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Touch, Feel and Read it!

Innovations in Tactile Type for the Visually Impaired

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Abstract:

Touch, Feel and Read it! - is a study to document, understand and analyze the latest trends, experiments and innovative ways of developing tactile typefaces which cater specifically to the visually impaired people and how this could change the use of Braille in near future. Primarily, the focus is to look at how tactile typefaces/typography can enable a conducive environment for language learning — for both sighted and visually impaired and/or non-sighted people. Further, the aim is to design an innovative tactile typeface for the visually impaired which will help them to transition smoothly into learning/adapting to the new letter system, along with exploring the current innovative production/printing techniques.

Key words: Tactile Typography, 3D Printing, Laser engraving, Kobigraphs, Braille, Visually Impaired, ELIA FRAMES™, Typeface design, Devnagri.

1. Introduction

With a population of 1.28 billion, India has around 12 million people who are visually impaired due to various biological or physiological circumstances. Precisely, 29.7% of this population is under 15 years of age and 64.9% lies between 15 years to 64 years of age. As we are aware that Braille is the only language learning system for the visually challenged or blind persons but there isn't any specific reading or language learning system for the visually impaired (partial vision). With the technological advancement, 3D printing and continuous development in type design and typography, I began exploring the different innovative ways and research that is currently happening in the field

of language comprehension and typography.

2. Goal

Designing an innovative tactile typeface for the visually impaired which will help them to transition smoothly into learning/adapting to the new letter system; along with exploring the current innovations in production/printing techniques. This system would be understood by both sighted and visually impaired in real-time for a complete and effective communication in every way. The focus primarily is to design for *Devnagri* readers/ learners. Further, enabling them to carry out their work and life productively, and independently. An aim to use various printing techniques like laser printing or 3D printing or embossing in order to effectively produce this letter system and resolve the problem in day-to-day life of a visually impaired person. This will facilitate seamless language learning and communication for people of different ages despite of visual impairment.

3. Need

After researching about the various learning tools and letter systems available for the visually challenged persons, I discovered that there isn't any specific letter system designed or available for the visually impaired (partial sightedness) which will help them in transitioning from what they have learnt previously to what limitations they have now, and to adapt to a new system which will help them function the same way as they did before having visual impairment. One of the roman typefaces 'Aphont' is designed to help with reading clearly but it's used for large print formats and when visually impaired persons use magnifiers to read something.

A few experiments which are being done by a few individuals are Kobigraphs, Learning Braille Type and ELIA FRAMES™.

Kobigraphs and *Learning Braille Type* are systems primarily based on the current Braille dots/cells and aid a sighted person to learn Braille which could facilitate effective communication between a non-sighted (complete blindness) and sighted person.

ELIA FRAMES™ is an innovative tactile type system developed for the visually challenged/impaired such that both the sighted and non-sighted can understand each other, communicate and participate. This is not based on the Braille cells unlike the previous two and has been inspired by, and devised for the roman letters only.

4. The Real Issue to Resolve

4.1 Understanding and Defining Visual impairment

"Visual impairment is defined as the limitation of actions and functions of the visual/vision system. The National Eye Institute defines low vision as a visual impairment not correctable by standard glasses, contact lenses, medication or surgery that interferes with the ability to perform activities of daily living." (Ref.)

"The definition of vision impairment by the Centers for Disease Control and Prevention (CDC) says a visually impaired person's eyesight cannot be corrected to a "normal level". It may be said that visual impairment is the functional limitation of the eye or eyes or the vision system." (Ref.)

The impairment places an individual as a handicap that's a person's disadvantaged position in the society due to this disability. Visual impairment could be:

- **Loss of visual acuity** and inability to see objects clearly as a healthy person.
- **Inability to see as wide** an as a normal person without moving the eyes or turning the head.
- **Photophobia** – inability to look at light.
- **Diplopia** – double vision.
- **Visual distortion** or distortion of images.
- **Visual perceptual** difficulties or difficulties of perception.
- Or **any combination** of the above features.

4.2 Causes of Visual Impairment

Visual impairment could be due to various reasons/situations viz. eye damage, failure of the brain to receive and read the visual cues sent by the eyes, diabetic retinopathy, age-related macular degeneration, formation of cataracts and raised pressure within the eyes leading to glaucoma. **Infections** is another major cause of impairment viz. herpes simplex keratitis, trachoma (6 to 9 million cases of blindness), leprosy, river blindness (28 million – 40% become blind). **Vitamin A deficiency** is a common reason of corneal degeneration in developing nations, 5 million become visually impaired and 5% end up blind. It can occur at any point in life and could be **inherited** (retinitis pigmentosa-night blindness). In such cases, the individual may experience it at birth or in childhood. Due to partial impairment early in life, children are developmentally delayed in gross and fine motor skills, and as

adults they struggle to find employment and carry out day-to-day activities (1 in 5). In most cases the situation is irreversible depending on the severity and timely treatments.

'Visual impairment affects some 285 million people worldwide, about 39 million of whom are considered blind, according to a 2010 estimate from the World Health Organization.'

4.3 How does it affect physically and emotionally?

If a person experiences visual impairment at any point in their life, they struggle to accept and adapt to a new way of doing their daily activities. Since, they have been used to doing things a certain way and being independent, visual impairment is a big hurdle in their life. They have learnt a language by reading, writing, speaking and understanding a certain alphabet system, and after visual impairment for them to adapt to using newer assistive methods takes great effort and time. The limitations in reading, writing and seeing affects their state of mind and overcoming the fact that they would be unable to do things they previously did with ease, is difficult for them; and now they would be dependent on people around them and other assistive methods. It affects one's self-confidence as there is negative attitude toward vision loss and thus to braille, which makes it even harder to accept to learn it eventually.

It is also a very challenging situation for the family members, care givers and people who are in constant interaction with them, to adjust and communicate differently as they would have never been in such a situation in their lives too.

4.4 Learning tools/aids available for the visually impaired

Timely medical treatments and preventive methods can help from worsening the situation at the physical level depending on the severity and cause of the impairment.

Primarily, the available technological aids could be classified as **General technology** and **Assistive technology**. **General technology** includes GPS devices, computers and smartphones. **Assistive technology** consists of screen readers, hand magnifiers, stand magnifiers, telescopes, prisms, braille watches, braille printers, speech synthesizers, CCTV for large magnification etc. are a variety of learning aids and tools that are available to help the visually-impaired carry out day-to-day activities. Also, **non-optical aids** include large print books and magazines for reading. Certain therapies, training and support empower them to live life independently.

From an educational perspective, the only way to learn to read and write for a visually impaired person is by learning Braille and use of technological aids as mentioned above to

carry out daily tasks. So, there isn't any specific language learning system/way designed for a visually impaired person. Aphont is a roman typeface designed for visually impaired people who would use large print books and magazines, and magnifiers for reading purpose.

5. Blindness/Non-sightedness

5.1 Understanding and defining Blindness/Non-sightedness

"Blindness is a lack of vision. It may also refer to a loss of vision that cannot be corrected with glasses or contact lenses. Complete blindness means you cannot see anything and do not see light." (Ref.)

"In blindness or total vision loss there may be total darkness of the visual fields." (Ref.)

5.2 Learning tools/aids available for the blind/non-sighted persons

Braille is the oldest and the only language learning print system available for the non-sighted persons apart from the technological aids like speech synthesizers, computers, smartphones etc. These technological aids/gadgets help in carrying out day-to-day activities but very few have the privilege of owning these gadgets/aids. Also, each gadget needs to be learnt to operate and requires time, skill, efforts, money to own and maintain them, and most importantly a trainer to help in teaching its operations. They help in enhancing the person's skills and abilities but not resolve the issue of language learning.

5.3 Understanding Braille: How and why it works/doesn't?

Braille is the only language learning system available for anyone with visual impairment or/and complete blindness. It requires a very high tactile sense or finger sensitivity to grasp the alphabets and takes a couple of years to master it. Braille is based upon a cell of 6 dots with the respective letters formed by one or more dots in one cell. People who are born blind or become blind in their childhood are able to learn braille over a period of time and eventually with their physiological and physical development through childhood, it is easier to use their tactile sense and memorize the complex system of dots with consistent practice. As young children, they are still in the process of learning and grasping new things and languages, hence it is easier for them to explore and develop the tactile sense required to learn Braille. They have more time to become proficient with it and their brain is able to compensate for this lack of visual stimulation by adapting and reorganizing the way information is received. Also, as children they learn his complex

system step by step over a period of time which makes learning Braille less overwhelming and less challenging.

Types of Braille: There are several types of braille depending on the use and complexity of the information to be read - Alphabetic Braille, Literary Braille (Type One braille, Type two Braille, Type Three Braille), Nemeth Braille, and Music Braille.

Learning Braille as a visually impaired adolescent, young adult or mature adult:
It requires a lot of effort and decision to adapt to a new way of learning to read, write and communicate. Having being used to learning the roman alphabets or alphabets of a particular language and then changing to learning Braille which is a completely different system of learning the language based on combinations of dots; takes courage, decision, ability to memorize, finger sensitivity and lot of efforts over a couple of years. This transition is a difficult time and frustrating due to the sudden limitations an individual experiences as a result of visual impairment. With the available aids, people tend to depend on them because of their convenience and continue to struggle with reading and writing print. The use of aids doesn't truly solve the physical problem but just increases dependencies on several gadgets which may or may not be accessible all the time to everyone.

Also, after a certain age i.e. age 12, language and code patterns are established in the brain and one has developed their motor skills, senses, and learnt to read and write efficiently. After age 12, the brain is closed for easily learning new language codes and it is a difficult task to learn a new language code. Vision impairment affects the other parts of the brain as well as visual parts as a result of which other senses such as hearing and touch could be affected. Moreover, learning a new language system now that is engaging only the touch sense is harder than learning something which engages two or more senses.

5.4 There are several factors which affect the learning speed of Braille:

Age: – as with most things, Braille is easier to learn when one is young because the brain is still establishing patterns to develop different skills and codes, and the finger touch is more sensitive.

Finger Sensitivity: - some people are more touch sensitive than others depending on the kind of physical labor/work they do. If one is into hard labor then learning Braille might be difficult due to the finger sensitivity required.

Memorization Skills: - It requires a very high degree of memorization so depending on the person's memorization skill, learning it can take longer or vice-versa. Since, it wasn't how

they originally learnt a language, it will take a lot of effort and time before the language in the memory can be activated by the finger's tactile input.

Motivation and Alternative Reading Methods: - Depending on the urgency and necessity to continue to read and write, one might learn faster.

Spatial vs. Auditory Processors: - Braille being a spatial code, it might feel difficult to grasp if one is an auditory learner unlike a spatial or visual learner who would find it easier to grasp.

Visual vs. Tactile Mode: - As a sighted person, everything that one has learnt is through vision and relied less on the other senses, and to make a shift from visual to tactile mode and gross perception to a fine one, involves a lot of reorganization of thought processes. Therefore, the touch sense or nerve endings in the fingers have not been stimulated enough and pathways of language learning by touch have not been well developed as compared to a person who knows Braille. One has to learn to read letter by letter as opposed to visually perceiving letters and memorizing them by going back and forth. The knowledge of signs and symbols has been well-ingrained in our brains. Hence, it requires a lot of skill, practice and patience to remove these print symbols, unlearn and learn new things a certain way.

6. Role of the Family Members, Care Givers and Peers of the Visually Impaired

With the diagnosis of visual impairment, the situation is challenging for the person as well as their family members, peers and care givers. As we have seen earlier that it takes a lot of courage, decision and determination to accept to learn braille and eventually master it over a couple of years – one can only imagine how challenging it would be for the closed ones to deal and communicate with the visually impaired family member.

Family members help in providing the emotional support, various aids and treatments required to deal with visual impairment and help in restoring self-confidence. But, the problem is communicating the written word, visual signs and symbols which is challenging and tedious. In most cases family members do not learn braille and even if they decide to understand braille they learn by looking at it and not by touch. Usually, parents of younger children who are non-sighted or partially sighted may learn it along with the child to facilitate learning and it happens over a period of years and is done step by step.

7. Experiments and projects done by individuals with Braille and tactile typefaces

7.1 Kobigraphs:

What is it and how it works?

Susan Jolly is the curator of dotlessbraille.org, which is a website dedicated to 'demystifying braille'. Kobigraphs were originally designed in the 1970's by her father with an aim to increase awareness and literacy about Braille. He developed it so that the sighted people could read and write braille in inkprint i.e. by hand than dots. This would give sighted and Braille readers (non-sighted) to understand and share the same language.

Kobigraphs use Braille cells as a foundation to simply write the letter without lifting the pen of the paper which results in a form that is easily understandable and readable by the sighted and Braille readers (non-sighted); yet retaining the original embossed dots. The aim is to enable each one to understand and adapt to braille easily.

Greg Bland, a young graphic designer in 2014 studied Kobigraphs and experimented with the forms. Furthermore, he designed a Kobi-Serif typeface that is inspired from Kobigraphs but the links of the Kobigraphs are embossed along with the braille dots. His aim was to refine and evolve the Kobigraphs and make it more tactile for visually impaired as well as non-sighted to learn braille with ease. At the same time the sighted would understand braille by looking at it in print. The embossed links in the Kobi-Serif aim to engage the tactile sense more, and at the same time retaining the braille dots in the letters; which is beneficial and makes it more tangible for visually impaired adults and children to adapt to learning braille.

Factors that don't work:

As the Kobigraphs and Kobi-serifs are based on the Braille, the visually impaired would still have to learn Braille. This system makes understanding Braille easier for the sighted people than for the visually impaired who still need to learn a new letter system and hence, they would have to learn Braille.

As we have seen, that there are several types of braille which get complex or have contractions depending on its use. Thus, Kobigraphs would further get complex too. Kobigraphs and Kobi-serifs work well to understand braille but contribute less in resolving the issue of helping the visually impaired learn the letter system.

Figure.1 Kobigraphs

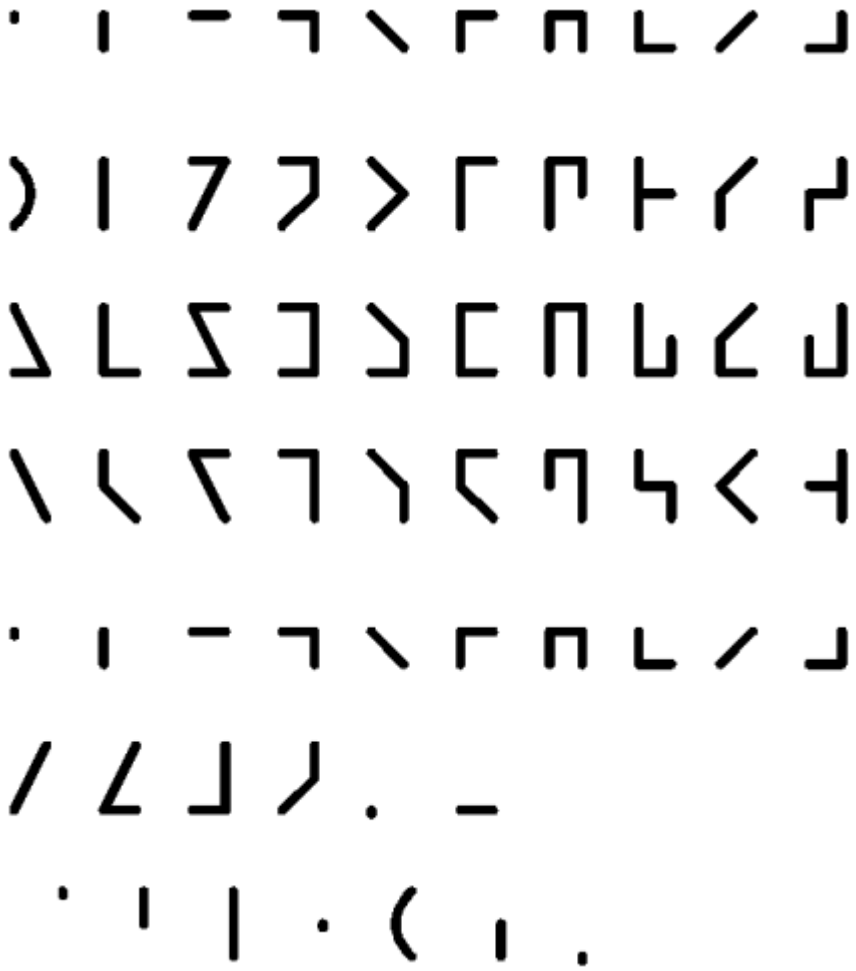

Figure.2 Entire set of Kobigraph letters

Figure.3 Kobi-serifs

7.2 Learning Braille Type:

What is it and how it works?

Developed by Simone Fahrenhorst, the aim here is to understand and read Braille by combining the roman letters and braille cells such that a sighted person can read braille by deduction – as they are designed on the same grid as the braille cells. The focus here is for the sighted person to understand Braille, thus facilitating the interaction between sighted and non-sighted persons.

Factors that don't work:

Again, as the different types of Braille get complex or have contractions i.e. type two, type three, literary braille etc. writing and understanding through deduction could not always be possible. Eg. Shorter syllabus and words like 'can' or 'of' use one cell.

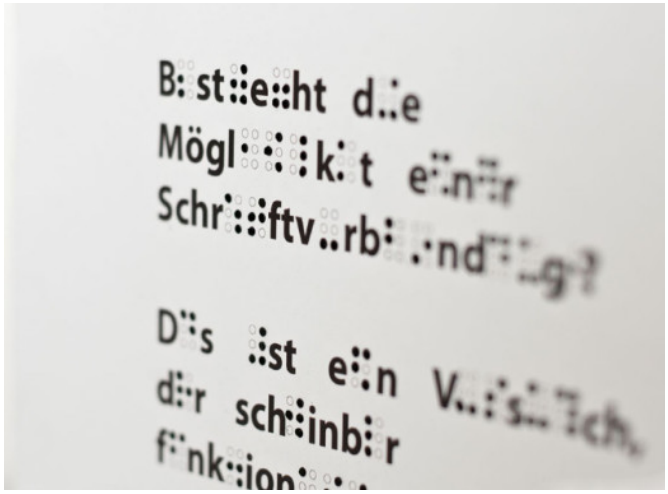

Figure.4 Learning Braille by deduction

Figure.5 Learning Braille by deduction

7.3 ELIA FRAMES™:

What is it and how it works?

The most innovative and fresh tactile type ELIA FRAMES™ is designed based on roman letters but uses a peculiar design system of frames which consist basic shapes of circle, square, and a house. Since, it is based on the roman letters it is easy to grasp, memorize and learn this letter system in 2-3 hours and the type is a relief. The sighted learn it faster because of their vision and it is designed to help the visually impaired and non-sighted to adapt to a letter system which is based on roman letters. The frames help in understanding the beginning and end of a single letter due to its frame structure. So, people who already know the roman alphabets and have visual impairment later life will be able to learn and adapt to ELIA FRAMES™ if they do not wish to learn braille.

Factors that don't work:

To me, it is a fascinating tactile type but considering the frame structure, each letter must be read at a certain minimum size and needs more space as compared to the previous tactile types. Though it is scalable to larger sizes it will need more space to accommodate fewer words/letters. Currently, there aren't any contractions but eventually when they are developed they could get very complex considering the current frame structure which is the basis of it. It is quicker to learn/understand visually than by touching the frames when they are in set of words and sentences, given their unique design. Also, this tactile type can be read and typed but cannot be handwritten.

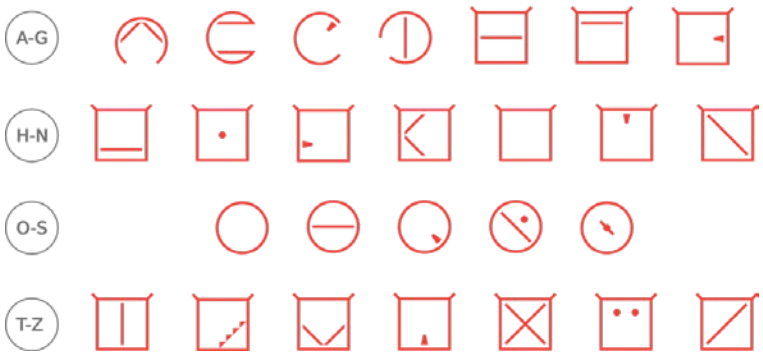

Figure.6 ELIA FRAMES™ design

Figure.7 ELIA FRAMES™ entire alphabet set

Figure.8 Reading ELIA FRAMES™

7.4 Aphont:

What is it and how it works/doesn't?

Aphont is the only roman typeface available and designed for people who would use large print books and magazines, and magnifiers for reading. It is a sans-serif, monolinear, semi-bold typeface with a wide width, and its cap height and x-height are distinct and

balanced. The lower case ‘q’ and ‘p’ are distinct with the descender of the ‘q’ having a peculiar curve/tail. The upper case ‘Q’ has an angular tail which tilts away from the baseline.

This typeface works well for people who have low vision and need large prints to read. But, in severe and irreversible visual impairment cases which is common, Aphont would be of less use.

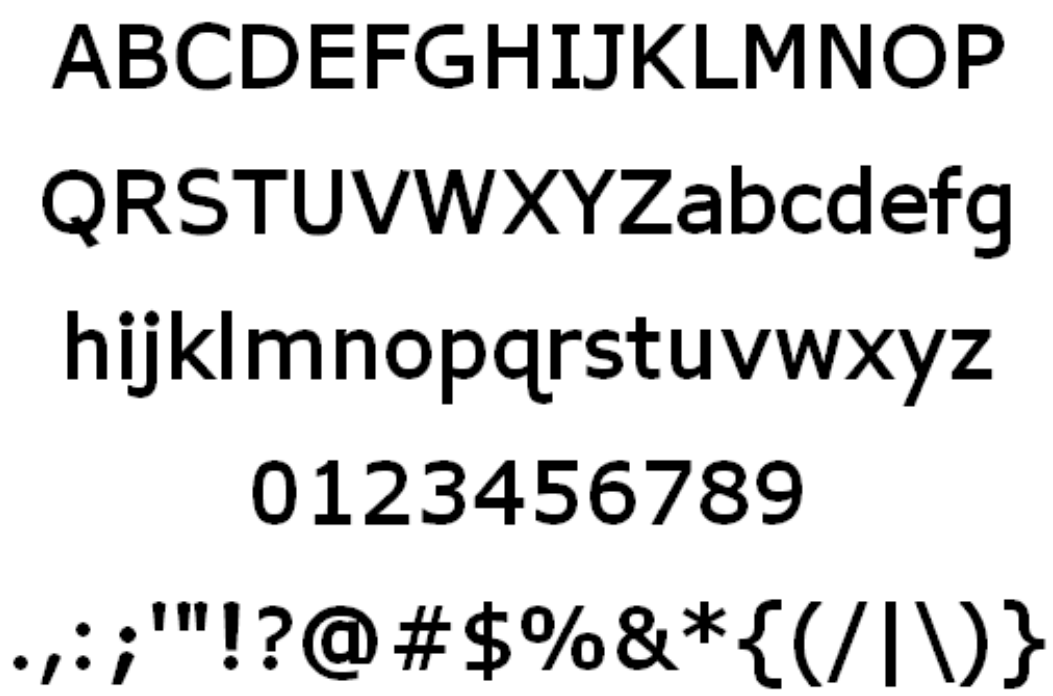

Figure.9 Aphont Typeface

8. Why Technological Aids and Tools are not enough?

As we have seen, various technological tools – General and Assistive aids are available to assist with certain activities but the focus is not literacy. They don’t necessarily give them the freedom to read and understand what they want, and whenever they want. Audio aids involve only the hearing sense and cannot be used in every interaction and they cannot be used to become literate i.e. read and write. It facilitates one way communication and without a response or a feedback the communication is incomplete. This leads to neglecting the other person in interaction as they are not able to participate or get involved in that interaction. Everyone doesn’t have access to technological aids and even if they do, one cannot physically carry them along each time. They are an added expense and not everyone can afford several devices just to accomplish several tasks.

Furthermore, one needs to be trained by a trainer to use these specific aids and there are several aids/tools for different tasks. These tools/aids create dependency on them and in their absence the non-sighted or visually impaired person may not have a back-up to complete the tasks at hand.

Even though these aids are available, they can help in assisting but cannot replace print because we use printed material all the time and in almost every scenario. It is easy to transition to learn from being sighted to partially-sighted with the help of printed material because of its tangibility, accessibility, ease of carrying it and the independence it gives a person to use whenever needed.

9. The Characteristics of the New Tactile System: Concept and Aim.

As we have seen that ideally the focus would be to develop a system that is more helpful for the visually impaired person to transition into learning a new letter system; it could be an extension of what they already know, and what they have left with them now.

Also, we have seen that most of the tactile typefaces are based on braille cells and encourage the sighted people to understand braille and create sensitivity toward Braille, with an aim to facilitate interaction with non-sighted person. Hence, the focus was more on how it looks visually for the sighted person. But there isn't a specific language learning system for the visually impaired who have already learnt a language and need to switch to another way of reading, writing and understanding the language.

9.1 After researching and analyzing several works, I think the new tactile system/typeface must have the following characteristics:

- An extension of what the visually impaired have already learnt and what skills they have now, which will help them in using their other senses and skills effectively.
- The type/way of tactile input will be an important factor to learn because the only way to experience a tangible substance is by touching it, as it stimulates a close interaction with it and further enables to understand it.
- Aim is to develop a tactile letter system for the *Devnagri* readers/learners.
- The typeface doesn't necessarily need to have uppercase and/or lowercase alphabets (in case of roman letters) as the focus is functionality and not how appealing it needs to look visually. Also, it is necessary to keep the letter system simple and straightforward with the required alphabets with minimal or no embellishments.

- If the tactile type could be combined with another kinesthetic learning activity for better, faster grasping, and memorization while the visually impaired are learning it; it will make the learning process more interesting.
- Focus on using the existing visual memory of the previously learnt letters and language, further reinforcing the tactile input/understanding of those letters, such that it becomes an extension about what they already know and what they have now.
- Apart from the design of the letters/glyphs, the focus would be a more pronounced tactile input through the material and printing method.
- Simplifying and deconstructing the letters yet maintaining their innate characteristics.
- Testing the letter system with the sighted persons by blindfolding them.
- It doesn't need to be based on the braille cells as the focus is not to learn or understand braille because they haven't learnt it previously. Here, the aim is to help them to continue to read and write the way they did.
- Exploring different production/printing techniques in order to produce a prominent tactile system because visually impaired people do not necessarily possess high tactile acuity.
- A tactile input by letters that are engraved or relieved which would work well for limited finger sensitivity.
- It should be independent of technological devices though technology will be used to produce them.
- It must be a printed matter as that is the primary, most accessible, basic and easiest mode to literacy.
- Each word needs to have a distinct start and end tactile glyph for better comprehension of words and sentences.
- Designing mono-linear letters to maintain the consistency of the strokes in order to develop and reinforce the tactile acuity, which will help in identification and memorization.
- Fixing a minimum size to set the letters at which they can be comfortably read by touching.
- Maintaining consistent space between two letters for clearer touch understanding and grasping of the letters.
- The sighted persons too would be able to comfortably visually read and understand the letters.

After researching and as we see now, there aren't any developments or experiments done in the Indian languages/scripts for the visually impaired. Hence, my aim is to extrapolate

and design for the *Devnagri* readers and learners who are visually impaired and need to seamlessly transition into adapting the tactile way of comprehending language. *Devnagri* being a widely and prominently used script as compared to other region specific scripts and languages, there is a higher need to develop a system for *Devnagri* readers/learners. Considering the number people who have learnt and have been educated in Hindi and Marathi, the need to devise a system for *Devnagri* readers/learners is high. This could further be extended to various other languages and scripts too depending on the flexibility and adaptability of each language/script.

Using all the characteristics mentioned above, the image below shows how the tactile letter system is being devised by simplifying and deconstructing the *Devnagri* letters, and by addition of inventive glyphs to facilitate the language comprehension. The tactile input is reinforced by producing the printed material through laser engraving because it adds depth to the letters. Thus, the finger would snugly fit in the groves of the strokes of the letters and aid in intuitively leading to touching the letter from beginning to end with least distraction. The slightly pronounced edges of the letters due to engraving help in prominent tactility that is necessary for those with lower finger sensitivity. The letters are designed such that they are a continuous stroke without any breaks or pauses. Each stroke is mono-linear and has a thickness of 3 mm and each letter is set at a minimum width of 12 mm. A comfortable touch sensitive area ranges from 9 mm to 12 mm for touch devices or surfaces hence, 12 mm would be comfortable for an engraved letter. Considering the tip of the finger an ideal size would vary between 4 mm to 7 mm, hence the width of the mono-linear strokes of the letters is 3 mm and since, the stroke is engraved it further enables high tactility to feel and read the letter.

10. Conclusion

As I experiment and devise the letter system further, production and testing are the two important factors that will lead to refining and making this a successful tactile language learning system. Furthermore, I aim to explore the writing aspect of this system with the help of subtle physical writing aids and newer production/printing techniques. With the aim of empowering and bridging the communication gap between a visually impaired and a sighted person, it will be interesting to witness how the visually impaired people will be benefitting from it, and live an independent and productive life by making use of the opportunities that come their way.

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