

NORTH

September 10, 2019

Stephen Lake  
CEO  
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Thank you for your interest in Focals smart glasses by North, the first pair of everyday smart glasses. Focals keep users connected to their information *and* connected to the people around them. As requested, a recommendation report is attached for your review.

Because of its strategic vision, North has a history as a technological innovator and a future as a wearables market leader. I look forward to our collaboration and to giving consumers see how they can oversee their technology.

I'm happy to discuss the project and am available at [christinaoakland@gmail.com](mailto:christinaoakland@gmail.com) or (510) 712-9493.

Sincerely,

*Christina Headley*

Christina Headley  
Communications Manager  
North

cc: Matthew Bailey, CTO  
Alex Bard, Board Member  
Kelly Daly, VP of People  
Mike Galbraith, CFO  
Aaron Grant, co-founder  
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Enc: (1)

# Recommendation Report: Focals Smart Glasses by North



September 10, 2019

Prepared for:  
Stephen Lake  
CEO  
North

Prepared by:  
Christina Headley  
Communications Manager  
North

# Abstract

Wearable devices are coming of age. The era of fitness trackers has come and gone. Over three-quarters of the US adult population is interested in owning a wearable. Consumers are interested in full-featured devices, and once wearables become advanced enough, they're willing to replace their smartphone with one. Wearables are preparing to stake their claim on the \$400+ million (USD) annual smartphone revenue. Most wearables in today's market disappoint consumers, but innovative wearable technology start-up North developed Focals smart glasses, a device that won't disappoint. Focals are an eyewear-first approach to wearables that will change the way you look at technology. They look like ordinary glasses, but contain electronics equipment that provide personalized and discrete visual notifications that float in front of you. You can stay connected to your information, stay connected to the world around you, and leave your phone in your pocket. The following recommendation report provides an overview of the consumer electronics industry, the wearable device market, Focals technology, and an implementation plan. The report then evaluates Focals on the criteria of performance, cost, and ergonomic. It discusses the tests performed to judge the criteria, the results achieved, an analysis, and the final recommendation for North to immediately move forward with the Focals smart glasses project.

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# Introduction

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## Background

**Wearable**<sup>1</sup> devices are coming of age. The era of **fitness trackers** has come and gone. Over three-quarters of the US adult population is interested in owning a wearable [1]. Consumers are interested in full-featured devices, and once wearables become advanced enough, they're willing to replace their smartphone with one [2]. Wearables are preparing to stake their claim on the \$400+ million (USD) annual smartphone revenue [3].

As requested by North CEO Stephen Lake, "Proposal: Focals Smart Glasses by North" was submitted on September 2, 2019. The proposal reviewed the wearable market, the technology needed for North Focals, the benefits of Focals for consumers and for North, and an implementation plan to develop and release Focals. In response to the proposal, Stephen Lake requested a recommendation report be developed to score Focals on the criteria of performance, cost, and **ergonomics**.

The following recommendation report provides an overview of the consumer electronics industry, the wearable device market, Focals technology, and the suggested implementation plan. The report then reviews the evaluation criteria, the tests performed, the results achieved, and the final recommendation for North to immediately move forward with the Focals smart glasses project. North's Quality Assurance team conducted the study with assistance from North scientists and software engineers.

<sup>1</sup> Bolded terms are defined in the Glossary (Appendix A) at the end of the report.

# Consumer Electronics Industry Overview

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An overview of the consumer electronics industry and the wearable device market follows.

## Industry Description and Outlook

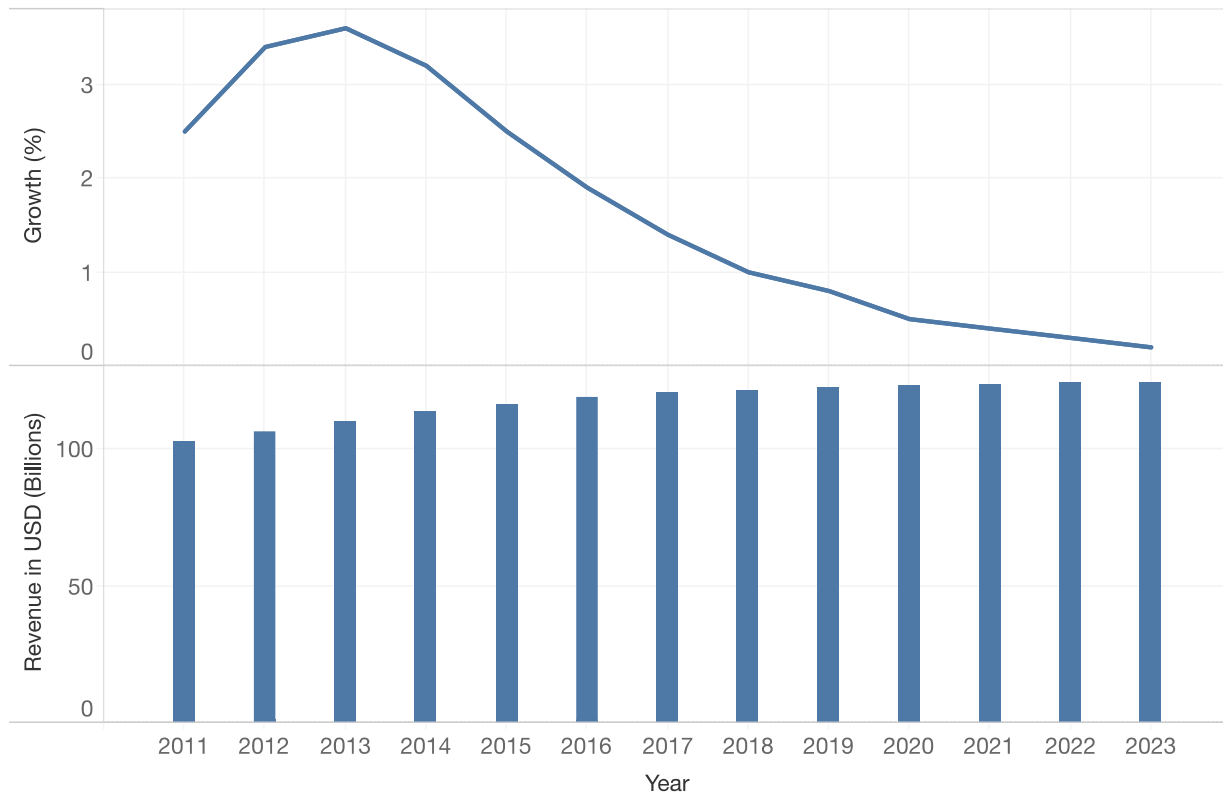
### Description of Consumer Electronics Industry

The consumer electronics (CE) industry includes electronic equipment purchased by individuals that is not for resale [4]. These electronics are “specifically designed for entertainment, communication, or information purposes [5].” Items included in this industry change over time, and currently include mobile phones, televisions, computers, audio and video equipment, and wearable devices such as **smartwatches** and **fitness bands** [6]. The CE industry has manufacturing and retail components, including ecommerce. Equipment rentals and household appliances are not included in this category.

### Industry Performance: Current and Historical

The CE industry is mature and generally experiences low and steady positive growth. The market experienced a recent growth high of 3.5% in 2013 [7] as smartphone ownership became widespread. Since 2013, growth has been steadily declining but remains positive. Global CE revenue was \$997 billion (USD) in 2018, with a **compound annual growth rate** (CAGR) of +2.6 (2012-2023) [3]. As seen in figure 1, US revenue in the CE industry totaled \$128 billion (USD) in 2018.

## US Consumer Electronics Growth and Revenue



2019-2023 data are forecasted

Figure 1: US Consumer Electronics Growth and Revenue 2011-2023 [7]

Some segments, such as CE manufacturing, have higher growth than the industry as a whole, while other segments, such as US brick-and-mortar retail stores, are experiencing negative growth [4]. The CE market is saturated [4]; however, new enterprises continually launch as technological advances lead to new markets. For example, while revenue from brick-and-mortar stores is decreasing, ecommerce retail revenue is increasing.

## Industry Outlook and Forecast

The global CE industry includes many established and emerging companies. Analysts predict future growth will be positive and slow, at 1% or less. As shown in figure 1 above, US revenue in the CE industry is predicted to grow slowly to \$137.2 billion (USD) in 2023, with a predicted CAGR of +1.2 from 2012-2023 [7].”

While the CE industry is long-standing, its product offerings change with the introduction of new technology. Mobile phones are an example of a strong market created from technological innovations. The technology revolution, the **Internet of Things** (where everyday objects are embedded with an internet connection), and ecommerce opportunities

contribute to the changing industry landscape. “Competition in this industry is high and the trend is steady [8].” Newer markets, such as wearables and the Internet of Things, expect higher growth rates than the industry as a whole. Both new and existing CE enterprises need to adapt to recent technology developments and meet consumers’ expectations for innovative and useful products. Increased competition and lower manufacturing costs mean that prices and profit margins are expected to fall.

## Industry Segmentation

We can place the consumer electronics industry into four main components: telephony; computing; TV, radio, and multimedia [3]; and wearable devices.

### TELEPHONY

The **telephony** segment includes landlines and mobile devices. Smartphones account for the majority of telephony revenue. Of the \$997 billion (USD) in 2018 global CE revenue, 48% (\$474 billion USD), was from the telephony segment [3]. This segment experienced dynamic growth in the last twenty years as more and more people purchased a smart phone for the first time. Slow growth is expected in the near future. Almost all sales are replacements with few first-time purchases.

### COMPUTING

The computing industry segment includes computers and all related equipment, such as mice and printers. It accounts for 28% of the market, with 2018 global CE revenue equaling \$276 billion (USD) [3]. Over 90% of US households own at least one computer [9], so sales include few first-time purchases. Market penetration will continue to rise while computer prices fall.

### TV, RADIO, AND MULTIMEDIA

This segment, which accounts for 24% of the market [3], was the core of the industry throughout the twentieth century. It includes items like televisions, gaming consoles, cameras, and speakers. This segment also includes newer products such as **smart speakers** and **peripheral TV devices**. **Smart TVs**, **OLED displays**, and **rolling screens** are TV products with predicted growth [10].

### WEARABLE TECHNOLOGY

The newest and smallest segment comprises just 3% of the global CE industry [11]. Global revenue in 2018 was \$26 billion (USD) [12]. This segment may experience great growth and

volatility in the coming years. Common items in this category include the Apple smartwatch and Fitbit **activity trackers**.

## Target Market Analysis: Wearable Technology

### Market Description

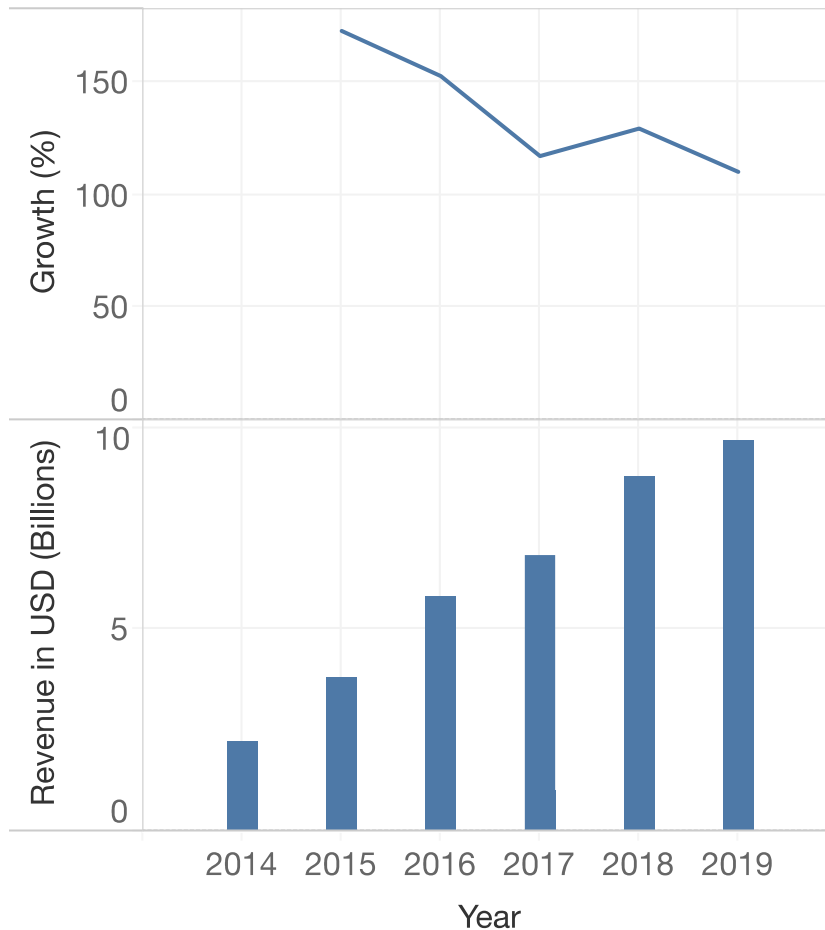
The wearable technology market began growing around 2013, when Fitbit introduced its first wristband activity tracker. Wearables have remained a growth market and new submarkets keep it growing.

### Market Performance: Current and Historical

Capturing less than 2% of the US consumer electronics industry in 2014, the wearable technology market does not have a long history to track historical performance. In the few years we can track sales, we see significant market gains. Market revenue nearly doubled in 2014 and 2015 with the introduction of the Fitbit wristband and the Apple Watch, respectively. As seen in figure 2 below, US wearables market revenue quadrupled from \$2.2 billion (USD) in 2014 to \$9.7 billion (USD) in 2019 [2].

Currently, wearable technology is used by 56.7 million US adults (about a quarter of the population) and over half of those use smartwatches [13]. Global market penetration is high. China currently leads market penetration, with 66% of Chinese adults owning a smartwatch or activity tracker [13].

## US Wearables Growth and Revenue



2016-2019 data are forecasted

Figure 2: US Consumer Wearable Revenue 2014-2019 [2]

## Market Outlook and Forecast

The wearable technology market is expected to remain in a growth stage. Analysts predict a promising future, with CAGR predicted between +16% (2016-2022) [14] and +19% (2019-2024) [15].

The acceptance and ownership of wearables is multiplying quickly [16]. Market penetration for US wearable users is expected to reach 67 million adults in 2022 [2], an 18% increase from 2018 [2]. Global wearables revenue is predicted to quadruple from \$16 billion (USD) to over \$73 billion (USD) in 2022.

Although double-digit growth is predicted, the future of any new market is not as predictable as the outlook for a mature market. Previous revenue predictions for wearable devices have been higher than actual earnings. Consumers haven't welcomed items such as Google Glass or **virtual reality** headsets as quickly as expected. However, analysts anticipate that consumer behavior is changing as technological advances in wearables become more exciting and beneficial to people's lives, and as the construction of items becomes more stylish. An example of this is the **hybrid watch** trend, a growing market of traditional-looking watches with the features of a smartwatch.

Fluctuation is high in wearable submarkets. Activity trackers were nearly the whole market in 2014, but their market share steadily decreased while smartwatches overtook them and also grew the market [17]. Other submarkets, such as **hearables**, will grow and increase total market revenue.

## Market Segmentation

### SMARTWATCHES

Smartwatches, like the Apple Watch, dominate the current wearable device market, making up about half of market revenue [2], [18]. Hybrid watches, which look like traditional watches but act like smartwatches, are new to the market and quickly selling to consumers who appreciate wearing a watch with a traditional watch face instead of a screen.

### ACTIVITY TRACKERS

Activity trackers, or fitness trackers, are often known by the popular brand name Fitbit. They are typically bands worn around the wrist, but may clips or pieces of jewelry. They track individual user statistics, such as distance walked, flights climbed, and heart rate. Some fitness trackers operate independently while others make use of app and smartphone integration. Activity trackers have more total shipments than other wearables, but sales are declining as users replace them with more advanced wearables, or simply use the activity tracking features built-in to their smartphones.

### SMART HEADPHONES (HEARABLES)

Hearables are expected to be the biggest growth segment of the wearable technology market [2]. Technology companies such as Samsung, Google, and Apple as well as audio equipment companies such as Bose and Sony have products in this category. Most hearables play music, take calls, and include integration with a **digital assistant**. Some offer specialized hearing assistance or translation services. There is some crossover with the hearing aid market.

## VIRTUAL REALITY (VR) AND AUGMENTED REALITY (AR)

Virtual reality and **augmented reality** devices include headsets or glasses that alter the wearer's view either completely or partially. They may also be called **head-mounted displays**. The appearance of these devices varies widely, from standard-looking glasses to helmets. VR devices have a variety of price points, while AR devices tend to be several hundred dollars or more. This segment has a predicted CAGR of 13% between 2017 and 2023 [19].

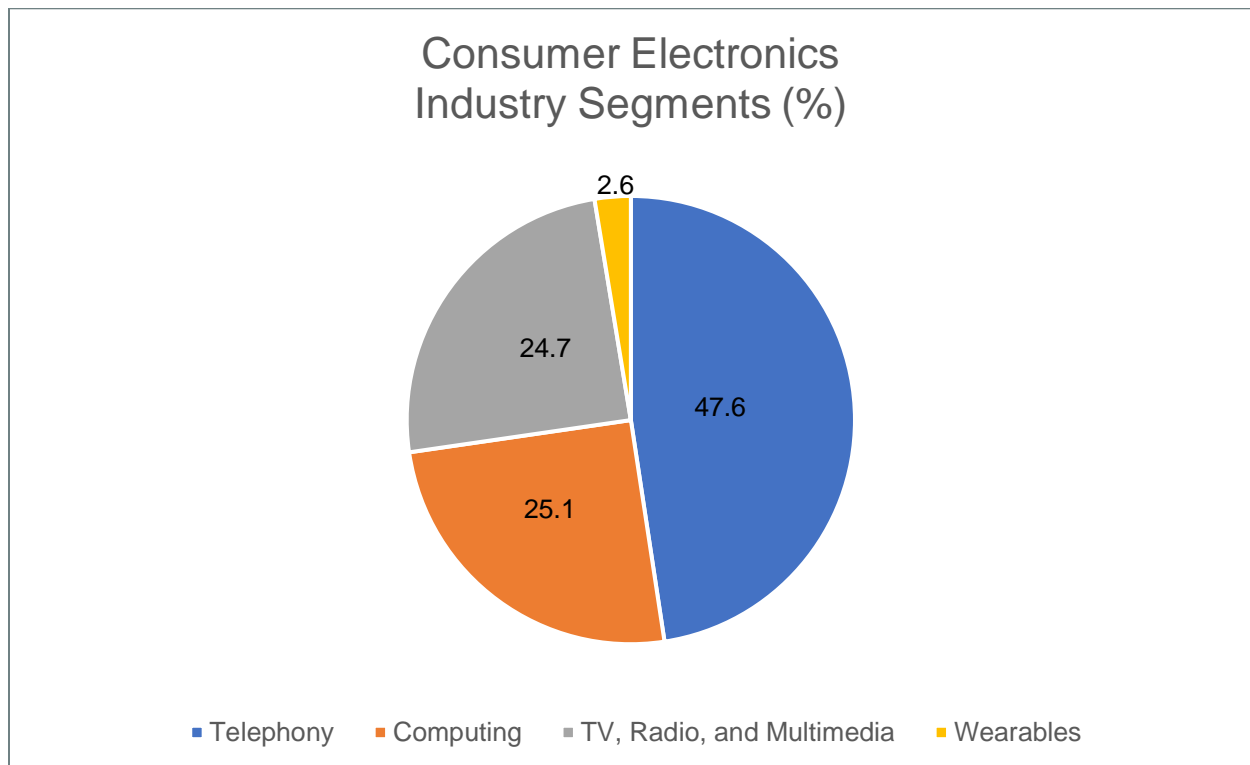


Figure 3: Segments of Consumer Electronics Industry (by %) [3]

## Market Characteristics

Wearable technology is a fragmented, growing, and evolving market. Consumer reluctance or acceptance determines market growth. Global device sales and market penetration are expected to increase exponentially in the next few years [20].

## FEATURES

**Fragmented market concentration.** The wearable technology market is somewhat fragmented, as shown below in figure 4. Smartwatch maker Apple and activity tracker maker Fitbit are two of the market's largest companies. The fragmented nature of the industry



makes it easier for new enterprises to find footing in the market. Once an innovative brand is established in a fragmented market, it can be sold or operated.

**Changing submarkets.** The wearables market was built on activity trackers, but that submarket is declining, and major revenue now comes from the smartwatch submarket. The composition of the market will continue changing as fitness tracker sales continue to decline and other submarkets emerge and grow. Hearables, TV peripheral devices, AR, VR, **smart clothing**, and the Internet of Things are all markets expecting significant growth in the near future [21].



Figure 4: Market Concentration Level of Wearable Technology Market [15]

## TRENDS

Even though customers will adopt new technology, they have requirements about these items. Price, innovation, looks, and functionality play significant roles in a product's success.

**Young consumers.** Wearable technology is most popular with adults age 34 and younger [2]. They also consume more media than other age groups. Because of young consumers' acceptance of wearable devices, analysts expect to see carryover as these consumers age up into the next bracket.

**Innovative Technology.** Consumers are looking for easy-to-use items that allow them to connect to their information. They are looking for technology that is “naturally smart, intuitive, and unobtrusive [3].” New devices and new models of existing items need significant advancements or new features to attract consumers. For example, advances in **voice assistance** technology mean that hearable device makers are able to add new features and attract more customers [15].

**One device to replace the smartphone.** Consumers are adapting an “everything now” mentality, expecting easy access to everything all at once [22]. Because their smartphones do so many things, consumers expect items to be practical and to perform multiple functions. They are willing to use wearable devices that do it all in place of their smartphones [2], although most wearable devices don’t have this functionality yet.

**Style.** Companies are focusing on the aesthetics and design of their devices as a way to attract customers [15]. Most consumers don’t want their wearable to make them look strange or like a cyborg. VR headsets and Google Glass are critiqued by consumers for their odd looks. Whereas industry leader Apple is famous for focusing on the design and aesthetic appeal of their products.

## Market Catalysts

**5G.** The updated speed and connectivity of **5G networks** will provide greater reliability and functionality for wearable devices. It will also allow users to connect more devices at the same time than ever before [23]. 5G is a very recent release, and it will help shape technology markets for years to come. New submarkets or competing markets may emerge, as 5G networks “usher in the next era of innovation, delighting consumers and driving our economy [24].”

**The Internet of Things.** As the Internet of Things grows, market penetration and consumer acceptance of new products also increases. Consumers see neighbors with **video doorbells** and hear about advances in self-driving cars. Repeated exposure to smart products leads to familiarity and acceptance.

**Involvement of US Government.** Increased tariffs on Chinese products and electronic components could drive prices up, thereby affecting consumer interest in wearables. Tariffs in Chinese products could affect prices directly or indirectly, as items are shipped through an intermediary location or production is moved to a different country. Trade bans on Chinese manufacturers, such as smartphone and wearable device company Xiaomi, severely limit their opportunities in the US market.

**Hearables.** Hearables have the biggest growth potential in the wearables market. Samsung, Google, Apple, Bose, and Sony are all large companies selling hearable devices that also invest in R&D to keep their products innovative and competitive. The best-known hearable might be Apple EarPods, which are a smart device because they are integrated with the digital assistant Siri.

## Competitive Landscape

### Key Players

Key players in the wearables market include Apple, Huawei, Xiaomi, Garmin, Fossil, and Fitbit. Many of these enterprises sell wearables as well as other consumer electronics. Almost all of the wearable devices these companies sell are smartwatches or activity trackers [25], [26], [27], [28], [29], [30], [31], [32].

Table 1: Comparison of Companies in the Wearables Market by Expertise, Strengths, Weaknesses, and Revenue

Company	Areas of Expertise	Strengths	Weaknesses	Annual Revenue*
Apple	<ul style="list-style-type: none"> <li>Computers</li> <li>Smartphones</li> <li>Smartwatches</li> </ul>	<ul style="list-style-type: none"> <li>High R&amp;D investment</li> <li>Industry leader</li> <li>Loyal user base</li> <li>Luxury branding</li> <li>Profitable</li> </ul>	<ul style="list-style-type: none"> <li>High price point</li> <li>Incompatibility with other brands</li> </ul>	265.6
Huawei	<ul style="list-style-type: none"> <li>Activity bands</li> <li>Computers</li> <li>Enterprise networking</li> <li>Smartphones</li> <li>Smartwatches</li> </ul>	<ul style="list-style-type: none"> <li>Profitable</li> <li>Quick growth</li> <li>Wide variety of product offerings</li> </ul>	<ul style="list-style-type: none"> <li>Lack of capital</li> <li>US trade ban</li> </ul>	107.4
Xiaomi	<ul style="list-style-type: none"> <li>Activity bands</li> <li>Artificial Intelligence of Things</li> <li>Audio equipment</li> <li>Smartphones</li> </ul>	<ul style="list-style-type: none"> <li>Competitive prices</li> <li>Focus on creating and updating products</li> <li>Large product catalog</li> <li>Worldwide distribution</li> </ul>	<ul style="list-style-type: none"> <li>Brand differentiation</li> <li>Service</li> </ul>	26.1

Company	Areas of Expertise	Strengths	Weaknesses	Annual Revenue*
Garmin	<ul style="list-style-type: none"> <li>• GPS devices</li> <li>• GPS-enabled: <ul style="list-style-type: none"> <li>○ Activity trackers</li> <li>○ Hybrid watches</li> <li>○ Smartwatches</li> <li>○ Watches</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• In-house manufacturing</li> <li>• Quality</li> </ul>	<ul style="list-style-type: none"> <li>• Lacks integration with 3rd-party services</li> <li>• Limited to GPS-centered devices</li> </ul>	3.3
Fossil	<ul style="list-style-type: none"> <li>• Watches: <ul style="list-style-type: none"> <li>○ Hybrid watches</li> <li>○ Smartwatches</li> <li>○ Traditional</li> </ul> </li> <li>• Accessories: <ul style="list-style-type: none"> <li>○ Bags</li> <li>○ Jewelry</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Global brand recognition and distribution</li> <li>• Leader in hybrid watch market</li> <li>• Style</li> <li>• Successful expansions</li> </ul>	<ul style="list-style-type: none"> <li>• Declining revenue for the last five years</li> <li>• High inventory levels</li> </ul>	2.5
Fitbit	<ul style="list-style-type: none"> <li>• Activity trackers</li> </ul>	<ul style="list-style-type: none"> <li>• Brand is synonymous with fitness bands</li> <li>• Market trailblazer</li> </ul>	<ul style="list-style-type: none"> <li>• Declining submarket</li> <li>• High price point</li> </ul>	1.5

\*Annual revenue is for 2018 and in billions of USD

In 2018, 172.2 million wearable devices shipped worldwide. The key players' market share by unit shipments is shown in figure 5 below.

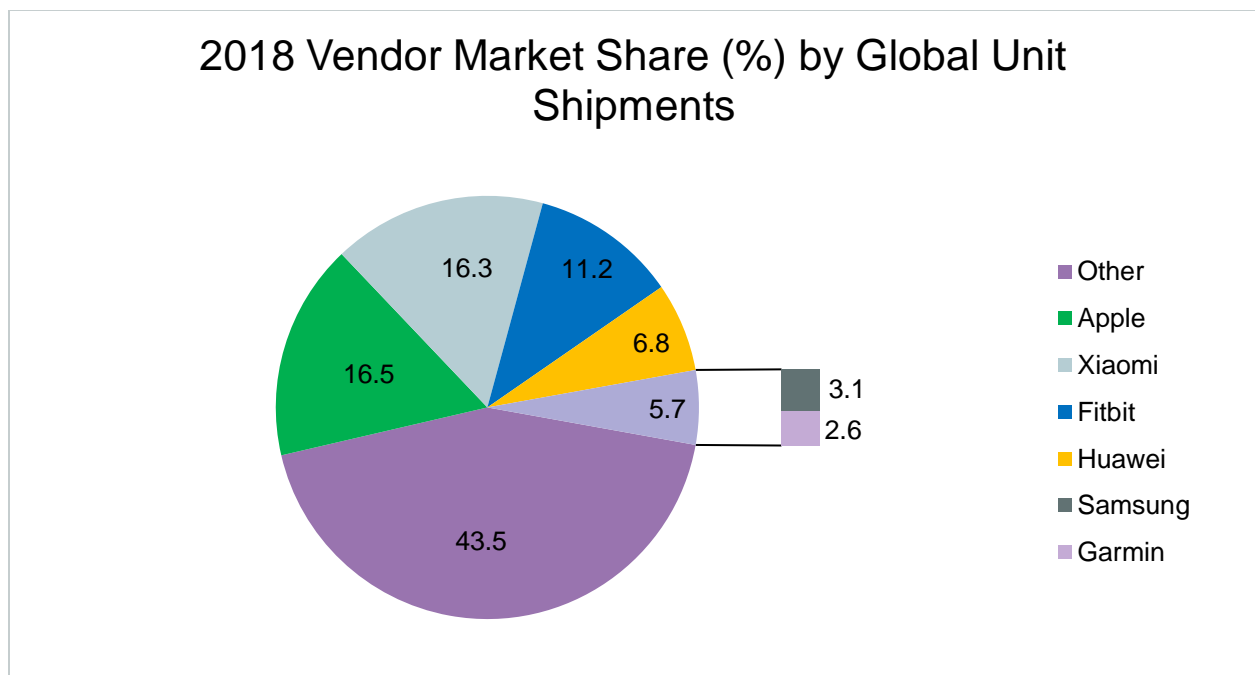


Figure 5: 2018 Global Unit Shipments by Vendor Percentage [33]

## North's Competitive Advantage

Start-up company North plans to change the wearable device market by introducing the first pair of main-stream smart eyeglasses for consumers.

**Must-have technology.** North smart glasses provide a futuristic user experience. Users see their information floating in front of them without blocking their view. Once freed from staring at their phones, users will be able to stay connected to their data without disconnecting from their world. They also combine many features in one easy-to-use device, such as texting, maps, music, and the digital assistant Alexa.

**Aesthetics.** Consumers want items to look a certain way, and will reject items that don't meet their expectations. North Focals are simple, plastic-framed, and resemble Warby Parker glasses [34]. Most of the technology is housed in the companion ring, which keeps the glasses light and prevents users from continually tapping or reaching for their glasses.

**Potential market leader.** North has the opportunity to become a market leader and brand name in an emerging market. The best-known items in this arena are Oculus VR headsets for gaming and Google Glass, an augmented reality headset which originally failed because of aesthetics, user safety concerns, and privacy issues arising from the video recording feature [1].

**Price.** Most augmented reality wearables cost \$1,000 or more. North's Focals smart glasses start at \$599. The competitive price point matters in a market where "54% of consumers say price has limited their interest in purchasing a wearable device [22]." The low price point will attract wearable seekers as well as other consumers.

# Project Summary

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The project summary that follows included detailed information from the proposal submitted September 2, 2019.

## Opportunity Analysis: North Focals Smart Glasses

### Limitations in Wearable Technology

The wearable technology market is in its infancy. Technological innovations and consumer behavior will continually move the market forward until wearable devices rival the ease and functionality of smartphones.

### Overview of Wearable Technology

Wearable devices are a nice-to-have product, owned by the young, the affluent [1], the fitness-motivated, or the tech-savvy [35]. Most work only in conjunction with a smartphone or an app. Less than a quarter of US consumers own a wearable device today [10], with Fitbit activity trackers, the Apple smartwatch, and digital assistant-enable headphones among the most common. Up to 78% of Internet-using adults are interested in wearable devices [1], but high prices and lack of features prevent most from purchasing one. Instead, consumers buy and rely on their smartphones.

#### LIMITATIONS OF CURRENT WEARABLE DEVICES

Customers want an attractive, affordable device that does it all and works well.

**Activity trackers.** Ten years ago, activity trackers spurred the creation of the wearable device market and accounted for the bulk of sales. As the name implies, activity trackers keep track of a user's activity levels and other fitness metrics such as heart rate. Some offer additional functions like displaying the time or playing music. However, their scope is limited. Although consumer interest in fitness tracking is still high, the activity tracker as a stand-alone device is going the way of the iPod or the VCR, and is being replaced by smartphones or full-featured wearables.

**Smartwatches.** Smartwatches have much more functionality than an activity tracker, and have replaced the activity tracker as the market leader. Most smartwatches are an extension of the user's smartphone and need to be configured with an app. They can pass along

notifications from your smartphone and do the same things an activity tracker can, but they cannot replace a smartphone. Not everyone finds watches comfortable to wear. And someone who constantly glances at their watch may seem uninterested or bored with their company. Over 50% of consumers say they are too expensive to even consider purchasing [1].

**Hearables.** Hearable devices are simply earphones or ear buds that can access a digital assistant or the internet. Their portability and lower price points are attractive to consumers, who use them to place calls or listen to music. While some hearables can track activity such as heart rate, they lack the functionality of a smartwatch or a smartphone. Since hearables have no screen or keyboard, they rely on a digital assistant to make them smart. While your digital assistant might be able to read you an email, more advanced functions like writing and editing emails are best left to devices like smartphones.

**VR and AR devices.** AR and VR devices typically look very strange and bulky. They tend to be worn indoors and are used in business or gaming. Many people don't understand the features offered by these devices [36]. Also, AR devices are very expensive, costing several hundreds or thousands of dollars. At this time, VR and AR devices are "niche products" [37]. However, consumer interest is growing, and AR should reach "its full market potential" [38] in ten years.

**High prices.** The high price of wearable devices prevents many consumers from considering them and purchasing them. Most devices are sold to young or affluent consumers. And even though US discretionary spending and consumer interest are rising, [35], there are still large portions of the population who cannot or do not want to spend hundreds of dollars on a wearable device.

**Battery life.** Battery life hasn't kept up with other technological innovations. Touchscreens and bright displays can consume battery life very quickly, and many devices have a battery life of one or two days [1]. Standalone devices have a longer battery life, perhaps 5 days, and batteries in screenless hybrid watches can last over a year. At this point, long battery life and multiple features do not usually exist in the same device, and battery life is often a trade-off for features and functionality. Analysts predict higher acceptance of AR glasses in the next five years if battery life can be improved [37].

**Style.** Style is an important concern for consumers, but many wearables take a technology-first approach. Many people thought Google Glass backfired because of its looks [41], and VR headset and smartwatches "can be bulky and awkward" [36] to wear.



**Features.** Few consumers are interested in wearables with limited functionality. Fitness tracker sales have fallen because they don't compare to full-featured smartphones. However, "consumers are very interested in wearable devices that can handle many of the multitasking features common to cell phones, including texting and calling, in addition to tracking fitness and playing music [36]."

Table 2: Comparison of Popular Wearable Devices

Item	Features	Limitations	Battery Life	Price*
Fitbit Charge 3 activity tracker [39]	<ul style="list-style-type: none"> <li>• Backlit touchscreen</li> <li>• Fitness and sleep tracking</li> <li>• Smartphone notifications</li> <li>• Waterproof</li> </ul>	<ul style="list-style-type: none"> <li>• Utilitarian style</li> </ul>	Up to 7 days	149.95
Apple Watch 4 [40]	<ul style="list-style-type: none"> <li>• Proactive health monitor, including electrocardiogram</li> <li>• Multiple notifications, sensors, and trackers</li> <li>• Cellular version can be used without iPhone</li> <li>• Pressure-sensitive touchscreen</li> <li>• Waterproof</li> </ul>	<ul style="list-style-type: none"> <li>• Can only pair to iPhones</li> <li>• Staring at your watch may be socially unacceptable</li> </ul>	Up to 18 hours	399.00 and up
Apple AirPods [41]	<ul style="list-style-type: none"> <li>• True wireless</li> <li>• Siri digital assistant</li> <li>• H1 chip for fast and stable pairing</li> <li>• Fast charging</li> </ul>	<ul style="list-style-type: none"> <li>• Unusual look</li> <li>• Not secure for use while exercising</li> <li>• Average sound quality</li> </ul>	5 hours (24 hours with charging case)	159.00

Item	Features	Limitations	Battery Life	Price*
Oculus Quest VR headset [42], [43]	<ul style="list-style-type: none"> <li>• Self-contained</li> <li>• Wireless</li> <li>• Room-scale VR</li> <li>• Responsive touch controllers</li> <li>• Crisp graphics</li> </ul>	<ul style="list-style-type: none"> <li>• Limited apps</li> <li>• Download process</li> </ul>	2.5 hours	399.00 and up
Vuzix Blade AR Smart Glasses [44]	<ul style="list-style-type: none"> <li>• Alexa digital assistant</li> <li>• Touchpad</li> <li>• HD camera</li> <li>• Motion trackers</li> <li>• Smartphone notifications</li> <li>• Companion app</li> <li>• Location aware</li> </ul>	<ul style="list-style-type: none"> <li>• Bulky, style resembles safety glasses</li> <li>• Heavy</li> <li>• Complicated touch gestures</li> <li>• No speakers</li> </ul>	Up to 8 hours	799.00

\*Price in USD

## SIGNIFICANCE OF LIMITATIONS ON STAKEHOLDERS

Consumers are limited in their adoption of wearable technology because of lack of interest, lack of availability technology, and lack of affordable options.

**Impact on consumers.** Consumers think of wearables as either meant for fitness tracking or as entertainment. They aren't aware of how wearables might benefit them and can't envision not being tethered to their smartphones. Or they are left with devices that don't meet their expectations. They would like a single device that is affordable, works well, and is full of features that make their lives easier. At this point, the device that best meets those criteria is the smartphone.

**Impact on North.** North needs to understand the limitations of current wearables and what consumers want when considering which products to develop. If they don't offer products that improve on the status quo, consumers will keep looking until they find the innovation they seek. Therefore, North would miss out on revenue-generating products in their own industry. As a start-up with extremely limited product offerings, it is important that North

only release products that capture enough market share for them to operate and grow the company.

## SIGNIFICANCE FOR NORTH

North can take advantage of a fragmented and growing market to provide smart glass technology that is largely unavailable in the consumer market.

**Fill a gap in the wearables market.** Consumers are interested in wearables, and 31% would consider purchasing AR glasses [36]. With no market leader, North has the opportunity to fill this gap, but creating a product that delivers on what customers want is critical. Acceptance of AR has been slower than expected. Issues such as privacy, features, battery life, and price need to be addressed before most consumers will consider AR. Because of high customer expectations and a capital-intensive market [40], North will need a about \$130 million (USD) in investment and R&D capital. Since “North America is the largest market for smart wearables [40],” North’s location is ideal for reaching its target market.

**Unique product offering.** North focuses on development of one unique product at a time. Since “product uniqueness is the significant factor that is currently providing a competitive advantage” [40] to vendors, North should capitalize on that advantage and create a ground-breaking product. North is a unique company, with its headquarters in Canada instead of Silicon Valley. It could become a well-known brand name in the wearable market, and create more wearable products in the future. Or it could be acquired by a larger company such as Apple or Facebook, where wearable technology would continue to be created and improved.

## Opportunity Fulfillment: North Focals Smart Glasses

### North Focals Device Architecture [45]

Smart glasses are eyeglasses with computer technology that display images for the user to see. They are worn on the face like traditional glasses. Focals resemble traditional glasses in many aspects, including their plastic frame and optional prescription lenses. A companion ring called the **Loop** and a charging case are included. The glasses and ring are paired via Bluetooth to a smartphone and the Focals application.



Figure 6: Focals Smart Glasses with Charging Case, Charging Cord, and the Loop Ring [46]

## MATERIALS

Focals are made of Swiss Grilamid plastic frames and lightweight die-cast aluminum [47] with stainless steel spring-loaded hinges and copper accents. The lenses, which have several protective coatings, are curved to fit either non-prescription or prescription lenses. An invisible **holographic film** is molded to the right lens, which works with a tiny light-emitting projector to create the images. Customers can choose from two styles and three colors. Sunglass clips, which come in two colors, are included with every pair. Focals are water resistant with an IP55 rating.

## DISPLAY

A small projector inside the right arm of the glasses sends out light, which reflects off the holographic coating applied to the right lens. This coating acts like a mirror and reflects light onto the fovea, the part of the eye where your vision is best [48]. This process is called **laser beam scanning** [49]. The resulting image is clear, colorful, and appears to float in the air at arm's length. The images are see-through and fade away after a few seconds. By freeing the display from a screen, we're no longer limited to a solid, opaque background. Brightness, volume, and notification settings are adjustable.



Figure 7: Focals Smart Glasses Display (Left) [50] and with Projector in Right Arm (Right) [48]

## HARDWARE

Focals contain an advanced Qualcomm APQ8009w processor and a 700 mAh battery, which lasts up to 18 hours. The right arm of the glasses also contains a speaker to provide notifications and a microphone to contact the digital assistant Alexa. Focals contain several sensors, including a motion-tracking sensor, an ambient light sensor, and a proximity sensor.

## LOOP COMPANION RING

The Loop is a polycarbonate ring that operates Focals smart glasses. By pressing or moving the tiny joystick component in one of four directions, you can scroll through apps or reply to text messages. By placing hardware in the Loop, the glasses remain lightweight and can be operated discretely.

## APP INTEGRATION

Focals smart glasses and the Loop ring both connect to smartphones via Bluetooth. Access through the app allows the user to access a variety of features, including digital assistant Alexa, texts, email, walking directions (driving with AR glasses is illegal), Spotify music, Uber ridesharing, calendar, weather, voice-to-text, Google Fit activity tracking, screen time tracking, Google Slides, Slack, Microsoft OneNote, reminders, to-do lists, language flashcards, Evernote, travel updates, and more.

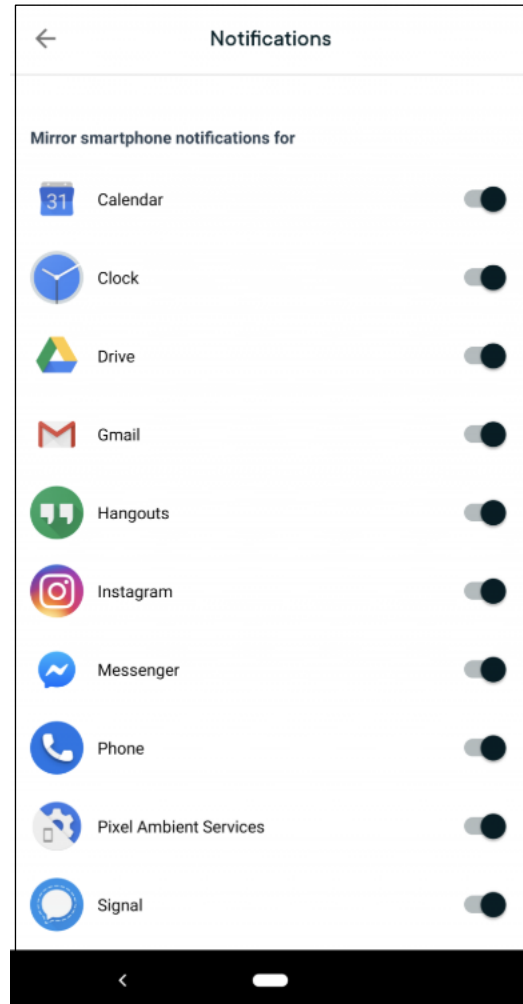
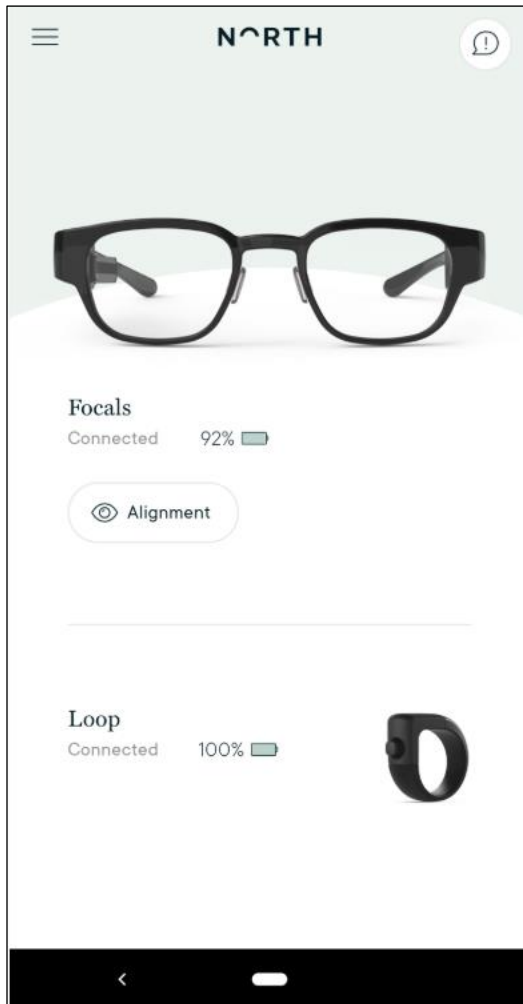


Figure 8: Focals App Screenshots [48]

## Features and Functionality

Focals smart glasses are a one-of-a-kind wearable technology that provide the best of both worlds.

Table 3: Features and Functionality of Focals Smart Glasses

Feature	Functionality
Materials	<ul style="list-style-type: none"><li>› Focals use materials common to traditional eyeglasses, resulting in a socially acceptable product.</li><li>› Premium accents are needed for a higher-priced product.</li></ul>
Display	<ul style="list-style-type: none"><li>› Users sees crisp and colorful images that are pleasurable to look at.</li><li>› See-through display offers safe and unobstructed view, and gives users freedom and the ability to move around.</li><li>› Only the user can see images, so information remains private.</li></ul>
Hardware	<ul style="list-style-type: none"><li>› A smartphone-level processor improves product speed.</li></ul>
Bluetooth	<ul style="list-style-type: none"><li>› Bluetooth connectivity reduces latency and allows for easy pairing with smartphones.</li></ul>
Loop Ring	<ul style="list-style-type: none"><li>› Allows user to operate glasses discretely.</li><li>› Prevents users from awkwardly reaching for face all the time and throwing off alignment.</li><li>› Keeps glasses lightweight and stylish.</li></ul>
App Integration	<ul style="list-style-type: none"><li>› Allows users to leave their cell phones in their pocket and stay connected to their world.</li><li>› Multiple apps provide consumer with satisfying user experience and increase perceived value.</li><li>› Digital assistant provides voice-to-text, so that users don't need a keyboard.</li></ul>

## Benefits of North Focals Smart Glasses

### BENEFITS FOR CUSTOMERS

North Focals provide several benefits to customers that other wearables do not.

Table 4: Limitations of Current Wearables, and Solutions and Benefits of Focals

Limitations of Current Wearable Devices	Focals Solution	Benefits Provided
Need a screen to look at information	<ul style="list-style-type: none"><li>› Information floats in your view without needing a screen.</li><li>› Remain in your world instead of disconnected from it.</li><li>› No need to touch glasses.</li></ul>	<ul style="list-style-type: none"><li>› Hands-free use.</li><li>› A new way of interacting with digital data.</li><li>› Not stuck behind a screen or looking down.</li><li>› Stay engaged in life.</li><li>› Reduced smartphone use.</li></ul>
Battery life	<ul style="list-style-type: none"><li>› 18 hours use on one charge.</li><li>› Carrying case that doubles as a charging case.</li></ul>	<ul style="list-style-type: none"><li>› Easy to charge while sleeping.</li><li>› Lasts all day.</li></ul>
Lack of multiple features	<ul style="list-style-type: none"><li>› Offers dozens of apps and features, such as GPS, music, texting, shopping lists, and fitness tracking.</li></ul>	<ul style="list-style-type: none"><li>› Customers get a multi-functional device.</li><li>› Device is exciting to use.</li><li>› Provides enough features to compete with smartphones.</li></ul>
Style	<ul style="list-style-type: none"><li>› Focus on creating traditional-looking eyewear.</li><li>› Focals can replace the prescription glasses you already wear.</li></ul>	<ul style="list-style-type: none"><li>› User doesn't feel awkward wearing Focals.</li><li>› Socially acceptable</li><li>› Don't need to carry an extra item.</li></ul>



## BENEFITS FOR NORTH

Table 5: North's Benefits for Developing Focals

Benefit	Description
Create revenue	<ul style="list-style-type: none"><li>› As a start-up, North can be flexible and quick to launch products.</li><li>› No well-known smart glass makers as competition.</li></ul>
Create jobs	<ul style="list-style-type: none"><li>› Development, product release, and in-house manufacturing result in the creation of hundreds of jobs.</li></ul>
Receive investments	<ul style="list-style-type: none"><li>› Generated investments of \$170 million (USD) from Amazon Alexa Fund, Intel, Canadian government, and others [51].</li></ul>
Become a key player in an emerging market	<ul style="list-style-type: none"><li>› Creator of first pair of everyday smart glasses.</li><li>› Increase brand recognition.</li><li>› Be seen as a market leader.</li><li>› Be known for cutting-edge technology.</li></ul>
Hold valuable patents	<ul style="list-style-type: none"><li>› Created several patents for smart glasses.</li><li>› Acquired related patents from Intel [52].</li></ul>

## Implementation Plan

### Feasibility Assessment

#### TECHNICAL FEASIBILITY

North has significant technical capability to create smart glasses, especially surrounding hardware design and the creation of patentable mechatronics engineering and design. Since North wants to take an eyewear first, technology second approach, they would need to hire new employees who specialize in eyewear design. Manufacturing facilities and associated production and operations staff would need to be added. Retail facilities and staff would also need to be found, and additional software engineers will need to be hired. Some existing manufactured equipment, such as processors, should be purchased from an outside vendor.

North excels in the most specialized aspect, the creation of smart eyeglass technology invented to fit in a typical-looking pair of glasses. They also have existing management and

human resources personnel. Extensive R&D and venture capital is necessary, so the project has an estimated timeline of three years.

## FINANCIAL FEASIBILITY

North Focals will cost at least \$130 million (USD) in investment capital to get to market. Partnerships with Amazon and Intel would provide most of the funds in the form of debt financing. By creating a manufacturing plant in Kitchener-Waterloo, Canada, the home of North's headquarters, North can receive up to \$24 million (CAD) (about \$18 million USD) in loans from the Canadian government [53]. The \$130 million (USD) would support R&D, prototypes, employee salaries, creation of a manufacturing plant, and at least two retail locations (one in Canada and one in the US).

By keeping retail pricing relatively low, between \$599 (USD) and \$999 (USD) depending on customizations, North can increase sales volume. Assuming an average sale price of \$799 and a net profit margin of 20% [54], North would need to sell 876,000 pairs to recoup its investments, exclusive of compound interest. That equals 0.25% of the 357 million people who live in Canada and the US [55]. This is a reasonable expectation given that one in six American adults owns a smartwatch [56] and wearable ownership is increasing.

## MARKETABILITY

North Focals would be the first pair of everyday smart glasses. Given high consumer interest in smart eyeglasses, the lack of competition, and the double-digit growth expected in the emerging wearables market for years to come, marketability is high. Focals would appeal to a broad range of customers, including busy executives, social butterflies, commuters, and even those who want less interaction with technology. North's focus on style and a premium retail experience [57] further increase marketability.

## Recommendation

North should develop Focals smart glasses as its next project. The project's ability to raise capital, meet consumer demand, and lead development in an emerging market are strong indicators of its future success. North should begin this project immediately to ensure they enter a highly fragmented market, become a market leader, and capitalize on the growth trend over the next ten years.

## Resources Required

Since this would be North's only product, all company expenses would be billed to this project. Existing personnel and resources such as office space would be folded into the Focals project.

### STAFF

Staff projections for North begin at 202 employees in the first year and increase to 510 employees in the third year of the Focals project. A complete list of employees by role and quantity can be found in table 6 in the [Financials](#) section. An organization chart showing North's hierarchy is shown here.

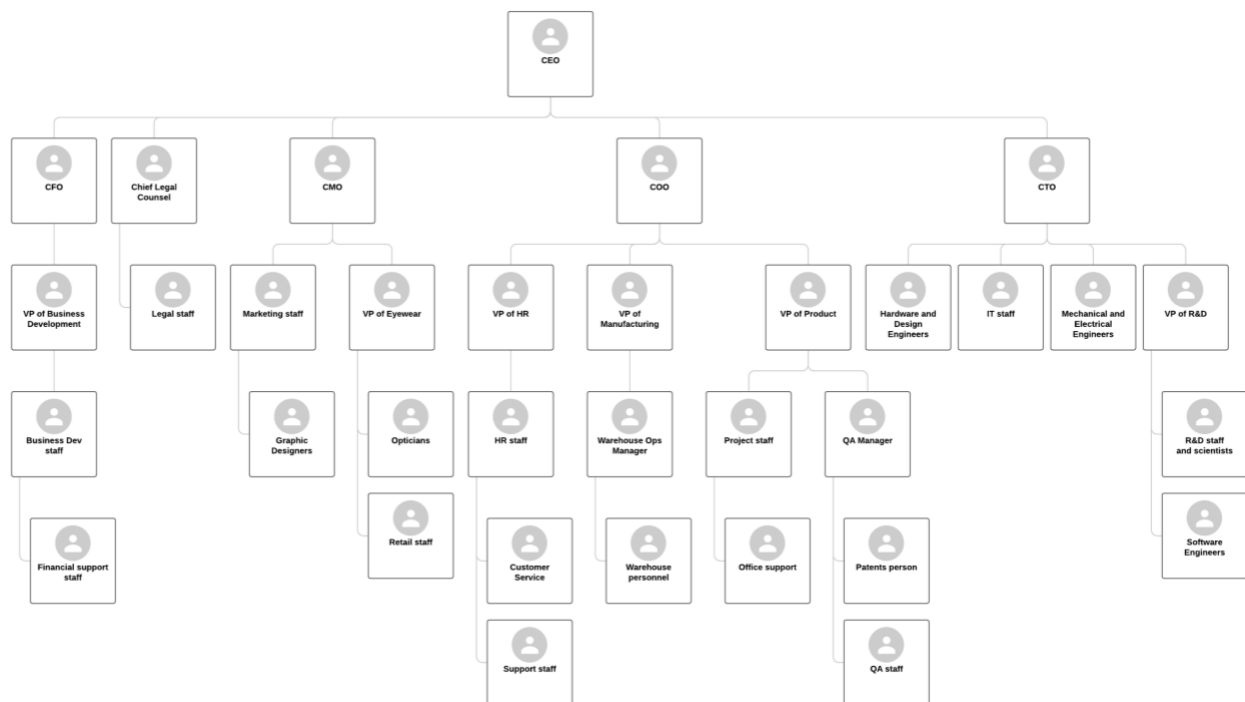


Figure 9: North Employee Organization Chart

### PHYSICAL AND OTHER RESOURCES

The Focals project will require resources such as raw materials, manufacturing space and equipment, and marketing and business development expenses. A complete list can be found in table 6 in the [Financials](#) section.



## Implementation Timeline

The estimated timeline to create and release North Focals is three years. The project begins with R&D and securing investments, followed by testing and development, and at the end of three years North will be manufacturing and retailing Focals smart glasses. Project milestones are listed in the figure below.

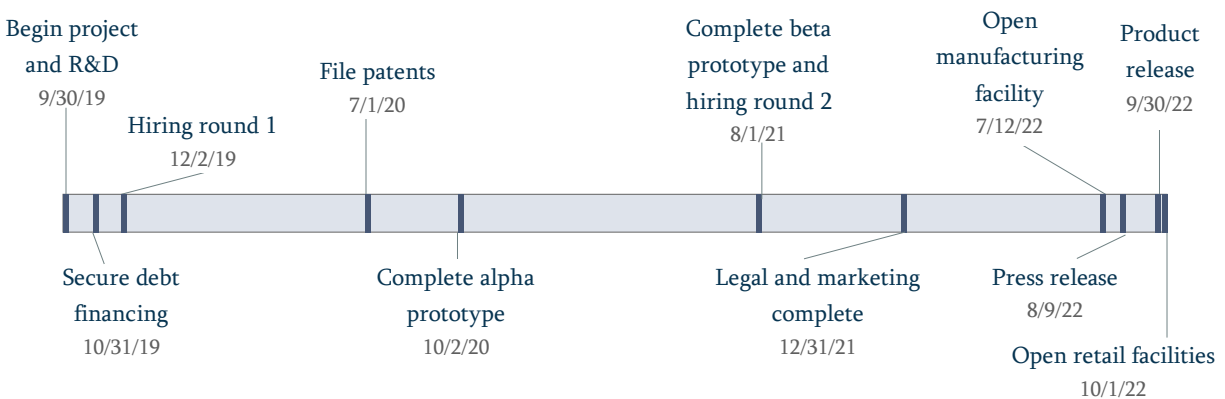


Figure 10: Focals Project Timeline 2019-2022

## Financials

The Focals project would take three years to complete, with spending as follows:

- The full project cost is \$130 million (USD) over 3 years.
- Year 1 would cost \$29 million (USD), or 22% of the total funding.
- Year 2 would cost \$40 million (USD), or 31% of the total funding.
- Year 3 would cost \$61 million (USD), or 47% of the total funding.

Expenses would increase significantly in the third year, as additional staff and manufacturing items will be needed. A complete breakdown of expenses over three years is listed below in table 6.

Table 6: Three-Year Cost Breakdown of Focal Smart Glasses

Item	Annual Cost (USD)	Quantity Year One	Quantity Year Two	Quantity Year Three	Total (USD)
<b>Staff:</b>					
<b>Executive Staff</b>					
CEO	200,000	1	1	1	600,000
CFO	175,000	1	1	1	525,000
CTO	175,000	1	1	1	525,000
COO	175,000	1	1	1	525,000
CMO	150,000	1	1	1	450,000
Chief Legal Counsel	150,000	1	1	1	450,000
VP of Business Development	150,000	1	1	1	450,000
VP of Eyewear	150,000	1	1	1	450,000
VP of HR	150,000	1	1	1	450,000
VP of Manufacturing	150,000	1	1	1	450,000
VP of Product	150,000	2	2	2	900,000
VP of R&D	150,000	1	1	1	450,000
<b>Additional Staff</b>					
QA Manager	135,000	1	1	1	405,000
Mechanical and Electrical Engineers	130,000	25	25	20	9,100,000
Legal staff	120,000	5	15	15	4,200,000
Project staff	120,000	20	20	20	7,200,000
Hardware and Design Engineers	110,000	30	25	25	8,800,000
Software Engineers for app development	110,000	2	25	40	7,370,000
Warehouse Operations Manager	90,000	0	1	1	180,000
Patents Lead	85,000	1	1	1	255,000
Business Development staff	80,000	15	15	15	3,600,000
Marketing staff	80,000	5	15	20	3,200,000
R&D staff and Scientists	80,000	25	20	20	5,200,000
HR staff	75,000	5	5	10	1,500,000
IT staff	70,000	3	5	10	1,260,000
Graphic Designers	60,000	3	10	15	1,680,000
Opticians	55,000	2	2	6	550,000
QA staff	55,000	20	20	20	3,300,000
Retail staff	55,000	0	1	8	495,000

Item	Annual Cost (USD)	Quantity Year One	Quantity Year Two	Quantity Year Three	Total (USD)
Additional support staff	50,000	15	20	30	3,250,000
Financial support staff	50,000	2	2	5	450,000
Customer Service	45,000	0	2	15	765,000
Office support	45,000	10	10	20	1,800,000
Warehouse personnel	45,000	0	10	180	8,550,000
Staff sub totals		202	263	510	
Annual salaries subtotal		18,940,000	24,015,000	36,380,000	79,335,000
Employee Benefits (30% of salary)		5,682,000	7,204,500	10,914,000	23,800,500
Total staff cost (salaries and benefits)		24,622,000	31,219,500	47,294,000	103,135,500
<b>Physical costs:</b>					
Office space and related costs (utilities, insurance)	300,000	1	1	1	900,000
Hardware and software	15,000	202	263	330	11,925,000
Manufacturing plant and equipment	100,000	0	1	10	1,100,000
Raw materials	50,000	5	20	50	3,750,000
Portable lab trailer	500,000	0	1	2	1,500,000
<b>Other costs:</b>					
Business-related expenses (travel, conferences)	100,000	2	5	5	1,200,000
Marketing-related expenses (website, conventions)	100,000	2	15	25	4,200,000
Contracts and miscellaneous fees	250,000	2	3	2	1,750,000
Subtotal of physical and other costs		4,480,000	8,595,000	13,250,000	26,325,000
<b>Total costs</b>		<b>29,102,000</b>	<b>39,814,500</b>	<b>60,544,000</b>	
Percentage of total		22.48	30.75	46.77	100.00
<b>Grand total</b>	<b>129,460,500</b>				

# Management

## Management Overview

The North senior management team consists of its three co-founders and other seasoned professionals, all with years of direct experience in wearable technology.

The senior management team includes:

- Stephen Lake, CEO and co-founder
- Matthew Bailey, CTO and co-founder
- Aaron Grant, co-founder
- Adam David Ketcheson, CMO
- Mike Galbraith, CFO
- Kelly Daly, VP of People

## Management Profiles

Stephen Lake

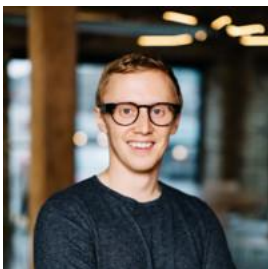
CEO and co-founder, North



Stephen Lake co-founded North in 2012 to create new technology. His bold leadership and big ideas have earned him several awards, including Forbes 30 Under 30 – Consumer Technology (2017), Entrepreneur of the Year (2014, Canadian Startup Awards), Maclean's Future Leaders under 25, and Canada's Top 20 under 20. He is a graduate of the University of Waterloo Mechatronics Engineering program [58].

Matthew Bailey

CTO and co-founder, North

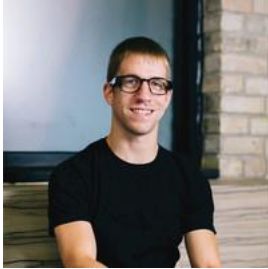


Matthew Bailey co-founded North in 2012 to change the way people interact with technology. He combines his technical skill with his interest in augmented and mixed reality. He received honors by Forbes 30 Under 30 - Consumer Technology (2017) and Maclean's Future Leaders under 25 for his contributions in wearable technology. He is a graduate of the University of Waterloo Mechatronics Engineering program [59].





Aaron Grant  
Co-founder, North



Aaron Grant co-founded North in 2012 to change the way people interact with technology. He has a broad range of engineering experience, including software, mechanical, and electrical. His honors included Forbes 30 Under 30 - Consumer Technology (2017) and Maclean's Future Leaders under 25. He is a graduate of the University of Waterloo Mechatronics Engineering program [60].

Adam David Ketcheson  
Chief Marketing Officer, North



Adam David Ketcheson excels at strategic planning and is defining the emerging wearable category in his work at North. He began his career in sales, held several leadership roles at the North Face, and worked as Global VP of Marketing at Arc'teryx Equipment. His retail and ecommerce leadership experience are critical to North's vision for Focals. He is a graduate of Concordia University [61].

Mike Galbraith  
Chief Financial Officer, North



Mike Galbraith is a Chartered Professional Accountant and CPA who joined North in 2013. He excels at financial analysis, reporting, forecasting, and planning. He served as Senior Vice President of Operations at BlackBerry from 2000-2013. He holds a business degree from Wilfrid Laurier University [62].

Kelly Daly  
VP of People, North



Kelly Daly is a Certified Human Resources Leader skilled in leadership and change management. She works to improve employee performance and satisfaction. She held several senior roles at BlackBerry, including VP of Global HR Operations & Services and VP of HR Business Partnerships. She also served as VP of Human Resources at Wellpoint Health Services. She holds degrees from Wilfrid Laurier University and Queen's University [63].

## Report Summary

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North conducted several tests and got informative results for North Focals and comparable consumer smart glasses Blade, by Vuzix. The quantitative test results and comparison to Blade smart glasses provide valuable information about how North should proceed. The results of these tests are discussed below using a *comparative analysis model*. North Focals were evaluated on three specific criteria, listed below in order of descending importance:

- **Performance:** Device performance, including battery life, is a major customer concern for portable consumer electronics. Consumers expect a device to run for a minimum of one day. And North wants to create a product which customers can wear and use all day long. Also, consumers value full-featured devices over limited devices, which is why the market has seen growth in full-featured smartphones and a decline in specialty devices such as fitness trackers. *Because the performance of a device greatly influences consumer interest, North Focals should provide a minimum of 16 hours of battery life and must include at least 10 working apps.*
- **Cost:** Wearable devices range in price from ten dollars to thousands of dollars. Customers are willing to pay for technologically advanced and unique offerings, but North should keep the price as low as possible to attract customers and be a competitive option. North analytics and marketing determined that Focals can successfully retail for \$799 (USD) for a pair of prescription glasses. North aims for a net profit margin of 20%. *For North to make a profitable pair of smart glasses, the cost to produce each pair should be below \$639.20 (USD).*
- **Ergonomics:** Consumers care about the look and feel of a product, especially one they plan to wear all day long. To be comfortable enough to wear all day long, glasses need to be lightweight and fit well, without pinching the nose or the temples. Because Focals are electronic, consumers need to be able to operate the device without difficulty. *To be ergonomically desirable, Focals should weigh less than 80 grams, have an average or better fit and comfort level, and be considered somewhat easy to use.*

North assigned a weight to these three criteria using a scale of 1-10, with 1 being the least important and 10 being the most important. North Focals were given a value for how well they met each of the three criteria. The values were assigned using a scale of 0-5, with 0 meaning they did not meet the criteria at all, and 5 meaning they fully met the criteria. A score was determined for each criterion by multiplying the weight times the value. The total score combined the scores of all three features. The process was repeated to provide a total score for Blade smart glasses. The analysis compares the scores between Focals and Blade.

North Focals were scored higher than competitor Vuzix Blade by using a comparative analysis model. Out of a possible score of 150, Focals received a total score of 126 and Blade received a total score of 89. Three main criteria – performance, cost, and ergonomics—were used to evaluate both North Focals and Vuzix Blade. North Focals met all the suggested criteria except for cost. The calculated cost was only slightly higher than the suggested cost, and Focals outperformed Blade in every test and category. Because Focals met so many suggested criteria and scored much higher than their closest competitor, it is strongly recommended that North proceed with Focals as their next project without delay.

# Methodology

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Once the North Focals prototype was developed, several tests were conducted to determine their ability to enter the market based on specific criteria. The tested criteria were performance, cost, and ergonomics. Each test had a number of tasks that provided quantitative results about the criteria.

Several tasks were based on survey responses. A survey size of 68 was selected so that the results would provide a 90% confidence level for a population of 5 million with a 10% margin of error [64]. The individuals represented a wide variety of demographics, agreed for their data to be used and published, and were compensated with gift cards. Survey questions were reviewed in advance with senior management and answers were provided anonymously. Survey questions and results are shown in Appendixes B, C, D, and E.

The tests for the three criteria and their associated tasks are listed below in order of importance:

## Phase 1: Performance

**Task 1: Battery life test.** A 700 mAh battery was selected for the North Focals because it was small enough to fit into the arm of the glasses and powerful enough to last for 20 hours based on the discharge rate of the average consumer. Because batteries often lose up to 20% effectiveness due to contributing factors such as temperature, North wanted to test battery life in the lab. An algorithm was written to test the expected battery life using a wide range of discharge rates. Tests were run on 24 prototypes for 10 days. The devices were charged for 4 hours, or to a minimum of 95% charge, between cycles. The results were recorded.

**Task 2: Battery use test.** The 68 survey participants were asked to wear Focals for at least 12 hours a day. They were asked not to charge Focals until the battery died. Then they were to charge the smart glasses to at least 90%, and repeat the process as needed. App data was collected to measure the battery length of all complete cycles and the data was recorded. Participants willingly agreed to share their app data as part of the experiment.

**Task 3: App testing.** Algorithms were written to randomly test the ten apps installed on the prototype for ten days. Apps included text, email, digital assistant Amazon Alexa, calendar, walking directions, Facebook notifications, Uber, Spotify, time, and weather. Response times

were averaged, and execution errors and excess latency were tracked by app and sequence. The results were recorded.

## Phase 2: Cost

**Task 1: Calculate the cost of materials.** The cost of materials, including plastic, copper, glass, polycarbonate, and hardware were totaled. Any unusable excess was also included in the calculation. The cost per pair of Focals was calculated and the results were recorded.

**Task 2: Calculate the cost to manufacture.** Costs related to the manufacturing plant, equipment, and staff were totaled. The cost per pair of Focals was calculated and the results were recorded.

**Task 3: Calculate additional costs.** All additional costs, including overhead, salaries, physical equipment, R&D, and marketing were totaled for one year. This number was divided by 200,000, which is the projected sales figure for the first full fiscal year. This figure was combined with the manufacturing costs and the cost of materials. The results were recorded.

## Phase 3: Ergonomics

**Task 1: Test product weight.** Two sets of prototypes were made in every combination of North's two styles and three colors, both with and without prescription lenses. Each prototype was weighed by North scientists on a precision digital scale to a tenth of a gram. The results were recorded.

**Task 2: Test fit.** Survey participants were asked to wear North Focals for 12 hours a day for 3 days and to wear Vuzix Blade for 12 hours a day for 3 days. Half wore Focals the first 3 days and half wore Blade the first 3 days. Participants then filled out a survey asking them to rate the fit of the glasses on a scale of 1-5, with 1 being very poor and 5 being very well. The results were computed and recorded.

**Task 3: Test comfort.** Survey participants were asked to wear North Focals for 12 hours a day for 3 days and to wear Vuzix Blade for 12 hours a day for 3 days. Half wore Focals the first 3 days and half wore Blade the first 3 days. Participants then filled out a survey asking them to rate the comfort of the glasses on a scale of 1-5, and also to rate their comfort wearing the smart glasses in public on a scale of 1-5, with 1 being very uncomfortable and 5 being very comfortable. The results were computed and recorded.

**Task 4: Test ease of use.** Survey participants were asked to wear North Focals for 12 hours a day for 3 days and to wear Vuzix Blade for 12 hours a day for 3 days. Half wore Focals the first 3 days and half wore Blade the first 3 days. Participants then filled out a survey asking them to rate the ease of operating the glasses on a scale of 1-5, with 1 being very difficult and 5 being very easy. The results were computed and recorded.

## Results

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### Phase 1: Performance

**Task 1: Battery life test.** The algorithm tested a variety of discharge rates and ran on 24 prototypes of Focals smart glasses for 10 days using a 700 mAh battery. The battery life average was **18.6 hours**. The longest and shortest recorded time were considered outliers and were not included in the average.

**Task 2: Battery use test.** Data from the 68 survey participants was collected from the North app. Data for all battery cycles that ended with less than 10% battery life were collected. Of the 136 data points collected, the top two and bottom two were discarded as outliers. The remaining 132 data points averaged **18.1 hours**.

**Task 3: App testing.** Many data points were recorded from the testing ten apps with North's algorithm, including 17,310 response times to all apps. The average response time for all apps, minus outliers, was 2.1 seconds. Response times over 20 seconds were recorded 379 times for digital assistant Amazon Alexa and 248 times for walking directions. Digital assistant Amazon Alexa averaged the longest response time at 9.5 seconds. At 0.2 seconds, the clock was the app with the quickest average response time. Failure to launch apps occurred 208 times, or 1.2% of the time.

Table 7: Performance Task Results for Focals and Blade

Task	North Focals	Vuzix Blade
Task 1: Battery life test (hours)	18.6	8.0*
Task 2: Battery use test (hours)	18.1	2.5**
Task 3: App testing (number of working apps)	10	150*

\* Result provided by Vuzix

\*\*Result provided by independent source

### Phase 2: Cost

The total cost to create a pair of Focals was \$647 (USD).

**Task 1: Calculate cost of raw materials.** The cost of raw materials, including plastic, copper, glass, polycarbonate, hardware, and excess materials were tallied. The average cost of materials was **\$150** (USD) a pair.

**Task 2: Calculate cost to manufacture.** Costs related to the manufacturing plant, equipment, and staff were tallied. The cost of manufacturing was **\$140** (USD) a pair.

**Task 3: Calculate additional costs.** Additional costs including overhead, salaries, physical equipment, and marketing were tallied for one year. This number was divided by 200,000, which is the projected sales quantity for the first full fiscal year. The cost per pair was calculated at **\$357** (USD) per pair. When combined with manufacturing and material costs, the average pair of Focals would cost **\$647** (USD).

## Phase 3: Ergonomics

See table 7 below for a summary of ergonomic test results of phase one.

**Task 1: Test product weight.** Twenty-five pairs of prototypes were weighed to a tenth of a gram on a precision digital scale and recorded. The average weight was **72.7 grams** for a pair of Focals smart glasses. A table of these results is listed in Appendix F. The product weight of Blade smart glasses is **90.0 grams**.

**Task 2: Test fit.** Question #3 of the North Focals survey asked survey participants to rate the fit of Focals smart glasses on a scale of 1-5, with 1 being very poor and 5 being very well. The average fit rating for Focals was **3.7**, which is above average but not excellent. The **mode**, or the most common rating, was 4. Complete results can be seen in Appendix C.

Question #3 of the Vuzix Blade survey asked survey participants to rate the fit of Blade smart glasses on a scale of 1-5, with 1 being very poor and 5 being very well. The average fit rating for Blade was **3.6**, which is above average but not excellent. The mode was 3. Complete results can be seen in Appendix E.

**Task 3: Test comfort.** Question #1 of the North Focals survey asked survey participants to rate the comfort of Focals smart glasses on a scale of 1-5, with 1 being very uncomfortable and 5 being very comfortable. The average rating for Focals was **3.5**, which is above average but not excellent. The mode was 4.



Question #2 of the North Focals survey asked survey participants to rate how comfortable they felt wearing Focals smart glasses in public on a scale of 1-5, with 1 being very uncomfortable and 5 being very comfortable. The average rating was **3.8**, which is above average but not excellent. The mode was 4. The combined average of both comfort ratings was **3.6**. Complete results can be seen in Appendix C.

Question #1 of the Vuzix Blade survey asked survey participants to rate the comfort of Blade smart glasses on a scale of 1-5, with 1 being very uncomfortable and 5 being very comfortable. The average rating for Blade was **2.6**, which is slightly below average. The mode was 3.

Question #2 of the Vuzix Blade survey asked survey participants to rate how comfortable they felt wearing Blade smart glasses in public on a scale of 1-5, with 1 being very uncomfortable and 5 being very comfortable. The average rating for Blade was **2.6**, which is slightly below average. The mode was 2. The combined average of both comfort ratings was **2.6**. Complete results can be seen in Appendix E.

**Task 4: Test ease of use.** Question #4 of the North Focals survey asked survey participants to rate how easy it was to use Focals smart glasses on a scale of 1-5, with 1 being very difficult and 5 being very easy. The average rating for Focals was **3.9**, which is above average but not excellent. The mode was 5. Complete results can be seen in Appendix C.

Question #4 of the Vuzix Blade survey asked survey participants to rate how easy it was to use Blade smart glasses on a scale of 1-5, with 1 being very difficult and 5 being very easy. The average rating for Blade was **3.4**, which is above average but not excellent. The mode was 3. Complete results can be seen in Appendix E.

Table 8: Ergonomics Test Results for Focals and Blade

	North Focals	Vuzix Blade
Task 1: Test product weight (grams)	72.7	90.0*
Task 2: Test fit**	3.7	3.6
Task 3: Test comfort**	3.7	2.6
3a. How comfortable**	3.5	2.6
3b. How comfortable wearing in public**	3.8	2.6
Task 4: Test ease of use**	3.9	3.4

\* Result provided by Vuzix

\*\*On a scale of 1 to 5, where 1 is poor and 5 is excellent



# Discussion

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## Introduction

North conducted several tests and got informative results for North Focals and comparable consumer smart glasses Blade, by Vuzix. The quantitative test results and comparison to Blade smart glasses provide valuable information about how North should proceed. The results of these tests are discussed below using a *comparative analysis model*. North Focals were evaluated on three specific criteria, listed below in order of descending importance:

- **Performance:** Device performance, including battery life, is a major customer concern for portable consumer electronics. Consumers expect a device to run for a minimum of one day. And North wants to create a product which customers can wear and use all day long. Also, consumers value full-featured devices over limited devices, which is why the market has seen growth in full-featured smartphones and a decline in specialty devices such as fitness trackers. *Because the performance of a device greatly influences consumer interest, North Focals should provide a minimum of 16 hours of battery life and must include at least ten working apps.*
- **Cost:** Wearable devices range in price from ten dollars to thousands of dollars. Customers are willing to pay for technologically advanced and unique offerings, but North should keep the price as low as possible to attract customers and be a competitive option. North analytics and marketing determined that Focals can successfully retail for \$799 (USD) for a pair of prescription glasses. North aims for a net profit margin of 20%. *For North to make a profitable pair of smart glasses, the cost to produce each pair should be below \$639.20 (USD).*
- **Ergonomics:** Consumers care about the look and feel of a product, especially one they plan to wear all day long. To be comfortable enough to wear all day long, glasses need to be lightweight and fit well, without pinching the nose or the temples. Because Focals are electronic, consumers need to be able to operate the device without difficulty. *To be ergonomically desirable, Focals should weigh less than 80 grams, have an average or better fit and comfort level, and be considered somewhat easy to use.*

North assigned a weight to these three criteria using a scale of 1-10, with 1 being the least important and 10 being the most important. North Focals were given a value for how well they met each of the three criteria. The values were assigned using a scale of 0-5, with 0 meaning they did not meet the criteria at all, and 5 meaning they fully met the criteria. A

score was determined for each criterion by multiplying the weight times the value. The total score combined the scores of all three criteria. The process was repeated to provide a total score for Blade smart glasses. The analysis compares the scores between Focals and Blade.

## Performance

### Background

The wearable technology market thrives on innovation and excitement, but also needs to meet basic consumer standards. Devices need to have a reasonable battery life and be full of features, or consumers will overlook them and use their smartphones instead. Analysts predict higher acceptance of AR glasses in the next five years if battery life can be improved. And consumer purchases of specialty devices with fewer features have fallen substantially in favor of full-featured wearables or smartphones. The influence of performance on consumer purchasing behaviors cannot be understated. *Therefore, the performance criterion was given a weight of 10.*

### Analysis

#### Option A: North Focals

In the battery life test, North Focals were used with a wide range of discharge rates. The battery life average was 18.6 hours. In the battery use test, Focals were tested with 68 users, who reported an average of 18.1 hours of use per charge. Both tests surpass the defined criterion of 16 hours use.

In Focals app testing, ten apps were installed and repeatedly launched. Although latency issues and errors were found, especially with the digital assistant and walking directions, all ten apps worked. Additional research into the digital assistant app is suggested to reduce errors and response time. Also, because Focals have much fewer apps than Blade, it is suggested North release additional apps after product release. However, the test results do fully satisfy the criterion that Focals include at least ten working apps. *Focals completely met the established performance criteria because the test results showed the battery life lasted over 16 hours and there were ten working apps, and therefore received a value of 5.*

#### Option B: Vuzix Blade

Vuzix Blade smart glasses include a 470mAh Lithium polymer battery. Independent sources report that the battery lasts 2 hours and 28 minutes with high usage [65], while the company states most users get 8 hours use on a single charge. North's survey results returned an average battery life of 0.38 days. In none of these instances did Blade smart glasses meet the 16-hour battery life criterion.

Blade comes with five pre-installed apps and four pre-installed games. However, Vuzix hosts its own app store with over 150 apps for its products. Therefore, Blade fully meets the criterion of having ten working apps. *Because it does not meet the 16-hour battery life but does have over ten working apps, Blade received a value of 3.*

## Conclusion

### Option A: North Focals

Based on a criterion weight of 10 and a value of 5, the performance feature for Focals was given a score of 50.

### Option B: Vuzix Blade

Based on a criterion weight of 10 and a value of 3, the performance feature for Blade was given a score of 30.

## Cost

## Background

Full-featured smart glasses often retail for several hundred dollars or more, which limits the pool of potential consumers. Over half of consumers say price limits their interest in a wearable device. Since high-performing devices usually cost more, a balance should be struck for a product to be successful. Lower prices may open the market to more consumers but reduce profit margins, again requiring a balance based on careful analysis. *Due to the significance of price on consumer spending, the cost criterion was given a weight of 9.*

## Analysis

## Option A: North Focals

Prescription North Focals can be manufactured at a total cost of \$647 (USD). The cost of materials, manufacturing, and overhead costs including marketing and R&D were combined to determine the total cost. This cost is slightly more than the target cost of \$639 (USD), but it is close enough to the desired cost for North to proceed. It provides North with a net profit of 19% instead of 20%, which is still a considerable profit. North could review its operations to look for ways to reduce costs. Also, if sales go up, then the cost per unit should fall, which could bring the net profit to 20% or higher. *Focals almost met the established cost, so they received a value of 4.*

## Option B: Vuzix Blade

Vuzix Blade smart glasses are retailing for \$799 (USD). Until recently, their retail price was \$999 (USD). This reduced price may signify that customers weren't willing to pay as high of a price as expected. Or product sales may have slumped after technology enthusiasts purchased them upon release. In any event, it signifies the need to offer competitive pricing on smart glasses. Although the exact manufacturing costs of Vuzix Blade are unknown, the retail price of \$799 (USD) plus \$199 (USD) for prescription inserts is \$200 (USD) is higher than the retail price of prescription North Focals. Therefore, we can assume that the cost to produce them is also higher. *Because prescription Blade smart glasses likely do not meet the cost criteria, they receive a value of 3.*

## Conclusion

### Option A: North Focals

Based on a criterion weight of 9 and a value of 4, the cost feature for Focals was given a score of 36.

### Option B: Vuzix Blade

Based on a criterion weight of 9 and a value of 3, the cost feature for Focals was given a score of 27.

## Ergonomics

## Background

Product ergonomics allow a person to interact with an object without stress or strain. Smart glasses need good ergonomic design to be comfortable to wear, easy to use, and to prevent strain on the user. Products with poor design may get a bad reputation and lower sales.

*Therefore, the ergonomics criterion was given a weight of 8.*

## Analysis

### Option A: North Focals

Weight testing of North Focals determined an average product weight of 72.7 grams per pair. The ergonomics criterion suggested a weight of 80 grams or less per pair, so the weight portion was fully met.

The average fit rating for Focals was 3.72 out of a possible 5, and the average comfort rating for Focals was 3.65 out of a possible 5. A rating of 3 is average and a rating of 5 is excellent, so the comfort rating for Focals was above average. Both fit and comfort ratings fully met the specified criterion. Because the rating could still be improved, North may want to adjust this criterion and aim for a rating of 4 and improve fit and comfort before product release.

The average ease of use rating for Focals was 3.91 out of a possible 5, which is above average but not excellent. This rating does fully meet the suggestion criterion. *Focals fully met the ergonomics criteria of weighing less than 80 grams, having an average or better fit and comfort level, and being considered somewhat easy to use, so they received a value of 5.*

### Option B: Vuzix Blade

Vuzix Blade smart glasses weigh 90 grams [44], which is over the suggested criterion of 80 grams. The average fit rating for Blade was 3.62 out of a possible 5, and so they meet the fit criterion.

The average comfort rating was 2.60 out of a possible 5, which does not quite meet the suggested criterion. The average rating for ease of use for Blade smart glasses was 3.37 out of a possible 5, which does meet the suggested criterion. *Because Blade fully met two of the ergonomics criteria and almost met the other two, they received a value of 4.*

## Conclusion

## Option A: North Focals

Based on a criterion weight of 8 and a value of 5, the ergonomics feature for Focals was given a score of 40.

## Option B: Vuzix Blade

Based on a criterion weight of 8 and a value of 4, the ergonomics feature for Blade was given a score of 32.

## Decision Matrix

Table 9: Decision Matrix for North Focals and Vuzix Blade

			Test Result	Result Needed to Meet Criteria	Criteria Weight	Criteria Value	Criteria Score
North Focals	Performance				10	5	50
		Battery life (hours)	18.4	16.0			
		Functional apps	10	10			
	Cost (USD)		647	639	9	4	36
	Ergonomics				8	5	40
		Weight (grams)	72.7	80.0			
		Fit	3.7	3.0			
		Comfort	3.7	3.0			
		Ease of use	3.9	3.0			
	Total Score						126
Vuzix Blade	Performance				10	3	30
		Battery life (hours)	5.3	16.0			
		Functional apps	10	150			
	Cost (USD)*		798	639	9	3	27
	Ergonomics				8	4	32



	Weight (grams)	90.0	80.0			
	Fit	3.6	3.0			
	Comfort	2.6	3.0			
	Ease of use	3.4	3.0			
<b>Total Score</b>						<b>89</b>

\*Assumed manufacturing cost based on \$998 (USD) retail price and 20% profit margin

## Recommendation

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North Focals were scored higher than competitor Vuzix Blade by using a comparative analysis model. Out of a possible score of 150, Focals received a total score of 126 and Blade received a total score of 89. Three main criteria – performance, cost, and ergonomics—were used to evaluate both North Focals and Vuzix Blade. North Focals met all the suggested criteria except for cost. The calculated cost was only slightly higher than the suggested cost, and Focals outperformed Blade in every test and category. Because Focals met so many suggested criteria and scored much higher than their closest competitor, it is strongly recommended that North proceed with Focals as their next project without delay.

## Appendix A: Glossary of Terms and Abbreviations

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Term	Description
5G network	Fifth-generation cellular wireless network. The newest and potentially fastest network [23].
activity tracker	An electronic device carried or worn on the body that measures activity, such as distance walked, flights climbed, or heart rate. Also known as a fitness band or fitness tracker.
augmented reality (AR)	A composite view or experience created by superimposing digital information on a real-world view or experience.
compound annual growth rate (CAGR)	“The year-over-year growth rate of an investment over a specified period of time [66].”
digital assistant	Voice-activated software that can respond to some human language commands and perform basic tasks, such as answering questions. Common examples include Amazon Alexa and Apple’s Siri. Also known as a voice assistant, smart assistant, or virtual digital assistant.
ergonomics	Optimizing design to provide an efficient and safe relationship between humans and products [67].
fitness band	See activity tracker.
fitness tracker	See activity tracker.
Google Glass	Google Glass is a brand of augmented reality smart glasses released in 2013. Production was suspended due to consumer backlash regarding privacy concerns. An enterprise version was released in 2017 [68].
H1 chip	A propriety chip from Apple for use in headphones that improves connectivity and synchronization [69].
head-mounted displays	A headset, goggles, glasses, or helmet used with virtual reality systems [70].
hearables	Advanced earphones, ear buds, or noise amplifiers. They may track biometrics, make phone calls, or access a digital assistant.
holographic film	A thin, flexible plastic film that is embossed and will diffract white light [71].
hybrid watch	A hybrid watch combines a traditional watch with a smartwatch. It looks like a traditional watch, does not have a touchscreen, and has some of the same features a smartwatch does.
Internet of Things	Everyday objects that have a relationship between each other that is not dependent on the user. They are connected to the Internet, or to each other with sensor technology [72].

laser beam scanning	The “controlled deflection of laser beams [73]” off a mirror or reflective surface, resulting in a clear and colorful image.
mechatronics	A combination of electrical and mechanical engineering.
mode	In a given set of numbers, the number that occurs most frequently [74].
OLED display	Organic light-emitting diodes (OLED) displays are thin films that create light from electricity. Their quality, flexibility, and energy efficiency make them the best display currently available [74].
peripheral TV device	A device that connects to a TV, such as a DVD player, TV remote, or streaming device.
rolling screen	A TV with a rolling screen will roll up inside its base and be stored out of sight.
smart clothing	Clothing or fabric with added technology. It may be used to monitor or interact with the user.
smart headphones	See hearables.
smart speaker	“An Internet-enabled speaker that is controlled by spoken commands and capable of streaming audio content, relaying information, and communicating with other devices [75].”
smart TVs	A digital television with Internet connectivity.
smartwatches	A wearable device with a touchscreen that is worn on the wrist [76].
telephony	Telephones and related systems.
video doorbells	Video doorbells, also known as smart doorbells, include video viewing or recording through an app, two-way audio communication, and a motion sensor.
virtual reality (VR)	“The use of computer technology to create a simulated environment [77].”
voice assistance	See digital assistant.
wearable	An electronic device or piece of technology that is worn on the body. It is usually integrated into a wearable item, such as clothing, glasses, or a watch.

## Appendix B: North Focals Smart Glasses Survey

1. Rate how comfortable Focals smart glasses were to wear.

	1	2	3	4	5	
Very uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very comfortable

2. Rate how comfortable you felt wearing Focals smart glasses in public.

	1	2	3	4	5	
Very uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very comfortable

3. Rate how well Focals smart glasses fit you.

	1	2	3	4	5	
Very poorly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very well

4. Rate how easy it was to operate the smart glasses with the Loop ring.

	1	2	3	4	5	
Very difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

5. How many days did the battery last all day?

For smart glasses only, not including the ring

	0	1	2	3
Number of days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How many days did you start with a full charge?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix C: North Focals Smart Glasses Survey Results

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Question	Rating					Average	Mode
	Poor	Average		Excellent			
	1	2	3	4	5		
1	3	6	22	25	12	3.54	4
2	1	6	16	30	15	3.76	4
3	0	9	18	24	17	3.72	4
4	3	4	14	22	25	3.91	5
	Days						
	0	1	2	3			
5a	0	0	6	62		2.91	3
5b	0	2	8	58		2.82	3

## Appendix D: Vuzix Blade Smart Glasses Survey

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1. Rate how comfortable Blade smart glasses were to wear.

	1	2	3	4	5	
Very uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very comfortable

---

2. Rate how comfortable you felt wearing Blade smart glasses in public.

	1	2	3	4	5	
Very uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very comfortable

---

3. Rate how well Blade smart glasses fit you.

	1	2	3	4	5	
Very poorly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very well

---

4. Rate how easy it was to operate Blade smart glasses.

	1	2	3	4	5	
Very difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

---

5. How many days did the battery last all day?

	0	1	2	3
Number of days	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How many days did you start with a full charge?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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## Appendix E: Vuzix Blade Smart Glasses Survey Results

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Question	Rating					Average	Mode
	Poor	Average		Excellent			
	1	2	3	4	5		
1	13	18	24	10	3	2.59	3
2	12	23	19	8	6	2.60	2
3	0	7	26	21	14	3.62	3
4	3	5	33	18	9	3.37	3
	Days						
	0	1	2	3			
5a	45	20	3	0		0.38	0
5b	0	2	5	61		2.87	3



## Appendix F: Complete Results for Ergonomics Test 1: Weight in Grams of Focals Prototypes with Assorted Features

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Prototype Number	Style	Color	Rx?	Weight (g)
1A	A	1	Y	73.6
1B	A	1	Y	75.2
2A	A	1	N	65.1
2B	A	1	N	66.8
3A	A	2	Y	77.9
3B	A	2	Y	78.6
4A	A	2	N	72.0
4B	A	2	N	71.5
5A	A	3	Y	73.7
5B	A	3	Y	74.1
6A	A	3	N	71.6
6B	A	3	N	71.1
7A	B	1	Y	70.8
7B	B	1	Y	72.3
8A	B	1	N	69.6
8B	B	1	N	68.2
9A	B	2	Y	70.9
9B	B	2	Y	71.8
10A	B	2	N	69.9
10B	B	2	N	68.7
11A	B	3	Y	80.0
11B	B	3	Y	79.2
12A	B	3	N	76.6
12B	B	3	N	75.4
Average Weight				72.7

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