Product Specification Document

Product Name: Adjustable Lens Glasses
Date: August 15, 2025
Prepared by: Design for Planet Impact
Version: 1.1

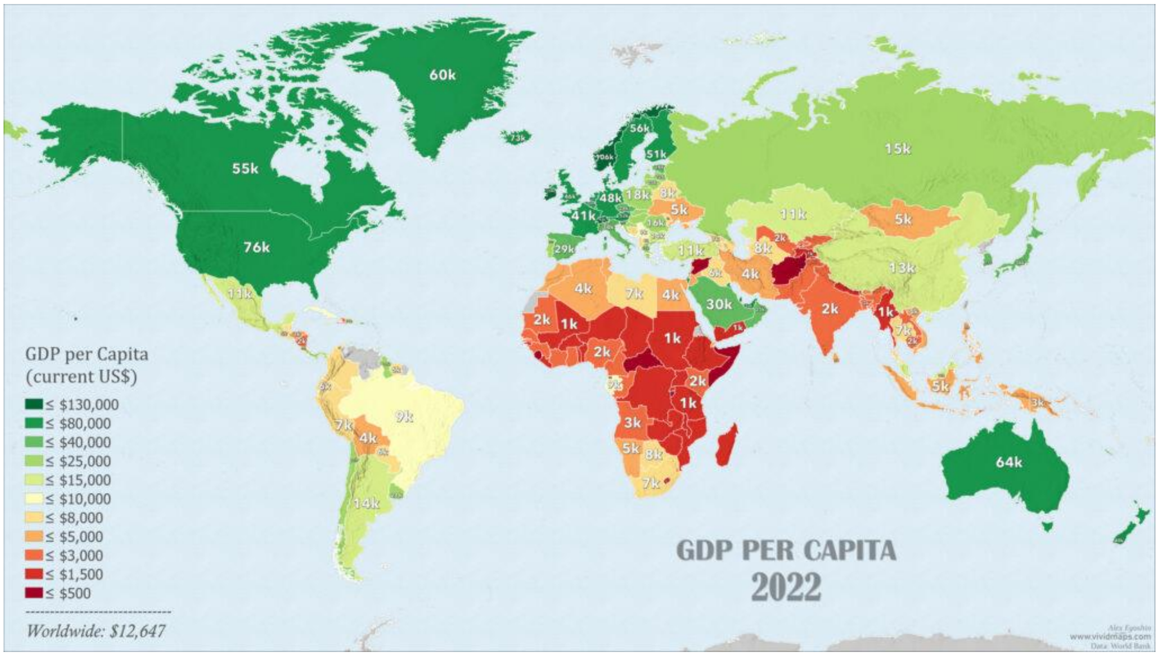
Design for Planet Impact (I.e. Planet-Impact) is a Georgia Tech initiative that engineers product-based solutions for social good. This project is one of many projects Planet Impact has developed and will be overseeing over multiple semesters. This is Planet Impact's first semester. Hopefully, you will be the beginning of lasting change.

1. Product Vision and Overview

Objective:

The focus of Adjustable Lens Glasses is to allow the user to easily adjust the focus of their lens to meet their needs without having to buy multiple new glasses. This technology is already currently available, however, there are issues with the quality and long-term success of these designs. This is largely due to the tight tolerances needed for an effective design, while also simultaneously needing to be cheap to reach the intended communities. Therefore, your objective is to create an iteration of this project that rectifies this conflict

Target Users:
- Rural Communities
- Low-income homes
- Visually impaired.



Overall, the project seeks to aid countries that are in the range of 5,000 GDP or lower. The map above shows an encompassing map of countries and their GDP levels in 2022.

Example Countries:

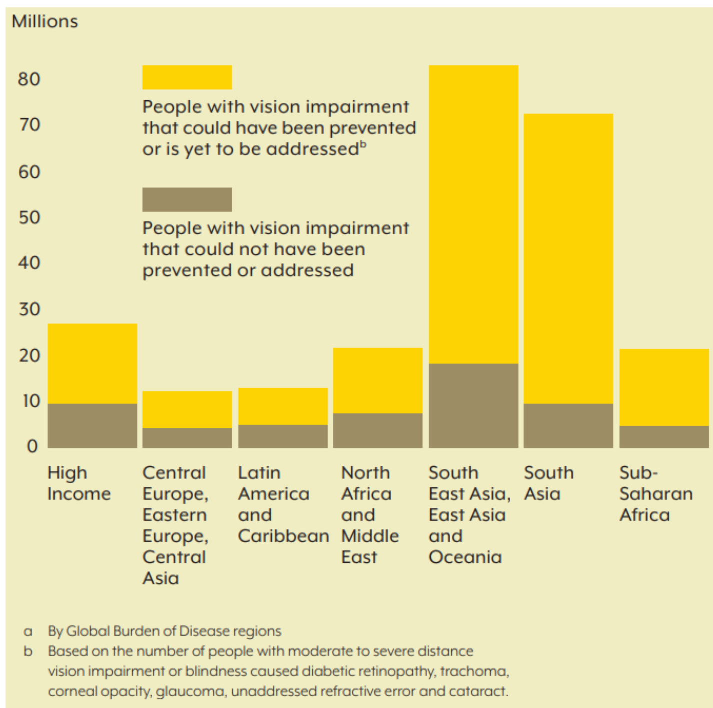
> **Note:** This project is country independent. The countries below are not necessarily the focus of this project, but some example countries that could benefit from a product like what your team sets out to make.
>
> **Namibia:**
> GDP (Nominal) - $4,168
> Needs - Visual impairment is the second most common disability. Education for the visual impaired is also an issue. Almost 30,000 blind or impaired, with only two ophthalmologists serving the country. However, the growing middle class is allowing for more to be spent on visual aid, and the industry is rising. High numbers of cataracts and refractive errors
>
> **Sri Lanka:**
>
> GDP (Nominal) - $3,672
> Needs - 1.7% blindness in 40+ year olds. Regardless of age 1.6% severe cases of visual impairment and 15.4% visual impairment. Blindness rates vary between provinces from nearly 3% to 0.29%
>
> **Guatemala:**
>
> GDP (Nominal)- $5762

Needs – While slightly outdated, in 2015, Guatemala dealt with 2.9% blindness, 5.2% severe visual impairment and 27.6% moderate visual impairment. To put these numbers into perspective. Less than 0.3% of people in America deal with blindness. Worsening the issue there are only 19.9 Ophthalmologists and 44.7 Optometrists per million people in Guatemala.

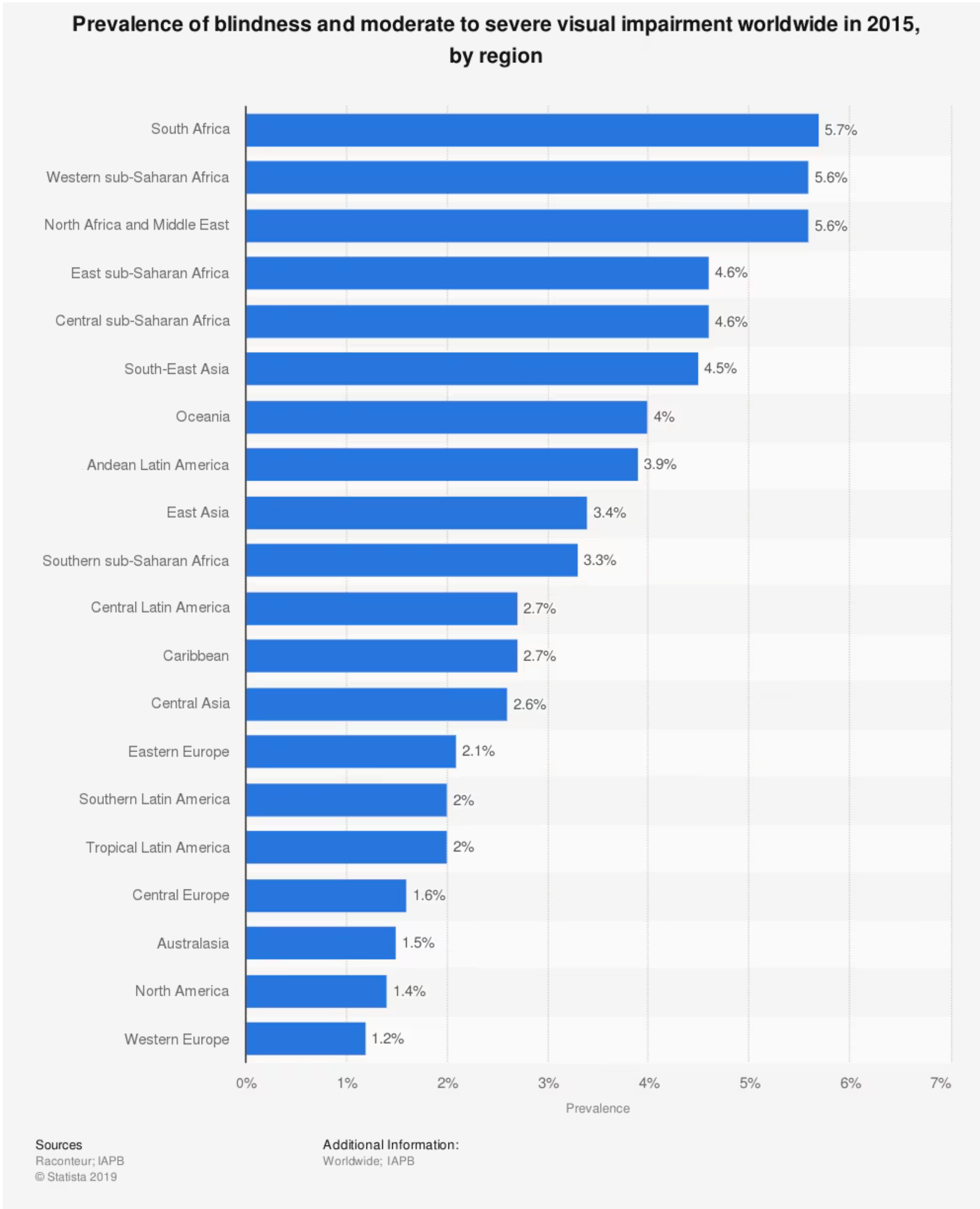
Key Value Propositions:

- Prescription is easily changeable and **STABLE**
- Clear and unblurry
- Sturdy and not easily breakable
- Attractive to look at

The costs of the coverage gap for unaddressed refractive errors and cataract globally are estimated to be $14.3 billion US dollars.



Adapted from: Flaxman SR, Bourne RRA, Resnikoff S, Ackland P, Braithwaite T, Cicinelli MV, et al. Global causes of blindness and distance vision impairment 1990–2020: a systematic review and meta-analysis. The Lancet Global Health. 2017;5(12):e1221–e34



2. Key Features and Requirements

Feature	Description
Prescription Range	Able to be used by range of prescription in order to support as many customers as possible without comprising quality in the meanwhile, accuracy of prescription is paramount, Current models provide prescription ranges from -6D through + 3D.

Adjustment Tech	Accessible adjustment system, comprehensible to all levels of prior education experiences, does not affect aesthetic and form.
Diagnostic Index	Visual indication that correlates an accurate prescription reference, comprehensible and externally visible, does not take away from aesthetic and form
Locking mechanism	System to keep prescriptions that's chosen by user accurate during everyday wear, does not take away from aesthetic and form
Form Factor	Able to be worn daily, looks as close to modern glasses as possible, varying shape options if design permits, necessary features do not comprise the aesthetic

3. Design Guidelines and Cost Targets

Industrial Design:

- Unisex, sleek look with sustainable material.
- Color options for personalization and style if budget permits.
- Pediatric Consideration: Create a variation for pediatric patients. Adjust frame size and aesthetical components to increase pediatric appeal.

Performance Targets:

Most of the performance targets are selected due to the faults of current models of similar products that need to be addressed moving forwards. New issues may begin to arise that are integral to the success of the product as a whole; these may be subject to change moving forwards in the design and testing process.

Pediatric and Adult Variations: There should be two separate variations of the design. 1 version for pediatric patients, and one version for adult patients. The designs should vary based off aesthetical components that appeal more to each age group, as well as accounting for frame measurements of standardized pediatric vs adult measurements. The pediatric variation should have emphasis on aesthetic compatibility with child preferences, as well as length adjustment options.

Diopter Range: Diopters are the measurement range of optical correction in which it is possible for a lens, indicating the lens ability to focus light in accordance with a specific prescription. Negative diopters (minus numbers) correct nearsightedness (myopia). Positive diopters (plus numbers) correct farsightedness (hyperopia). For the adjustable lens, a range of diopters will be necessary in order to create an efficient product, with current models having ranges from -6D through + 3D. Our goal is to help as many people as possible, as it should be able to tackle both near and far sightedness. According to the WHO, over 800 million people (10% of the global popluation) experience nearsightedness, with a typical prescritption range of –0.25D to more severe cases being –5.0D. For farsightnedness, 30.6% of adults worldwide experience hyperopia, with common prescription falling between +0.25 to +5.0. The highest prescription offered by optometrists typically ranges from –20D to +20D, but the highest ever recorded goes into the hundreds. Thus, our range of -6D to +3D has the goal of accounting for a vast majority of these patients.

Tolerances: Due to the nature of accuracy needed in order to be reached for optimal usage, tolerances for the adjustment mechanism need to very precise in order to replicate useable prescriptions. The location of the lenses and their overlap need to be very specific to create a function product. This is a common issue for existing products and must be addressed moving forward.

Opitical Tolerances Information: https://wp.optics.arizona.edu/optomech/wp-content/uploads/sites/53/2016/08/8-Tolerancing-1.pdf

Adjustable Glasses with Tolerance Information: https://patents.google.com/patent/US7325922B2/en

Field of View: The mechanism required for this product to function properly often hinders visibility when used, so innovative solutions for location of mechanism and overall mechanical design is necessary in design process. Peripheral vision must not be compromised due to adjustable nature of product idea and must be as comparable as mechanically possible to regular prescription glasses. Users must still be able to rely on their field of vision, as this is non-negotiable due to safety considerations.

Weight and Balance: A frequent concern brought to attention through research and interviews are concerns over "bulkiness." These glasses must be able to function for everyday use, requiring a design of lightweight but durable materials that do not hinder the user. They must also not be top-heavy due to the mechanics, as this would greatly disrupt the user experience. Current models that are on the lower end of quality are around 90 grams, with the average weight of glasses in general are around 20-40 grams depending on material and quality; finding a middle ground while protecting the quality will likely be a challenging task.

Durability: One of the main goals of this project is to create a cost-effective product for underdeveloped areas with inaccessible optometrists. This comes with the onerousness of balancing inexpensive materials that will last the user for as long as possible. This, again, is non-negotiable, as it is the foundation of the project and the mission of DPI as a whole. The use of acetate frames or a form of polycarbonate is a minimum requirement for durability purposes as long as the cost goal prevails.

Visual Aesthetics: With pediatric considerations being paramount, the visual form must not be affected by the adjustment technology. It must be discreet with a consistent form, as this was a major and valid concern expressed by our younger interviewees. While the focus is underdeveloped countries, the visual form is still a major concern as the design process begins, as the balance of functionality and style must go hand in hand.

Discreet Mechanics: This performance target is a larger concern for the use of fluid-filled technology. Current models of this design our very blatant visually, so it is a priority moving forward. The same still goes for the use of the Alvarez design, as an inconspicuous design with protect users from any unwanted attention.

User Friendly: A major similarity with many of the undeveloped countries in which we are focusing on is a lack of education, making optometrists inaccessible and hard to understand. This product must be able to be worked by customers who lack formal education and have even younger clients, requiring a simple and visually understandable design in order to accommodate those from all levels of education.

Cost Targets:

The main purpose of this product is to be able to create an affordable product that is accessible to those with lower incomes. This comes with the challenge of balancing affordability with quality, but it is paramount that is balance is found. This section will be subject to change as the product and mechanics get finalized, but, again, this is the main objective of the project and DPI as a whole. The cost must be comparable to over-the-counter glasses to maintain the affordability, with the average cost being around $25. Most designer glasses brands have manufacturing costs of around $20 with extremely inflated profit margins, so an affordable but high-quality product should be manageable. The costs shown below are basic and inflated estimates, so actual costs are expected to fluctuate.

Component	Target Cost (USD)
BOM (Bill of Materials)	≤ $ 13.04 (based on research) to 20 (max)
Frames	≤ $ 7
Lenses	≤ $ 0.20 per
Adjustment Mechanism	≤ $ 3
Screws	≤ $0.11 per

Hinges	≤ $0.35 per
Nose pads	≤ $0.75 per
Manufacturing + Assembly	≤ $ 4
Packaging	≤ $0.05 per poly bag
Gross Margin	25–50% at scale

Making a profit is not the priority, so a smaller gross margin that allows the company to continue to produce this product is the goal. Again, the goal of DPI is to help others, not to dominate the market.

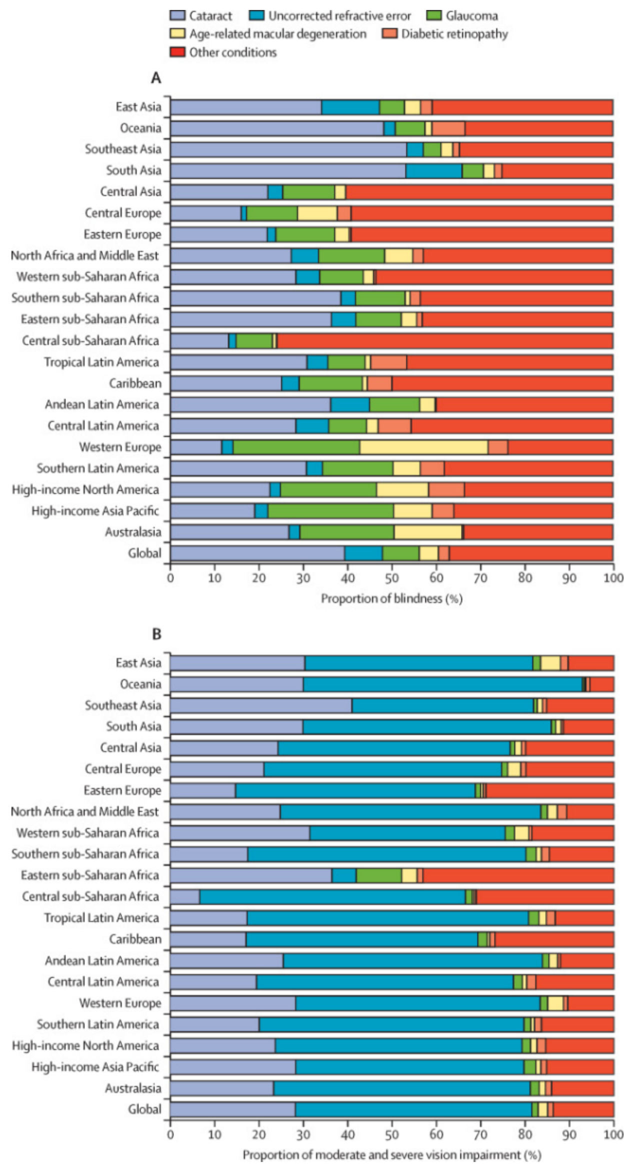
4. Market Size and Competitive Landscape

TAM:
- Globally 2.2 billion people suffer vision impairment
- Eyewear market is valued to be 335.9 billion by 2030

Product		Price	Prescription Range	Adjustment Tech	Strengths	Weaknesses
Prescription Glasses		$100 - $500	NA	NA	Works extremely well	Need multiple glasses for different prescriptions and prescriptions are constantly changing, Expensive
Eyejusters		$89	+0.5D to +4D	Sliding Dual Lens	Middle level reviews	Smaller range than others, Relatively expensive for target

Dial Vision		$15	-6D to +3D	Mechanical Dial Lens	Cheap, High range	Very poor reviews
Adspecs		$19 (Not Available)	-6D to 0; 0 to +6D	Fluid Filled Dial-Able Lenses	Cheap, High Range	Not available, Feedback limited due to lack of availability
Flex Focus		$60	-6D to +3D	Mechanical Dial Lens	Good reviews on site, High range	Claims of scam, Not BBB Accredited, Expensive for the technology used
VOY Adjustable Eyewear		$70-120	0 to -6D; +3D to -3D	Nano Precision Tunable Tech	Good reviews	Not for everyday use but instead for VR, Different sets needed for full range

Competition (function not market):



5. Regulatory and Compliance

- International Standards:
    - ISO 14889
- Regional Standards:
    - America: ANSI Z80.1

6. Development Timeline

Milestone	Target Date
Requirements Freeze	August 15, 2025

Capstone Team #1 Kick-off	August 18, 2025
Capstone Team #1 Design Review	October 15, 2025
Capstone Team #1 Final Report	December 2, 2025
Capstone Team #2 Kick-off	January, 2026
Capstone Team #2 Design Review	March 2026
Capstone Team #2 Final Report	April 2026

7. Engineering Responsibility Breakdown

Frame Design Engineering Responsibilities

- Adjustment Mechanism: Innovate adjusting mechanism which controls movement of lenses.
- Precision Tolerances: Establish tolerances of optimized lens design and ensure frame supports movement within those tolerances.
- Frame Material Design: Choose materials of frame so that it is firm enough to support lenses yet remains cost efficient.
- Pediatric Consideration: Create a variation for pediatric patients. Adjust frame size and aesthetical components to increase pediatric appeal.
- Locking Mechanism: Create locking mechanism to stop lenses from moving once ideal prescription is achieved.

Lens Engineering Responsibilities

- Optical Zone Enlargement: Expand optical zone of lenses so a larger area of sight be seen by the patient.
- Peripheral Vision Clarity: Improve edges of lens so blurred vision isn't disorienting, increasing user comfort.
- Lens Material Design: Choose material to make lenses out of; hard plastics vs glass.
- Assembly Process: Establish manufacturing methods of lens with local labor of Guatemala: specify 3d printing, molding.
- Prescription Indexing: Provide engraving or some metric of measurement that can be used to see how far they adjusted the prescription so they can easily go back and set it to their prescription if someone else had to use it.

User Experience Responsibilities

- Manual Design: Create user manual in multi- languages, focusing on accessibility to countries below or near a Nominal GDP of $5000
- Diagnostic Methods: Include vision chart and testing metrics so they can self-prescribe their dipoles once achieved.

8. Product Ideation Timeline

Pivotal findings

1. Centre for Vision in the developing world: Researched what had been done and who has been working on similar efforts. Came across Centre for Vision in the Developing World where they share 4 different routes to provide access to vision throughout the world.
    a. Electrowetting: Electrowetting lenses use the surface tension of a conductive liquid to alter curvature and, therefore, optical power. By applying an electric field, the contact angle between the fluid and electrodes changes, causing the lens to shift between negative and positive power states. This approach offers a very large adjustable power range, often ±50–100 diopters, and extremely fast response times. However, electrowetting is difficult to scale to the larger sizes needed for eyeglasses, making it more suitable for small applications such as cameras and consumer electronics.
    b. The Alvarez lens: Alvarez lenses are made of two specially shaped optical surfaces that follow a cubic polynomial profile. Sliding these elements relative to each other changes the overall thickness profile, altering the refractive power. They can be produced relatively cheaply, shaped in almost any form, and require only a simple sliding mechanism for adjustment. Limitations include a narrower power adjustment range compared to fluid-filled systems and distortion outside the central viewing area. Alvarez lenses have not yet been clinically tested for prescription eyewear but have been used in other optical applications, such as Polaroid cameras.
    c. Fluid filled: Fluid-filled lenses adjust power by pumping liquid into or out of a reservoir between two flexible membranes. Increasing fluid volume bows the membranes outward for greater positive power, while removing fluid flattens them for reduced power. The mechanism is simple, inexpensive, and effective for a wide range of prescriptions, with proven results in clinical trials (such as the AdSpecs project). Current limitations include difficulty correcting astigmatism and the predominance of round lens shapes, though research is addressing these issues.

d. Electroactive: Electroactive lenses rely on liquid crystals that change refractive index when exposed to an electric field. In one design, a central liquid crystal element matches the surrounding material when inactive and adds fixed refraction when activated. A more advanced "graded index" version uses a varying electric field to create a smooth refractive index gradient across the surface, producing precision focusing. These lenses can change power almost instantaneously and could be made thin and large enough for eyewear without external fluid reservoirs. Current challenges include high manufacturing complexity and cost.

2. Optical Physicist and Prof. Leanne West

We then met with Professor Leanne West, who shared her opinions and takeaways from her time studying optical physics. She proposed the idea of changing the optical density of the glass by exerting a specific voltage through it, allowing for instantaneous results. This approach would also be beneficial in mitigating issues such as accidentally moving the glass and changing the prescription if it were dependent on modular components, such as sliding glass lenses back and forth like the Alvarez lens or even influencing syringes that stabilize prescriptions in the fluid-filled method. She had not personally developed an Alvarez lens but had worked on a team that aimed to achieve what the Alvarez lens does. Upon seeing simultaneous advancements in the field, they opted to wait rather than attempt to tackle a project already being actively developed. Reflecting on her time working with existing models, she expressed a need for an improved optical zone and tighter tolerances. She explained that the current market designs have such a limited line of sight, with only a small area in the center of the lens that can be clearly seen through; the edges of the glasses are often very blurry and disorienting. She also discussed the finicky nature of the design and emphasized that our main priority should be keeping the design within proper tolerances and controlling these tolerances effectively through whichever adjustable mechanism is chosen. She expressed her support and encouragement for the project, saying she saw extreme potential for success, especially with the tools of 3D printing and AI. She recommended using AI to manipulate the Alvarez equation in order to optimize some of the issues with blurred edges.

She also suggested rotating the lenses at a different pivot point instead of a lateral shift, possibly in a turnstile manner with a central pivot, as is often seen in virtual reality headset lenses. While this would pose its own challenges, it could mitigate blurred edges and allow for greater expansion of the optical zone. However, it would also require substantial modifications to the Alvarez lens design as a whole. Next, she discussed the possibilities of 3D printing glass or using molding techniques. She spoke positively about the resources Georgia Tech has across its various optical physics labs that can analyze prescriptions from the glass being created. This technology could be leveraged to test different variations and optimizations of the

Alvarez lens. She is willing to support the process and connect us with the lab if needed. She also recommended the Zemax Optic Studio software by Ansys. This software allows users to optimize and simulate optical designs. More can be found in the link below.

After digesting her feedback, we began researching the different ideas, approaches, and solutions she proposed. We ruled out altering the optical density of the glass by applying voltage. While novel in concept, this does not have the capacity to bend light in the way required for our refractive index needs. However, it does hold promise for applications such as shifting glasses to sunglasses, which have already been successfully executed by other distributors. We also ruled out electrowetting and electroactive solutions. Unfortunately, these are too expensive and technologically complex for the scope of our project. The solution must be affordable, accessible, and culturally adaptable. If people cannot easily understand how it works, it becomes harder for the technology to be adopted, further reinforcing our decision to follow the simplified routes of fluid-filled or Alvarez designs.

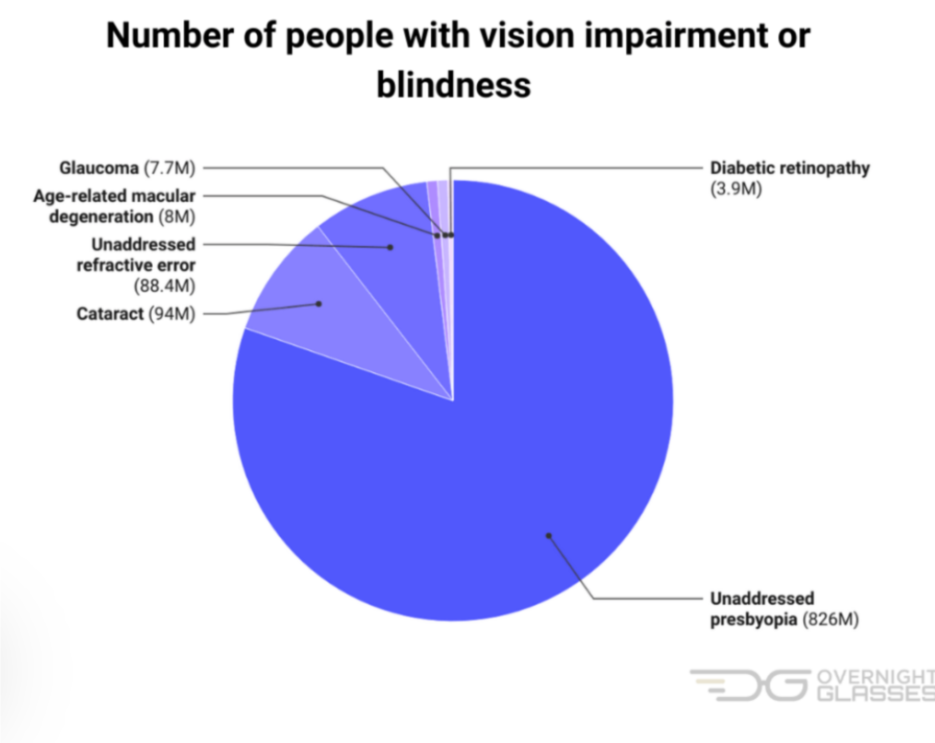
Zemax Link: https://www.ansys.com/products/optics/ansys-zemax-opticstudio?&utm_campaign=product&utm_medium=paid-search&utm_source=google&utm_content=digital_optics_copr15op_contact_contact-us_opticstudio-optics-brand-search_1a_en_global%7C145629538940%7C643132945089%7C&campaignid=7013g000000cXF7AAM&utm_term=zemax&gad_source=1&gad_campaignid=19408321809&gbraid=0AAAAAD8uywZrtBVsbj9rxIV6A1_eYtvtx&gclid=Cj0KCQjwjdTCBhCLARIsAEu8bpKTw2ah7s06LpbDuJKRodbCa5JkhgZPImzzusuCJtYsofmaTfH1XVUaApCcEALw_wcB

3. World Health Organization: Statistics about who and where

We spent time researching who would be wearing these glasses to get a better understanding of what would be necessary for successful integration as well as better understand any country's specific regulations required. We gathered data on different countries with low access to optometry care who also had a GDP per capita of around 5000.

Our research showed that the need is everywhere According to the World Health Organization (2023), at least 2.2 billion people worldwide live with near or distance vision impairment, and in at least 1 billion of these cases the impairment could have been prevented or remains unaddressed. The leading global causes are refractive error and cataracts. Refractive error is the greatest cause of low vision worldwide and the second largest cause of preventable blindness after cataracts. Yet access to effective treatment remains limited—only 36% of those with refractive error and just 17% of those with cataracts have received appropriate care.

Refractive error occurs when the eye fails to focus light correctly on the retina, causing blurred vision. Correction aims to manually refocus light to compensate for how the eye bends light, typically achieved through eyeglasses, contact lenses, or refractive surgery. However, a severe shortage of trained professionals leaves billions without access to care. The greatest barrier is the lack of trained optometrists: in many developing nations, there is as little as one optometrist per million people. In Sierra Leone, there is just one optometrist serving the entire country—approximately one for every six million people. By comparison, the figure in the UK is about one per 5,000 people, and in high-resource nations it averages around one per 8,000. This shortage is compounded by a lack of dedicated facilities and equipment, and for many living on less than one dollar per day, the cost of conventional eyewear is simply prohibitive (Centre for Vision in the Developing World).



Several innovators have attempted to address this crisis through adjustable eyewear that enables users to self-correct their vision without relying on immediate access to a professional. Notable developments include:

- Joshua Silver's AdSpecs (1990s): Fluid-filled, dial-adjustable lenses, patented early with Oxford distribution. Specifically designed for rural populations, the glasses use plastic tubing, aluminum rings, silicone fluid, polyester thin film, and polycarbonate covers. Users adjust the fluid to achieve the desired correction, after which the adjusters can be locked or removed. AdSpecs are not currently available for individual purchase; distribution is limited to research and clinical trial partners. Field studies have shown that 95% of subjects can adjust the glasses correctly, with a World Bank–funded study demonstrating that 90% of students aged 12–17 could self-adjust to correct nearsightedness with teacher assistance—nearly matching the outcomes of professional exams. The life cycle is estimated at 3–5 years.
- Martin Wright prototypes (1978+): Slider-based opto-mechanical designs, later continued under US 7,325,922 (2008). Never mass-produced.
- Stephen Kurtin's SuperFocus (2000s): Dial-actuated spherical lenses, covered by US 5,138,494 and US 5,668,620. Discontinued.
- Eyejusters (2011+): Sliding dual lens via dials, US 9,335,446 and US 10,302,967. Available online.
- Dial Vision generics (2017+): Mechanical dial lenses, generic designs with no unique patent. Widely available in the mass market.
- VOY Adjustable Eyewear (2024+): Nano-precision tunable lens technology, patent-pending. Available online.
- Smart autofocus research (2010+): Electric liquid or liquid crystal lenses, multiple early-stage patents, not yet available commercially.

While these solutions demonstrate diverse approaches, ranging from fluid-filled systems to precision mechanical adjustments, challenges remain. Issues of cost, durability, user understanding, and distribution continue to limit impact. The need for an affordable, robust, and easily understood adjustable lens design that can be produced and maintained in low-resource environments remains urgent.

4. ICAN conference pediatric feedback

Next, we had the opportunity to go to ICAN conference to gain pediatric feedback on our ideas. We presented about what DPI is and the different sub teams. We surveyed both qualitatively and quantitatively about Team Sight, Team MD, and Team Fuzzy. We also spent timetabling each day and were able to receive conversational feedback.

The overwhelming takeaways were 2 concerns. First being that they would be scared to wear the glasses because they wouldn't want to diagnose their own prescription and have it be a little off leading to damage to their eyesight due to an incorrect prescription. The next concern was for the aesthetic appeal. Many state that with the way that the glasses are currently marketed they would draw much attention to the user and could be distracting, especially in a pear heavy environment.

5. Optometrist Input

To gain clarity on the medical concerns of wearing glasses with an incorrect prescription, we spoke with an Optometrist at the Peachtree Corners Eye Clinic (Anon). He began by discussing the increasing prevalence of virtual appointments, particularly in regions with a shortage of optometrists. According to the Dr., all of the equipment used in standard eye exams can now be fully operated remotely, making tele-optometry a viable option for areas lacking local specialists. However, he noted that cost remains a significant barrier-not only the expense of hiring optometrists and technicians but also the challenge of introducing advanced equipment into low-resource environments. Even if the technology is donated, issues such as susceptibility to rust, lack of consistent power, and general unsuitability for harsh conditions can hinder its success.

When asked about the potential for injury from wearing an incorrect prescription, Dr. Eid emphasized that there is no risk of causing permanent vision loss or worsening a patient's eyesight. The primary effect would be discomfort, rather than long-term harm. This is an encouraging point when considering adjustable glasses, since it would be difficult to guarantee that every user perfectly adjusts their lenses to their exact prescription.

This discussion led the Dr. to outline the current options for specialized eyewear aimed at preventing refractive error progression in pediatric patients-if caught early enough, before the eye has fully developed. He described three main approaches:

1. Corrective Glasses - Available only in Europe and not yet FDA-approved in the United States, meaning any U.S.-based development would require a lengthy approval process before mainstream use.
2. Corrective Contact Lenses - Designed to reshape how light enters the eye.
3. Sleeping Eye Casts - Comparable to a dental retainer, but for the eyes. These are worn only at night and removed in the morning, functioning similarly to rigid contact lenses by gently reshaping the cornea. Since refractive error is often caused by an irregular eye shape that misdirects light onto the retina, these devices can temporarily correct the issue.

Finally, the Dr. shared his thoughts on adjustable glasses such as the Alvarez lens and fluid-filled lens designs. Conceptually, he finds the idea promising. However, he noted that many companies in this space are still in early development or crowdfunding phases, which complicates collaboration and research. Additionally, he mentioned that improving these technologies is challenging because companies tend to be protective of their designs due to ongoing patent work.

6. Centre for Vision in the Developing World Contact

We got in contact with Centre for Vision in the Developing World in hopes of gaining perspective on the challenges and difficulties they have faced in trying to distribute adjustable glasses to low resource countries. We asked about issues with quality of the glasses themselves and if the main challenges in practicality were tolerance based. To which they confirmed that it was less technical, but more based on the uproar from the optometry industry. His response is as follows.

“A little research will tell you that I am the Oxford University professor who invented a very simple low cost adaptive lens of good optical quality on 13 May 1985, and from there introduced the self-prescription procedure which our dozen or so peer-reviewed published clinical studies to date demonstrate works about as well as conventional prescription eyewear from an optometrist.

It is my belief that self-prescription with our adaptive lens eyeglasses will disrupt over time the $150 billion optical industry, because they will lead to a one to two orders of magnitude reduction in the price of corrective eyewear, and indeed after a long preparatory period, I have founded a new company , VISION , to do exactly that.

We have already manufactured relatively small batches of glasses which only cost a few dollars to make and perform well, and the main obstacle to scaling up to several billion pairs is not in fact in any way technical now, but arises from the industry incumbents, their fear of technology disruption, and their ongoing resulting efforts to protect the profitability of their companies .” We are currently working to set up a meeting to discuss his findings and perspectives.

7. Peter Rupprecht Ideas

Peter Rupprecht is a researcher at the Brain Research Institute Zurich and shared some intriguing takes on how the Alvarez lens could be manipulated. He shared his thoughts on the Alvarez lens and how its principles could extend far beyond their original application. He first came across the concept through a 2017 paper from Monika Ritsch-Marte’s lab in Innsbruck, Austria, where the researchers had adapted the Alvarez lens in an inventive way. Instead of relying on slower physical sliding, they used a rotating galvo mirror in a creative optical setup to replicate the focusing effect at higher speeds. While their implementation relied on visible light and diffractive rather than refractive lenses, and came with its own limitations, it demonstrated how flexible the Alvarez concept can be.

Peter also talked about how the Alvarez lens concept could be useful in optical scanning. He’s interested in how specially shaped lenses or mirrors could take a simple back-and-forth movement of light and turn it into more complex patterns like spirals or grid shape without adding complicated machinery. One idea he shared was using this kind of lens to fix the uneven, wave-like motion of certain scanners so that the movement becomes smooth and even over time. This would mean designing a lens whose focusing power changes depending on how far from the center the light passes through, something that's tricky to make but very interesting from a design perspective. He noted that challenges like limits on beam size, the precision needed to make the lens, and the fact that it would only work perfectly at one zoom setting make this hard to achieve in practice. Still, Peter sees the Alvarez lens as a flexible and inspiring piece of optical design, with potential for both practical uses and experimental research. Once we connected, he also mentioned that his own expertise in this area is limited and recommended we speak with Monika Ritsch-Marte's lab, which could provide more specialized insights.

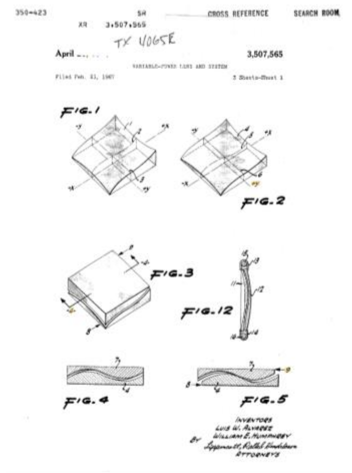
8. Luis Alvarez Patent

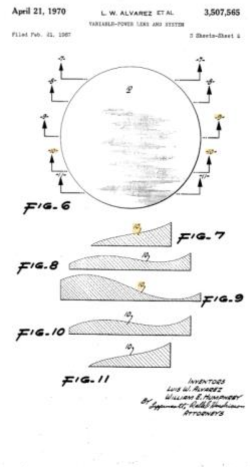
In this patent, Luis W. Alvarez introduces a clever way to create a variable-power spherical lens that changes focus with just a small sideways shift of its elements. The design uses two thin lenses with specially shaped surfaces, each defined by a cubic-and-quadratic thickness profile, that cancel each other's optical power when perfectly aligned. Slide one relative to the other, and a controlled focusing effect appears.

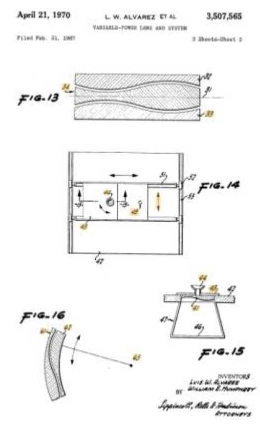
Earlier attempts at variable lenses, often based on conical or other unconventional shapes, suffered from distortion and impractical manufacturing requirements. Here, the precise mathematical form of the surfaces ensures that the optical path length varies exactly as needed, making the focusing change linear with displacement while keeping aberrations low.

The lens thickness equation includes constants that can be tuned to control focal range, minimize total thickness, and offset unwanted prism effects. When both elements shift in opposite directions, the lens smoothly transitions from a neutral, flat-plate state to a range of positive or negative powers. This makes the design suitable for everything from zoom optics to adjustable-focus spectacles.

Alvarez also describes integrating the pair into larger optical assemblies, where stationary elements handle fixed prescriptions, and the moving pair adds adjustable power. The result is a compact, mechanically simple system that offers significant optical versatility with minimal moving parts.







9. Frame Design Parameter research

The following research articles go in depth regarding proper framing dimensions and evaluations.

Thompson, A. J. (2021). Paediatric facial anthropometry applied to spectacle frame design (Doctoral dissertation, Aston University).

Kumaran, S. L., & Periakaruppan, S. P. (2022). Ophthalmic anthropometry versus spectacle frame measurements: is spectacle fit in children compromised?. Asian Journal of Pharmaceutical Research and Health Care, 14(1), 48-54.

Rosyidi, C. N., Riyanti, N., & Iftadi, I. (2016). Head and facial anthropometry for determining the critical glasses frame dimensions. Journal of Engineering Science and Technology, 11(11), 1620-1628.

10. Competition User Feed Back

In feedback from user review of Dial Vision glasses, the user stated that the glasses were really cool in concept but that he had some serious difficulty getting them to the same prescription. He said his prescription was approximately -2.00 diopters, and he would get one lens close but could not get the other, and vice versa. He said he thought that if there had been a click/set mechanism on the twist knob, it would have made them 100 times more user-friendly. For instance, every 0.25 diopters it could have clicked. He explained that when you wind a watch, you pull the crown out to change the time and push it back in to set it, this could also have worked.

He stated that the field of view was rough with the edges; it made his peripheral vision pretty bad. He mentioned he was not sure if there was a reason they made the lenses like that, but he thought it would have been better if the whole lens changed when altering it.

He noted he had no problem with the size or comfort of the plastic. He said he understood why they looked bulky on the top, but he thought various colors would have helped people feel more comfortable having them on. He added that glasses covered the most looked-at part of the body, so it was nice to have them look good.

1. Ecuador Clinic Feedback

Does your clinic provide any optometry services? If so, do you think self-adjustable glasses would be useful or of interest? Is there any lack of optometry services in the area?

- No optometry services offered, noted as a gap in care in the area.

Contact Log

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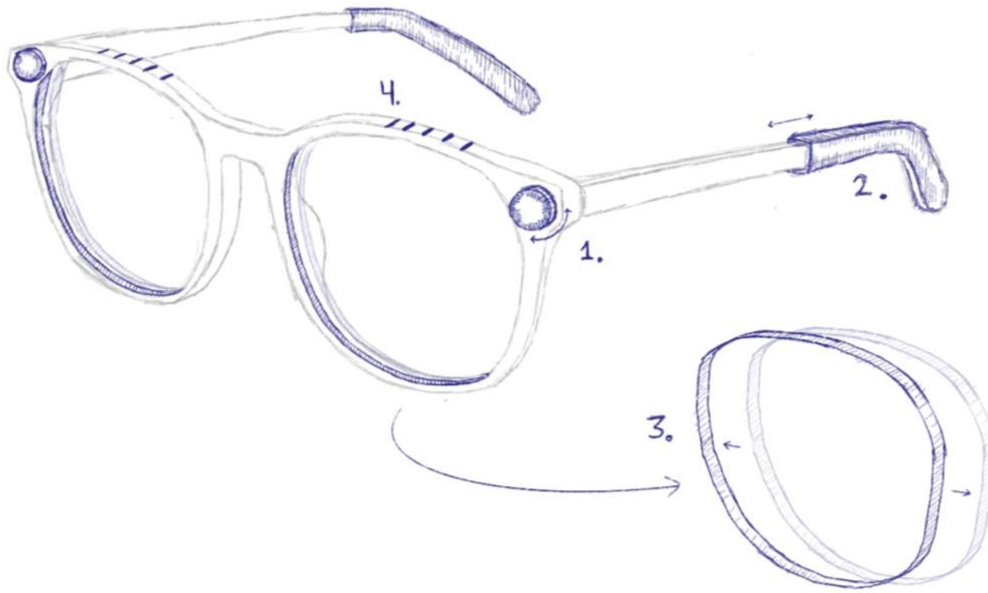
11.Our Vision

The goal of creating adjustable glasses has many different potential successful approaches. This section in aimed at sharing our vision if we were to go forward and manufacture the glasses, solely based on our research. As the capstone team, you have full autonomy over which creative choices to add and which solutions to implement. We offer this section as supplementary to add clarity.

The sketch below shows the former standard glasses that we would design the adjustable glasses aesthetically based off. The blue additions show how we would visualize some of the different mechanism required to make the glasses adjustable.



1. **Adjustment Dial:** Ideally there would be a discrete turning mechanism that would allow for the client to adjust the positioning of the underlying lenses. User feedback recommended taking inspiration from a watch dial; where it would be pulled out, then rotated to prescription, then pushed back in, locking it into place. The goal would be tight tolerances so that the patient can easily control and specialize their prescription.

2. **Adjustable Length:** Especially for the pediatric variation, an adjustable length component would allow for the glasses to fit larger range of patients, as they grow and develop through the years. Refer to ____ for further specifications on ideal adjustment ranges and lengths.

3. **Optimized Alvarez Technology:** Through our surveying, we found the Alvarez mechanism to be more favorable in the pediatric setting due to its more inconspicuous design. However, the Alvarez equation and technology would need to be optimized so that it is there is an enlarged optical zone and decreased blur around the edges.

4. **Diagnostic Index:** Simple notches on the frame could be used as a diagnostic index to notify the patients of which diopter their prescription falls closest to. This would

utilize the distance of overlapping lens, or the lack thereof. The specific positioning or mechanic of the diagnostic index would vary depending on the adjustable lens technology implemented.

Material Information

Cellulose Acetate, High scratch & impact resistance, $1–$4/frame blank, Common in mid-range brands; can be CNC-cut or injection-molded

Injection-Molded Polycarbonate, Moderate, flexible, light, $0.50–$2/frame, Cheaper, but more prone to surface scratching

Metal (Stainless Steel), High tensile strength, corrosion resistant, $2–$6/frame, Lightweight but costlier than molded plastics

Aluminum Alloy, Medium durability, $3–$7/frame, Lightweight, can deform under stress

Titanium, Very high durability, hypoallergenic, $7–$15/frame, Premium material; longer lifespan but higher upfront cos

CR-39 Plastic, Good optical quality, lower impact resistance, $0.80–$2/pair, Cheapest option; scratches without coating

Polycarbonate, High impact resistance, lighter, $2–$4/pair, slightly lower optical clarity than CR-39, needs AR coating

Trivex, High clarity + impact resistance, $3–$6/pair, better optics than polycarbonate, slightly higher cost

Glass, Excellent clarity, scratch resistance, $3–$5/pair, Heavy, breakage risk in impact situations

Coating, Durability Impact, Typical Add-On Cost, Recommendation

Hard-Coat Scratch Resistance, Extends lens life by 2–3×, $0.25–$0.50, Essential for plastic lenses

Anti-Reflective (AR), Improves clarity, reduces eyestrain, $0.50–$1.50, Not required for ultra-low cost, but strong value add

UV Protection, Prevents eye damage, $0.05–$0.20, Always add; low cost

Hydrophobic/Oleophobic, Resists smudges, easier cleaning, $0.20–$0.60, Optional for budget lines

Sources

Section 1:

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GDP Map: https://vividmaps.com/gdp-per-capita-worldwide-mapped/

Namibia: https://www.seeintl.org/countries-served/namibia/

https://www.statista.com/outlook/hmo/otc-pharmaceuticals/eye-care/namibia

Sri Lanka: https://www.iapb.org/news/sri-lanka-releases-latest-blindness-survey-data/

Global Optometry Statistics: https://pmc.ncbi.nlm.nih.gov/articles/PMC11363951/

Guatemala: https://pubmed.ncbi.nlm.nih.gov/30726408/

https://www.seva.org/pdf/Seva_Country_Fact_Sheets_Guatemala.pdf

https://www.nei.nih.gov/sites/default/files/2019-04/NEI_Eye_Disease_Statistics_Factsheet_2014_V10.pdf (US)

WHO eye-impairment information: https://iris.who.int/bitstream/handle/10665/328721/WHO-NMH-NVI-19.12-eng.pdf

Section 3:

Prescription Stats: https://www.eyecaresuperior.com/understanding-highest-eye-prescription-for-glasses

Nearsightedness Stats: https://www.who.int/news-room/questions-and-answers/item/blindness-and-vision-impairment-refractive-errors#:~:text=Uncorrected%20refractive%20error%20is%20the,modifiable%20lifestyle%20related%20risk%20factors.

Farsightedness: https://www.contactlensesplus.com/education/hyperopia-stats?srsltid=AfmBOopKXgpZK5IB2mx6_1g7f5w60zWWGfumtyhx6l8wJYNXwPCp3f05

Section 4:

TAM: Blindness and vision impairment

Eyewear Market Size, Share & Trends | Industry Report, 2030

Graphic: https://www.thelancet.com/journals/langlo/article/PIIS2214-109X%2820%2930488-5/fulltext

Vision Impairment graphic: https://www.overnightglasses.com/eyewear-industry-statistics/?srsltid=AfmBOop_GlWNJqYTNAMnB1BETqS8sq_YWjy96VMp3W7W7BlZuw4yIgtU

Purchase Links:

Eyejusters: Eyejusters - Oxford Edition Adjustable Glasses

Dial Vision: Dial Vision Flex Eyewear: Adjustable Focus Glasses for Reading & Distance Vision, All Ages - Walmart.com

Flex Focus (Scam likely): Flex Focus

VOY: voyglasses.com/pages/adjustable-vr-prescription-lenses?gad_campaignid=21925064542&gad_source=1&gbraid=0AAAAA-hL3PwbFWxKcJbG4oFEZ1G665LKL&gclid=CjwKCAjwx8nCBhAwEiwA_z__076qXg3qrek_gFPjD9UXMihmhOhwrj5O0cFWR-AnFDqBDFjg5ohZHhoCq00QAvD_BwE

Adspec Info: https://www.engineeringforchange.org/solutions/product/adspecs/

Low-Tech Eyeglasses with User-Adjustable Water Lenses - Core77

Section 5:

ISO 14889: ISO 14889:2025(en), Ophthalmic optics — Spectacle lenses — Fundamental requirements for uncut finished lenses

ANSI Z80.1: ANSI Z80.1-2020 - Ophthalmics - Prescription Ophthalmic Lenses - Recommendations

Section 8:

https://jestec.taylors.edu.my/Vol%2011%20issue%2011%20November%202016/11_11_9.pdf

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