudelft.nl

APPENDIX C:
BREAKDOWN OF DEVICE COMPONENTS

This detailed component breakdown serves to further specify how the device would work and demonstrate that the desired functionality is possible with today's technology. As seen in the table, Abit's main functionality relies on standard parts commonly used in the industry to meet similar customer needs in different ways. Abit combines features from different existing wearables in a unique way to target habit formation as the vehicle for healthy living. From this we can deduce that the current concept for Abit is technically feasible.

FUNCTIONALITY	COMPONENT	DESCRIPTION	RECOMMENDED PART
Central Processing	Microcontroller	Manages device operations, processes sensor data, and handles communications.	STM32L432KC
Haptic Feedback	Haptic Motor	Provides tactile sensations for notifications and alerts through vibrations.	Precision Micro Drive 312-101 Vibration Motor
Movement Detection	IMU (Inertial Measurement Unit)	Combines an accelerometer, gyroscope, and magnetometer to track movement and orientation.	TDK InvenSense MPU-6050
GPS Navigation	GPS Chip	Provides location tracking.	u-blox NEO-M8 series
Health Monitoring	Temperature Sensor	Measures the skin or body temperature, providing data for health monitoring.	MAX30205
	Heart Rate Sensor	Optical sensor that monitors heart rate by detecting blood volume changes.	MAX30102
Skin Contact Verification	Skin Contact Sensors	Ensures the device is in proper contact with the skin for accurate sensor readings.	Generic capacitive touch sensor
Audio Output	Speaker	Delivers audio output for alerts, notifications, and user feedback.	CUI Devices CMS-151103-078
Audio Input	Microphone	Enables voice command input, and can also be used for detecting sounds.	Knowles SPH0645LM4H-B
Power Supply	Battery	Provides power to the device.	Custom Li-Po Rechargeable Battery
	Charging Circuit	Manages battery charging, enables wireless charging	Texas Instruments BQ51013B
Bluetooth Connection	Bluetooth Chip	Wireless module for app communication.	Nordic Conductor nRF52832
Data Storage	Memory Storage	Stores data locally before syncing with the app.	Microchip 25LC256 - SPI serial EEPROM
Circuit Integration	PCB	The board where all the electronic components are mounted.	Custom
Visual Notifications	LEDs	Used for providing visual feedback and status indicators.	Standard SMD LED

APPENDIX D: USABILITY TESTING

INTERVIEW GUIDE

Set-up & Introduction

- Introduce study's purpose & what participants will be doing
- Informed consent

Part 1: Perceptions & Attitudes

- Intro
  - Tell me a little about yourself. Age, occupation, lifestyle, etc.
  - Rate your health prioritisation on a scale of 1 to 7.
  - Rate your familiarity with wearable devices on a scale of 1 to 7.
- First Impressions
  - What are your initial impressions about the device?
  - How do you feel about the visual design?
  - How does the device feel in your hands?
  - How do you feel about the device being an ear-worn wearable?
- Comfort & Placement
  - How does it feel to put on the device?
  - How is the initial comfort? Are there any pressure points or discomfort?
  - Now please walk from one side of the room to the other.
  - Bend over and look at your toes.
  - Lightly shake your head back and forth.
  - Run in place.
    - Does the device stay in place?
    - Does it feel secure?
    - How would you rate its comfort?
    - Did you feel any urges to adjust its position?
  - Now imagine that you need to press the button on the device to turn up or down the volume.
    - How does it feel?
    - Rate its accessibility and ease of use.
- Participants take off/put down prototype

Part 2: Vibrotactile Feedback Testing

- Participants are set-up with vibrotactile prototype/delivery mechanism
- Test/trial vibration
  - Can you feel the vibration?
  - On a scale of 1 to 10 how would you rate the intensity of the vibration?
- Initial reaction/impression
  - Describe what you are feeling?
  - How does it feel? Anything positive? Anything negative?
- Pattern Perceptions
  - Cue pattern
    - Cue pattern delivered 3 times
    - Describe the sensation
    - Use three adjectives to describe the vibration
    - Anything you would change?
  - Reward pattern
    - Reward pattern delivered 3 times
    - Describe the sensation
    - Use three adjectives to describe the vibration
    - Anything you would change?
- Visualisation
  - Tell me about a habit you'd love to improve or change.
  - Now imagine, that this device would...
  - Do you think this would be an effective
    - Reminder? Motivator? Reward?
  - Do you have any other thoughts about this experience?
- Wrap-up
  - Do you have any feedback on the vibrotactile test?
  - Now that you've experienced it, how do you think it would add to the utility of the device?
  - Are there any improvements that could make it more intuitive or useful?

APPENDIX

Conclusion

- Concluding questions
  - Intention to use(adoption)/assumptions/expectations
  - What are your initial assumptions about the utility of this device? How do you think it would benefit you?
  - Based on your experience today, how likely are you to use this device if it were available? Why?
  - What factors most influence this decision?
  - Are there any aspects you would change or improve before you would consider using the device?
  - Is there a scenario in your life where you imagine this device would be particularly useful?
  - Do you have any expectations regarding the benefits this device should provide?
- Closing remarks
- Thank you

APPENDIX

APPENDIX D: USABILITY TESTING, INFORMED CONSENT

Informed Consent Form:
Enhancing Habit Formation Through Vibrotactile Design

You are being invited to participate in a Master's thesis research study titled Enhancing Habit Formation Through Vibrotactile Design. This study is led by Victoria Holbrook and overseen by Gijs Huisman PHD and Rebecca Price PHD.

The purpose of this research is to gather direct user feedback on the device's ergonomics and perceived utility through a low-fidelity prototype, ultimately, informing any necessary refinements to enhance device usability and utility.

This session will take approximately 30 to 45 minutes and will be fully anonymous. Audio recordings will not include any personally identifiable information and will be transcribed and then destroyed.

As with any activity, the risk of an online data breach is always possible. To the best of my ability, your data will be kept confidential. I will minimize any risks by collecting the data anonymously and saving all files on a secure server.

Your participation in this study is entirely voluntary and you can withdraw at any rime. You are free to omit any questions.

Contact details:
Victoria Holbrook (v.l.holbrook@student.tudelft.nl)
Gijs Huisman (g.huisman@tudelft.nl)
Rebecca Price (r.price@tudelft.nl)

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated 06/05/2024, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: - 30-45 minute face-to-face interview - Audio recording of interview, transcribed to text then destroyed	☐	☐
4. I understand that I will not be compensated for my participation.	☐	☐
5. I understand that the study will end 29/06/2024.	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves minimal risks but that some participants may experience mild mental strain or extremely mild physical discomfort. I understand that these will be mitigated by the ability to stop the session at any time.	☐	☐
7. I understand that the data collected during this study will be anonymous but that there is always a risk of data breaches.	☐	☐
8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: - anonymous data collection - secure data storage - transcription then destroying of audio recordings	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
9. I understand that after the research study the de-identified information I provide will be used for a Master's Thesis Report.	☐	☐
10. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
11. I give permission for the de-identified quotes that I provide to be archived in TU Delft Master's Thesis repository so it can be used for future research and learning. I understand that access to this repository is unrestricted.	☐	☐

Signatures

_____ _____
Please write "Yes" if you agree Date

_____
Participant Number

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

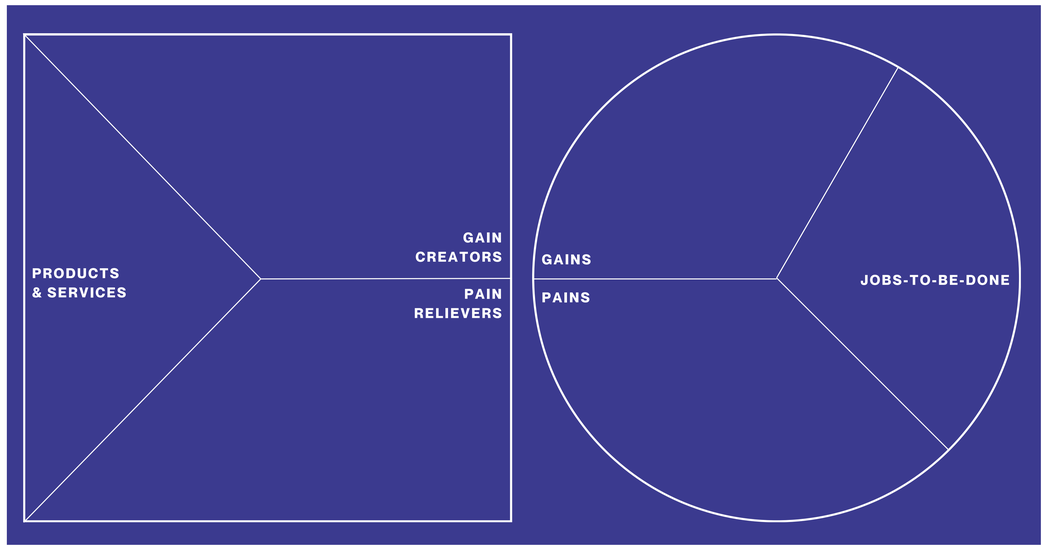
_____ _____ _____
Researcher name [printed] Signature Date

Study contact details for further information:
Victoria Holbrook
06 25 29 29 62
v.l.holbrook@student.tudelft.nl

APPENDIX E: VALUE PROPOSITION CANVAS

To craft a powerful and resonant positioning, The Value Proposition Canvas has been employed. This method is used to deeply understand customers and map out the benefits that a product uses to address these needs (Osterwalder, 2014). It looks at who the customer is, what they want, and how the product can help them achieve it. Here we refer back to our user personas, Tech-Savvy Tara and Active Alex.

The Value Proposition Canvas (Osterwalder, 2014)



JOBS-TO-BE DONE

What are the jobs your customer is trying to get done in work and life?

- Manage a busy schedule while maintaining a healthy lifestyle
- Balance work, personal, and social obligations
- Maintain a high level of performance and productivity at work without compromising commitment to health
- Get high-quality sleep to allow for high-performance
- Manage day-to-day stress through mindfulness techniques
- Optimise routines to improve physical & mental health continually

GAINS

What would make your customer happy (social benefits, functional. and financial gains)?

- Effortlessly forming healthy habits or changing negative ones
- Seeks technology to simply lifestyle and enhance productivity

- Desires effective & reliable tools for health management
- Benefits from solutions that encourage effective unplugging
- Appreciates intuitive design that fits seamlessly into life without requiring constant attention and adjustment

PAINS

What is annoying or troubling to your customer? What is preventing them from getting the job done?

- Old bad habits hold them back from achieving their health goals
- Long-term behaviour change is hard and failed attempts have led to frustration and insecurity
- Feels overwhelmed by busy schedule
- Health goals can easily be forgotten due to the demands & distractions of everyday life
- Struggles to manage stress and often feels anxious
- Sometimes lacks energy to keep up with the demands of daily life
- Wants to track health data but is concerned with accuracy and gets frustrated by lack of integration among devices
- Finds it difficult to disconnect from digital devices and focus on mental health
- Can feels technology fatigue and is sceptical about new tech
- Feels that wearable technology can be perceived negatively and fears social rejection
- Views health management as private and doesn't want to openly share feedback and notifications with those around him

PRODUCTS & SERVICES

What products and services help your customer get the job done?

- Enhance healthy habits and consistent routines to improve overall health by focusing on a key area such as sleep, stress, exercise and more
- Intuitive, non-intrusive design to motivate long-term change without being overly distracting
- Clear goal setting to promote constant focused improvement
- Promotes gradual long-term change to avoid falling back into old patterns of behaviour
- Better health and habits improves efficiency, productivity, and satisfaction in all areas of life

GAIN CREATORS

What can the product offer to help fulfil the gains?

- Establishing health habits makes all aspects of life more enjoyable
- Real-time feedback and rewards encourage continual health improvements and keep goals top-of-mind
- Lifestyle management becomes easier & improves productivity
- Personalised recommendations tailored to user behaviour enhance day-to-day routines
- Integration of small daily goals leads to small dopamine releases which encourage long-term commitment and grow confidence over time
- Social features encourage accountability & social engagement-
- Reminders to unplug relieve stress and anxiety

PAIN RELIEVERS

How can you help the customer relieve their pains?

- Real-time feedback allows for awareness of negative habit cues allowing for more effective behaviour modification
- Small, consistent rewards contribute to a sense of accomplishment & confidence
- Daily goals and reminders make maintaining consistency easy
- Continuous improvement to routines and overall health leads to more energy, less stress, less anxiety, and more life satisfaction
- Automated measurement and tracking eliminates the hassle of manual inputs
- Accurate and reliable data reassures the user of their progress
- Personalisable notifications that learn the user's preferences over time reduce technology fatigue
- Features designed to disconnect from overstimulation aid in stress management and mental health focus
- The discreet, headphone-like, design easily blends in and reduces fear of social rejection
- Subtle haptic feedback remains a private experience and eliminates the embarrassment of visual or auditory cues

By integrating these insights into Abit’s marketing strategies and product development, we ensure that the value proposition resonates clearly with our target audience, driving both adoption and satisfaction.

APPENDIX

APPENDIX

APPENDIX F: ERGONOMICS STUDY EAR MEASUREMENTS

PARTICIPANT NUMBER	LENGTH (MM)	WIDTH (MM)	OUTER HELIX TO INCISURA (MM)	CONCHA TO UPPER HELIX (MM)	DEPTH OF CARTILAGE (MM)
1	56	30	18	16	4
2	62	39	23	18	3.5
3	53	32	18	17	4.3
4	52	30	23	17	4
5	55	31	17	14	5.2
6	58	35	21	17	5.4
7	56	38	23	18	3.7
8	45	35	16	15	4.2
9	54	33	16	15	4.6
10	53	34	21	17	4.2

APPENDIX

APPENDIX G: THE ORIGINAL PROJECT BRIEF

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Victoria Holbrook **Student number** 5686377

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Enhancing Habit Formation Through Vibrotactile Design

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

In an age where the general population is growing more ill, there's a growing interest in health and wellness among consumers (Sleeman et al., 2019, Callaghan et al., 2021). Underserved by healthcare systems designed to treat instead of prevent, individuals are taking charge of their well-being. Devices like the Apple Watch, FitBit, and Oura Ring cater to this shift, offering biomarker measurements that empower users to make informed lifestyle choices.

Yet, changing one's habits is no small feat. While research shows the pivotal role of cues and rewards in the habit formation cycle, effectively engineering them on an individual level poses a considerable challenge (Gardner & Lally, 2018; Mazar & Wood, 2018; Neal et al., 2012). Vibrotactile feedback presents as a possible intervention, with discreet yet personalizable cues and rewards delivered in real-time based on a wide variety of variables such as time, movement, and place.

This project aims to explore how vibrotactile feedback, as compared to other communication modalities, can accelerate habit formation and retraining processes. The first phase of the project will help to narrow and define the user group and types of habits targeted and will culminate in the design of a wearable device that can measure, monitor, and provide vibrotactile feedback within the habit cycle. The design focus will be on the human elements such as user interaction and less so on the measurement technicalities. The resulting product will be designed to aid consumers in both forming new habits and reshaping existing ones to improve their overall health and wellness.

To support this, I will employ strategic design principles to craft a business and go-to-market plan, exploring the needs and desires of the customer and other stakeholders involved by focusing on the desirability, feasibility, and viability framework.

➔ *space available for images / figures on next page*

introduction (continued): space for images

Landscape of Wearable Wellness Devices

image / figure 1

image / figure 2

APPENDIX G: THE ORIGINAL PROJECT BRIEF CONT.

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

The problem this project aims to solve is the difficulty of behaviour change on an individual level, specifically in forming and reforming habits.

The primary focus of this project is designing a solution aimed at helping customers form habits more effectively through a product service system. The customer group will be further defined and narrowed down as the project progresses.

The primary stakeholder audience is the target group of consumers who consist of health-conscious individuals with an interest in personal development, wellness, and personal optimization.

The value created for them is a transformative product that empowers them to make lifestyle changes more effectively and thus live a more healthy and full life.

My goal is to eventually create this product and launch the company behind it. In this case, I am a stakeholder that stands to gain purpose and profit.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a product/service system and accompanying go-to-market plan to create a vibrotactile wearable device that makes it easier for consumers to train and retrain habits to improve their overall health and wellness.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The project approach is broken into three parts.

1. Literature Review: The literature review is aimed at understanding the context of the project: habits and vibrotactile haptics. This literature review will synthesise existing scientific literature and present research gaps and design opportunities.

2. Product/Service Design: In this phase of the project, I will use learnings from my literature review to design a product and service system including the wearable device itself as well as the digital service that accompanies it. This phase utilises user interviews, prototyping, and user tests. Deliverables will include customer journey maps, product visuals, and technical specifications. The focus will be more on the user interaction and less of the technical specifications.

3. Business & Go-To-Market Plan Design: The final phase of the project aims to create a plan for launching the product into the market. It looks at the market landscape, competition, and positioning and culminates in a

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	Week of 12 February
Mid-term evaluation	Week of 1 April
Green light meeting	Week of 27 May
Graduation ceremony	Week of 24 June

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

When I was twenty years old, I was diagnosed with a suite of autoimmune diseases that left me incredibly sick. After a phase of intense medical treatment, I was back on my feet but had to find ways to adjust my lifestyle to better manage these new ever-present conditions. The following years were a trial of my ability to change my behaviours and habits. Through this, I realised just how difficult behaviour change is.

When I decided to come back to school to do my Master's, this concept had been on my mind for years. It's a topic that's incredibly personal to me and something that I've been interested in for a long time.

This project combines my background experience in business and marketing with my newly gained skills in design and academic research. Throughout completing the project, I'd like to put my business strategy and marketing skills to the test while further developing my competencies in design and research.

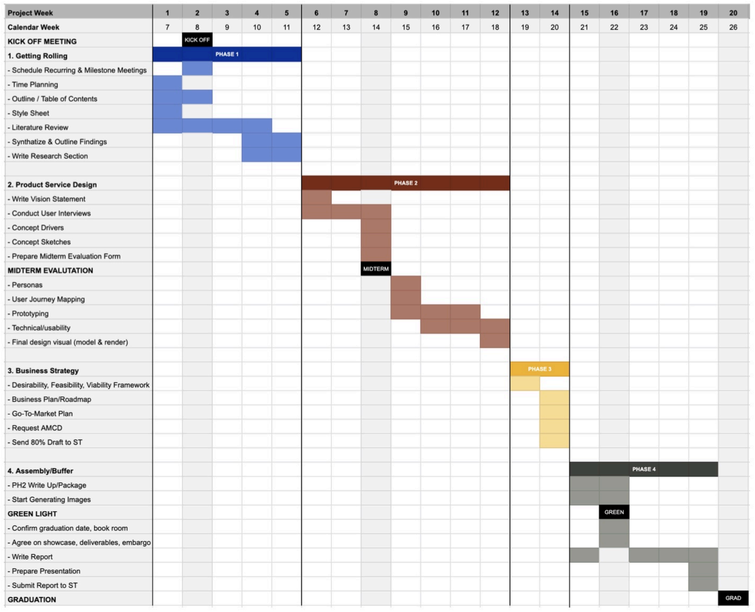
The culminating report will serve as the foundation to launch this product and company in the real world within the next five years. I'd like to use this opportunity to become a subject matter expert in the domain of habits, habits, and wearables.

APPENDIX G: THE ORIGINAL PROJECT BRIEF CONT.

Project Planning & Key Moments

Kick-off Meeting: Week of February 12th
Mid-term Evaluation: Week of April 1st
Green Light Meeting: Week of May 27th
Graduation Ceremony: Week of June 24th

LINK



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APPENDIX H: ADDITIONAL RESEARCH

VARIOUS DEFINITIONS OF HABIT

AUTHOR	DEFINITION
Aristotle, 2007 (translation)	A disposition according to which that which is disposed is either well or ill disposed, and either in itself or with reference to something else.
James, 1890	A habit simplifies the movements required to achieve a given result, makes them more accurate and diminishes fatigue.
Verplanken & Aarts, 1999	Behavioural patterns enacted automatically in response to a situation in which the behaviour has been performed repeatedly and consistently in the past.
Verplanken & Wood, 2006	A type of automaticity in responding that develops as people repeat actions in stable circumstances...habit formation involves the creation of associations in memory between actions and stable features of the circumstances in which they are performed. Recurring aspects of performance circumstances come to trigger habitual responses directly without input from people's intentions or decisions to act.
Wood & Neal, 2009	A phenomenon whereby behaviour is prompted automatically by situational cues, as a result of learned cue-behaviour associations.
Nilsen et al., 2012	Behaviour that has been repeated until it has become more or less automatic, enacted without purposeful thinking, largely without any sense of awareness.
Neal et al., 2012	Psychological dispositions to repeat past behaviour. They are acquired gradually as people repeatedly respond in a recurring context.
Gardner et al., 2012	Behavioural patterns, based on learned context-behaviour associations, that are elicited automatically upon encountering associated contexts...acquired through context dependent repetition.
Gardner, 2014	A process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association.
Rebar et al., 2018	The process by which a person's behaviour is influenced from a prompt to act based on well-learned associations between cues and behaviours

FACTORS THAT INFLUENCE THE FORMATION OF HAVITS

There are several important related factors that influence the formation of habits. Gardner and Lally lay out these factors as (2018):

Cue-Related Factors

- Planning: Planning helps people remember to act in opportune settings such as anticipating environments suitable for performance, and how the action will precede.
- Cue Salience & Stability: More salient, accessible, and perceptible cues are most effective though more research is needed on this topic.

Behaviour-Related Factors

- Consistency: Habit formation requires consistent cue-behaviour pairings, though they do not necessarily need to be frequent.
- Complexity: Behaviours that are less complex in nature, require less cognitive effort to perform and therefore are performed automatically more quickly.
- Reward Value: Though unnecessary for habit formation, both intrinsic and extrinsic rewards support automaticity development.

Person-Related Factors

- Motivation Type: Intrinsic motivation may facilitate habit formation by fostering stronger intentions and enabling the translation of intention into action.
- Stress & Cortisol: Stressful situations may facilitate the learning of habit associations because cortisol is thought to increase stimulus-response learning.
- Self-Control: If self-control contributes to habit formation, it does so indirectly because people with better self-control are better able to act on intentions and maintain performance over time.

HOW HABIT STRENGTH IS MEASURED

Several habit measurement models have been developed over the past couple of decades to further advance the scientific study of habit. Each method has its strengths and weaknesses but the Self-Report Habit Index (SRHI), which is designed to capture automaticity, has become the gold standard in the study of habit theory (Verplanken & Orbell, 2003). It has now been used in over 300 empirical studies across many contexts and in a review of 136 habit studies, the SRHI method was used in 88% of these studies due to its reliability of results (Gardner, 2013) with test-retest correlations ranging from 0.87 to 0.91 across studies (Verplanken & Orbell, 2003; Verplanken & Melkevik, 2008).

The Self-Report Habit Index consists of a 12-item index and requires participants to reflect on automaticity, lack of awareness, lack of control, mental efficiency, and repetition of the given behaviour. In addition, the method also incorporates the idea of self-concept, meaning how habitual behaviours become incorporated into an individual's identity. While performing SRHI, participants do not reflect directly on the habit but instead on the symptoms of habitual responding demonstrating that people can be aware in reflection even if they were unaware in the performance of the behaviour (Orbell & Verplanken, 2015).

Since its introduction, the method has been criticised for several factors including that it neglects the role of cues, redundancy of items, and the inclusion of self-identity (Gardner et al., 2011; Gardner et al., 2012; Rhodes et al., 2010; Sniehotta & Presseau, 2012). It has also been further built upon with the development of the Self-Report Behavioral Automaticity Index (SRBAI; Gardner et al. 2012) and the Habit Index of Negative Thinking (HINT; Verplanken et al, 2007). Thus, SRHI emerges not as the perfect habit measurement instrument but rather as an experiential instrument that can be used and adapted in the study of habit theory.

The Self-Report Habit Index (Verplanken & Orbell, 2003)

THE SELF-REPORT HABIT INDEX

Rank each on a scale from 1 to 7, 1 meaning you completely disagree, and 7 meaning you completely agree.

(Behavior X) is something...

1 . . . I do frequently.

2 . . . I do automatically.

3 . . . I do without having to consciously remember.

4 . . . that makes me feel weird if I do not do it.

5 . . . I do without thinking.

6 . . . would require effort not to do.

7 . . . that belongs in my (daily, weekly, monthly) routine.

8 . . . I start doing before I realize I'm doing it.

9 . . . I would find it hard not to do.

10 . . . I have no need to think about doing.

11 . . . that's typically 'me'.

12 . . . I have been doing for a long time.

TYPES OF WEARABLE DEVICES

DEVICE TYPE	BRIEF DESCRIPTION
Activity Trackers	Focus on everyday activity monitoring, including the number of steps, basic heart rate, and/or body temperature data collection. The main goal is to increase the overall physical activity participation of an average user.
AR Devices	Augmented reality applications can provide additional “seeing with more eyes” information that cannot be displayed and is usually hidden from the observer in a see-through manner. The most attractive areas of the AR development are related to tourism, exhibitions, and manufacturing.
Audio Systems	Conventional wired and wireless headphones, bass systems, as well as hearing aids. Moreover, high-quality wearable audio could be integrated as part of XR or MR system to improve the immersion.
E-Skin or Nano Patches	An artificial skin with mechanical properties of human skin, providing various sensing functions with the main application area of artificial tactile systems. It is commonly located either right on the human skin or the arms of robotic systems to provide close-to-human perception abilities, e.g., to for the operation of humanoids.
E-Textiles & Smart Fabrics	It is very similar to the e-Skin concept but broadens the opportunities to any close-to-the-body textiles that incorporate electronic functionality. Here, the sensors, circuits, or input/output devices are directly integrated with the fabric, allowing for seamless integration of the technology into everyday garments.
EEG & ECG Belts	Allow monitoring the user’s health state from both fitness, medical, and professional sports domains, potentially without the need for specialised medical equipment.
FPV, HMD	Devices for full immersion of, e.g., the Remote control (RC) of various robotic systems teleoperation, human interaction, e.g., police or firefighters, and/or conventional movie watching.
Haptic Suits	Haptic feedback and capture both motion and biometrics features devices. Full or partial body haptic feedback systems are built into the suit and can be engaged in actions, on-demand, or in response to motion capture comparison to provide deeper immersion in various reality applications.
Ingestibles & Insertibles	Objects that go in, through, and underneath the human body or may be a size of a medicine capsule and are packed with sensors, microprocessors, controllers, etc. Ingestibles are considered the next step of wearable technology and used in healthcare for disease diagnostics and monitoring.
Location Trackers	Functions of remote position estimation of the user. Those are of specific interest for pet owners and parents besides the historical crime-oriented market.
Neural Interfaces	Allow for a completely new experience in HCI for both complex medical states of the patients with movement disability, treatment of tactile function, behaviour monitoring, and gaming.

Personal Notification Devices	Those could be considered as one of the earliest areas of mass wearable devices. When the first activity trackers received an embedded vibration motor and Bluetooth communications, it became possible to send a simple sign to the user about the incoming call or received message. Today, we cannot imagine almost any wrist-worn device without this function.
Portable Radios	Those devices were also taking place in the wearable devices evolution back in the first part of the 19th century. Starting with walkie-talkies, we have arrived at the era when surviving a day without your smartphone could be problematic.
Relaxation Masks	This group is an interesting set of devices that could be affiliated with luxury or medical purposes but keep the same function of improving the sleeping experience. The devices could also be suitable for people who travel a lot to improve the day-time adaptation period after, e.g., jet lag.
Safety Buttons	This group corresponds to a specific set of notification devices but operating vise-versa, i.e., aiming to notify either some special units, e.g., police or hospital or the user’s relatives, if something is happening with the owner.
Smart Bands	Carry the functionality of modern activity trackers but sometimes also provide gesture recognition, stress/mood detection, or ECG monitoring functionality.
Smart Contact Lenses	Devices to boost vision and monitor physiological parameters that help track blood glucose level from the body fluid, i.e., also tears intraocular pressure, with the help of the electronic device’s resistance and capacitance.
Smart Clothes & Footwear	A broad segment coupling together various common-looking clothes, ranging from pants to scarfs, but with invisibly embedded features, such as heating, charging, displaying, etc. Smart shoes can be used to monitor a person’s posture, gate, and number of steps.
Smart Gloves	Another hand-held type of wearables is commonly utilised for systems requiring either sophisticated gesture recognition, rehabilitation, or providing better haptic feedback and other wearable devices.
Smart Jewellery	Luxury jewellery with activity tracking, health monitoring, posture correction, or safety functionality. This group of devices did not find much attention due to the actual need for miniaturisation and keeping the appearance high.
Smart Tattoos	A set of biosensors implanted under the skin that measure glucose levels and change color depending on the result. Smart tattoos promise to make life easier for people with diabetes and become an alternative to permanent blood collection from the finger.
Smart Watches	The most widely adopted wearables after the activity tracker. Generally, it provides almost the same functionality as a smartphone. However, most smartwatches’ energy efficiency is still challenging without the gateway node due to the small form-factor.
VR/XR/MR	Visual immersion in the virtual environment with well-progressing VR applications being entertainment, education, and healthcare. MR are a particular subset of VR that involve merging the real world and the virtual world somewhere in a “continuity of virtuality” that augments completely real environments to virtual ones, as defined in the basic work. Interestingly, the relatively new concept XR is currently trying to unite all previously known reality-related paradigms.

Adapted from Ometov et al., 2021

APPLICATIONS OF WEARABLE TECHNOLOGY

Wearable technology, a broad concept in and of itself, has a wide variety of applications across many domains. Until recently, it has largely existed in the consumer electronics space with most products catering to individuals who want to track and optimise their health. Most wearables available on the market today are composed of a combination of sensors measuring either movement or biometrics that wirelessly connect to smart phones and give information on activity, sleep, and stress levels. There are also a growing number of products that offer augmented reality experiences such as the Meta Quest, the HTC Vive, and newly released Apple Vision Pro.

Based on current technology, consumer wearables can serve the following purposes:

Functions of Consumer Wearables (Ometov et al., 2021).

FUCTION	BRIEF DESCRIPTION
Communication	Provides the potential not to process the data locally but to exchange it with surrounding nodes and/or remote cloud.
Control/input	A broad area of input devices ranging from smart buttons to sophisticated gesture recognition devices. This group's main task is to extend conventional Human-Computer Interaction (HCI) input focusing on the usability of the devices keeping a small form-factor as a rule.
Heads-up, hands-free display	Extend the conventional ways of the data delivery to the user utilising personal assistants, AR, XR , Remote Expert Devices, wearable cameras, etc.
Location tracking functionality	Requires to have either some Global Navigation Satellite System (GNSS) on board or, at least, a wireless communication technology. On the one hand, the concept here corresponds to location awareness from the node's perspective and, on the other hand, to remote localization of the device if needed.
Notification functionality	Ranges from simple vibration notification to complex AR extensions. Similarly to sensing functionality, almost any personal device connected to the cloud directly or via the gateway can carry this functionality.
Output functionality	Various visual, audio, or haptic-enabled devices to provide the user and/or people around with prompt information from the personal ecosystem.
Monitoring functionality	Including activity and biometric tracking.

In recent years, wearable technology has started to enter the healthcare domain with applications in patient assessment, treatment, and management (Godfrey et al., 2018). Enabling continuous monitoring of physical activities and behaviours, as well as physiological and biochemical data, wearables become a promising addition to modern medical practices, granting professionals access to comprehensive diagnosis and treatment insights (Mu & Luo, 2019). The introduction of this technology has the potential to enhance quality of life and even minimise loss of life (Park & Jayaraman, 2003).

The healthcare industry is facing significant challenges such as healthcare worker shortages, underfunding, and decreasing quality of care (Wortley et al., 2017). This creates a need for a mobile information infrastructure and monitoring system that is personalised to the individual and leverages advancements in telemedicine and information processing (Park & Jayaraman, 2003).

Wearable health monitoring devices, made up of sensors or implantable devices, can record over 7,500 physiological and behavioural variables, such as, respiration rate, heart rate, and body temperature, which can be displayed on a user interface or transmitted to a medical provider (Wortley et al., 2017).

Examples of remote monitoring devices can be categorised as:

1. Prevention and Maintenance of Health (such as fall identification and prevention, physical activity monitoring, and sports medicine)
2. Patient Management (such as activity monitoring and remote rehab)
3. Disease Management (such as biometric monitoring including heart rate, hypertension, and blood glucose)

Some leading projects in the space include the Onduo Virtual Diabetes Clinic, a telehealth model that combines connected devices, remote lifestyle coaching and clinical support to help (Dixon et al., 2020). Another example is the BioIntelliSense BioSticker which is a single-use wearable medical device that enables at-home continuous passive monitoring of key vital signs. It played a critical role in supporting care for COVID-19 patients (Philips, 2023).

Reliability is a limiting factor currently slowing the adoption of these devices. Current sensors range in their ability to give accurate measurements and more development is needed in this area before the mass adoption of wearables in the healthcare industry.

Advancements in technology – such as smart textiles, eyewear, and ingestible sensors – open up new opportunities in the market for the integration of wearables into new domains particularly in the B2B space including workplace safety and efficiency. Although still relatively unexplored, wearable devices have applications that could make many professions more efficient and more safe. Examples include devices that monitor body position and communicate potentially dangerous positions to prevent injuries. Another application is in the use of AR glasses to guide professionals in the completion of complex tasks, such as assembling high-tech products or repairing space satellites.

Additional opportunities for future wearable devices include aid for the disabled, such as those with visual impairment, as well as disaster relief and public protection (Lee et al., 2016).

APPLICATIONS OF VIBROTACTILE FEEDBACK

Over the past several decades, applications of vibrotactile feedback have appeared in a wide range of domains showcasing its versatility and effectiveness. Below, we highlight a few fields that are particularly relevant in the health and wellness space.

1. **Motor Learning:** Vibrotactile feedback has been proven to be effective for motor learning applications, where motor skills are taught and trained with the assistance of vibrational feedback. In particular, reward-based feedback has been shown to benefit skill retention (Losey et al., 2016).
2. **Affect Regulation:** Previous research has studied how vibrational feedback can target affect regulation – such as cueing specific through patterns and influencing experiential, behavioural, or physiological components of a response (Gross, 2015; Miri et al., 2017). Vibrations aligned with a slow heart rate of breathing pace can help to regulate overall physiological arousal and reduce anxiety and stress (Azevedo et al., 2017; Costa et al., 2016; Miri et al., 2020).
3. **Parkinson's Disease:** Positive results have been observed in patients' gait performance, postural stability, and decreased risk of falling through the use of vibrational cues output from a wearable device (Gonçalves et al., 2021).
4. **Rheumatoid Arthritis:** In the area of treatment devices, vibrations applied to the cymba concha showed a suppressive effect on inflammation of both healthy patients and those with rheumatoid arthritis (Addorisio et al., 2019).

The integration of this technology holds promise not only for enhancing habit formation but also for fostering advancements in healthcare, human-computer interaction, and overall well-being. As research continues to unveil new possibilities, vibrotactile feedback stands as a pivotal tool, bridging the gap between technology and human sensory experiences, becoming a powerful communication mode applicable across a wide range of devices from consumer technology to medical tech.

Thank you.

Victoria Holbrookv