Products beyond the hegemony of vision:
Design a toy for visually impaired children
with emphasis on tactile and acoustic characteristics combining Braille and Alphabet learning

Stavros Mountelos

SCHOOL OF ECONOMICS, BUSINESS ADMINISTRATION & LEGAL STUDIES
A thesis submitted for the degree of
Master of Science (MSc) in Strategic Product Design

February 2017
Thessaloniki – Greece
Student Name: Stavros Mountelos

SID: 1106150019

Supervisor: Prof. Dr. Georgios Liamadis

I hereby declare that the work submitted is mine and that where I have made use of another’s work, I have attributed the source(s) according to the Regulations set in the Student’s Handbook.

February 2017
Thessaloniki - Greece
Abstract

This dissertation was written as part of the MSc in Strategic Product Design at the International Hellenic University.

Through the dissertation, it is researched the meaning of visual impairment, the characteristics of visually impaired people, and their needs. The focused group is children. After a brief research on Braille system, methods used to teach Braille to children, are being particularly examined. A market research to disclose the products designed for visually impaired people, focuses finally on products designed for visually impaired children. The significance of play, in children’s education, is underlined, describing the essentials children are able to gain. The dissertation ends up with the design of a toy for visually impaired children, which aims to help children learn the Braille writing and the English alphabet, as well as the correlation between them.

I would like to acknowledge my gratitude to my supervisor Mr. George Liamadis, for allowing me the space and freedom to choose the topic and to work, and for the continued support, encouragement and the valuable advice he has provided. Also, I want to thank my family that trusts and supports me in every step of my life.

Keywords: Visually impaired, children, toy, design, Braille and alphabet.

Stavros Mountelos

February 26, 2017
Contents

Abstract ................................................................................................................................. iv

Contents ............................................................................................................................... v

1. Introduction ......................................................................................................................... 13

2. Literature review ............................................................................................................... 14
   2.1 Visual Impairment ......................................................................................................... 14
      2.1.1 Definitions ......................................................................................................... 14
      2.1.2 Population ......................................................................................................... 15
      2.1.3 Blindness and Vision Impairment ..................................................................... 17
      2.1.4 Types of Visual Impairment ............................................................................. 19
      2.1.5 Individuality ....................................................................................................... 20
      2.2 Project rationality .................................................................................................... 21

3. Braille ................................................................................................................................. 22
   3.1 Grade 1, Grade 2 and Grade 3 braille ........................................................................ 22
   3.2 Braille writing and reading ......................................................................................... 23
      3.2.1 Grade 1 braille .................................................................................................. 23
      3.2.2 Grade 2 braille .................................................................................................. 24
   3.3 Braille and children ...................................................................................................... 25
   3.4 Methods of Teaching Reading ..................................................................................... 25
      3.4.1 Phonic Method .................................................................................................. 25
      3.4.2 Look and Say Method ..................................................................................... 26
      3.4.3 Learning Experience Approach ...................................................................... 26
      3.4.4 Context Support Method ............................................................................... 27
   3.5 Tactile versus Visual Reading ....................................................................................... 27
   3.6 Complexity of the Code .............................................................................................. 29
   3.7 Teaching Braille to children ....................................................................................... 29
      3.7.1 Step 1: Make It Fun .......................................................................................... 31
      3.7.2 Step 2: Make It Meaningful ............................................................................ 32
      3.7.3 Step 3: Make It Developmental ...................................................................... 33
4. Designed products for visually impaired people – Market research .34

4.1 Clocks & Watches...........................................................................................................35
4.2 Living aids ....................................................................................................................36
4.3 Electronic devices..........................................................................................................40
4.4 Mobility ........................................................................................................................44
4.5 Kitchen oriented products............................................................................................47
4.6 Education & Leisure .....................................................................................................50
    4.6.1 Regular Toys Suitable for Visually Impaired Children ........................................51
    4.6.2 Toys Designed and Produced for Visually Impaired Children ............................58
    4.6.3 Toys and educational play tools about Braille ......................................................64
4.7 Evaluation .....................................................................................................................69

5. Visually Impaired Children and Playing.................................................................73

5.1 Playing with Toys...........................................................................................................73
5.2 Visually Impaired Children Playing with Toys............................................................75
5.3 Learning through play....................................................................................................76

6. Design of the toy ...........................................................................................................77

6.1 Methodology ................................................................................................................77
6.2 Design specifications.......................................................................................................79
6.3 Design Process ..............................................................................................................80
    6.3.1 Definition of the Problem (Design specifications) .................................................80
    6.3.2 Information Collection ..........................................................................................81
    6.3.3 Product Development ..........................................................................................82
        6.3.3.1 Sketches ........................................................................................................82
        6.3.3.2 Drawings ........................................................................................................85
        6.3.3.3 CAD Design ..................................................................................................88
    6.3.4 Design Improvement ...............................................................................................90
    6.3.5 Final Design ...........................................................................................................99
        6.3.5.1 Using the toy ................................................................................................100
        6.3.5.2 Final Design Renders ..................................................................................104

Conclusion .........................................................................................................................106
Pictures

Picture 2.1: Vision disorders (from left to right): Normal Vision, Cataract, Macular Degeneration, Diabetic retinopathy and Glaucoma Images, (Source: National Institute of Health) .......................................................... 19

Picture 3.1: Grade 1 Braille (Source: Tennessee Council of the Blind) ...... 24

Picture 3.2: Grade 2 Braille (Source: Tennessee Council of the Blind) ...... 24

Picture 4.1: Tactile Watch (Source: www.trendhunter.com) ....................... 35

Picture 4.2: Tangibowls (Source: www.idsa.org) ...................................... 37

Picture 4.3: Operation of See with Fingertips (Source: www.yankodesign.com) ................................................................................................. 38

Picture 4.4: Credit Card for the Blind (Source: www.yankodesign.com) ..... 39

Picture 4.5: Operation of Credit Card for the Blind (Source: www.yankodesign.com) .................................................................................. 39

Picture 4.6: Voice Stick (Source: www.designtoimprovelife.dk)............... 40

Picture 4.7: operation of Voice Stick (Source: www.designtoimprovelife.dk) ................................................................................................. 41

Picture 4.8: Siafu – Magneclay (Source: www.youngisthan.in) .............. 42

Picture 4.9: 2-D to 3-D image conversion technology by Siafu (Source: www.youngisthan.in) ........................................................................... 42

Picture 4.10: SÉNS phone (Source: www.taqumidesign.jp) ...................... 43

Picture 4.12: Spot Stick (Source: www.behance.net) ................................. 45

Picture 4.13: The Safe Stick (Source: www.behance.net) .......................... 46
Picture 4.14: Supersonic Stick on the Wrist (Source: www.yankodesign.com) ................................................................. 47

Picture 4.15: The Pitcher concept water container (Source: www.petitinvention.wordpress.com) .................................................. 48

Picture 4.16: Buoy Cup (Source: www.yankodesign.com) ................. 49

Picture 4.17: Sentino Cook-top (Source: http://www.coroflot.com/R_D_Silva) ................................................................. 50

Picture 4.18: Toys Designed by Several Textured Materials. a) Loveys Chime Ball by Kids Preferred. b) Musical Inchworm by Lamaze. c) Octotunes Musical Toy by Lamaze. (Source: www.kidspreferred.com and www.lamazetoys.co.uk) ........................................................................ 51


Picture 4.20: Jungle Magnetic Blocks by Tegu. (Source: www.yoyo.com) 53


Picture 4.21. Teach Me Shapes by Roylco. (Source: www.amazon.com)54


Picture 4.23: Bop It XT by Hasbro. (Source: www.hasbro.com) .............. 55


Picture 4.25: a) 3 in 1 Trike by The Little Tikes b) Trampoline by Springfree. (Source: www.ableplay.org) ................................................................. 56

Picture 4.27: a) 3D Slide Puzzle: Penguin by Sequential Puzzle b) 3D Slide Puzzle: Tropical Fish by Sequential Puzzle. (Source: www.seriouspuzzles.com) ................................................................. 58

Picture 4.28: a) Touch and Match Texture Board b) Ruff’s House Teaching Tactile Set by Learning Resources c) Tactile Turn’n Match by TFH Special Needs Toys. (Source: www.rnib.org.uk and www.specialneedstoys.com/uk) ................................................................................. 59

Picture 4.29: Tactile Discs by Gonge. (Source: www.ableplay.org and www.equip4education.co.uk) ........................................................................................................ 59

Picture 4.30: Picture Maker Textured Strips (Source: www.aph.org/advisory/2008adv02.html) ........................................................................................................ 60

Picture 4.31: Sound Box by Guidecraft. (Source: www.rnib.org.uk) ........ 61

Picture 4.32: Memory Caps by Guidecraft. (Source: www.rnib.org.uk) ... 61


Picture 4.34: a) Texture Dominoes by Guidecraft b) Tactile Tic-Tac-Toe Game by MaxiAids. (Source: www.guidecraft.com and www.shopping.com) ........................................................................................................ 63


Picture 4.36: a) Giant Jingling Bell Ball b) Foam Bell Ball c) Goal ball d) Reizen Audible Football. (Source: www.rnib.org.uk) ................................................................. 64


Picture 4.38: Braillin Doll by Once. (Source: http://kcmcnew.umf.maine.edu/includes/kcmc/itemPg.php?cat=296&item=3044 ) ............................................................................................................. 65
Picture 4.39: a) Braille Slide Puzzle by Maxi Aids, b) Braille System by Tack Tiles.  

Picture 4.40: Braille Set Pastel and Bold by Eni Puzzle (Source: www.twistypuzzles.com) ................................................................. 67

Picture 4.41: Touch and Tell by American Printing House for the Blind.  
(Source: www.shop.aph.org) ................................................................. 67

Picture 4.42: Reach & Match Designed by Mandy Shuk-Man Lau.  
(Source: www.core77designawards.com/2012/recipients/reach-match-2/) 68

Picture 6.1: Visually impaired people reading braille (left) and writing in alphabet (right) ................................................................. 81

Picture 6.2: First sketch - main function of the toy .................................................. 82

Picture 6.3: Second sketch – connection of the parts ............................................. 83

Picture 6.4: Third sketch - Improvements on the connections ................................. 85

Picture 6.5: Dimensions of the ring shaped part ..................................................... 86

Picture 6.6: Dimensions of end cap 1 ..................................................................... 86

Picture 6.7: Dimensions of end cap 2 ..................................................................... 87

Picture 6.8: Dimensions of base 1 .......................................................................... 87

Picture 6.9: Dimensions of base 2 .......................................................................... 88

Picture 6.10: CAD design all parts ......................................................................... 88

Picture 6.11: Detail of the connection ...................................................................... 89

Picture 6.12: All parts combined .............................................................................. 89

Picture 6.13: Detail of the combined parts ............................................................... 90

Picture 6.14: Design refinement ............................................................................... 91
Picture 6.15: Endcap (blue colored) fixed with ring part

Picture 6.16: Rotation handle

Picture 6.17: Final connections

Picture 6.18: Metal blades and dots producing sounds

Picture 6.19: the 26 shapes on the ring part sides

Picture 6.20: Braille bricks

Picture 6.21: Letter A corresponding with hexagon shaped brick with Braille symbol – A

Picture 6.22: a pin activates the sound pin for every brick connected

Picture 6.23: the sound producing pin

Picture 6.24: revealed and blocked holes on the sides when a letter is chosen

Picture 6.25: Final design

Picture 6.26: Braille bricks

Picture 6.27: Step 1 – Choose letter “F”

Picture 6.28: Step 2 – Find the shaped hole revealed and “read” the shape

Picture 6.29: Step 3 – Find the corresponding brick

Picture 6.30: Step 4 - Fit the brick into the shaped hole

Picture 6.31: Step 5 – Rotate the handle and play the song

Picture 6.32: Final design – Toy in child’s room

Picture 6.33: Final design – Toy in child’s room
Tables

Table 1: Global estimate of the number of people visually impaired by age, 2010; for all ages in parenthesis the corresponding prevalence (%). (Source: WHO, 2012) .......................................................... 17

Table 2. Examples of Toys and the Purposed Skills and Senses. ................. 70

Table 3: Combination of dots in order to produce the song “Mary Had a Little Lamb” ........................................................................................................ 94

Figures

Figure 1: The population of blind people (in millions) over the years. ....... 16

Figure 2: The Design Process Methodology .................................................. 78
1. Introduction

In this dissertation, the general topic, is about researching and analyzing the characteristics of visually impaired people, emphasizing on children and the educational methods used for this group. Based on the findings of this research, a design synthesis of a toy for visual impaired children takes place, presenting an innovative design.

Visually impaired children, ages from 0 to 14, were estimated to be 18.939 millions in 2010 (WHO, 2012). This means that is a group considerable for further research, on product designs, to make their life easier and better.

Starting with a general research about visual impairment, the characteristics of visually impaired people and their needs, in the first chapter, the dissertation continues with the analysis of the Braille writing system.

The description of the Braille writing system, and the educational methods used to teach it, as well as the analysis of them, is the key issue on this chapter.

A research of the products designed for visually impaired people, takes place on the next chapter, ending with a detailed research on toys and educational tools designed for visually impaired children. An evaluation of these foundings will be the key for the final design.

The dissertation ends up with a designed toy for visually impaired children, which provides the ability of the simultaneous learning of the Braille writing system and the alphabet, as well as the correlation between them. This is why, this design is innovative. It uses and develops the tactile and hearing senses, mental, cognitive and communicating skills.

Concluding, the ultimate scope of this dissertation is the fully incorporation of visually impaired people and especially children, in the society, by constituting the spark for further researches or implementations.
2. Literature review

In the first chapter, is being researched the general topic of the study and the theories that support it. As a required necessity for the cohesive continuation and the extensive understanding of the research made, some definitions are presented below, in order to familiarize with the subject of the study and the project rationale in order to lead to the specific objectives of the survey.

2.1 Visual Impairment

Primarily, the definitions of the terms that are being extensively used though the study are presented, continuing with the population, the types and the characteristics governing the visual impaired people.

2.1.1 Definitions

Definition of impairment


- Impairment is defined as “any loss or abnormality in an anatomical structure or a physiological or psychological function.”
- Disability is " any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being”.
- These conditions lead to a handicap, which "indicates a person’s disadvantaged position in society, resulting from impairment and/or disabilities." (WHO, 2001).
Definition of Visual Impairment

Visual impairment is defined as "a functional limitation of the eye(s) or visual system" (United States Department of Health and Human Services, 1996). The Centres for Disease Control and Prevention (CDC) define vision impairment as "a person’s eyesight cannot be corrected to a "normal level"." Visual impairment can be declared as reduced visual acuity or contrast sensitivity, photophobia, visual field loss, diplopia and visual distortion (Glossary,1-6). Visual perceptual difficulties, or any combination of the above (Freeman et al., 2007). The National Eye Institute (2012) 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".

2.1.2 Population

Visual impairment is one of the most common kind of impairments, as the visually impaired and blind people are estimated to be 285 million worldwide (WHO, 2014). The first time that the number of visual impaired people was counted, in 1975, gave as a result about 28 million blind people (WHO, 2007). Later, in 1977, World Health Organization estimated that the population of blind people was around 38 million (WHO, 1997). This number, had been increased until 2009 to 45 million blind and 135 million visually impaired people worldwide (UFS, 2016). This increase, is anticipated in 2020 to reach 76 million blind people worldwide (WHO, 2007) (Figure 1). This increase has a similar sharing in most of the countries, including Europe. On the other hand, China counts about 18% of the world’s blind population, having the largest number of blind people in the world, as a result, mainly, of its size and population. The main group of people with visual impairment, belongs to the senior
citizen category, where the 66% of people with impaired vision are over 75-year old (MoBIC, 1997); (Lacey & Dawson-Howe, 1998); (WHO, 1997).

Figure 1: The population of blind people (in millions) over the years.

Population of disable people is estimated between ten (10) and nineteen percent (19%) of the world population (Bull, Hoose & Weed, 2003; Huh & Singh, 2007) by whom almost the one third (1/3) are visually impaired. That means the four percent (4%) of the total amount (Table 1). It is a fact that every five seconds one person and every minute a child lose their vision. Blind people analogy in Greece, is twenty three (23) per one hundred thousand (100.000) (Cultural Institute of Academic Research and Study, 2016). As a result of the large population of visually impaired people, more studies will take place in near future aiming to improve their living conditions (Bull et al., 2003; Huh & Singh, 2007). As shown in table 1 below, the number of visually impaired children (ages 0-14) is estimated to reach the 18.939 millions, generating a need for studies concentrated in this specific category of the society.
Table 1: Global estimate of the number of people visually impaired by age, 2010; for all ages in parenthesis the corresponding prevalence (%). (Source: WHO, 2012)

<table>
<thead>
<tr>
<th>Ages</th>
<th>Population (millions)</th>
<th>Blind (millions)</th>
<th>Low Vision (millions)</th>
<th>Visually Impaired (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-14</td>
<td>1,848.50</td>
<td>1.421</td>
<td>17.518</td>
<td>18.939</td>
</tr>
<tr>
<td>15-49</td>
<td>3548.2</td>
<td>5.784</td>
<td>74.463</td>
<td>80.248</td>
</tr>
<tr>
<td>50+</td>
<td>1,340.80</td>
<td>32.16</td>
<td>154.043</td>
<td>186.203</td>
</tr>
<tr>
<td>All ages</td>
<td>6,737.50</td>
<td>39.365(0.58)</td>
<td>246.024(3.65)</td>
<td>285.389(4.24)</td>
</tr>
</tbody>
</table>

2.1.3 Blindness and Vision Impairment

According to the CDC, blindness is maybe the most significant type of visual impairment, as it can not be rectified by standard vision glasses, contact lenses, any medication, or surgery methods and it prevents people from participating in everyday activities.

"Legal blindness" is defined as vision equal or worse than ten percent (10%) or a visual field of less than twenty (20) degrees in diameter. "Legal blindness" is used mainly to determine people’s eligibility for disability benefits from the state, but it is not presenting the true impairment or disability. Vision impairment, is defined as vision of fifty percent (50%) or worse, in the better watching eye, even if wearing eyeglasses. However, people with the lighter form of visual impairment can certainly face difficulties in their everyday activities. For example, people with vision less than fifty percent (50%) can not obtain a driver's license.
The major blinding eye diseases are: cataracts, age-related macular degeneration, diabetic retinopathy, and glaucoma.

A cataract is “a clouding of the eye’s lens. The cataract blocks or changes the passage of light needed for vision. The lens of the eye is located behind the pupil and the colored iris, and normally is transparent. Its role is to help focus images onto the retina (the back layer of the eye), the area that transmits the images to the brain. Cataracts can cause vision to become blurred or dimmed because light cannot be transmitted properly through the lens to the retina”. (Freeman, K. F., Cole, 2007)

Age-related macular degeneration affects the part of the retina which is responsible for sharp central vision, divided into two forms:

- dry (non-exudative) and
- wet (exudative).

Diabetic retinopathy is “an eye disease that affects the tiny blood vessels in the retina of people with diabetes. Diabetes causes the small blood vessels in the retina to become weak and break down or become blocked. Diabetic retinopathy is the leading cause of blindness among working-age adults”. (Freeman, K. F., Cole, 2007)

Glaucoma is not one, but instead, a group of diseases, inextricably linked to increased pressure, inside the eyes’ retina. This pressure causes injury to the cells which are linked to the optic nerve which is responsible to carry the information from eyes to the brain. The damage is progressively increased, resulting to peripheral vision loss at first stage, followed by reduction of central vision and, sometimes, blindness.
Blindness and visual impairment can have a negative impact on psychology and affect the quality of life of impaired people. Blind people have many difficulties with their everyday life activities (e.g., driving, reading, education, and social activities).

![Image of children playing]

Picture 2.1: Vision disorders (from left to right): Normal Vision, Cataract, Macular Degeneration, Diabetic retinopathy and Glaucoma Images, (Sourse: National Institute of Health)

2.1.4 Types of Visual Impairment

Visual impairment is divided into four (4) sub-categories. These sub-categories differ, according to the level of vision loss. These are: low visual impairment, high visual impairment, blindness and color blindness. Color blindness is occurred to ten percent (10%) of the world’s population. An other sub-category is elderly people as visual impairment increases at late age, usually after the age of forty (40). (Keusekotten, 2006).

The causes of visual impairment vary and can provoke different malfunctions. In total blindness, for example, the person has total vision
loss, while some other diseases can occur types of vision loss like glaucoma, age-related macular degeneration, cataract, diabetic retinopathy, a disease of the retina associated with diabetes mellitus, characterized by microaneurysms, hemorrhages, exudates, and proliferative retinal changes, presbyopia, a reduction in accommodative ability that occurs normally with age and necessitates a plus lens addition for satisfactory seeing at near, and retinitis pigmentosa, a primary degeneration of the neuroepithelium of the retina resulting in night blindness and progressive contraction of the visual field (Mandal, 2012).

2.1.5 Individuality

The difficulties in skills, such as sensory disabilities, which a person can confront at some point in his life, empower himself to develop other skills to cope with their disability. Blindness is the most difficult sensory disability to cope with, which makes blind people try more in order to complete everyday tasks. (Craven & Brophy, 2003; Ivory, Yu & Gronemyer, 2004; Petrie, Hamilton & King, 2004). Moreover, people who are born blind do not have any insight into life, in addition to people who become blind during their life. For this reason it is believed that people who become blind, are able to manage better with blindness rather than people who were born blind, mainly because of their memories. However, this assumption depends on individual learning and life experiences every person has (Chambel, Antunes, Duarte, Carriço & Guimarães, 2009). In any case, vision disabilities cause plenty and different problems in everyday life activities such as mobility difficulties, navigation, environment accessibility and interaction with it (Nguyen et al., 2013).
2.2 Project rationality

Despite their disability, visually impaired people have the right to be active members of the society. Their special needs may incommode their daily activity and mobility, excluding them from the community. These special needs or difficulties can be fulfilled or overpassed by customized products. Thus, there is the need for design of products for visually impaired people, and specially children such as toys which would help them with their disability. The last decade have been made products specialized for blinds that cover a series of needs. A need for a blind or visually impaired child is learning Braille. This need will be examined and tried to be covered through this study. The continuous evolution reforms the needs, making necessary to reexamine them in order to design new, up to date objects.
3. **Braille**

*Braille* is a writing system, or else, a code used by blind people or visually impaired in order to read and write. Braille is a tactile writing system, where letters and words are represented using embossed dots. There are different braille systems for different languages. Braille uses a sequence of sets consisting of six dots, called cells. Every combination represents a letter of the alphabet, a punctuation, a numbers, or even whole words (Wikipedia).

3.1 **Grade 1, Grade 2 and Grade 3 braille**

Braille can be written using individual letters of the alphabet. This is known as Grade 1 or uncontracted braille. It can also be written using whole words or contractions, and it is known as Grade 2 braille.

Uncontracted or Grade 1 Braille, is a braille writing system consisted of the letters of the alphabet, punctuation symbols and numbers, governed by 180 rules. Unlike, contracted or else Grade 2 Braille consists of the alphabet letters plus 189 one or two cell contractions representing different combinations of letters. Contracted braille, is governed by 450 rules, and is a more complicated writing system consisted of letters, whole words or part word constraints. As Grade 2 Braille has the advantage of space saving, because of its contracted form, is extensively used in literacy. Since the 1950s the most publications from the American Printing House for the Blind or any other braille producing organization, have been written in Grade 2 Braille. (Cyral & Rash, 2001)

Grade 3, is used only in personal letters, diaries, and notes. It is a kind of shorthand, with entire words shortened to a few symbols. Codes have also been established for music braille and mathematical
notation, called Nemeth braille. Because it is standardized, Grade 3 Braille is not used in publications. (Jeff Frcho, 2013)

3.2 Braille writing and reading

3.2.1 Grade 1 braille

In Grade 1 Braille, as mentioned before, every combination of dots inside a cell, represents a single letter of the alphabet, a number or a punctuation, in contrast with Grade 2 Braille where every cell can represent whole words. Books or publications using Grade 1 Braille are larger than others using Grade 2, as a result of its debility to shorten words or phrases. For this reason, Grade 1 braille is typically used by those who are new in learning Braille. (Holbrook, Nannen, 1997)
3.2.2 Grade 2 Braille

Grade 2 braille was introduced as a space-saving form, in contrast to Grade 1 Braille. Grade 2 Braille uses abbreviations. That means that a cell can represent a whole word and not an alphabet letter. This is the reason why this Grade of Braille is the most popular among the others. There are part-word contractions, which often replace common suffixes or prefixes, and whole word contractions. Abbreviations, use a special symbol to precede either the first or last letter of the word while shrinking the rest of the word. By using a double letter contraction such as "bb" or "cc", or by removing most or all of the vowels in a word results a shorten form. A complex system of styles and usage rules has been developed for this grade of Braille. (Holbrook, Nannen, 1997)
3.3 Braille and children

As with children who learn to read printed letters and whole words, children who are blind must exercise frequently the language skills before they receive the first reading education. Parents should read to children out loud and give them the ability to familiarize with braille books in their early age. Except for language skills development, a complete understanding of basic rules, and an interest in books, it would be necessary, braille readers, to possess appropriate tactile skills and fully controlled motor ability. Previous familiarization and skills development is the only way to success as a braille reader. Each teacher should be close to every child individually, to recognize child’s special needs and conflicts in order to adjust the educational process of braille reading, according to them. (Sarah J. Blake LaRose, 2000)

3.4 Methods of Teaching Reading

There is a large number of methods that teachers can use, while teaching reading to beginners. Among them, the most commonly used are the phonic method, look and say, learning experience approach and the context support method.

3.4.1 Phonic Method

Phonic method is the most common educational method of reading and writing in every language. Through this method, children learn the alphabet, the names of the letters and the sound they make when pronounced. Subsequently, they start learning how to blend two letters together in order to make simple words, and then add more
letters. Children can use phonically written books, to learn easier regular words, as these books are interesting to young children. They should read every word out loud, in order to achieve the highest level outcome (Griggs, 2000).

Most children learn to read regular words and small sentences within three to six months, using the phonic method. The method supplies learners with tools, ideal to help them expand their vocabulary (Griggs, 2000).

3.4.2 Look and Say Method

Using the look and say method, children learn to read whole words and sometimes sentences, in contrast to phonic method where they read individual sounds. Teacher sounds a word and children repeat it. During this method, flash cards with individual words written on them are used. Sometimes this cards are accompanied with a related to the written word, picture. Teachers read out loud short sentences, consisted of a card combination, asking children to repeat them, while pointing at each single word. Alternative card sequence can present different sentences (Griggs, 2000).

3.4.3 Learning Experience Approach

Using learning experience approach, learners use their own sentences stemming by life experiences. They draw a sketch that represents a moment of their life, and the teacher writes a sentence about it. Sometimes this method is used firstly, with a view to help children connect their drawing with the sentence written above, as a form of communication. This method, helps with child’s concept and
vocabulary development, as offers an interactive way of learning (Griggs, 2000).

3.4.4 Context Support Method

When children start reading themselves, a useful tool to improve their reading skills, is a book. For every child, there is the appropriate book, related to its interests. If the book is close to the child’s interests it can engender enthusiasm as children are looking things to rely on. For example, books related to cars would be more interesting for boys than books for dolls which would be in the field of interests for a girl (Griggs, 2000).

3.5 Tactile versus Visual Reading

Various research studies by Kosman and Castellano (1997), Harley, Truan and Sanford (1987) and Holbrook and Koenig (1992) support that people who are visually impaired, should train the rest of the senses like hearing and tactile sense, as they will replace vision for information collection.

Reading is important for three basic reasons. The first reason, is that when a children learn to read by their own, without the need of further help, they can do much more learning by their own. This can give them the advantage over the rest of the children when learning their subjects. Moreover, the second reason why reading is important, is that feelings, experiences, ideas or situations that usually can not be communicated in everyday life, can be written instead. Books, magazines and newspapers is a way to communicate them, and reading is the tool needed to receive the. Last but not least, reading is the most important
tool for information gathering, about the environment, helping to collect and respectively use them (Brunner, 1996).

The basic point, where Braille reading differs from visual reading, is the sense used to collect information. While in visual reading people use vision, in Braille reading they use tactility.

Kusajima (1974) came into some conclusions when researching the two different types of reading (tactile and visual). These conclusions are still valid and can help teachers understand the two processes. Kusajima summarized the different characteristics of efficient visual and tactile reading as follows: “Good visual reading is characterized by a small number of short regular pauses, no regressive movements and well-adjusted return sweeps combined with a deep and accurate understanding of the meaning of a text”. On the other hand, “Good Braille reading is characterized by few zigzag, up-and-down, or fluttering movements, uniform pressure of the finger on the page, no regressive movements and well-adjusted movements between lines with the help of both hands combined with a deep and accurate understanding of the meaning of the text”. As a result of Kusajima’s research, perception seems to have a close relation to movement during Braille reading. Subsequent research by Mangold and Wormsley (1978) also proved that movement is an important key in developing good Braille reading skills. This difference in perception between Braille and print reading, has significant impacts on the skills that a Braille reader needs to learn. This is the reason why teachers should make sure that their strategies keep up with the ways, Braille readers gather information (Rex, Koenig, Wormsley, & Baker, 1994).

In print reading, is not strongly needed teachers to observe the mechanics used to read, which may be, the movements of the eyes. On the other hand, the Braille teacher should help students develop advanced hand movements and tactile skills in order to become
efficient readers. As Kusajima (1974) supports, “Many teachers think that they can teach tracking or the ability to follow a line of Braille across the page and down to the next line, by itself. As a general rule, therefore, teachers should pay close attention at the beginning of Braille reading instruction to teach the child how to move his or her hands on the Braille materials and to constructing materials that allow for movement across lines and characters in the manner of the most efficient readers”.

3.6 Complexity of the Code

Braille reading and writing differs from print. Braille is a more complex writing system with more symbols needed to be learned by its own users. As a result, Braille readers need more time to learn reading than print readers do. Generally, the most of the print symbols except some marks, are presented at the first grade.

However, children’s vocabulary would not contain all of the Braille symbols and contractions until they have reached third grade. However, reaching the third grade may not ensure that children are able to recognize or interpret all the Braille symbols appear. Except for the symbols Braille readers should learn, they should also learn rules of usage of the Braille symbols. As a result, Braille readers need more time to learn their literacy, while print readers can move on beyond learning the alphabet.

3.7 Teaching Braille to children

Children and adults learn to read in a very different way and time. In fact, children can learn reading in many different ways, depending on their abilities, motivation, interests and sometimes their mood. This is
the reason why teachers should know a wide range of teaching methods, in order to select the most suitable every time (Mousty & Beterlson, 1985).

Teaching Braille to visual impaired children is not only teaching them just the meaning of the Braille symbols and the sequence of the Braille cells. Visually impaired children learn to read Braille symbols in the same manner as young sighted children learn to read printed letters of the alphabet. In both situations they learn the meanings of symbolic representations and how they form words and then sentences in turn. Many teaching methods as presented before may work for both sighted and visually impaired children possibly with some modifications (Holbrook & Koenig, 1997).

As visual impaired or blind children learn how to write braille, the method used, needs to be developmental. According to Laurel J. Hudson (2014), “we need to look at readiness for formal instruction, and then we need to adjust our pacing, expectations, and activities according to the learning needs of young children. In the guidelines that follow, these approaches are addressed”.

Before children start a formal Braille writing curriculum, they should firstly be able to isolate their fingers’ movement and additionally their thumbs, learning how to press each one independently. There are many ways children can strengthen their fingers. For example, playing with clay can help them exercise their fingers and make them stronger while playing. Moreover, it would be helpful if children already have some experience with braille symbols, before they start learning them formally. Lastly, because Braille is based on spoken language, they should be able to speak the language or even write letters, communicating with others.

Hudson, created a process that helps children read and write Braille, while being excited and confident about their results. Through this
process, children understand why Braille writing and reading are important, and how these two types of communication are strongly connected together. This process has as a result, children start creating their first symbols, learn how to read them and become faster in reading and writing Braille. It has three (3) main steps:

3.7.1 Step 1: Make It Fun

This step emphasizes the fact that “play is the work for children”. While children enjoy learning and especially when they have fun during learning Braille, they would easily accept it and the learning process will become faster. The possibilities to reject the learning process are less if they look at it as a game. Teachers can make braille learning become fun, by using children’s own ideas. Another way to make it fun, is to use music, such as singing or listening an alphabet song while writing the ABCs.

The most important thing during this step is to let children live the experience and act as they want. “Let them pretend to read as they move their fingers across pages, even if they have no idea what the letters and words say”, Hudson says. As well, they should feel free to form patterns pretending to write their own words. Children usually love copying adults’ actions, and even more when adults try to read back what they have created.

At the beginning of the curriculum, adults should happily accept all the attempts children do to write or read Braille. Subsequently they should try guide children to read and write real words, have the right posture and decode words every time one step closer to success. The
key at this step, is that adults, should never discourage children but instead enthusiastically accept what they do.

3.7.2 Step 2: Make It Meaningful

Children should experience whole events, like finding a book or reading it and write in Braille. It takes time for a child to run on a shelf, find a book, then take it to his desk and read it or take a piece of paper, insert it to the Braillewriter and produce text. However, experiencing these events, allow children create their own literature processes, and develop them.

Furthermore, children should witness adults reading and writing braille. By observing adults write articles and texts using Braille, they become motivated to act like them. The sounds of the Braillewriter, the paper loaded in can also influence children in a same manner. With these models, they become motivated to do literacy, themselves.

Although Braille reading and braille writing are quite separate processes, adults should combine Braille reading and writing simultaneously. Braille writing and reading are based on different sensory systems. Tactile and motoric sense are used for reading and kinesthetic/proprioceptive and motoric for writing. Understanding these differences between them, allow children integrate reading and writing. This, sets the stage for more advanced literacy development, by writing more integrated texts and reading them back. Finally, give children the opportunity to produce braille characters which are meaningful to them, like their name.
3.7.3 Step 3: Make It Developmental

During this step, adults should give the leadership to children at some point. Letting them choose a letter of the alphabet and write down names beginning with this letter for example, will motivate them more to participate thoroughly.

Different combinations of written letters which use different and less “functional” fingers when using the Braillewriter, will develop the ability in writing Braille.

Short lessons, should be scheduled, expecting speed and stamina in writing and reading Braille, only at the end of the curriculum. Young children can pay attention only for a short time. For this reason schedule short and quick lessons. Physically, it takes time to learn how to maintain correct reading and writing posture and finger positioning. As lessons progress, they can gradually become longer.
4. Designed products for visually impaired people – Market research

Nowadays, society is described as a society of large goods consumption, in order to satisfy a variety of needs. These needs can be described as the basic needs to live or on the other hand, as additional needs, created by the world’s overconsumption trend. Due to products addressed to visually impaired people, this phenomenon is not so extended. This may happen even because these products are not able to fulfill all the generated needs, even, because their price or availability does not make them accessible to the general world. Nevertheless, there are designed products addressed to people with visual impairment. During a research, designed products addressed to this target group were found and listed. These products can be grouped in six categories:

1. Clocks & Watches
2. Living aids
3. Electronic devices
4. Mobility
5. Kitchen oriented products
6. Education & Leisure

Some products may fit in more than one category, but they are introduced in the category closer to their function and field of use.
4.1 **Clocks & Watches**

In the first category, clocks and watches there is a variety of devices designed for visually impaired people. It includes, mostly, portable small hand watches using new technologies able to let visually impaired people tell the time. There are also some table and wall clocks that tend to leave behind as technology has overpassed their use.

The Tactile Watch, designed for visually impaired people (Picture 4.1), uses tactility as raised minute and hour dots, positioned around the watch screen, to know the current time. The watchband material is flexible rubber I, making usage easier for the blinds.

![Picture 4.1: Tactile Watch (Source: www.trendhunter.com)]
4.2 **Living aids**

The next category includes everyday small products, that involve functions unnecessary for vision able people but at the same time functional for visual impaired people. As many functional tasks are easily getting through by vision able people, although, they seem complicated and even impossible for visually impaired people and specially blinds. These products, include functions that help blind people complete routine everyday tasks.

Sometimes, having a meal can be a Herculean task for visually impaired people. Tangibowls (Picture 4.2) have been designed to help them enjoy their meal with less effort. Tangibowls is a set of tableware, and it has been designed, trying to make dinning an easy task for blind people. It consists of a tray and 5 bowls. The trace has five shaped slots, one for every bowl.

There’s a built-in magnet in each bowl able to keep it stable on the tray. Different textures between the bowls help the user identify them.
The Tray
1. Single, straight arrangement
   - to make a comfortable moving line of the arms.
2. Distinct textures on each separated part of the tray
   - Each of them correspond with the texture of each bowl, to provide
     the users with information about the position of bowls.
3. Built-in magnets - to fix the bowls on the tray securely.
4. Raised hills - to prevent the bowls from getting knocked off the tray.
5. Handle - to move the set of tableware easily.

The Bowls
6. Angled edges & Handle
   - to optimize the hold. (People with visual impairments usually hold the dish up to their mouth in order not to spill foods)
7. Curved inner side - to help foods naturally slide to the tilted side.
8. Narrowly curved edge for human mouth - to slide foods seamlessly into the mouth.

Picture 4.2: Tangibowls (Source: www.idsa.org)
Similar design, the See With Fingertips (Picture 4.3) is a product for the blind, which is able to help them hold the food-plate with hands and eat confidently, without spilling out the food. The shape of each alcove is designed in order to be recognizable, using Braille symbols.

On the other hand, to help the visually impaired carry out everyday activities as vision able people do, designers are coming up with new
innovative products. The Credit Card for the Blind (Picture 4.4 & 4.5) is one of them. When a blind person uses his credit card, it is impossible for him to check the billing amount. For this reason, this credit card, after being swiped over the card reader, requires the card owner’s signature, making use of his fingerprint recognition. The payment sum is displayed over the card using Braille symbols. By this way, shopping can become an easy everyday task for visually impaired people.

Picture 4.4: Credit Card for the Blind (Source: www.yankodesign.com)

Picture 4.5: Operation of Credit Card for the Blind (Source: www.yankodesign.com)
4.3 **Electronic devices**

Another category of products are electronic devices. This category includes products that their function is based on electronic systems. Mobile phones, as well as reader assistants, are some of them. Using the continuous technological development, they aim to eliminate some certain abilities that can help people with disabilities who try to overcome them.

Technological development becomes more visible day by day, and many innovations are being presented. Many of these innovations are also invented for people with visual impairment. The Voice Stick (Picture 4.6 & 4.7), is a concept which provides text scanning for the visually impaired people. As its name suggests, when the stick is used to scan the printed letters, the O.C.R (Optical Character Recognition) function “reads” the text to the user, converting text into voice. It is a quite innovative and practical product as it can help visually impaired people read their letters or a newspaper for example, tasks that vision able people can easily do.

![Voice Stick Image](Picture 4.6)

*Picture 4.6: Voice Stick (Source: www.designtoimprovelife.dk)*
On the other hand, Siafu (Picture 4.8) is a PC designed device, able to give people with vision loss or impairment a more integrated computer experience. Its function is similar to a tablet with the only difference that allows the user interact using tactile sense. It uses a conceptual material called magneclay or magnetized liquid which creates a tactile surface on the screen, via a controlled electromagnetic field.
Siafu’s magneclay material can generate braille symbols on the screen, allowing users to enjoy reading digital content as vision able people do with their computers. On the other hand, it utilizes a 2-D to 3-D image conversion technology to project images on the screen as shown in Picture 4.9.
Furthermore, mobiles have become a part of our life. Mobiles have become tools of higher necessity nowadays. Many visually impaired people, have the ability to recognize colors, lights and of course surfaces. Designer Takumi Yoshida, gives these characteristics through color illumination and identifiable keypad, to visually impaired people, with a mobile phone called SÉNS (Picture 4.10).

![Picture 4.10: SÉNS phone (Source: www.taqumidesign.jp)](image)

SÉNS, combines touch sensors and regular mechanical keys to provide real-time audio feedbacks. Whenever user presses a key, SÉNS sound the key he has pressed.

Once the user is sure his finger is on the correct key, he then can press the key just like on any other standard phones. Once a key is pressed, another ‘click’ sound is fed back to confirm the input (Picture 4.11). The tactile surface also helps the user navigate his fingers on the keys and select the desired one. This system is essentially an audio version of ordinary mobile phones. It provides more efficient interactions and reduces the chance of mistakes for people with vision disabilities.
4.4 Mobility

There are products that work as guides, in order to improve the mobility of visually impaired people. Mobility, outside of the well-known home environment, is quite difficult and a real challenge for this group of people. For this reason, tools, used to transcend these difficulties, have been designed. The most common mobility and orientation tool is the cane. The cane, even in its simplest form, can assist blind effectively. The familiar to all white cane, is now, equipped with additional technological based features, as GPS and voice maps.

“Spot Stick” concept (Picture 4.12) is a modular system that can be attached to an ordinary cane. When a blind person uses public transportation, it’s hard for him to identify the correct route or the bus route numbers. Due to their disability or even because of miscommunication, they might end up in a wrong destination. An other problem faced, by this group of people, is the road crossing especially during night, or walking among crowded places. Spot Stick concept features R.I.A.S (Remote Infrared Auditory Signage) receiver technology that helps people receive the bus number and routes name directly from the bus.
On the other hand, while crossing the road, especially during night, a built-in red LED light notices cars about the visually impaired person.

Similarly, the Safe Stick (Picture 4.13), a walking stick for sight-impaired individuals, utilizes a network of checkpoints at landmarks, like bus stops or intersections in order to help users navigate with safety. The design relies as well, on R.I.A.S (Remote Infrared Auditory Signage) technology which notices the user about his position and some information for the landmark he is close to. For nighttime use, a bright red LED flasher gives additional safety by notifying drivers of the user’s location.
An other design, having the same function, but is used in a different way, is Supersonic Stick fitted on the wrist of Blind People (Picture 4.14). It uses “supersonic signals” aka sonar to both send out signals and receive them back, giving a warning to the user of possible danger using sounds and vibrations.
This design gives the ability to the user to “see” what happens around him as it replaces the sense of vision.

Picture 4.14: Supersonic Stick on the Wrist (Source: www.yankodesign.com)

4.5 Kitchen oriented products

Kitchen is the space where natural primordial needs about food and water, human has. There are many different designed products for blind for kitchen oriented tools. This variety is expected, as these needs have to be fulfilled regardless gender, age or other social or economical parameters. Visually impaired people, encounter everyday tasks in the kitchen as a result of daily routine that they deal with. Cook tops,
cooking utensils and tools are modified in such a way, that user can handle them easier. Sounds, tactile elements like surfaces, create a base to visually impaired peoples life, for independent living.

The Pitcher concept water container (Picture 4.15) features a pitcher, which can produce particular sounds when it is hit. By this way, users can determine if the pot is empty or not without opening it. The metal handle of the pitcher, works as a tuning bar. When there is no water inside the pitcher, the sound produced, is the same as when the ball hits on both the body and the handle of the pitcher. On the other hand, when the pitcher is full, the sound has a higher tone than that of the handle. Using this product, the user can easily determine the level of the water inside the pitcher, by comparing the different sounds.

Picture 4.15: The Pitcher concept water container (Source: www.petitinvention.wordpress.com)
Designed using the same logic, the Buoy Cup (Picture 4.16), uses the sense of touch to help user calculate the volume of the liquid poured into the cup, or to be notified when the cup is full, as a component on top of the handle, taps the user’s finger.

Picture 4.16: Buoy Cup (Source: www.yankodesign.com)

Cooking also, can be an easy everyday task for any person, but for people with visual impairments it may be a really complex one. Due to many technological changes, a lot of products are making their entry into the market. One product to be mentioned is Sentino Cook-top (Picture 4.17). It has been designed in such a way to make cooking, simple and efficient for visually impaired people. Using this product, blind people can easily turn it On/Off, locate the cooking surfaces and feel the power volume selected.
An important point to be mentioned, is that none of these products uses Braille, and as a result they can be used worldwide as they have been designed, overcoming the linguistic boundaries.

4.6 Education & Leisure

Last but most important category, as closer to the topic of this study, is the one introducing leisure products that have primitive educational role addressed mainly to younger users. There are various educational toys, for visually impaired children, including leisure tools, able to enhance the mental and physical abilities of them. Books, puzzles, Braille games and tactile maps are some of the items that are introduced in this category. They use combinations of different materials, textured surfaces.

This category can be separated into three subcategories:

a) Regular Toys Suitable for Visually Impaired Children
b) Toys Designed and Produced for Visually Impaired Children
c) Toys and educational play tools about Braille
4.6.1 Regular Toys Suitable for Visually Impaired Children

In this sub-category the toys introduced, were not designed with a target group of visually impaired children. However, their tactile surfaces, the materials they obtain, colors and generally their features, make them ideal for visually impaired children.

- Tactile sense:

Feeling different textured materials and surfaces, is a very important point for visually impaired children. The toys in Picture 4.18 are specially designed in order to develop the children’s senses. Their bright colors and the sound effects excite children. The first one, is also suitable to play as a ball and the others are 3D models of animals. The features they provide, are suitable for the development of cognitive skills, tactile and hearing sense of visually impaired children. There are many toys like these examples, having as main purpose the improvement of texture awareness.

![Picture 4.18: Toys Designed by Several Textured Materials. a)Loveys Chime Ball by Kids Preferred. b)Musical Inchworm by Lamaze. c)Octotunes Musical Toy by Lamaze. (Source: www.kidspreferred.com and www.lamazetoys.co.uk)]
The toys in Picture 4.19 have textured surfaces using only one material forming several patterns. While playing with these toys, visually impaired children, are able to develop sensitivity of their fingers.

![Textured Toys](image)


The next one, is a toy for elders actually. On the other hand, the tangle toy is also suitable for visually impaired children. Building blocks is the main purpose of this toy, which let children use their imagination and develop their creativity. There are many and different building block toys using different materials, shapes, colors, aiming to different target groups. The toy in Picture 4.20 is a version of a wooden building blocks toy containing magnets within blocks, in order to fix the blocks together.
The next two toys (Picture 4.20) are made to develop children’s art and craft skills. As their main feature is creating 2D shapes, children can use strings to create their own shapes. This feature makes them suitable for visually impaired children. Being able to use bright colored strings, create different textures and many different shapes makes them ideal toys to develop creativity of visually impaired children. With Wikki Stix (on the left) children may demonstrate different shapes, small maps or guides or even some drawings. Additionally by playing with String Along Lacing Kit (on the right) children can use different pattern cards in order to copy them and initially learn how to make their own patterns after a while.

The textured plates in Picture 4.21 are mainly placed under the paper in order to color over them. By this way, the patterns on the plates are copied on paper. On the other hand, this toy can be used by children with visual impairments. Using the plates and reading the tactile patterns, children may easily learn, shapes, animals etc. It may also be a good exercise for fingers’ tactile sense.

![Picture 4.21. Teach Me Shapes by Roylco. (Source: www.amazon.com)](image)

- Auditory sense:

Musical instruments or even toy models of them always draw children’s attention. Producing sounds and even songs by playing the musical instruments, can develop visually impaired children’s sense of hearing. (Picture 4.22)

Bop it (Picture 4.23) is a toy that is able to develop the reflex of children. When it is turned on commands like “bop it”, “twist it”, “pull it”, “spin it”, “flick it” and shake it” are used randomly. “Bop it” is the command of hitting the middle of the toy, on the black part of the toy. The other commands are applied on in different colors and actions. The last command for example, refers shaking the whole toy. Playing with this toy, children can improve speed, agility and co-ordination of their movements, motor and memory skills.

Picture 4.23: Bop It XT by Hasbro. (Source: www.hasbro.com)

- Motor Skills:

Moving around and even walking is one of the hardest things during childhood. Toys like the Walk N Roll in Picture 4.24, are helpful for visually impaired children helping them overcome difficulties in mobility. Moreover, Walk N Roll produce sounds which also attract attention of children. It can be used as a white cane, for children.
Physical exercise is very important for visually impaired children. In some unknown environments it is difficult for them to exercise, or even move around. As a result, the toys like tricycles with push handles and trampolines, like in the Picture 4.25, are able to help children have enough physical activity. The only thing is that they always need an adult to take care of them.

Picture 4.25: a) 3 in 1 Trike by The Little Tikes b) Trampoline by Springfree. (Source: www.ableplay.org)
Cognitive skills:

The Danish craftsman Kay Bojesen (1886-1958) designed the toy elephant in 1903 and the toy monkey in 1951 (Picture 4.26). These classic wooden toys, are suitable for visually impaired children because of their 3D form. They represent animals which children could never touch and so understand their form. Toys like these help children imagine how these animals look like. The toys have animated parts presenting the body moving parts of the animals.

![Toy Elephant and Monkey](source.jpg)


Also as in many wooden toys, the natural wooden texture of the toy, is a value for the children’s tactile sense development which should be taken into account.

Sliding puzzle is a type puzzle which would normally be not suitable for visually impaired children. However, this specific puzzle, is a three dimensional versions of the ordinary puzzles as shown in Picture 4.27. By playing with them, children are able to develop cognitive and fine motor skills.
4.6.2 Toys Designed and Produced for Visually Impaired Children

There are toys and play tools specially designed and produced for visually impaired children. They can also be categorized, as the previous sub-category, by their influence on senses and skills used or developed.

- Tactile sense:

There are many toys suitable to develop children’s tactile sense. The toys presented below, are played by matching the same pairs together (Picture 4.28). Different materials are in order to provide different textures.
The toy set on Picture 4.29 is an example of toys presenting a variety of patterns to create different tactility. The main difference of this toy set, is that it allows children to feel the patterns not only with their hands but also with their feet too. This is a well-designed toy as it develops tactile sense and cognitive skills not only by holding it but also when stepping on it.
These strips set (Picture 4.30) helps visually impaired children to draw a picture. Children place the tactile parts on the black matte surface in order to create the shapes they want. After all, they can feel their creations using tactility.

![Picture Maker Textured Strips](source: www.aph.org/advisory/2008adv02.html)

- Auditory sense:

An example of toys specially designed for visually impaired children able to improve their auditory sense is the Sound Box set (Picture 4.31). Its function is similar to memory game, but it works with sounds instead of pictures. Six (6) different sounds for twelve (12) wooden blocks, create same sound pairs. Children try to match the same sounds while playing. Usage of auditory sense and development of it, is essential for these children.
• Cognitive skills:

Most of the memory games, use 2D elements, like cards. The play set in Picture 4.32 is a 3D version of the well-known memory game which has been designed for visually impaired children. This group of children needs to develop memory skills. Playing with this toy, children try to pair same geometrical shapes. It is also suitable for more than one players so it can also improve communication skills and social relationships.
Edushape Company, uses different patterns for every color to produce building block sets as shown in the Picture 4.33 below. This toy is suitable for visually impaired children who cannot distinguish colors. They can use their tactile sense in order to compare the different parts and create shapes.


There are many puzzle games for children. These puzzles in Picture 4.34 are toys suitable for visually impaired children. By using only a few colors they higher the level of contrast and underline the patterns and shapes used by visually impaired children. Dominos and tic-tactoe games on the Picture 4.34 are some examples of them. Domino, created by Guidecraft, uses textures instead of Braille symbols making it appropriate for children who do not know how to read Braille.
An other game familiar to almost everyone is chess. Redesigned, chess for visually impaired people uses simple dots to identify the chess squares (Picture 4.35). There are holes in the middle of every square which can be fitted with the pins under the chessmen. This provides stability of chessmen. There are also pins on the top of black chessmen in order to separate them from the white. Furthermore, the chessboard provide different level between the squares. The chessmen can be easily identified using tactile sense, as different shapes are used for chessman.

• Motor Skills:

Playing with a ball is a usual activity for children which provides physical exercise. According to their size, they can develop fine and gross motor skills. For visually impaired children there are many types of balls (Picture 4.36). They contain bells producing sounds when rolling in order to be easily located by visually impaired children.

Picture 4.36: a) Giant Jingling Bell Ball b) Foam Bell Ball c) Goal ball d) Reizen Audible Football. (Source: www.rnib.org.uk)

4.6.3 Toys and educational play tools about Braille

There are some toys aiming to train children on Braille learning. As main function, they tend to make children practice on Braille symbols by using their fingers’ tactile sense. These toys can easily help to improve children’s both tactile sense and cognitive skills. They can become pleasant educational tools as children learn while playing.

The Peg a circle on the Picture 4.37 is a toy that helps children develop fine motor skills. It is designed to teach children the notions, like next, sequence, clockwise, and counterclockwise. Touching the toy from top, children can feel the pegs like Braille dots. They learn how to array them and follow the order of them.

![Image](http://kcmcnew.umf.maine.edu/includes/kcmc/itemPg.php?cat=296&item=3044)

Picture 4.38: Brailllin Doll by Once.
(Source: http://kcmcnew.umf.maine.edu/includes/kcmc/itemPg.php?cat=296&item=3044)

The Brailllin Doll (Picture 4.38) is a playful way of teaching Braille alphabet to visually impaired children. It is commonly used to Schools for visually impaired children, as a teaching tool. The dots on the body of the doll can be pushed in and they come out again by a second puss. For every combination of dots pushed in, the doll sounds the letter formed.
The sliding puzzles on the Picture 4.39a is designed for blind children who know how to read Braille. There are letters from “a” to “o” on the puzzle. The purpose of this toy is the same as in every puzzle game. Children have to put the parts in order from “a” to “o” from upper left to down right. Another Braille toy is Braille System, produced by Tack-Tiles (Picture 4.39b). It has small parts, like bricks. On the top of the parts there are Braille symbols referring to letters, numbers and other Braille punctuations. On front of every brick, there is the equivalent letters or number in Latin alphabet, so parents can help children while playing. Playing with this toy, children can create words or phrases. Providing a similar way of use, sliding puzzle in Braille alphabet produced by Eni Puzzles (Picture 4.40) is a cylindrical puzzle, using numbers from one to eight in different colors written in Braille. Playing with this toy, children can create many combinations between numbers on columns or rows.
The Touch and Tell book on Picture 4.41 is a unique example of dots, used to present a whole picture or a shape. Using this book, children are getting used to the Braille writing system, as they “read” shapes with tactility. The usual avocation with the book, makes later education easier for them.
Mandy Shuk-Man Lau won the design award of Core77 in strategy and research category for her toy design called “Reach &Match” in 2012. The toy set uses both sides. One side is about developing tactile senses and the other side is for developing Braille alphabet skills. The addendum of sounds combined with the different shapes, makes the toy ideal for any skill development.

4.7 Evaluation

In order to evaluate the quoted examples of the exciting educational and leisure toys, a table was used with the toys presented vertically and the senses and skills they develop, horizontally (Table 2). With a view to develop physical, language, social, motor and cognitive skills, playing is an easy way for children to achieve it. In table 2, the physical development is used as fine and gross motor skills. Moreover, the development of social and linguistic skills are combined as social development.

The skills gained while playing each toy, are marked with a tick symbol (✔). Not only the features toys provide, but also the play types of them are equally considered.

In the table 2 audio and tactile senses are both placed under the heading of senses. Vision, taste and smell senses are excluded as they are not commonly used in toys for visually impaired children.
Table 2. Exampled Toys and the Purposed Skills and Senses.

<table>
<thead>
<tr>
<th>Exampled Toys (respectively)</th>
<th>Motor Skills</th>
<th>Cognitive Skills</th>
<th>Social Skills</th>
<th>Senses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fine</td>
<td>Gross</td>
<td>Mind Map</td>
<td>Educatory</td>
</tr>
<tr>
<td>Loveys Chime Ball</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musical Inchworm / Octotunes Musical Toy</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Squidgie Ball/ Super Yummy/ Tangle Toy</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jungle Magnetic Block</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Wikki Stix</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>String-Along Lacing Kit</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Teaching Me Shapes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Big Drum / Oval Xylophone</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bop It XT</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Walk-N-Roll</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 in one Trike</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trampoline</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Toy Elephant / Monkey</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3D Slide Puzzles</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Touch and Match</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rull’s House</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tactile Turn’n Match</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tactile Disks</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Picture Maker</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Interpreting the table, the strong relationship between the fine motor skills and tactile sense is obvious. An other well seen thing is that most of the toys develop these two skills, as they are the basic things which must be involved when designing toys for visually impaired children.

Perusing the table, we can observe that there are not many toys that develop gross motor skills of visually impaired children.
When the table is checked again it is obvious that there is not any toy or play tool which can combine Braille and alphabet learning. However this is also a vital need for visually impaired children. They need to do strengthen their learning ability and the best way is practicing during playing.

Another skill that is not mentioned sufficiently as a feature of the toys, is linguistic skill. As described until now, by exploring the different toy designs, let as draw conclusions for determining the design criteria such as materials used and textures, the importance of them, the posture and the fingers’ usage.

To conclude, there is a wide variety of toys designed and produced for visually impaired children in the market. Some of them are not designed for visually impaired children but their features make them ideal for them. As Aktürk Ablan mentions, “using high contrast and bright colors, and some more variety of textures in designs is enough to make the toys more suitable for visually impaired children. In addition several textured materials in the toys are essential for the development of tactile senses of every child”. 
5. Visually Impaired Children and Playing

At this part of the study, will be examined the relation and the influence of the play in the development of a child. More precisely, through this analysis, it will be clear, the relationship between children and games/toys as educational tools. To qualify such a toy for children, it is necessary to carefully design and test it, in order to determine the suitability of it for children.

5.1 Playing with Toys

Since the early years of human life, children were using different objects and materials to play. Children know the world through the objects used as toys. In the old days, the parents and the children were making their toys themselves and they didn’t buy them as they do now. Their toys were manufactured with materials being available, simple materials from the earth, such as stone, earth, wood, straw, metal, glass and paper. So, the toys were distinguished by simplicity, love, imagination, creativity and care by their creators. Even more, the construction process could be considered as a sort of play and entertainment. In all the above, Benjamin was referred to, in his book "On Children, Youth and Education", comparing these toys with toys of today, concluding, that modern toys are very majestic and striking in exterior, unnecessarily, losing their value of simplicity, humility and fun during game (Burton, R., 2011). Unfortunately, many times, modern toys are impressive but this is superficial, as they have no usefulness as learning tools, education and fun that they should had as toys (Pinkham, A. M., Kaefer, T. & Neuman, S. B., 2012).
In modern societies, toys are made to be very attractive to children. Each toy is made in such a way, having a history around it that is constructed by its company, to indicate to the child how it should be played. Thus, the child is not given the opportunity to develop its own imagination and to select a story for its own toy (Kaufman, Scott B, et al, 2012). Primarily, there is an opinion that the modern toys are a disaster in terms of growth and expression of creativity as well as imagination of children. An example that confirms this, is the existence of the organization "TRUCE" consisting of teachers, who professes the purpose to address the negative influences of media and marketing over children. In this organization's last annual guide, of toy selection, features for selecting toys high standards were published. According to this guide, a toy should have many different uses. Regarding to the use of the ideal toy, it should be able to be played by children of all ages, to be combined with other toys, it should also develop skills or new interests of a child, to be appropriate for boys and girls respectively, and be able to be played by one person only, or more (Andy Sharman, 2008).

Playing, has an important role in children’s lives. It can affect the physical, cognitive and psychological health of a child. It can also contribute, in a positive way, to children, to improve their skills, to externalize and enhance their strengths and to educate and socialize them. Harley (1987), mentions that a toy based on standards, other than the abovementioned, might destroy the imagination of children even though the toy remains functional. A toy by its own, should not determine the play activity, just to be used as a tool by the child. Children should have control of the play activity and their imagination would be their only guide.
5.2 Visually Impaired Children Playing with Toys

Through playing activity, children have the opportunity to discover and learn new things about the world, exploring features of toys and imitating roles or movements while playing. However, this process is different and more difficult for visually impaired children. They need a more specific approach. They need guidance and education regarding toys and play activity. Also it is important, the encouragement of these children in the exploration process of features of toys. This difficulty is also underlined in the article conducted by Lewis et al. as "[...] lack of vision making it harder for the children to detect the individual and collective properties of the toys they are presented with [...]"

It is known, that a disadvantage on a sense, strengthens and emphasizes other senses. For this reason, many of the toys designed for visually impaired children, include sounds in their operation functions. But a drawback with these toys is that older children need to train on using the sense of hearing and recognize sounds, over long distances, and not to focus on the sounds of toys, being isolated from the outside world as a result. However, acoustic toys continue to be useful for visually impaired children.

Another prevalent type of toys for visually impaired children, are toys based on the sense of touch. Hearing and tactile sense are two of the most important senses for visually impaired children. Toys tactile surfaces, should be made with materials that facilitate children recognize the different surfaces. As child touches the different materials and practices on this, develops the skills of tactile sense. Some guides propose materials for these toys such as wood, paper, fabric, plastic and metal.
5.3 Learning through play

Educational and psychological sciences present the aspect of “Learning through play”. Through play, children are able to learn easier and faster, as they do it pleasurably. They also get all the essentials needed to start their lives, acquiring social and cognitive skills. By this way, children are encouraged to gain new experiences in new environments to prepare themselves for a smooth integration in society. (Jack Kahn, Susan Elinor Wright, 1980)

Playing, broadens the horizons of children’s mind and enriches their knowledge. With a fun way, child manages to develop social and communication skills, to discover and externalize abilities that until then, they did not know, they had. The Vygotskian model of scaffolding indicates the play-based learning, where the teacher focuses on specific elements that come through the activity of playing, and teacher considers them as important. He emphasizes the positive elements that children have (positive psychology) and through this process encourages them to continue, as they develop their mental skills. The connection between, children’s participation in real life, and in imaginary playing activities, can be a challenge, as it develops children’s thinking. For the progress of the educational process, it is proposed sensitized intervention and adult support when it is necessary during play (Whitebread et al., 2009). Play-based learning can also be defined as: "...children being active and involved in their learning. Children learn best through first-hand experiences... the purpose of play-active learning is that it motivates, stimulates and supports children in their development of skills, concepts, language communication skills and concentration. It also provides opportunities for children to develop positive attitudes and to demonstrate awareness/use of recent learning, skills and competencies, and to consolidate learning." (Martlew, J., Stephen, C. & Ellis, J., 2011)
6. Design of the toy

At this part of the study the design process is described, as the design specifications are determined. Finally, the design of a new toy for visually impaired children is presented and its function is described.

6.1 Methodology

The methodology of design process follows the steps below:

- The definition of the problem: how the design of a toy for visually impaired children will be useful, and how it will help them.
- Collect information: examine the already existing similar products (Chapter 4).
- Brainstorming and analyze: definition of design specifications and initial sketches appearing them. Idea generation of new concept. Parameters from the research are being combined in order to accrue shape and forms.
- Model development: Sketching of possible solution. The first stage of new ideas is shown in simple free hand sketches which later become more accurate and the design intent is clear.
- Feedback: meetings with supervisor.
- Design improvement: 3D modelling show details and more specific views of the concept as well as it simulates the final structure and look and presentation of developed concept with clarity based on basic points of the concept creating a short comprehensive summary.

(Boeijen, et al., 2013)
Figure 2: The Design Process Methodology

DEFINITION OF THE PROBLEM - DESIGN SPECIFICATIONS

INFORMATION COLLECTION

BRAINSTORMING & ANALYZING

MODEL DEVELOPMENT

FEEDBACK

DESIGN IMPROVEMENT

FINAL DESIGN
6.2 Design specifications

As basic guidance, a designer must make sure products meet the design specifications. Design specifications are a list of requirements to which the design of a new product must comply. A requirement is an objective that any design alternative must meet. The product design specification should be directly influenced by the analysis of research. This will ensure quality of design and that the final product is fit for the purpose. A specification should include:

1. Product function
2. Overall dimensions
3. Materials
4. An outline of the appearance of the product
5. User requirements
6. Anthropometrics and ergonomics

More specifically, for the design of a toy for visually impaired children, the design specifications can be customized as:

1. Product function: toy inspired primarily for visually impaired people
2. Overall dimensions: as minimum as possible volume for innovative basic form easy to fit everywhere and also ideal for children.
4. An outline of the appearance of the product: rounded forms with no edges, tactile surfaces.
5. User requirements:
   - Comfort, easy to handle elements
   - Simplicity, no complex construction-minimal effort
   - Autonomy for the user
   - Safety
- Organization in storage
- Multi-stimuli elements
- Color and contrast
- Tactile surfaces

6. Anthropometrics and ergonomics: ergonomically designed for children

7. Environmental considerations: structure material

8. Long lasting value

6.3 Design Process

6.3.1 Definition of the Problem (Design specifications)

The design specifications which will be tried to be reached through this part of the dissertation, are:

- Design of a toy for blind or visually impaired children
- This toy should help children learn the Braille writing system while playing
- It should also connect the Braille writing system with the English alphabet
- It should include - activate the sense of touch and hearing

The designed toy, should help visually impaired children recognize both braille writing system and English alphabet. By this way, visually impaired children will be able to read in Braille and write in the English alphabet, as many times in everyday life it is necessary to write in alphabet letters. (Picture 6.1)
6.3.2 Information Collection

“The individuality of children dictates that a range of toys and games are necessary to address the specific needs and unique interests of each child. While many of the strategies used in the adaptation and design of play resources for visually impaired children are the same, the toys and games themselves reflect a variety as diverse as the children for whom they are designed”. (Hall, Lizewski, McCoskrie, 2006)

As analyzed in Chapter 4, there is a large range of toys designed for visually impaired children, or on the other hand, toys which have not been designed for this kind of use, but their materials, shape or surface makes them ideal for use by visually impaired children.

All these designs, help us discover the advantages of their use, their function and the senses they activate. Based on these characteristics, we conclude that the design of a new, evolved toy is an ongoing need. For this reason we involve the advantages at the new design, adding also new functions.
6.3.3 Product Development

After determining the design criteria, defining the “problems” which should be solved and gathering the information for the existing products, the first sketches were made in order to present the idea created through previous steps.

6.3.3.1 Sketches

As shown in Picture 6.2, the first sketch was made in order to present the idea for a new toy, designed for visually impaired children. The shape of the toy is cylindrical, consisted of three main parts. One ring-shaped part and two end caps. On the ring-shaped part, the English alphabet is projected all around the surface. On the other hand, each
one of the two end caps has thirteen (13) holes in several geometrical shapes, as much as the alphabet letters are. Furthermore, twenty six (26) bricks, each one shaped in such a way to fit in different hole, have the Braille symbols projected on their surface.

The main function of the toy, is the combination of the Braille writing system with the English alphabet. By rotating the toy, the child can “read”, by touching the surface, the alphabet letters. For every letter, there is a corresponding brick, with a Braille symbol on it. The child has to find the corresponding brick, among the other, with the right Braille symbol and fit it in the same-shaped hole.

By this way, the children are able to learn the combination between the alphabet and the Braille writing system, during playing. The most important part is that they can learn the alphabet and the Braille symbols at the same time, as well as the correlation between them. This is going to be useful in order to learn how to read and write in Braille, but also learn how to write using alphabet, to communicate with the sighted population.

Picture 6.3: Second sketch – connection of the parts
Subsequently, as shown in the second sketch, Picture 6.3, more details about the design took place. The need about the connection between the parts lead to a more detailed sketch in order to make it functional. The first three (3) parts are now replaced by five (5) ones. The main part (ring-shaped) remains the same. In the middle, there is a bored cylinder with a small protrusion (Picture 6.3 – No.1). Furthermore, two (2) parts on both sides, replace the end caps on the first sketch. They have a hole on their surface and a cylindrical rod, on each one, which helps them connect together with the ring-shaped part. The shape of the cylindrical rods are shown in Picture 6.3, No. 2, 3.

The connected parts are fitted in two (2) bases (Picture 6.3, No. 4, 5) on both sides in order to rotate. The two bases, feature the different shaped holes of the first sketch where the bricks can fit.

The function of the new design is now slightly different. While child rotates the main part to find a letter of the alphabet, the holes on the sides, releases two shaped holes on the bases. The child can now find the relevant brick and pass it through the shaped-hole released. Every letter of the alphabet has only one related hole, in order to prevent child make a wrong choice.

This change on the function of the toy, reinforces the learning process, by preventing mistakes.

Trying to make any possible improvements to the second design, the need of the stability between the rotating part and the bases came on the surface. For this reason, some changes on the connections between the parts were made (Picture 6.4).
As shown in Picture 6.4, the bases are now provided with cylindrical rods, as well as the connections of the rest of the parts have been changed. All parts are now connected in such a way that allows the ring shaped part, rotate with the end caps, regardless of the bases. The connections between all parts is shown in Picture 6.4.

6.3.3.2 Drawings

In order to start using CAD software to present the sketched idea, dimensions of the parts were needed. The dimensions are shown below on the pictures below (Pictures 6.5 – 6.9).
Picture 6.5: Dimensions of the ring shaped part

Picture 6.6: Dimensions of end cap 1
Picture 6.7: Dimensions of end cap 2

Picture 6.8: Dimensions of base 1
6.3.3.3 CAD Design

Having the final sketches done and the dimensions given, a CAD program was used in order to realize if the idea could become real and functional. Solidworks 2015 software was used to create the first designs (Pictures 6.10 & 6.11).
The different dimensional cylindrical rods, are able to fit in such a way that the middle three parts are stable together as the two external ones, are able to rotate. All the parts fitted together are shown on Picture 6.12.
6.3.4 Design Improvement

As the basic design was created, more details were added to the design, or some extracted from it, in order to improve it. As shown in Picture 6.14, the alphabet was designed embossed all over the ring part and a hole was added on both sides of the bases. Moreover, the bases’ edges were extruded so as to cover the ring’s surface and the letters. At the same time, a hole was created on the extruded edges in order to reveal a letter at a time.
Thinking of the ease of use and the ergonomics of the designed toy, an effort to decrease the number of the parts was made. The two endcaps were fixed to the ring, as shown in Picture 6.15 and the connections of the parts were changed as a result.

Picture 6.15: Endcap (blue colored) fixed with ring part
With a view to improve the function of the rotation, a rotation handle was added (Picture 6.16).

Picture 6.16: Rotation handle

As result of the changes described above, the connections of the parts were changed once more, ending up with their final form. The connections are shown below in Picture 6.17. The handle was designed in such a way to rotate only the ring and keep the bases stable.
During this design process, the tactile sense was covered by the embossed alphabet letters. On the other hand, as shown on the previous chapters, hearing is also a sense, which visual impaired people have developed. For this reason, a function was added on the toy design (Picture 6.18). A combination of small embossed dots (Table 3) next to every letter combined with five metal blades on the bottom of the toy, produces a note’s sound for every letter, when rotating the toy, a function similar to music boxes. The song produced is the “Mary Had a Little Lamb” a well-known song for children.
Table 3: Combination of dots in order to produce the song “Mary Had a Little Lamb”

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
On both sides of the ring part, twenty six (26) different shapes, thirteen (13) on each side, were designed recessed, in order to fit with the bricks. Every shaped hole works as a lock and the same shaped brick is the key. The shaped recessed holes are shown below in Picture 6.19.

![Picture 6.19: the 26 shapes on the ring part sides](image)

In the end, the edges of the toy were rounded up, to prevent sharp edges, and the Braille writing system bricks which fit in the shaped holes of the toy were designed. (Picture 6.20)

![Picture 6.20: Braille bricks](image)
As shown on Pictures 6.20 & 6.21 every brick is designed in order to fit the shaped hole which is released for every alphabet letter chosen. On the upper part, the Braille writing system is embossed. Under the Braille dots a line helps the orientation of them.

![Image of a bricks with Braille symbol](image)

**Picture 6.21**: Letter A corresponding with hexagon shaped brick with Braille symbol – A

In every shaped hole there is a small pin (Picture 6.22) which pushes the small embossed pins which produce sound, when the right brick is fitted in. By this way when all bricks are correctly connected with the shaped holes, the whole song “Mary had a little lamp” can be produced by rolling the handle.
Every time a letter of the alphabet is chosen, a shaped hole is revealed on the sides of the toy, left or right. The shaped holes are revealed alternately on the right and left side. The holes on both sides are designed in such a way that when a shaped hole is revealed on the right side, on the opposite side the hole is blocked, and the opposite (Picture 6.24).
Picture 6.24: revealed and blocked holes on the sides when a letter is chosen
6.3.5 Final Design

The final design was colored and rendered. The colors chosen were bright, creating additions between them. The material chosen was plastic, with different texture for every part. (Picture 6.25)

The outer surface of the toy, has a rough matte texture in order to be easily defined in addition to the inner part which has a shiny surface.

Picture 6.25: Final design
The embossed letters of the alphabet, have a matte finish to be easily recognized. Finally, the rolling handle is made of smooth rubber finished plastic for more friction (not slippery).

The bricks with the Braille symbols were designed in different playful colors for every brick, with the same semi-glossy texture. (Picture 6.26)

![Picture 6.26: Braille bricks](image)

6.3.5.1 Using the toy

After the design improvements of the toy were made, the final design was the output. To sum up, by rotating the handle, a letter of the alphabet is selected on the upper part of the toy. By finding the unique brick, with the same shape, as the one on the right or left side of the toy revealed, the child can fit the brick into the shaped hole. By this way, the sound pin is unlocked and revealed. When all bricks are fitted in, a song can be produced by rotating the handle. The followed steps are shown below in Pictures 6.27 – 6.31.
Step 1 – Choose the letter of the alphabet.

Picture 6.27: Step 1 – Choose letter “F”

Step 2 – Find the shaped hole revealed and “read” the shape.

Picture 6.28: Step 2 – Find the shaped hole revealed and “read” the shape
Step 3 – Find the corresponding brick with the same shape as the hole and read the Braille symbol on it.

Picture 6.29: Step 3 – Find the corresponding brick

Step 4 – Fit the brick into the shaped hole.

Picture 6.30: Step 4 - Fit the brick into the shaped hole
Step 5 – When all bricks fitted play the song.

Picture 6.31: Step 5 – Rotate the handle and play the song
6.3.5.2 Final Design Renders

Picture 6.32: Final design – Toy in child’s room
Picture 6.33: Final design – Toy in child’s room
Conclusion

The aim of this study was to determine the toy design criteria for visually impaired children and design a toy according to the determined design criteria, which would be able to help children learn Braille and the English alphabet at the same time, as well as to connect these two writing systems.

For this purpose, literature review, an observation study and a design process were carried out. In literature review firstly visual impairment and blindness were defined. Then being visually impaired was examined in four aspects: specific conditions, requisiteness, some techniques and tools used by visually impaired people. Lastly, features of visually impaired children, their playing and learning activity and some toys suitable for them were researched.

According to the design criteria, a toy which aims to help children learn Braille and the English alphabet was designed. The innovative part of this design is that helps children not only learn both writing systems, but also learn the correlation between them. By this way, the designed toy prepares the children for the needs of everyday life, giving the provision of writing and communicating with the whole community.

To point out, in the observation study the vital effect of practice is underlined. It is observed that the effect of impairment can be overcome by the help of practice. Here the repetition of acts, movements and skills gain value. All these activities take place in the activity of play. Because children do not get bored repeating only in plays. For this reason playing is one of the strongest tools of learning. In other words, play activity integrates exercise of life and learning.

“It is paradoxical that many educators and parents still differentiate between a time for learning and a time for play without seeing the vital connection between them.” - Leo F. Buscaglia
Bibliography


Budd, J., Frankel, L. and Thibaudeau, P. (n.d.) *A New Design Approach for Academia to Work with the Visually Impaired*. School of Industrial Design, Carleton University, Ottawa, Canada.


Erin, J. N.; Sumranveth, P. (1995). Teaching reading to students who are adventitiously blind. Re:View; (89)27(3) 103-111.


Family Health International (n.d.) Qualitative Research Methods: A Data Collector’s Field Guide. Module 1. Qualitative Research Methods Overview. Northeastern University, Boston, MA, USA.


Field Guide. Module 1. Qualitative Research Methods Overview. Northeastern University, Boston, MA, USA.


Hill, S. (2014). 5 amazing gadgets that are helping the blind see. Digital Trends. 20 June.


Kaufman, Scott B., Dr., Jerome L. Singer, Dr., and Dorothy G. Singer, Dr., (2012). The Need for Pretend Play in Child Development.


Pallasmaa, J. (2005). *The eyes of the skin*. Wiley Academy, Chichester, United Kingdom


The Centers for Disease Control and Prevention (CDC), National Center on Birth Defects and Developmental Disabilities (NCBDDD), *Facts About Vision Loss.*


United for Sight (UFS) (n.d.) Global Eye Health Statistics.


Appendix

Glossary

1. Visual acuity: a measure of the acuteness or clearness of vision, expressed as the angle subtended at the anterior focal point of the eye by the detail of the letter recognized. Visual acuity depends upon the sharpness of focus of the retinal image and the integrity of the retina and visual pathway.

2. Contrast sensitivity: the manifestation or perception of difference between two compared stimuli.

3. Visual field: the area or extent of space visible to an eye in a given position.


5. Diplopia: a condition in which a single object is perceived as two rather than as one. Double vision.

6. Visual distortion: any change in which the image does not conform to the shape of the object.

7. Macular degeneration: degeneration of the central part of the retina which results in reduced visual acuity.

8. Cataract: opacity of the crystalline lens or its capsule.

9. Glaucoma: an ocular disease characterized by elevation in the intraocular pressure, which causes damage to the optic nerve fibers entering the optic nerve, leading to loss of vision.

10. Diabetic retinopathy: a disease of the retina associated with diabetes mellitus, characterized by microaneurysms, hemorrhages, exudates, and proliferative retinal changes.
11. Presbyopia: a reduction in accommodative ability that occurs normally with age and necessitates a plus lens addition for satisfactory seeing at near

12. Retinitis pigmentosa: a primary degeneration of the neuroepithelium of the retina resulting in night blindness and progressive contraction of the visual field.