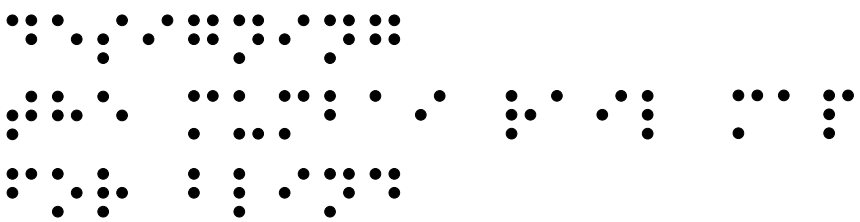

# DESIGNING
# THE MUMBAI RAIL MAP
# FOR BLIND

# DESIGNING THE MUMBAI RAIL MAP FOR BLIND

VISUAL COMMUNICATION | PROJECT 2

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Guide

IDC, IIT BOMBAY
November 2015

# *Acknowledgement*

I would like to express my heartfelt gratitude to those who have been a part of this project

Prof. Mandar Rane, my guide, for his mentorship and valuable feedback at every stage of the project;

Prof. Sudesh Balan, Prof. G V Sreekumar, Prof. Raja Mohanty and Prof. Alka Hingorani for their inputs & suggestions during the group feedback sessions;

Prof. Athavankar for his valuable feedback and kind words;

Prof. Sam Taraporevala for his timely advice and insights into understanding the world of blind people better;

Everyone at XRCVC for having me there and helping me with the project.

A heartfelt note of thanks to all my friends at IDC for contributing to the project in every small way possible. My parents, sisters and brother-in-law for their support throughout and for just being there.

# *Content*

# *Introduction*

People with disability access the world by using alternate senses to get the same information as people without disability. In the absence of accessibility people with disability get left out from the access to independent use of majority of products and services. India hasn't addressed the issues of accessibility in most fields as much as other countries have. In a country with one of the largest railway networks in the world, it is important to make the overall experience of using this system as inclusive as possible. This project aims to address one such issue of providing information about the Mumbai Rail Network using a map to the blind. This is a step towards making the overall experience of travelling on the network better for blind people eventually trying to make them independent and confident.

## *What is a map?*

A map is a visual representation of an entire area or a part of an area, typically represented on a flat surface. The work of a map is to illustrate specific and detailed features of a particular area, most frequently used to illustrate geography.[1]

## *What is blindness?*

Blindness is a physical handicap where there is a loss of vision. It is generally classified in two ways:

1. On the basis of degree of blindness:
    i. Partial Blindness
    ii. Complete blindness
2. On basis of onset of blindness:
    i. Congenital Blindness
    ii. Blindness after 5 to 7 years of age

It is believed that if a person is blind, they are born with more control over their other senses. Blind and low vision persons only with practise have a better sense of touch or smell.

## *Overview of blind population in India*

There are 3 crore 90 lakh blind people in the world out of which 50 lakh stay in India which is almost 13% of the total blind population. This makes India home to the largest blind population in the world. Out of those 50 lakh around 1 Lakh blind people stay in Mumbai.[2]

# *Overview of Mumbai's Rail Network*

Mumbai has 3 types of train systems:

**Mumbai Suburban Railway or The Local Train**
Mumbai suburban rail is one of the busiest rapid transit systems in the world operating more than 2000 train services and carrying more than 7m passengers everyday. This system has four routes:
1. Western Route runs between Churchgate and Dahanu road station with a total of 36 stations.
2. Central Route runs between Chatrapati Shivaji Terminus and Kasara/ Khopoli stations with a total of 62 stations.
3. Harbour Route runs between Chatrapati Shivaji Terminus and Panvel/ Andheri stations with a total of 38 stations.
4. Trans-Harbour Route runs between Thane and Vashi/Panvel stations with a total of 10 stations.

**Mumbai Metro**
Currently only one phase is up and running. It operates between Ghatkopar and Versova stations with a total of 12 stations.

**Monorail**
Like Mumbai metro, mono rail also currently has one phase up and running. It operates between Chembur and Wadala stations with a total of 7 stations.

# *Problem identification*

Mumbai has a complicated rail network. There are visual maps made for people which help them understand the network better and help in their commute by making them independent and confident. These maps can be accessed by people with all the disabilities except for people who have vision impairment. There is no map of Mumbai's rail network available which provides comprehensive information of the layout and the inter-relation of all the routes on the network. They don't get an overview of the entire rail network anywhere. It is assumed that people with disabilities depend on others and manage by asking people around. An overview can help clarify their mental model* of the network. Thus designing a map becomes an important task.

**Need for public information system in Mumbai**

Whenever one travels on Mumbai locals, one tends to ask around for information. The information received can be correct or can sometimes mislead. For a person without vision, this situation gets even more complex. We always believe that there will be people available to help and we would reach our destination. But if the information is provided to us in the first place, we wouldn't have to depend on anyone else. And this is a citizen's right and the government should provide the support for this. Most countries outside have provided support and made a more inclusive environment to live in.

Regular travellers on the Mumbai locals are usually well versed with their everyday route. Even regular blind travellers remember their route vividly. But as soon as they have to travel on a new route, they become a novice user and depend on asking other people. A blind person either asks a family member/ friend about the new route or tags them along. If they decide to travel alone, the level of complexity goes up several notches for them. The map aims to be an aid in reducing this complexity.

** The term mental map/model refers to the maps that aren't actually produced and just exist in our minds. These maps are what allow us to remember the routes that we take to get somewhere. They exist because people think in terms of spatial relationships and vary from person to person because they are based on one's own perception of the world.*

# *Ways of communicating with blind people*

There are multiple ways of communicating with blind people. The most common are:

1. Braille text
2. Tactile Graphics
3. Audio
4. Smell Inductions
5. 3D Models






A solution which uses multiple ways of communicating is always richer than the one that uses only one. In this map, the two systems that will be used are braille text and and tactile graphics. Audio as an option will be worked on once we get the map with braille and tactile graphics in place.

*Image source:*
*2. http://www.thebetterindia.com/2542/esha-empowering-visually-impaired/*
*3. http://g3ict.org/resource_center/newsletter/news/p/newsletterId_/id_476*
*5. http://www.entrepreneur.com/article/245985*

# *Braille*

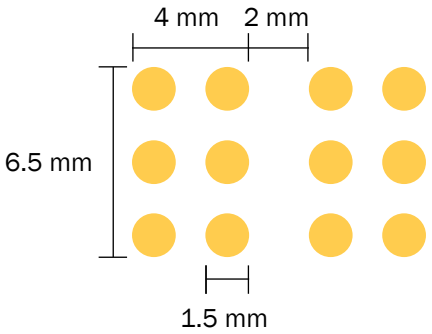
Braille is a tactile writing system used by blind and visually impaired people. It was devised in 1821 by Frenchman Louis Braille after he lost his eyesight because of an accident.

In braille, each character is made up of 6 dots arranged in 2 columns with 3 dots each. This group of 6 dots is called a cell. Different combination of dots symbolise different characters.

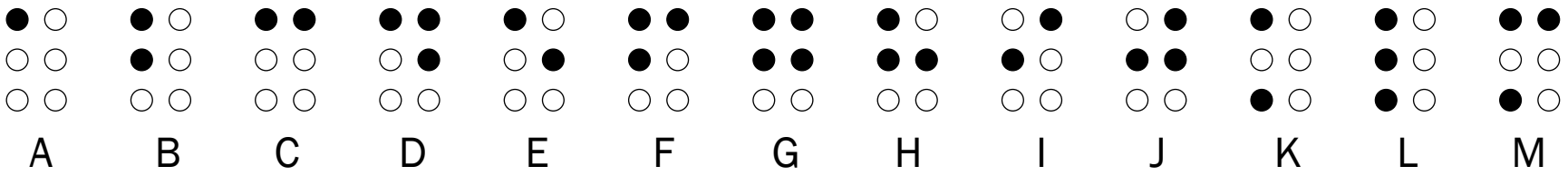
In English Braille, there are three levels depending on the level of difficulty.
Grade 1, is a basic set of letters and numerals.
Grade 2 comprises of letters, numerals, punctuation marks, contractions and abbreviations. This is the most commonly used system.
Grade 3 is individually designed shorthand.

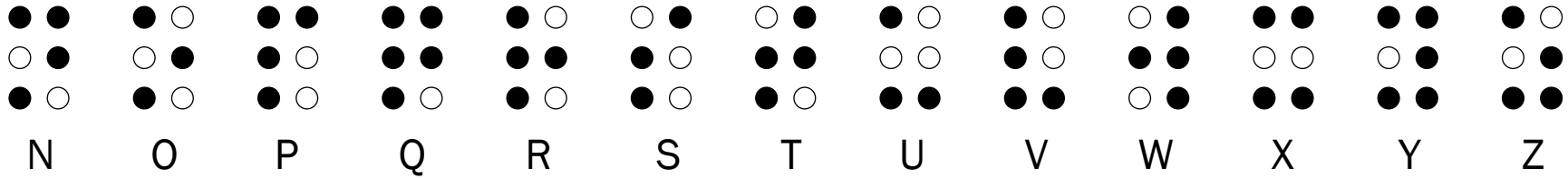
Like English Braille, many countries have adapted braille to suit their language. India has Bharatiya Braille which follows the same structure of a cell with six dots. It is consistent over different languages with minor changes made to suit that particular language. Hindi, Marathi, Bengali, Urdu, English are rendered in almost the same manner. Numerals as well as punctuations marks are borrowed directly from English.

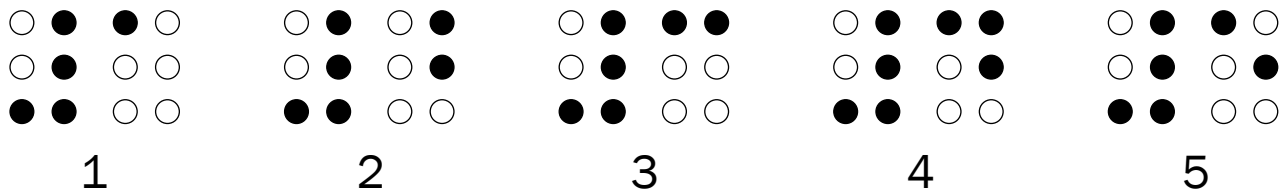
Braille cannot go smaller than a certain size. In India that size is

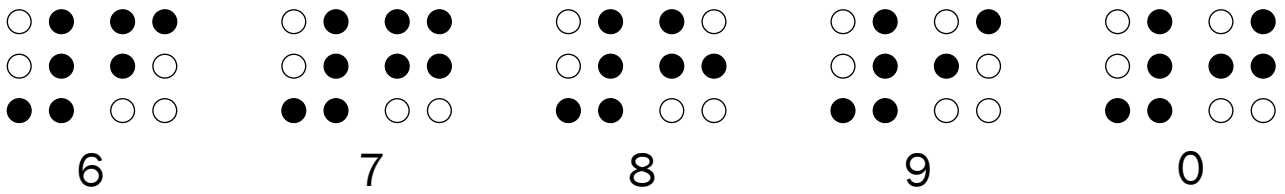


## *English Braille*



# *Tactile Graphics*

Tactile Graphics are relief drawings made on a 2-Dimensional surface. As early as 18th century, a number of blind individuals attempted to make tactile maps using wax, strings, pins and other commonly available material.
In 1837, Samuel Gridley Howe of Perkins School for the blind, Massachusetts, USA worked out a map which was the first tactile map to be mass produced.[3]

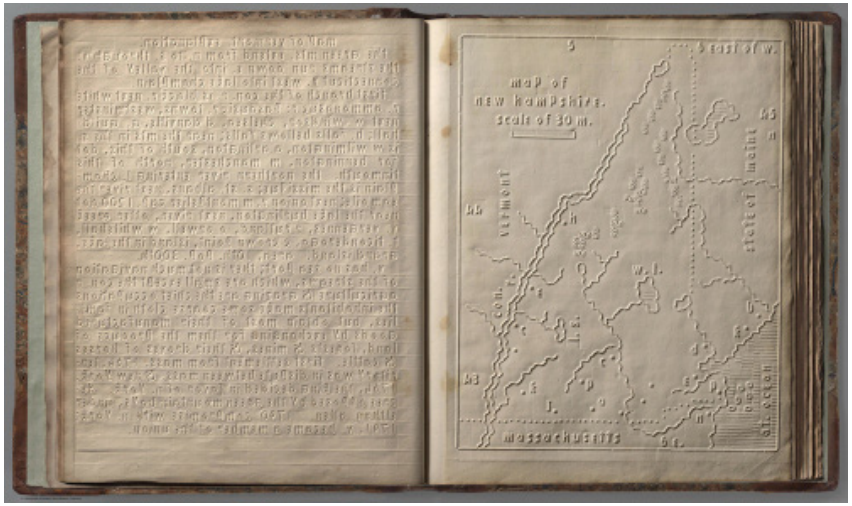
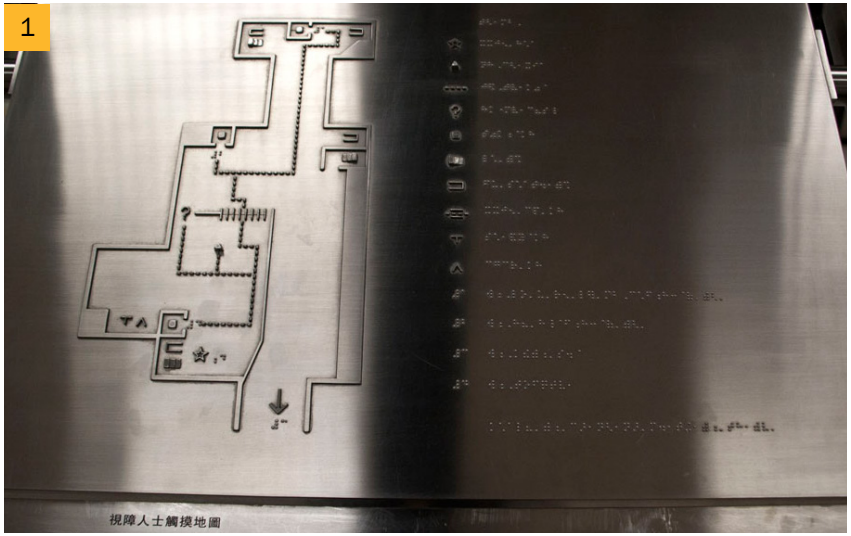



*Image source:*
*1. https://alexthephotog.files.wordpress.com/2014/07/bashinblog002.jpg*
*2. http://www.slate.com/blogs/the_vault/2014/08/13/history_of_education_for_the_blind_samuel_gridley_howe_s_boston_line_atlas.html*

# *Secondary data*

1




2

The first thing I did was looked at the different navigational tools used across the world as well as in India. These included apps, maps, different systems in place in those countries to help blind people navigate.

## *Navigation tools across the world*

Most developed cities have addressed the issues o accessibility to help ease the commute for people with disabilities. Maps play a very important part of these systems. Some of the cities which have maps in place are:

**1. Hong Kong**[4]
Hong Kong metro provides layout maps of different stations. These are display maps which use braille and tactile graphics. A music piece is played continuously which helps blind people identify the location of the map at the station.

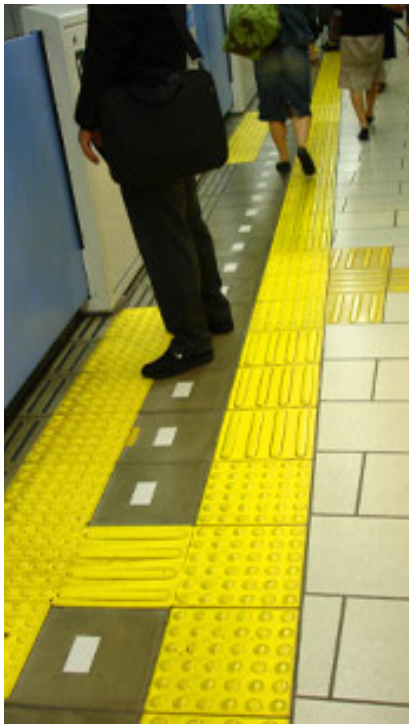
**2. San Francisco**[5]
Tactile maps of the Metro system with braille and raised characters are installed on the concourse and platforms levels of underground stations.

**3. London**[6]
London Underground has produced tactile maps of selected tube stations. In addition, there are also large print versions available for passengers with limited vision.

**4. New York**[7]
A series of raised-line tactile-braille maps with large print for each subway line of the New York subway system are available. Tactile-Braille overview maps of each borough and certain stations are also available.

**5. Japan**[8]

Japan has built a very inclusive environment for people with disability. Two very important features at that Japanese stations are tactile tiles which blind people follow to navigate at the station. And the second is handrails with braille markings. If the handrail is by the stairs going up to the platform, it tells the platform number, the metro line, and which direction is the train going in. When one goes up the stairs to the platform the other end of the handrail has an arrow and which tells which ticket gate one is going to.



# *Technology and apps*

**1. TalkBack/VoiceOver**
TalkBack is an in built service in android and VoiceOver is its counterpart for iOS. This service has been specially built for blind and visually impaired users of smartphones.As the name suggests, this service talks back to the user about what is on the screen and thus helps them use the smartphone.

**2. BlindSquare app**[9]

BlindSquare is a GPS-app available for iOS which describes the environment, announces points of interest and street intersections as a person travels.

When BlindSquare has determined the person's location, it looks up information about their surroundings on FourSquare and Open Street Map. If the person shakes his/her device, he/she can hear their current address, as well as information about the location of the nearest street intersection and venues around them.

It can also track their destination, periodically announcing the distance and direction while they are traveling.
Unfortunately BlindSquare is available in a lot of languages but not in any Indian language.

# *Navigational tools in India*

**1. At the railway station**

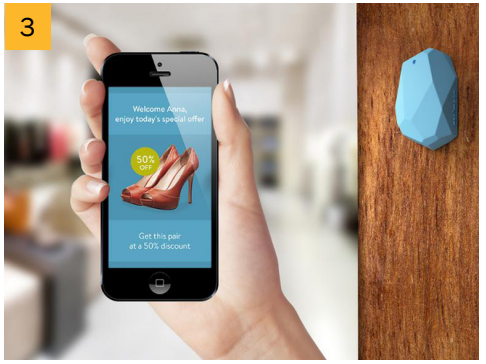
The compartment for physically handicapped and cancer patients in the Mumbai Local train is indicated by the wheelchair/cancer symbol. Yellow stripes marked on them also distinguish this compartment from the rest. The metro or monorail don't have a separate compartment dedicated to handicapped commuters but have special seats reserved on them.
A buzzer on the platform of the local trains continuously beeps indicating the position of the handicapped compartment.


**2. OnBoard**[10]
OnBoard is a bus identification system, which helps identify a bus' route number as well as the location of the door. It uses query based transaction and triggers auditory cues from the bus to enable the user to navigate towards the bus entrance.

**3. Beacon Technology**[11]
Beacon is a small hardware unit which can be mounted on a static or moving object. This device aids a smartphone to receive data using bluetooth. It transmits a special id which can be encoded with any data one wants. This technology is still in a nascent stage in India. It is still being tested here and isn't commercial available to use.

**4. M-indicator**[12]
Using TalkBack/VoiceOver service, blind smartphone users access apps like m-indicator which give information about train routes, train timings, bus routes, bus timings, etc.

3




4


m-Indicator

*Image source:*
*3. http://cdni.wired.co.uk/620x413/g_j/ibeacon3.jpg*

# *Key issues*


**Issue #1**

The whole model of Mumbai railway is mainly based on north - south direction as they were linear when started. But now, new stations have been added and all the lines have been extended and new lines have been introduced, there are lines which join east to west too. Without having an overview of the city, it will become very difficult for a person to figure out their journey.

**Issue #2**

User needs to know connecting routes prior to any query:
Suppose a novice user has to go from Andheri to Panvel, an app will tell him that he has to change the train twice once at Dadar and once at Kurla to reach his destination. But he will have no sense of the direction of these stations when he is using the app. He will not know how all three lines run in relation to each other. He will not know which direction is up, which is down. This will only add to the anxiety of a novice user.

**Issue #3**

The maps currently provided on the apps are not accessible to a blind user. The talk back feature is not supported. Even if it is made accessible, it would read out names of the stations like a list. It wont give a sense of orientation of the lines, the intersections and the overall layout of the system.In Mumbai, there are different ways to reach a particular place even using trains. If one knows the network better, he/she can plan their journey better and in advance.

# *Primary Data*

To figure how blind people currently travel on trains and what aids do they use to navigate I visited XRCVC (Xavier's Resource Centre for Visually Challenged). The aim was to understand the audience better.

Participants included the head of XRCVC and the HOD of Sociology at St. Xavier's College, Prof. Sam Taraporewala and four students studying at St. Xavier's College. Two of them had low vision while two of them were completely blind. Two of the students were residents of Mumbai and were regular train travellers. They knew their route by heart and travelled independently on it. The third one was a hostel student and had travelled infrequently on the trains and the fourth one was a resident of Mumbai but had only travelled a couple of times accompanied by her parents.

**The questions were divided in three sections:**

Demographic details: Name, age, current place of residence, class, type of blindness.

Travel related questions: If they had travelled by trains in Mumbai? If they have done so independently? What are the issues they face when they are travelling? How do they travel to a new station? Do they use any technology to get around? How do they understand when their destination has arrived?

Map related questions: Will a map help? Will a display map or pocket map work better? Will all the information in one map make it overwhelming? Will separate routes on separate sheets help? Is it important to know the whole network?

# *Findings and learnings*

**Everyday Travel**

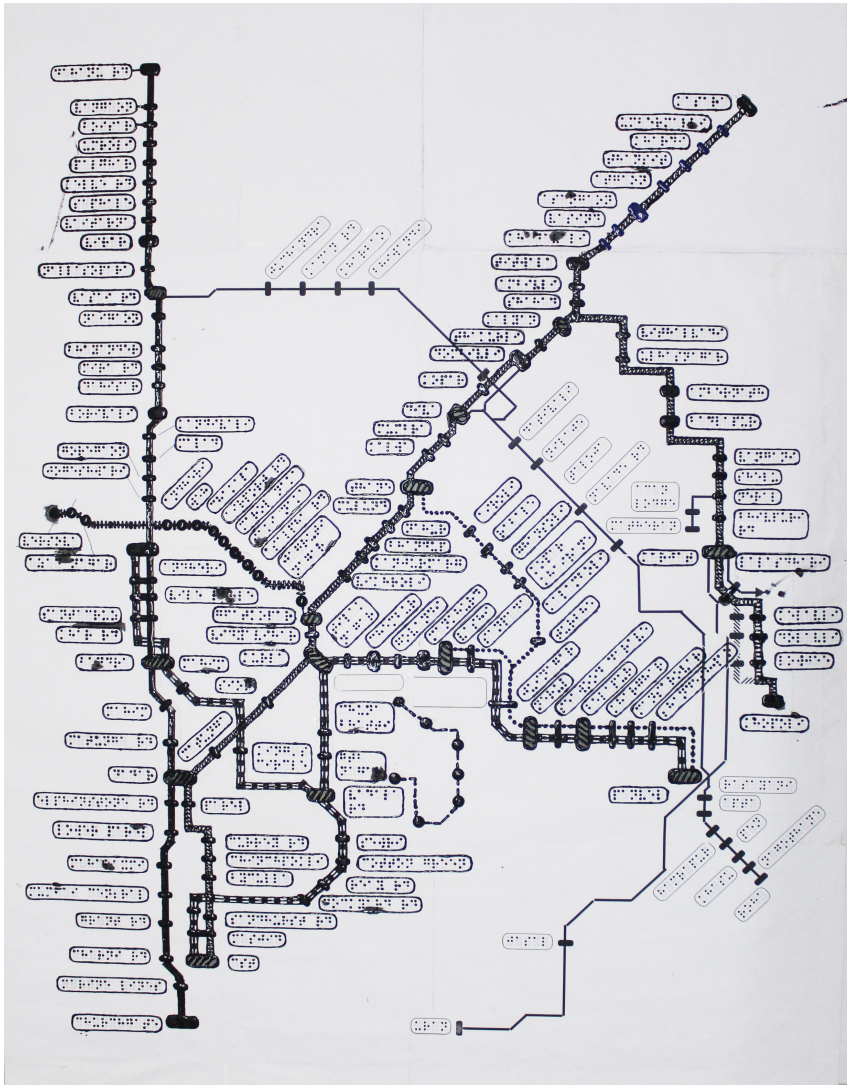
Blind people like people with vision are familiar with the route they travel on everyday. They generally know all the stations on their route by heart.
At the station, a buzzer is placed where the handicapped compartment arrives. They follow the beeping sound to find the compartment.
In new trains, they depend on the announcements in the train to know when their destination is arriving.
In old trains, they depend on announcements on the station or they ask fellow passengers to inform them when their station arrives.
When they are travelling to a new place or on a new route, they ask friends or relatives for detailed information about it. Or they ask their friends or relatives to accompany them.
Some of them use apps like m-indicator to get this information using the talkback feature on their smartphones.
The main issue all of them face when they are travelling is finding the platform and the direction of the train. Also finding out if the train goes to their destination is an issue.

**About the map**

Three of the students said that a pocket map will be a better idea as finding the display map will be another few steps added to finding the information. Pocket map will make the information available to them at any point. The one who disagreed said that since they carry a cane in one hand and might have luggage with them, carrying a physical map will make it difficult for them to read it easily. All of them agreed that understanding the network is important as it gives them a clear idea of their route before they start the journey and they don’t have to depend on someone else for the information.

**The meeting with Prof. Sam Taraporewala** was an insightful one. We discussed various kinds of geographical maps in detail. He mentioned that the map should be made inclusive, since a lot of blind individuals in the country are braille illiterate. He also discussed the other shortcomings of braille, that of size and space. An audio and braille map, according to him would be the optimum solution. He introduced me to a device called sonic labeller which uses coded labels which can be placed on the station markers. When the labeller is taken near the labels, it will readout the name os the stations. They have used this technology to make an inclusive menu for a restaurant called Bombay Blues in Mumbai. He also gave me insights on the different printing technologies they have used, the different projects they have worked on where they have used technology to aid blind people.

# Prototypes

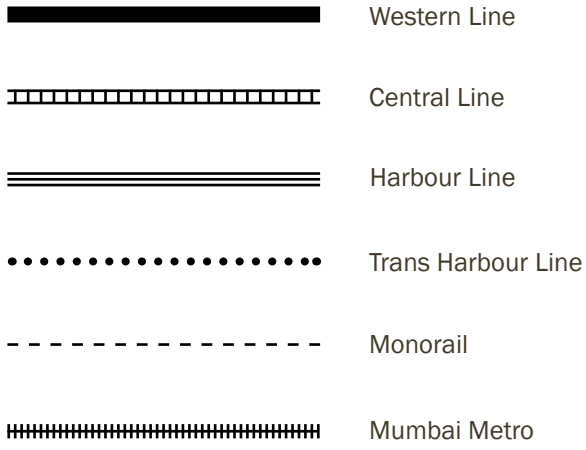


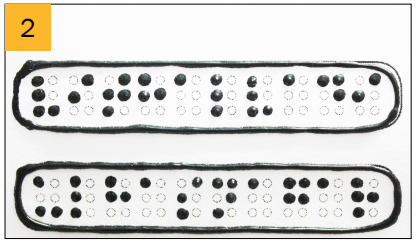
## First prototype

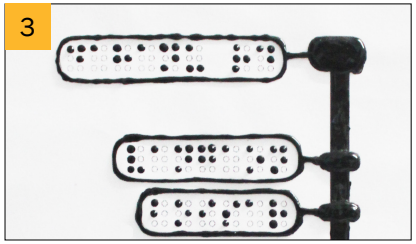
The first prototype as seen here was developed to fit on the visual map which is already in use. This was done, so that the map for blind people can be super imposed on the visual one which will bring down the production cost as well as save space. A 3D liner was used to make this.

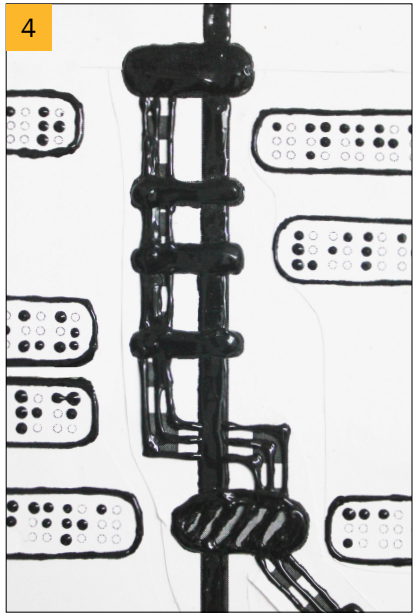
**Features of the first prototype:**

1. Textures to differentiate different lines
Since blind people would completely depend on touch to identify and differentiate between the different train routes, different textures were used to do the same. Following were the textures used to differentiate the lines:






2. Braille
As mentioned before, Braille has a certain minimum standard that is followed. This creates a major hindrance in creating a map as the overall size of the map cannot come down beyond a certain point. Thus minimum size for this map was A1.

3. Station Names
Frames were added around the names. This helped differentiate between two stations. It especially helped where the station name was long and had to be written in two lines.

4. Connectors
In visual maps, when two things are placed close to each other, they tend to form a group***add gestalt reference. So, what do we do when things are not being perceived visually? How do we still form groups? This is where we introduced the connectors between the station names and the station markers.

5. Station markers
There are mainly two types of stations on the Mumbai railway system - one where the train terminates or a train form only one track passes through and the other one where the train interchanges tracks. These were thus designed distinctly different to make identification simple.

## *Problems with the first prototype*

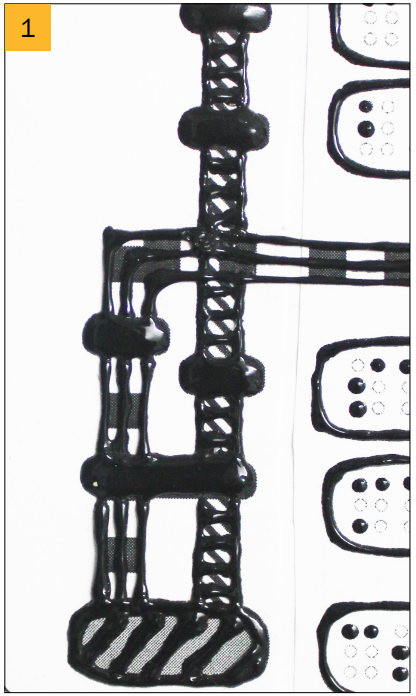
Only after making the prototype did we find out certain problems with the design ourselves:

1. Some of the textures were confusing and difficult to distinguish from the other, thus making the map complex to read.

2. Some of the elements (lines as well as station names) were too close to each other, which could create hindrance in tracking.

3. The smaller turns in the lines created unnecessary complications, as they were not providing any vital information.

1



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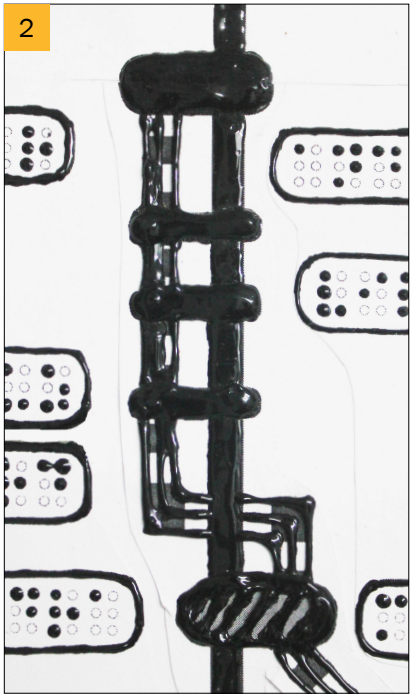
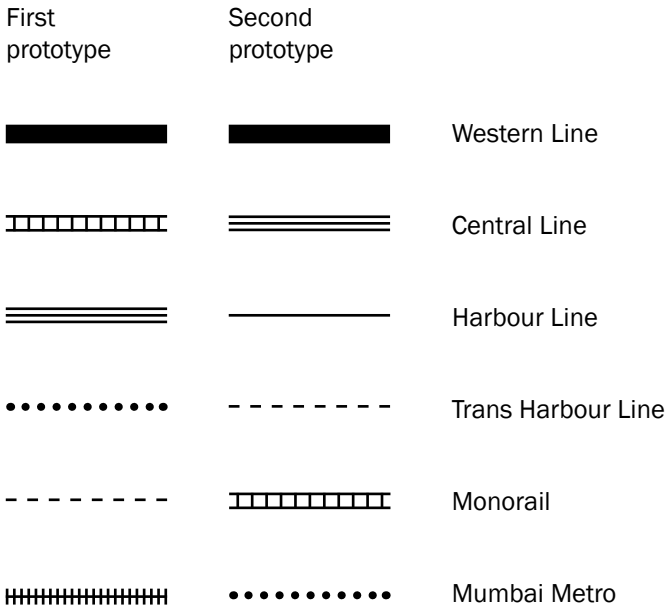


## *Second Prototype*

After considering the problems in the first prototype, the second prototype was made way simpler and clearer. Following changes were made:

1. Change in line texture
Considering the issue of confusing textures and proximity of lines adding to the complexity, following changes were made to the line textures:



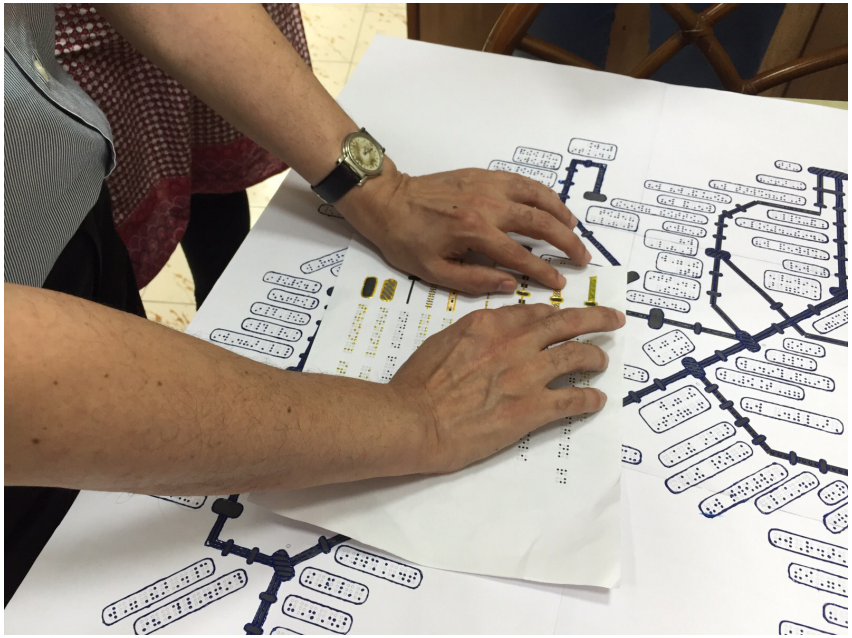
2. Change in station markers
The station markers for terminal station was changed from filled to one with a stroke.

First prototype Second prototype

3. Spacing between elements
In this prototype, enough spacing was kept between the lines and the station names.

4. The lines were made way simpler, getting rid of the smaller curves in the tracks. This was done without compromising on the directions of the stations. For e.g. Kasara was still in the north while Khopoli still faced south.

# *Feedback*

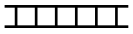
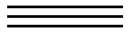


Both the prototypes were tested with Prof. Sam Taraporevala and he gave his valuable feedback on the same. There were certain things that worked in the favour of the map and some against it.

**Things that worked in favour of the map**

1. Line differentiation because of the different textures.
2. Frame around the braille words help specially in case of names that are very long and have to be written in two lines.
3. Differentiation between the terminal station markers and interchange station markers helps in understanding the change in tracks. Also the difference in the size of the markers for major stations and smaller station helps.
4. Filled markers work better than the one with just the stroke.
5. Connector between the station names and station markers, according to Prof. Sam is a good addition to the map as it helps in locating the station names easily specially in places where there are a lot of station names that come together.

**Things that worked against the map**

1. Some textures like   seem very busy and thus make the map more complex.
2. Distance between the braille dots and the surrounding space is less and at some places the frame almost merges with the dots making it difficult to read the name.
3. Quality of the braille dots needs to be worked on. At some places the dots fall really flat, almost merging into the paper.
4. Connectors between station names and station markers, though a good option makes the map more complex as it adds another set of small lines to touch increasing the cognitive load.

# *Further scope of the project*

Apart from improving on the issues pointed out by Prof. Sam, the printing technology and the material to be printed on also have to be figured out. The map has to be made foldable and easy to carry and thus the printing technology and material will be based a lot on this. This map will not only be used by blind people to figure out their travel route but also as an instructional tool to teach people about the layout of the railway network of Mumbai.

# *Shortcomings in the current map*

A major issue of this map is that one has to scan the whole map to find a particular station. The visual map has solved this issue by using the grid system where the whole map has been divided into several smaller sections. On a separate sheet, all the stations are listed alphabetically with their grid number placed in front on them. This reduces the area that needs to be scanned for the user. Adding more lines to the tactile map will only make it more complicated. Thus an alternative to this needs to be worked on.

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