Guidelines for Tactile Books

TACTICOS

KA201 Strategic Partnership Project
2022-1-NL01-KA220-SCH-000085654
Lead partner: Royal Dutch Visio

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ACKNOWLEDGEMENTS

These guidelines are the result of an Erasmus+ project led by Royal Dutch Visio, the Netherlands in collaboration with four European partner organizations and two external advisors.

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Disclaimer

The recommendations are based on collective expert knowledge and experience from all members of the project and are available on the Tacticos website including a written version which can be downloaded. While every effort has been made to ensure that the written information and images, including references are accurate Tacticos does not accept any responsibilities for inaccuracies or omissions.

PREFACE

Our world is overwhelmingly visual and the ability to see and interact with the environment is often taken for granted. For children with visual impairments, growing up in this visual world presents unique challenges. Tactile books and graphics play a crucial role in their education, providing access to literature, stimulating cognitive and sensory development, fostering language skills, and promoting inclusion, equal opportunities and independence.

The "Guidelines for Tactile Books and Tactile Graphics for Children with Visual Impairment, Age 1-12 Years," is a comprehensive resource for educators, printing houses, publishers, parents and professionals. In an effort to bridge the gap with sighted children the guidelines offer ideas for concept building and storytelling along with practical strategies, insights and guidance. These include recommendations for designing different kinds of tactile books and tactile graphics. Beyond didactic and practical advice, the guidelines promote a broader understanding of supporting children with visual impairments and emphasize how tactile books can help to remove gaps in knowledge and enhance literacy and equal reading experiences.

Learning by touch is very different from learning by sight and as such requires specific pedagogical methods and guidance. Children with visual impairments have limited access to books with meaningful tactile illustrations, so they must learn step by step to explore, recognize, and understand them. From infancy through their school years, tactile books provide sensory experiences that enrich learning, creativity, and imagination. Often paired with real objects or 3D models, these books help children form mental images of stories and concepts. Joint reading activities with carers, educators, and peers also strengthen social connections.

The ideas and recommendations in the guidelines have been shaped by the collective expertise of professionals in education, printing houses, accessibility and design, as well as feedback from children who tested the two books developed for this project. As such the guidelines support a collaborative, cost-effective approach to creating engaging tactile graphics and illustrated books.

We hope these guidelines will inspire collaboration and innovation, empowering visually impaired children to explore the world through touch and multi-sensory learning.

INTRODUCTION

The guidelines for making tactile books, produced as part of the Erasmus+ funded project Tacticos, provide comprehensive practical advice and best practices for creating books that engage a child's sense of touch.

Tactile books open the door to stories, concepts, and creativity, specifically tailored to visually impaired (VI) and blind children. Through the sense of touch, these books provide access to ideas and information, helping children build mental representations of the world around them. Tactile books foster early literacy skills, allowing children to engage with narratives in a way that supports their understanding of language, spatial relationships, and abstract concepts. By exploring tactile images and textures, children can connect physical experiences with cognitive development, laying a strong foundation for future learning and comprehension. These guidelines address several key aspects of tactile book creation, including what tactile books are, why they are important, and how they are developed.

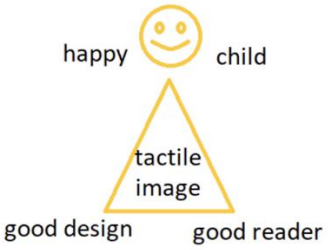
The guidelines are designed for various audiences, including parents, teachers, printing houses, designers, and anyone involved in creating or using tactile books for children. They explain what tactile books are, their various types, and their significance in promoting literacy and concept formation by helping children develop mental representations and understand complex ideas through touch.

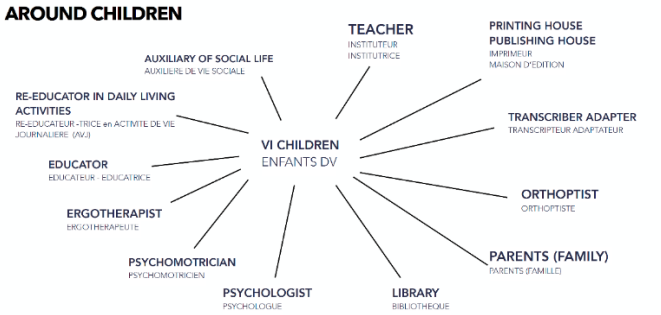
Detailed guidance is provided on designing and producing tactile illustrations, including suitable techniques and materials for different users. The guidelines also outline where these books can be found, their use at home and in schools, and the importance of clear instructions for effective engagement.

Additionally, the guidelines offer practical advice on developing tactile books, from brainstorming story ideas to designing tactile images, ensuring all stakeholders — from printing houses and designers to parents and teachers — have the tools they need to create meaningful and accessible books.

One important note is that the chapters have been written by different experts with varying levels of experience and English language skills. As a result, you may notice differences in writing style across chapters. Additionally, terminology such as "VI," "BVI," "tactile image," and others may vary. While we have chosen not to standardize all terms, a glossary and appendix are included for clarification.

One of the central ideas of these guidelines is that that everyone involved in tactile literacy—whether it's the parent, teacher, specialist, or child—should understand the underlying principles of tactile imagery, ensuring they "speak" the same tactile image language.





This document also acknowledges the wider network supporting VI children and the collaborative effort needed to foster their tactile literacy, recognizing the crucial role of teachers, specialists, and parents in guiding the tactile reading process. The guidelines provide both theoretical and practical insight into this process.

1 A SPECIAL BOOK FOR VISUALLY IMPAIRED CHILDREN

Unlike their sighted peers, children with a visual impairment have limited access to accessible books. Tactile books play a crucial role in their development and education.

Children with a severe visually impairment (blind or low vision) may not see their parents reading the paper or a book and they do not see what a sighted child sees in the street (for example the M for MacDonalds). Adults in their environment can help them by bringing the world to them.

Children with a severe visually impairment need tactile illustrated books with braille. They are a great way to foster the development of literacy and concept building skills but also to help visually impaired children understand their daily life. Tactile books stimulate imagination and help children expand and generalise their own experiences. Teaching children to explore tactile illustrated books with Braille should start from an early age (from 0 years onwards).

Reading a book can be fun and can stimulate the development of children in various ways. Being read to and learning to read is important for all children and surely this includes children with a visual impairment. Being able to read can give a source of lifelong pleasure and learning.

1.0 THE PLEASURE OF READING

Reading to children helps build a strong relationship, as it involves spending quality time together and enjoying a story. Children will remember the shared pleasure of being read to—whether at bedtime or during another quiet moment in the day. This is especially beneficial for young children (ages two to four) and for children with language or reading difficulties, as it can have a significant positive impact on their development.

Children with a visual impairment may not ask as often to be read to, so it's important to offer this activity proactively. Establish a fixed time and place for reading each day, and ideally, make time to read more than once a day. Draw the child's attention to the written text; for braille readers, explore the braille together. Use tools and media that support a relaxed and comfortable reading posture.

Blind and visually impaired children may not automatically notice or point out tactile illustrations in books the way sighted children do. They often need help recognizing that these illustrations are present. By being read to from an early age, they are more likely to develop a love for books that continues even after they learn to read independently.

Continuing to read aloud to older children and occasionally sharing a book together also gives you insight into their interests. This is important because both parents and teachers play a crucial role in selecting books over a longer period of the child’s life.

Reading can open many doors later in life, not only through knowledge and language development but also through the joy it brings. Books have a unique way of connecting people. As the child grows and develops greater tactile sensitivity, fine motor skills, and the ability to interpret sensory input, they

become better equipped to explore complex tactile illustrations—such as flat shapes, raised outlines, patterns, parts of objects, and distinctive features. [1]

1.1 LANGUAGE DEVELOPMENT

Early literacy refers to the knowledge children acquire about reading and writing before they can actually read or write. It is about laying the foundation, so that children have the necessary skills when they are developmentally ready to learn to read.

Early literacy involves sounds, words, language, and images. You can support this development by talking with your child, reading books, singing songs, playing with rhymes, and encouraging drawing.

Reading baby books to the child will evoke linguistic sounds (babble) and parents react to this babbling, which has a positive effect to the child's language development. Babies who are being read to aloud daily for more than 10 minutes, have a 2.5 times greater chance to start school with a sufficient vocabulary. Reading aloud influences language and reading skills. Children also learn how to hold a book, recognize letters and understand the connection between spoken words and written words arises as well as learning concepts.

Within the first 5 years every child has to obtain a basis lexicon. These words often refer to their world of experiences. They form the clue to learning other words relating to things they haven't yet experienced. The development of the basis lexicon of a blind child is a little different because their experiences of the world are different. They have to form a mental image on the basis of touch, hearing and smell, or by verbal explanation. This is more challenging for children with a visual disability but meaningful tactile books which are not based on visual concepts can help. Tactile books can also be source of gaining tactile language, words that refer to the things the child is feeling, such as bumpy, ribbed, dotted, rough, smooth, curved.

During the first five years of life, every child needs to develop a basic lexicon—words that typically relate to their immediate world of experience. These foundational words form the key to learning new words for things they have not yet encountered. For blind children, the development of this basic lexicon differs, as their experience of the world is shaped through touch, hearing, smell, and verbal explanation, rather than sight. This makes acquiring concepts more complex, but meaningful tactile books—not based on visual imagery—can be of great help.

A concept is an abstract representation of knowledge about an object, event, or idea, typically explained through words. While sensory experience is necessary for language learning, it is not sufficient; cognition and the ability to understand language are also required. A deeper and more extensive experience with a concept enhances understanding. When concepts are not fully grasped, language can become vague or "floating," a phenomenon known as verbalism (see Chapter 2 for further discussion on concepts). Clara Linders in the Netherlands introduced the term "Floating" language, because the concepts are not fully developed. The child knows something, but the concept is not complete.

[1] Ellen van den Broek , www.leesplezier/visio written in Dutch. Link YouTube video Leesplezier: https://www.youtube.com/watch?v=ijgLN0zGDhA

1.2 TOUCH AND BEYOND

1.2.0 WHAT IS TACTILE READING?

A tactile illustrated book contains images that can be felt by touch. Making these images meaningful for a child with severe visual impairment is an important aspect of the guidelines. Both braille and ink print are used to describe the illustrations and to support the child in discovering the joy of reading.

Figure 1.1: A mother with a blind girl, the girl explores the book "Crokato" made by Claudette Kraemer and her class with visually impaired children. (Photo Anneke Blok)

Being able to read through touch creates an inclusive literary experience for children who are blind or have low vision. Children should be encouraged to explore both the braille and the tactile illustrations. These illustrations are experienced through the fingers, rather than through sight. They are made tangible by using a variety of raised materials, allowing the child to feel shapes, textures, and patterns.

1.2.1 HOW TO EXPLORE A TACTILE BOOK

A very young child's ability to explore with their hands is initially limited by a whole-hand style of exploration—grasping objects and noticing only large areas of texture. Therefore, at this early stage, illustrations using real objects, larger textures, or bigger shapes are often the most effective.

Tactile illustrated books that include some words in braille support the early stages of learning to read braille. Over time, children can begin to read the story themselves. The presence of braille in books helps them understand that the braille words and text are linked to the narrative. It allows them to experience reading in a tangible way, and it can also be meaningful for family members or friends who read braille together with the child.

Blind children, or children with low vision for whom reading print requires too much effort, can learn braille either at special schools or with the support of an itinerant teacher in mainstream schools. Before formal braille instruction begins, children are introduced to pre-braille materials in rehabilitation centers or schools. These materials help develop the tactile skills necessary for learning the position of the braille dots, which form words.

Les Doigts Qui Rêvent, a publisher based in Dijon, France, has adapted many books into tactile formats. In other countries, tactile books can also be found in libraries and in schools for children with visual impairments [2]

[2] 'Touch sensitivity' https://nfb.org/images/nfb/publications/jbir/jbir14/jbir040101.html Designing Tactile Illustrated Books, by Philippe Claudet Tactual Profile* (Ans Withagen et al)

1.2.2 MULTI-SENSORY READING

Multi-sensory reading involves combining tactile, auditory, and other sensory inputs—such as smell—to enhance the reading experience. Research shows that children are better able to recognize and understand images when information is presented through multiple senses. This approach is also commonly used in tactile training.

Story box objects are physical items related to the content of a book that children can touch and explore while the story is being read aloud. These objects help young children engage with the story in a sensory-rich way, even if they do not yet fully grasp the connection between the object and its real-life equivalent.

Figure 1.2: De kar van Bas, by Marianne van de Vinne and Ann M. Conefrey. (Photo A.M. Conefrey)

Tactile illustrated books add audio, such as a 'talking pen' that explains the images or sound effects that enhance the experience.

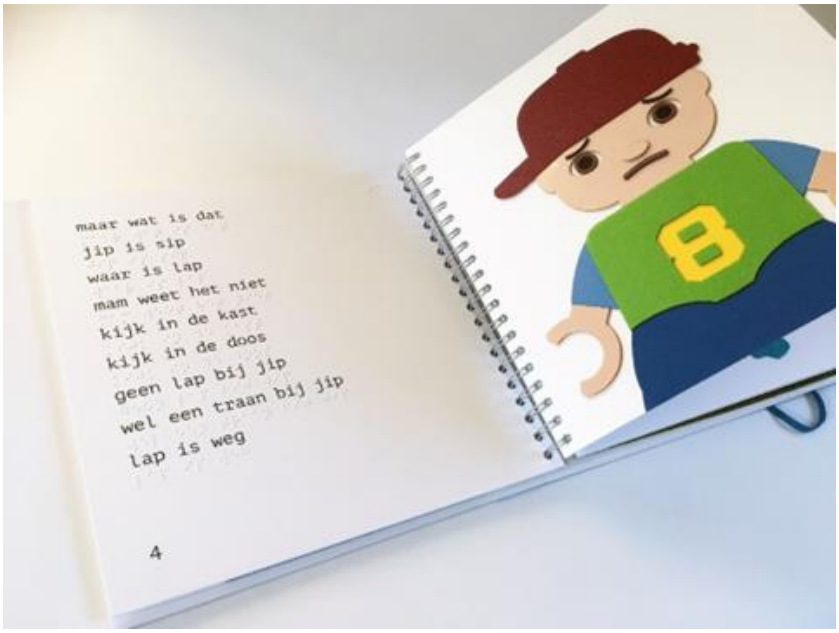


Figure 1.3: Book with Braille and tactile illustrations developed for the Learning Path 2D-3D from Visio and Bartiméus, the Netherlands. 'Lap is weg' by Brenda Zwijnenburg and Ann M. Conefrey. (Photo A.M. Conefrey)

It is also well known that children with an additional intellectual disability benefit more from books that appeal to multiple senses, rather than relying on the tactile sense alone.

Valente, Les livres multisensoriels (2010), Université Sorbonne Paris, in cooperation with Les Doigts Qui Rêvent, explored this in depth. Dannyelle Valente, now at the University of Geneva, conducted research on this topic and found that a multi-sensory approach is particularly effective in helping children understand illustrations.[3] She states: 'Understanding the beauty of reading is an experience sighted children naturally inherit, and which visually impaired children must struggle to overcome. But beauty of the world is there for all of us to experience and understand through our readings. The core part of this system is the multi-sensory interactions. In this multi-sensory interactive reading experience in a picture book, touch, texture, sounds, and smell, are incorporated."

1.2.3 BRAILLE

WHAT IS BRAILLE?

Braille is a universal writing system invented by Louis Braille. It consists of up to six raised dots arranged in two columns of three, which can be felt with the fingers to form letters and words. Braille is taught in special schools for blind children, and in mainstream schools, itinerant teachers provide braille instruction to blind students and those around them, such as teachers and peers.

WHY IS BRAILLE IMPORTANT?

Braille remains crucial despite technological advances. Unlike speech applications, Braille allows users to "see" words under their fingers, forming their own mental word images. For children, learning Braille helps them recognize how words are written. Braille can also be used with computers, making texts accessible to visually impaired children.

PRELIMINARY BRAILLE

Before learning to read Braille, children engage with preparatory Braille. This involves playful exposure to Braille letters, such as their name on objects or in tactile books. This phase helps children become familiar with letters and prepares them for reading.

LARGE BRAILLE

Large Braille, or Jumbo Braille, is about 50 % larger than standard braille. The height of the dots is the same. It may be used initially to introduce Braille to people who have less sensation in their fingertips, for example due to injury or diabetes. However, most teachers recommend using standard Braille from the start. Large Braille can be harder to read, as the size change can affect clarity.

[3] UN GUIDE POUR CONCEVOIR DES LIVRES MULTISENSORIELS ACCESSIBLES À TOUS AVEC LA MÉTHODE DU DESIGN PARTICIPATIF. Dannyelle Valente (Université de Genève), Florence Bara (Université de Toulouse) et Édouard Gentaz (Université de Genève et CNRS). A multi-sensory interactive reading experience for visually impaired children; a user evaluation, description of a research by Chamari Edirisinghe 1,2 & Norhidayati Podari 1,2 & Adrian David Cheok 1,2. In Springer-Verlag London Ltd., part of Springer Nature 2018.

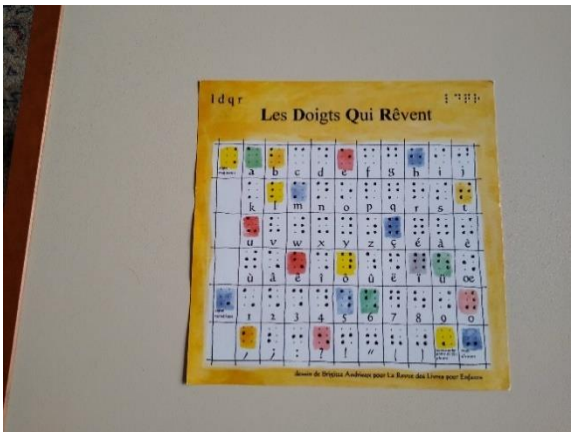


Figure 1.4: Normal size braille, source Les Doigts Qui Rêvent France. (Photo Anneke Blok)

PRINT AND BRAILLE

Tactile books often combine print and braille, especially for early readers. This helps children—including those with residual vision—grasp the concept of written language. It also enables sighted and blind children to read together, promoting shared reading experiences. It's important to maintain a balance between printed text and braille, so as not to overwhelm the child.

1.3 NEED TO KNOW

Children around the age of five who are beginning to learn braille and are ready for early literacy are the target audience for these simple books. The books feature basic braille letters on the right-hand pages and are designed to help children form their first braille words and short sentences, supported by tactile illustrations. The stories are simple and engaging—ideal for young children who enjoy narratives.

The books are designed for shared reading, with a story or rhyme on the left-hand page that corresponds to the braille words on the right. This approach is suitable for braille learners at a developmental level of approximately 0–15 months. Parents, teachers, or classmates can read the stories aloud, and after 12 to 18 months of braille learning, most children should be able to read at this level independently.

The series is called Voeljeleesboek (“Feel Your Reading Book”) and includes tactile illustrations that enrich the reading experience. These illustrations help blind children follow and understand the story—even before they are fully able to read—since they do not naturally encounter visual images. To help bridge the gap between concrete objects and tactile representations, each book is accompanied by a real, tangible object (such as a ball).

Parents play a crucial role in supporting their child’s braille literacy. These books allow them to actively and playfully participate in the learning process. Each book includes a braille alphabet and an instructional guide for parents.

The Voeljeleesboeken are available at special schools for children with visual impairments in the Netherlands (Visio and Bartiméus), as well as at the Spermalie School De Kade in Bruges. They can also

be borrowed via Passend Lezen in the Netherlands. Please note: these books are only available for Dutch children and their parents.

1.4 REFERENCES

2021 Reading pleasure (Leesplezier) Visio project Leesplezier: https://www.visio.org/professional/expertise/onderzoeken/lezen/projectpagina-leesplezier/

2021 Ellen van den Broek wrote a pilot study. This is in Dutch, but Designing tactile illustrations of Suzette Wright is in English.

Film Reading pleasure: https://youtu.be/ijgLN0zGDhA English subtitles can be found in Leesplezier

2014 *Designing Tactile Illustrated Books* by Philippe Claudet in Journal of Blindness Innovation and research Designing Tactile Illustrated Books

ldqr.org/catalogue/ and https://ldqr.org un guide pour concevoir des livres multisensoriels accessible à tous avec la méthode du design participatif 2022

Tactual Profile (Ans Withagen et al) Eduvip: https://eduvip.nl , also in English

Website of Lynette Rudman South Africa www.tactilegraphics.co.za

2 EXPLAINING CONCEPTS WITH THE HELP OF TACTILE IMAGES

2.0 INTRODUCTION

This chapter introduces you to the world of concept development of blind children, including understanding the relation between the 3D world and its representation as 2D drawings. Meanwhile you will also learn a lot about children's perception of the world. Part two of the chapter explains how the language of tactile images, a foreign language for children born blind, can be learned.

Children start to learn concepts at the age of 2 - 3 years, with preconceptual thinking. Initially, they shape subjective and often inaccurate precursors to true concepts. At that stage, sighted children form simple, visually based concepts but struggle with broader or hierarchical categories (e.g. flowers vs. tulips). Their thinking is limited to concrete and often subjective associations. Children at this stage may exhibit 'over-generalization', for example, calling any round object a "ball" or 'over-discrimination', for instance, recognizing only a black cat at home as a "cat" and not identifying a white cat as the same.

By around the age of 4, true concepts begin to form, characterized by understanding shared features and actions. At the concrete-operational stage, children develop logical and objective reasoning and can distinguish fantasy from reality.

To understand concepts, children with a visual impairment need experiencing, seeing, feeling, hearing, tasting and/or smelling to have complete mental representations. Description alone may leave a person with a very incomplete or even incorrect mental representation. Figure 1 illustrates this beautifully; a blind child that knew from hearsay that birds sit in a tree, imagined that a bird would sit on a branch on its bottom, like we all do. Another girl, when asked how an umbrella "catches the rain", as it was said, thought that an umbrella was like a bowl. These are not illogical thoughts at all if you have never felt the small claws of a parakeet around your finger or seen how a bird sits on a stick or twig. Or if you have never seen or held an umbrella.

A mental representation is much more than a 'picture in the head'. It is the result of being able to combine many previously learned 'concepts. In this example: the concepts 'bird', 'sitting', 'umbrella', 'branch' and 'rain'. Let's take the concept of a bird how is it 'put together'; what parts does it have; how does it move, fly, sit, …; what makes a bird a bird; what variations there are in dimensions, weight, shapes… What parts of the bird feel hard, soft, hot, cold, …. Or the concept of 'sitting': how does a human, a bird, a dog, … sit? Where can you sit? Why is something hidden behind something else, etc. On the other side, concepts can be more abstract too. In this image for example: humour, visualisation, and others. They all give meaning to this image.

Concepts are – if all goes well – slowly built up while growing up and while growing old, with the help of all the senses, through experience and by thinking. By giving words (labels) to 'things. Concept development and language development go hand in hand.

Sighted children are often triggered to find out more or try something by what they see. They will see 'the whole' and then focus on a detail. Soon they learn that, besides concrete concepts such as a bird or a tree, there are also abstract concepts like speed, the idea that something can be hidden behind something else, estimating distances, or recognizing someone's mood. Children with visual impairments lack the visual stimuli that naturally activate and engage sighted children. As a result, they do not intuitively develop certain skills, such as orientation, distance estimation and speed judgment. They may struggle to grasp the spatial relationships between objects and rely more on others for guidance and interaction to acquire these concepts. This dependency emphasizes the importance of targeted support to help children with a visual impairment build an understanding of their environment and develop compensatory strategies.

Young children may not know what an elephant, wolf, or a giraffe looks like. The number and range of concepts which they ae familiar with and understand is very limited. Sighted children see these animals in animations, in pictures, in video's etc. Blind children may have an elephant cuddly toy but that would probably be their only experience with of an elephant, and this makes building concepts much more challenging. To a lesser extent, this applies to children with partial sight. Some things can be heard, smelled and/or tasted but you cannot touch or feel lots of things that are too far, too dangerous, too small, etc. Some things are simply not in your environment, but in books or on screens, but what is an image for children with low vision? How do you 'read' an image?

2.1 A TACTILE IMAGE AS A FOREIGN LANGUAGE

Blind children need to learn and grasp the concept of an illustration (e.g. a tactile drawing, or a collage-type picture,) before we can use tactile images to explain various concepts, for example: birds sitting on a branch. In her guide to tactile graphics E. Więckowska compares the process of learning to understand drawings to learning a language, and notices that for persons born blind drawings and other tactile images are a foreign language. As any foreign language, the language of tactile graphics must be introduced step-by-step. Because of that, not only beginners, but also children with considerable experience in reading tactile images require an explanation of what a particular illustration represents. One cannot expect a blind child to be able to describe a picture only because it is tactile.

A tactile image is, in essence, a concept of its own. It can represent the real world, much like a photo or video. However, this can be difficult to grasp: how can objects with volume, which a child can explore by feeling multiple sides at once, be represented on flat paper? At the same time, tactile

images can also include flat elements, such as letters, logos, sketches, or specific types of drawings, all of which can coexist on the same surface.

Tactile images may provide access to visible aspects of the world, but they can also convey an inner world of imagination, emotions, or abstract concepts. In some cases, there is no "original" image to reference; instead, the tactile image is created specifically for tactile perception.

Tactile images that depict the surrounding world often include representations of animals, furniture, landscapes, houses, and more. However, simply making an image tactile does not guarantee that it will be meaningful or understandable, especially for someone born blind. This challenge arises from the significant conceptual gap between 3D objects and their 2D representations in drawings.

2.2 COLLAGE TYPE ILLUSTRATIONS AND RAISED LINE DRAWINGS

Tactile graphics and collage-type illustrations play distinct roles in the education of children with visual impairments, each with its own advantages and challenges.

Collage-type illustrations often incorporate real objects, which are easier for children to recognize if they are already familiar with them. When elements from one tactile image are repeated in another, children may begin to recognize them spontaneously. These illustrations provide clear tactile clues, as shapes are often defined by distinct materials. Movable parts, such as a curtain to lift or a wolf's mouth that can open, make illustrations interactive and intuitive. Even if a child does not grasp the full representation, they can understand parts, like ears or eyes, and interact with familiar objects, such as placing a doll of Little Red Riding Hood inside the wolf's mouth.

In contrast, raised line drawings rely on shapes, lines, and textures that require interpretation. They are more abstract and demand more detailed explanation, as they lack the tactile clarity and interactivity of collage-type illustrations. These drawings are better suited for introducing simple two-dimensional shapes, paths in a labyrinth, or basic concepts like shapes of the letters of the alphabet or numbers. For drawings of more complex objects, children must first develop motor skills, reasoning, language abilities, and an understanding of how to interpret tactile representations.

Despite their challenges, tactile graphics is essential for education. Access to subjects like geometry, math, and geography would be incomplete without tools like tactile diagrams and maps. They also help explain 3D concepts when real objects or models are unavailable or impractical. Raised line drawings, for instance, can make distant or dangerous objects accessible and offer an alternative when good 3D models are not at hand. For these reasons, learning to interpret tactile graphics is highly worthwhile.

However, the connection between flat tactile images and the real 3D world is not obvious for children born blind. The conceptual gap can make understanding tactile graphics one of the most challenging aspects of education for visually impaired students.

It was mentioned earlier on that for children born blind drawings and other tactile images were like a foreign language. This observation is crucial for creators of illustrations of books for children with a visual impairment. Their work can be compared to that of translators, who 'translate' visual images to the language of touch. But like any language, this can be taught.

In the following sections, we will explore the fundamental components of tactile graphics, along with the challenges and solutions for introducing children born blind to the wide range of concepts which

can be represented through tactile illustrations. It seems reasonable to start with a look at how children acquire understanding concepts which build their knowledge of the world.

2.3 CONCEPTS AND CONCEPT DEVELOPMENT

Based on what our senses reveal—sight, hearing, smell, taste, touch, and proprioception—we construct our concepts. This last 'sense', deep muscle feeling, informs us about our body position, but also about the position of (parts of) objects around us and about their weight.

Conceptualization, as this process is called, does not take place in quite the same way in blind children as in sighted children. Many objects that surround blind children remain unnoticed and therefore do not encourage exploration. The bright colored toy does not invite them to go for and play with. It may long be enigmatic what makes a sound. A blind child may get the name of the source of a sound, for example a boat passing, because a caregiver provides an explanation: "Do you hear the motorboat? The boat is passing by now. But without seeing it, much remains unknown (what the boat looks like, how it moves, what parts it has, etc.). Things that are not within hands reach, are literally far away and hard to get to know.

Several studies, beginning with Clara Linders' work (1998), have shown that learning words for "faraway things" without the benefit of sight or touch often leads blind and visually impaired children to develop incorrect ideas and inaccurate understandings.

Linders explains that the most problematic words, are the ones for objects and situations that cannot be touched, smelled, heard, or experienced in a single action entirely. Think about words like cloud, lion, skyscraper, etc. Words describing objects that can be touched (like a pencil), sensations that can be felt (such as warm or cold), or actions that can be experienced (like walking) are much easier to comprehend (Linders, 1998).

Description alone can only lead to a correct mental image if it builds on well-known, 'internalized' concepts. For instance, when a child knows a cat, you can explain what a tiger is, you can say that a tiger is a big cat and specify what is different, preferably using hands and referring to the child's body to indicate the size of the tiger and its parts. Additionally, playing out how a tiger moves while sneaking up on prey or climbing a tree can help the child understand behaviour of the animal. While the child may know the anatomy of their pet cat, they may not fully grasp how it moves and behaves in different situations.

Another difficulty in grasping concepts is the enormous variety in shapes and sizes that a certain 'category' or concept may have, even for not too far away objects What makes a chair a chair? Give the child the opportunity to explore for example all different kinds of chairs, to understand the concept "chair".

As has become clear, it is reasonable to assume that in order to engage in meaningful exploration of a drawing of an object, or in the act of drawing an object, the child must possess a clear understanding of the concept of that object. Of the various definitions of 'a concept', the one found in the Random House Dictionary of the English language (College edition) seems to be particularly useful for our purposes: "A concept is an idea of something formed by mentally combining all of its characteristics or particulars".

The inventory of concepts that children have at a particular stage of their development can be summarised as their knowledge of the world. And this is not something that can be learned in one

lesson. Concept development takes place over time. Without visual stimuli blind children need support, encouragement and motivation to explore and learn about the 'invisible world'. It's the responsibility of parents and caregivers to engage children in everyday activities, describe what is happening and to make sure that children growing up as children who do it themselves instead of having everything done for them. It's the most effective way of enriching the child's knowledge of the world and of explaining concepts which this knowledge entails. Toys can play the role of 3-D models of a variety of objects, helping children imagine what animals, vehicles, buildings etc. are like. And many concepts can be explained by engaging a child in play or everyday activities, for example, getting dressed, giving the child a bath or preparing the table for breakfast for the family.

In these guidelines we use the term 'mental representation'. A mental representation is more than a (visual) picture in the head; it combines former information gained through different senses, (pre-)knowledge, and of course, the ability to reason and combine. It is obvious that, despite such efforts, gaps in children's knowledge of the world are unavoidable and some of these gaps stay with blind persons throughout their lives, or until an opportunity emerges to receive an explanation. This was exemplified by a confession from a congenitally blind adult: "I have always thought that aeroplanes flap their wings when they fly." Many blind individuals will notice knowledge gaps themselves and may seek an explanation. Like the blind person who read about the space shuttle and didn't understand its exact shape and how it docked to the space station. Astronomy was, and is, his hobby. It took a long time before he found a 3D-model. He was relieved to finally know. Luckily, although some visual concepts cannot be explained, many gaps in the knowledge of the world have no negative effect on a blind person's everyday life or professional career. But many concepts can be explained with the help of tactile graphics and/or 3D-models.

By the way: all of us, sighted or not, have incomplete and sometimes incorrect 'concepts'. Sighted people often only know the visual part. Who (in Western Europe) has ever sat on an elephant or had a snake in their hands and arms?

When making tactile images to explain concepts for older children, you will soon find out that you often need to do research; how exactly is this or that? You'll find gaps in your own mental representations and knowledge – and you don't want to give them the wrong ideas.

2.4 THE INTERRELATEDNESS OF CONCEPTS

Young children learn new words and new concepts step by step. Concepts get more and more connotations and associations; the meaning deepens and widens. We call many things a chair: with different numbers of legs, hard and soft chairs, high and low ones, etc. A chair often is near a table and there are many different tables.

Each concept often derives its significance from its relationship to others, creating a network of interconnected ideas. For instance, the concept of "tree" is linked to notions of "nature," "growth," "shade," and even more abstract ideas like "life" or "stability." The concept "plate" can be intertwined with the concept of "sandwich" or "cup". These connections enrich our understanding and allow us to navigate the world more effectively.

Concepts often belong together. As concepts are interwoven, it is often impossible to separate the two. Concepts like "day" and "night", "hot" and "cold" or "big and "small" are often understood in relation to their opposites or complements. The inability to separate them from each other entirely

underscores the importance of teaching in a way that emphasizes connections, helping children build a more cohesive and integrated understanding of their world.

2.5 LEARNING TO READ TACTILE IMAGES

In the case of children with a visual impairment, especially those with total blindness, a striking similarity can be observed between reading a text and exploring a tactile illustration. Both texts and tactile drawings are identified through touch with fingertips. In both cases, text and tactile illustrations are accessed in small fragments, one at a time, moving from individual elements to larger 'wholes' – in the case of texts, from individual Braille characters and words to guide sentences, and from fragments of a tactile drawing to a whole picture. It is therefore justified to use the term 'read' when referring to blind children's ability to interpret and comprehend tactile images. But here the parallel ends. While curricula with clear criteria and methods of teaching Braille are easy to find, teachers and researchers are still looking for effective, widely available guidelines for introducing learners with congenital blindness to tactile graphics.

Introduction of the Transfograph at the 10th World ICEVI Conference (B. Marek, 1997) was probably one of the first attempts to introduce a teaching aid which helps teachers explain the relation between 3D objects and their representations as 2D drawing. Elaborated on or referred to in several publications (Marek B. 2004, 2008, 2013, Bishop T. 2016, Szubielska M. et al. 2016, Gower L. 2017 and A. Withagen et. 2020), the Transfograph is now, together with other teaching aids, a part of a step-by-step tactile graphics primer, briefly introduced in B. Marek (2018) and in a 2020 video which can be viewed at https://www.youtube.com/watch?v=cpWbHumH3Mg&t=184s .

Chojecka et. al. (2008), with main contribution by E. Więckowska is probably the first comprehensive guide to introducing tactile graphics to learners with total blindness, which presents a well-tested methodology of teaching to understand and to make raised lines drawings by learners with a visual impairment. Unfortunately, as the book is only available in Polish, its impact on teaching tactile graphics is limited.

The first attempt at designing a proper curriculum for teaching to read tactile drawings of 3D objects was made by Visio. In 2021 the 'Leerweg 3D-2D' (Learning path 3D-2D) was published. A rigid curriculum has, however, proved impractical due to numerous influencing factors involved. As a result, it has been renamed as a "learning path," which continues to be progressively developed over time. The main elements in this learning path are:

1. Make the transition from 3D to 2D understandable using different stages of relief of real objects, for example thermoform (see the chapter on techniques), forming sand (and tinkering materials) and with the help of the Transfograph (see below).
2. Start with objects that the child knows and can hold in its hands.
3. Gradually use bigger objects

The learning path is designed for three level:

1. Preparing; age indication 4 to 7
2. Initial: age indication 7 to 10.
3. Continued: age indication 11 and older.

The method incorporates a storyteller character named Willem Wijsneus, which translates to "William Wise Guy." However, the Dutch word “Wijsneus” also literally means "pointing nose." Willem has a long, Pinocchio-like nose that points in the direction in which he is looking. Among the learning materials, there is a large 3D model of a mill. In one lesson, Willem Wijsneus stands below the mill, looking diagonally upward. By following the direction of his nose, the child can understand that Willem sees not only the wall of the mill but also the underside of the wooden platform above, where the miller adjusts the sails to catch the wind. This exercise serves as an excellent preparation for understanding perspective, a complex and abstract concept that will be explored here in greater depth later.

The method also introduces key "insights" to help children grasp fundamental concepts of spatial representation. For example, they learn that objects which are farther away appear smaller, even if children do not yet fully understand the reasoning behind this phenomenon. Through this, a child becomes aware that in a drawing, a large figure and a small figure might indicate not only differences in size but also differences in distance, with the larger figure being closer.

Another important insight is the concept of occlusion: when one object is positioned in front of another, the object in the background partially or entirely disappears behind the one in the foreground. These insights build a foundation for understanding, interpreting and creating visual representations. It may be inspiring to have a look at the material on eduVIP (Withagen, 2022).

The importance of drawing for blind children became evident during the project, leading to the development of “Teken Mee!” (Literally translated: Draw Along) learning path for drawing, which follows the same levels. A Dutch guide with inspiring examples of drawings and materials is available in EduVIP (Koninklijke Visio & Bartimeus, 2023). It is useful to deepen your understanding of the concept ‘blind children drawing’.

These and the next paragraphs show how tactile images in children’s books can be used to explain a variety of concepts.

2.6 CONCEPT DEVELOPMENT VS. GRAPHIC REPRESENTATIONS

As Kennedy (1993) observes, in both blind and sighted children, the desire to represent emerges earlier than the ability accurately capture the likeness of the depicted object in a drawing. This arises from the significant difference between concepts of objects and the concept of a drawing as a two-dimensional representation of an object (Kennedy, 1993). This is confirmed by the attempt at drawing a table (Figure 2.1). It is unlikely that the author did not understand the concept of this common piece of furniture but was unable to ‘translate’ that knowledge into a drawing, because (s)he didn’t know the concept of drawing and/or the motor skills.

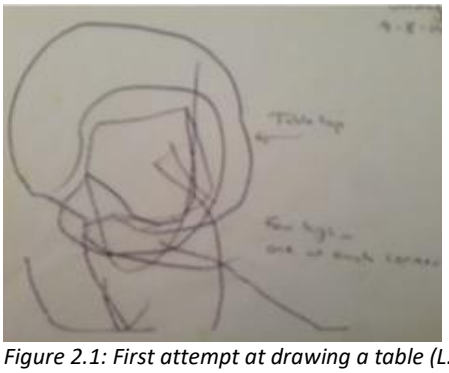


Figure 2.1: First attempt at drawing a table (L. Gower 2017, Australia)

At this point, one may wonder which features of an object are most likely to be represented graphically. The drawings presented below serve as a useful illustration of two distinct approaches to translating the concept of a table into a drawing of a table. For a sighted person, side view (projection) is probably the most characteristic representation of a table (Figure 2.2). But for a congenitally blind person, without an explanation the drawing bears no resemblance to an otherwise familiar object and will be interpreted as just three lines.

Figure 2.2: A sighted person's drawing of a table (projection)

For a blind child, the concept of a table at a concrete level may be developed by exploring a specific table or a model of a table. When asked to draw a table, many blind individuals (including children with some experience in creating tactile drawings) tend to recreate their method of exploring this piece of furniture. They often begin by identifying the square or rectangular shape of the tabletop and then proceed to locate the four legs, positioned at each corner. This process is reflected in drawings such as the one depicted below (Figure 2.3).

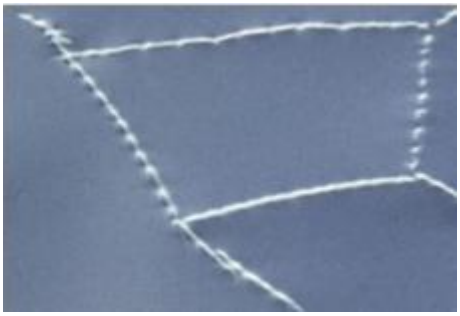


Figure 2.3: Drawing of a table made by a blind person (B. Marek, 2008)

The drawing of a table is not an isolated example confirming blind children's ability to represent graphically concepts derived from tactual experience. The drawing of a London bus found in a British newspaper and reported in Marek (1999) is a perfect example of how concept development and representation of concepts as drawings differs in children born blind (Figure 2.6) in comparison with sighted children (Figure 2.5):

Figure 2.4: Drawing of a bus by sighted child

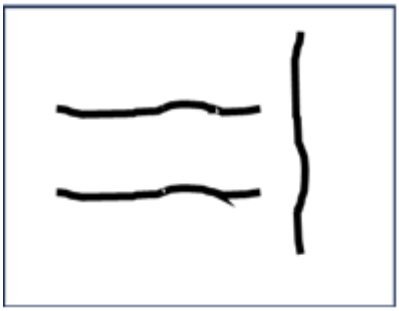


Figure 2.5: Drawing of a bus by a blind child

The authors of the drawings both clearly possess the concept of a bus in their mental frameworks. However, the processes they followed to form this concept and the results they achieved differ significantly. Over time and with increasing experience, the blind child's concept development will

grow, incorporating additional features of the vehicle. These features such as the step, the railing, and the seat, represented by the three lines, will enrich the child's concept. This development will likely result in a more comprehensive and refined graphic representation of the bus.

The drawings below illustrate an interesting case showing how concept development may be reflected in drawings. As was the case with the bus, a blind child's drawing of a tree focuses on and reflects accessible features of the concept. The tree is represented by a circle, a shape of the child's arms hugging a tree trunk (Figure 2.6). A similar drawing made by a congenitally blind adult shows branches and leaves (Figure 2.7). The drawing demonstrates not only a richer concept of a tree but also more advanced ability to represent that knowledge in a drawing. The two tactile drawings of trees show different levels of concept development or of the ability to represent concepts graphically.

Figure 2.6: Drawing of a tree by a blind child

Figure 2.7: Drawing of a tree by a blind adult

2.7 THE FOREIGN LANGUAGE OF TACTILE IMAGES

Explaining the unexplainable: what words do you use to express what you feel

As was mentioned earlier, for individuals born blind, drawings are considered a foreign language. The positive point is that any language can be taught and learned. However, like all foreign languages, the lessons must begin with the basics. They should progress in stages, gradually guiding children from simple to more advanced levels.

2.7.0 FIRST THINGS FIRST: LINES AND GEOMETRIC SHAPES

The section below introduces basic components of a tactile graphics primer, briefly described in B. Marek (2008, 2018) and in greater detail in a tactile graphics workshop programme (https://hungryfingers.com/work3.html).

Lines, whether solid, dashed, dotted, straight, curved, zigzagged, etc., serve as an excellent starting point for a systematic approach to tactile graphics. They are used to represent rivers, roads, borders on maps, and are a fundamental element in even basic geometry courses. In other words, lines are the most crucial component in graphic representations of any concept.

Basic geometric shapes are most effectively introduced using models, such as solid triangles, squares, and rectangles, accompanied by tactile drawings of these shapes. Shapes, such as square, triangles etc. may interact with other shapes to form new shapes (Figure 2.8), and each can be divided into component parts, as seen in activities shown in Figure 2.9). Therefore, it is essential to engage children in "geometry games" that facilitate an understanding of these relationships. Such activities raise children's 'spatial imagination' and confidence that they are in command and can organize – first the space within the wooden frame, and with time, the space around them.

Figure 2.8: Dividing shapes into component shapes - Space Organizer (Bob Marek)

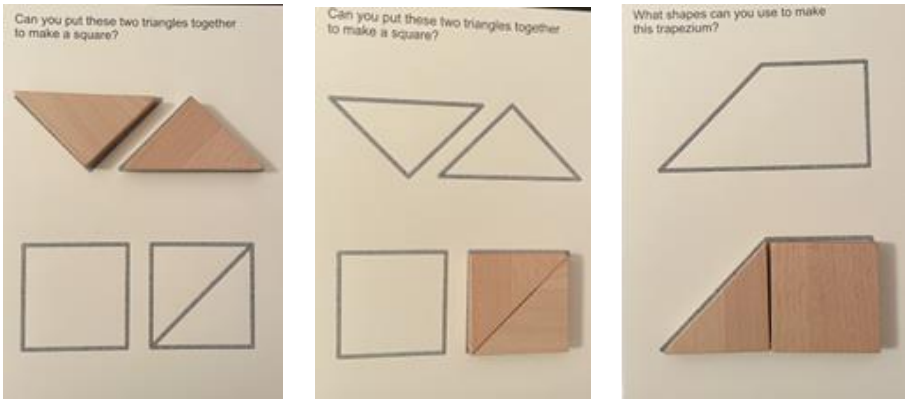


Figure 2.9: Building new shapes (B. Marek, Shape detective series)

After gaining confidence with such activities, a search for geometric shapes in familiar real objects, models or drawings (Figure 2.10) will be an enjoyable play rather than a source of frustration.

Figure 2.10: What shapes can you find in this drawing of a house? (pictures from https://www.hungryfingers.com/sequence.html)

2.7.1 Representing objects as drawings

The challenge of explaining the relation between 3-D objects and 2-D drawings to learners born blind has occupied the minds of teachers and professionals for decades. Probably the best way is to start with flat objects - an outline of the child's hand, a leaf (Figure 2.11), comb or a brush (Figure 2.12). Matching these objects with their outlines gives the child immediate access to both – an object and its representation as a drawing. Figures 2.11 and 2.12 are drawings of familiar flat objects.

Figure 2.11: Graphic representation of a leaf

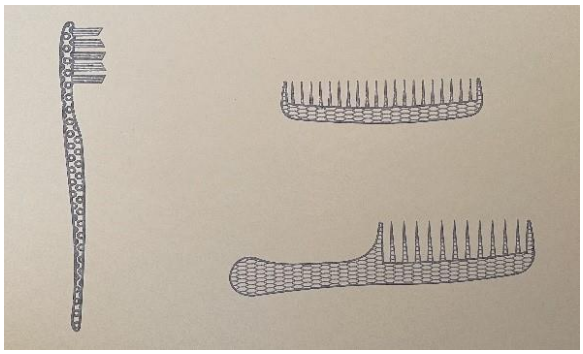


Figure 2.12: Graphic representation of a comb

A tactile adaptation of the well-known "Goldilocks" story is presented below in Figures 2.13. Whether depicted as a drawing or constructed with pieces of wood, these graphic representations of the concepts of a table, chair, and bed consist of three lines that bear no resemblance to the actual objects. This is where the Transfograph proves useful (see below).

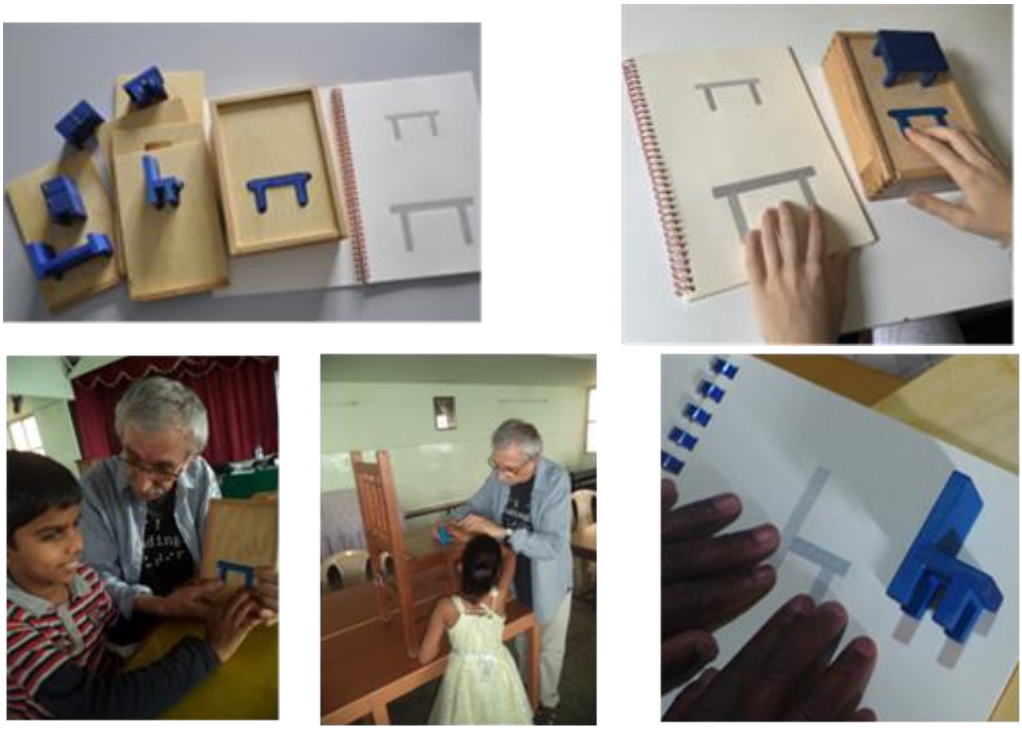
Figures 2.13: "Goldilocks" (ONA library, Belgium 1995)

2.8 THE HUNGRY FINGERS TRANSFOGRAPH

The Hungry Fingers Transfograph (Figures 2.14) is an educational tool which has proved particularly effective in helping understand the relation between 3-D objects and 2-D drawings. Introduced for the first time in 1997, at the 10th World ICEVI conference it has found its way to schools in several countries. It has also caught the attention of researchers in the field of psychology, who studied its effect on understanding of drawings and on making recognisable drawings of various objects. Reports from several countries confirm the effectiveness of the Transfograph (Bishop et al., 2015, L. Gower 2017) but they must be treated with caution.

The way the Transfograph works is simple. Models of six pieces of furniture inserted into matching slots in a wooden box reveal outlines of a table, chair and a bed, and front views of a desk, fridge and

a commode, each of which can be compared with a tactile drawing. The concept was incorporated into several training programs, such as Where's My Ball, which explains why a ball or sphere can be represented as a circle (Yamazaki, 2006). Additionally, it is featured in The Learning Path 3D-2D (Visio and Bartimeus, 2020), although this material is only available in Dutch.



Figures 2.14: Working with the Hungry Fingers Transfograph (Bob Marek)

The progress in drawing a table made by a child in just one session with the Transfograph (Figure 2.15), and the confidence with which the child below draws tables (Figure 2.16) must be a source of satisfaction for the teacher. However, we must be sure that the child really understands the transition from 3-D to 2-D and is not merely copying the drawing shown in the book. The only way to verify this is by asking the child to draw the observed models from a different perspective. The drawings below (Figure 2.18), one showing the back of a chair and the other depicting its left side, confirm the child's understanding that drawings of the same object can differ depending on the angle from which they are observed.

Figures 2.15: One session with the Transfograph (L. Gower 2017)

Figure 2.16: Understanding or copying?

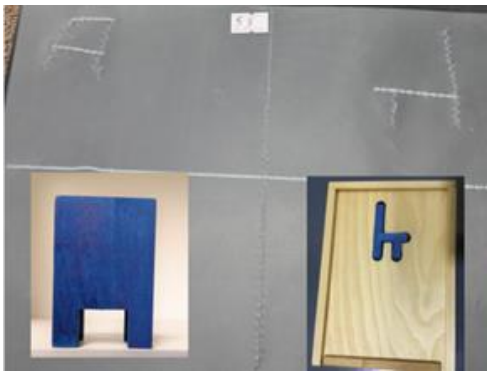


Figure 2.17: Two drawings of the same chair shown from different angles (Video – Working with the Hungry Fingers Transfograph)

2.8.0 THE POWER OF SEQUENCING

Tactile illustrations, whether collage type or raised line drawings, representing animals and humans may also require a step-by-step introduction. For an unprepared child, a drawing of a 'complete' teddy bear will probably be a 'tactile mystery', difficult to distinguish from, for example, a map of an exotic island. (Figure 2.18 and 2.19).

Figure 2.18: raised line drawing of a map

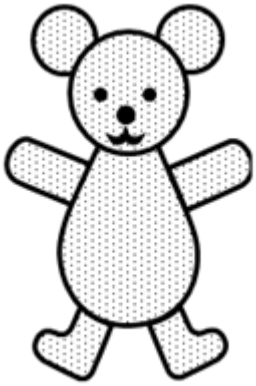


Figure 2.19: raised line drawing of a teddy bear

Introducing the drawing in stages, as in "The title of this book is…" will give the child time to explore each part of the body and gradually build the image of the whole teddy bear (Figure 2.20).

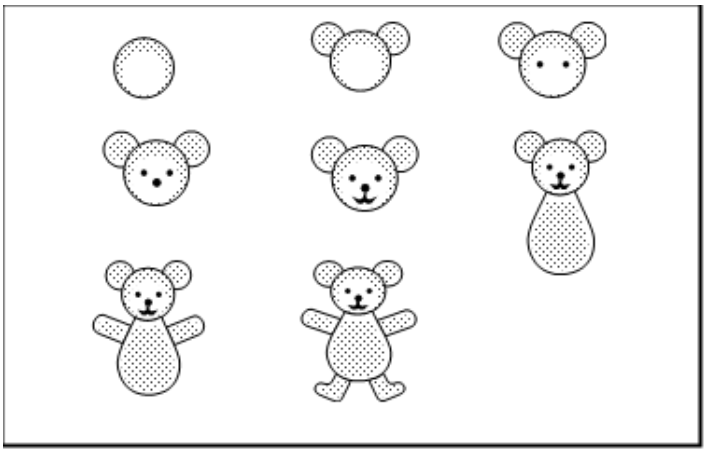


Figure 2.20: Introducing a drawing of a teddy bear in a sequence of stages

Children should be encouraged to add the eyes, nose and the mouth made with modelling clay. Figure 2.21 shows an example of a particularly effective technique in introducing tactile drawings of complex objects. This technique involves the use of 2- and ½-D shapes, such as a wooden magnetic teddy bear puzzle, which acts as an intermediate stage between a 3-D object and a 2-D drawing. The technique is demonstrated in a video (Teddy bear).

3-D 2 and ½ -D 2-D 2-D

Figure 2.21: A flat wooden magnetic teddy bear puzzle makes a perfect intermediate stage between a 3-D teddy and a drawing of this popular toy (B. Marek 2022; Video "Teddy bear")

The sequencing technique was adopted in Irmeli Holstein's beautiful story about a snowman (Figure 2.22). There are many more topics that can be used for tactile storybooks based on this technique. Some examples of possible topics are planting a seed or a tree, building a sandcastle, a doll choosing clothes for a party, packing luggage for the summer/winter holidays, etc. Such stories with collage-like illustrations are very valuable and help introduce and explain a wide range of concepts.

Figures 2.22: Holstein's winter story about a snowman

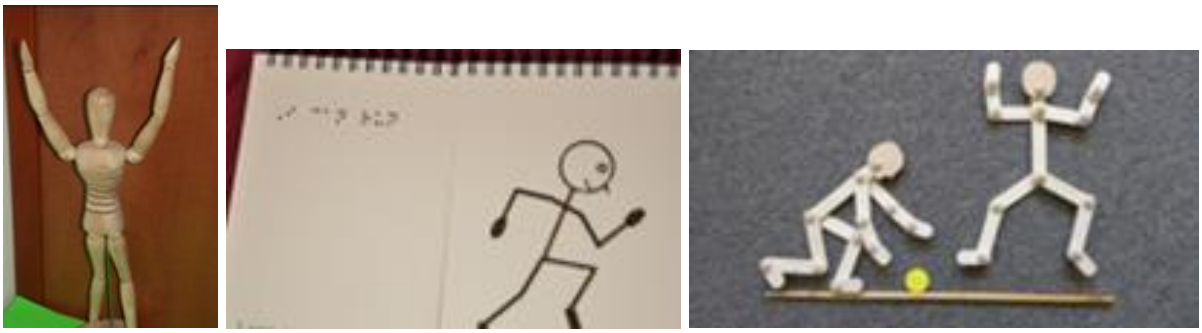
Whenever possible, children should be encouraged to make their own drawings. This gives more fun and the opportunity to check understanding of the concept(s) in the tactile illustrations. There is no doubt that there is a strong correlation between the amount of experience in exploring drawings and the ability to create recognizable drawings. This relationship works both ways. The more opportunities children have to create drawings, the better they become at reading and interpreting new drawings. Figure 2.23 gives an example of a child's ability to represent graphically a wide range of concepts: drawing of a table, chair, teddy bear and spatial concepts such as on, under, above and between.

Figure 2.23: Nepal (from video: Working with the Hungry Fingers Transfograph)

2.8.1 Drawing a person

"*I can draw, and I can understand a drawing of someone standing, but not when someone is doing something.*"

This statement, made by a 10-year-old born blind, inspired the creation of "Fleximan" (a magnetic stick figure with movable joints). The Fleximan can run, bend and assume various positions. The postures can be compared with drawings in a series of tangible booklets (Figure 2.24).



Figures 2.24: 'Fleximan' – a manipulative which comes with the 'Playing and learning with Fleximan" series of tactile booklets (Hungry Fingers, Bogusław 'Bob' Marek. Video: Working with the Hungry Fingers Fleximan)

As with all new drawings, it is advisable to check whether the drawings are really understood. After a few sessions with the Fleximan, the two eleven-year-olds copy, with great precision, an activity demonstrated by an illustration which they have not been shown before (Figure 2.25 & 2.26).

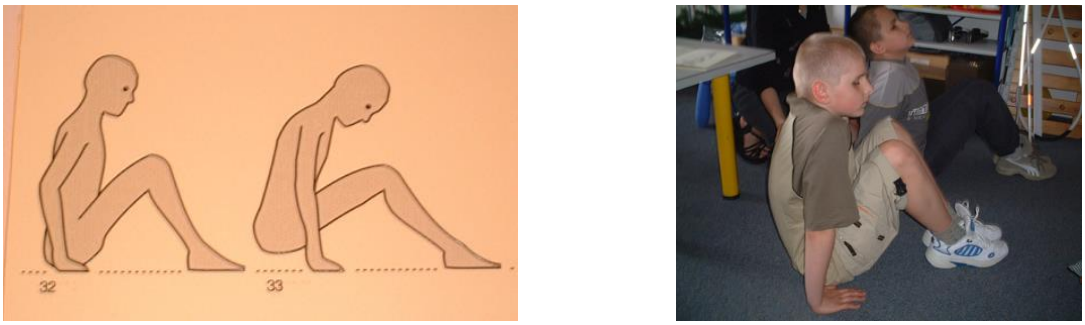


Figure 2.25 & 2.26: Checking understanding complex drawings, Bogusław 'Bob' Marek. Video: working with the Hungry Fingers Fleximan)

2.8.2 Getting ready for maps

Understanding the concept of a map does not develop spontaneously and requires an explanation. The best way to start is to introduce the concept of a plan ('map') of a small area which children can explore from one place, without having to change their location (For example, "Setting the table" (Talukder, A., Więckowska, E. 2005). (reprinted as "Getting ready for maps, Part 1 - 2"), offers one of the most effective techniques helping understand a wide range of spatial relations needed for a meaningful understanding of bigger maps and plans.

The system, as you can see in Figure 2.27, starts with activities in which children identify, copy and draw various arrangements of items making a breakfast or lunch set, first for one person, and later for a group of people. Such activities make a good foundation for introducing concepts of drawings of larger areas - floor plans (classroom, school, the child's home, neighbourhood), street plans and maps.

Figure 2.27: A breakfast set

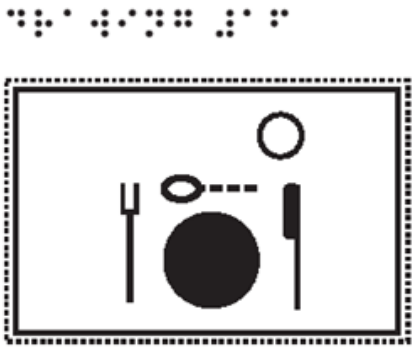


Figure 2.28: My first map

2.9 FROM 2D TO 3D WITH TOP, FRONT AND SIDE VIEWS

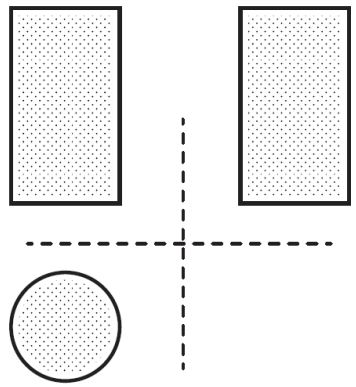
Once the child grasps the transition from 3D to 2D, the next step can be introduced. If only the front or side view of a table is provided, it remains unclear whether the table is square or rectangular, or how long it is. To gain this understanding, an additional corresponding top view is necessary. By this step, children can create a correct mental representation of a 3D object on the basis of a tactile image.

We began this chapter by stating that description alone is insufficient for forming a correct and complete mental representations of objects. With sufficient experience in reading tactile graphics it is possible to construct an accurate mental representation of a 3D object on the basis of a description and tactile images, for example of the of the top, front, and/or side views of an object. We refer to this approach as 'orthogonal projection.'

Orthogonal means at the right angle. As demonstrated in the examples above, adding perspective to a tactile image distorts shapes and angles, making outlines unrecognizable to touch. Projection, in this context, refers to how a photo, video, or (tactile) drawing captures an image. Orthogonal projection is a standard technique It is used in industrial design, as it provides precise dimensions of an object. If the term 'orthogonal projection' sound complicated, it can simply be referred to as the method of top, front, and side views.

This method is fundamentally simple and can even be learned by children with additional learning challenges. At the outset, it is crucial to use hand movements as though physically approaching a 3D object. This approach also aids in placing the image in the correct orientation. While the top view can remain flat on the table, the front and side views must be positioned (or mentally visualized) upright.

In essence, this method greatly enhances spatial thinking. Once children understand how to work with the top, front, and/or side views, they can not only discern the shape of a 3D object and the proportions of its parts but also understand their spatial relationships in relation to the observer.



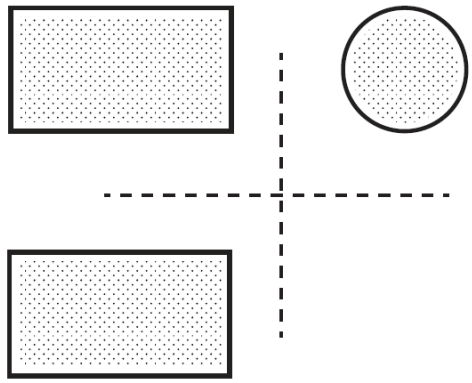


Fig. 2.29 & 2.30: standing and laying cylinder for swell paper in quadrants (Top left: front view, bottom left: top view, top right: side view from the left) ('Op de tast', 3D-2D, Dedicon).

I In figure 2.29 the top view is round and logically the front, and the side view are the same. They are rectangles. For a congenitally blind person who works for the first time with tactile images, it may be difficult to understand that the front and side view of a cylinder is a rectangle. If a child is already familiar with tactile images and has been working with the Transfograph, it will be easier to understand that the front view of a standing cylinder can be represented by a rectangle. The child needs to find the contour at its widest point. An additional way to help a blind person experience the contour at its widest point is by cutting a cylinder in half lengthwise, such as a piece of cucumber.

Note that the views are depicted with a dotted filling to indicate they represent solid shapes.

Now, consider the spatial perspective, in Figure 2.29, the top view is round (traced with the hand from top to bottom), while the front and side views are rectangular (traced with the hand from the front and side, respectively). This configuration represents a standing cylinder. In Figure 2.30, the top and front views are rectangular, while the side view (traced with the hand from the side) is round. This indicates that the cylinder is lying horizontally. To help the child understand the tactile drawing, you can place 3D materials on the drawings.

Figure 2.31 provides an example of a square table positioned directly in front of the viewer. In the top view, four dotted squares indicate the positions of the table legs, marking their placement within the overall structure.

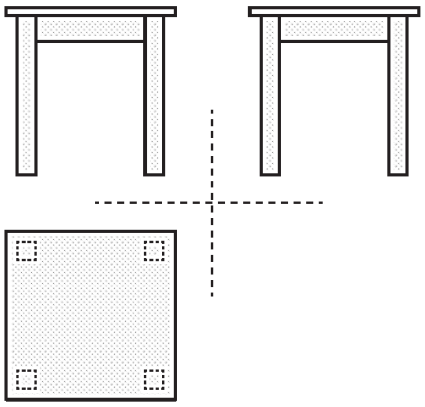


Figure 2.31: Orthogonal projection with top (left below), front (left above) and side view (right above) of a square table; for swell paper.

This method allows for flexibility; in some cases, two views may suffice (as would have been the case with the cylinder), while in others, additional views may be required. For example, when representing a telephone in a tactile graphic, multiple perspectives are necessary to accurately depict the placement of all buttons (Figure 2.32). The number of views depends entirely on the specific aspects of the object or subject that you wish to convey.

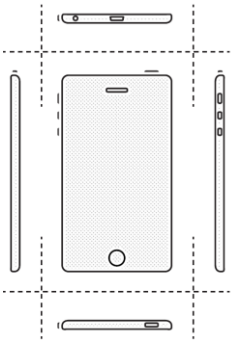


Figure 2.32: Orthogonal projection of an iPhone, showing the front and all narrow sides. Design prepared for swell paper.

Note that the side view from the left in this image is on the right. That is the standard way to draw this; the view is projected from the left. If there were a screen to project upon, that screen would be on the right. Likewise, the side view from the right is on the left, the top view is at the bottom, etc.

Did you notice, incidentally, that the raised-line drawing of the iPhone does not specify the views? Here the position of the object is not important. If it lays on the table, the front or back of the phone is the top view. If it is upright in front of you, the front is the front view. In this image it was just important to show the exact position of all the buttons. Note the difference between sides and front views of an object. Dice, for example, have no top side; the number thrown that appears on top is each time different. A car though does have a top side: its roof. However, if the car is laying on its roof, what is the top view? (Indeed: the bottom side of the car, the chassis with the wheels).

The examples above were made for (young) adults. As you can see, it is possible to play with the display of views, as long as it is clear to the reader, which is what. We stuck to the standard, but it is not a problem to change this if it more understandable for younger children; just add it to your description. In the book ‘Roundy’ we drew a half box of the rocket, that comes as a 3D model with the book. Here the side view from the left is on the left, the top view on top and the front view at the front of the box. We found that for younger children this is more intuitive.

Practice as much as possible to internalize this concept of working with top, front and side views. The encouraging thing about orthogonal projection is that sighted people need to practice it too! Once mastered, the reader can build a correct mental representation based on a good description supported by one or more tactile images. The description talks about the subject, directs the fingers and tells what is not drawn. We call it ‘accompanying explanation’. For supervisors of younger children such explanation often contains tips to tinker, work with clay or play dough, take positions with the body or go somewhere to feel, hear, smell and/or taste things in reality. The more concepts a child has mastered, the less this it will be necessary. For example, if the child knows what the fur of a rabbit feels like, a description is enough. It is interesting in this respect, that the language for touch is relatively poor. For sighted children too we may say: ‘The fabric of this coat feels soft and hairy like the fur of a rabbit’.

'Roundy' illustrates how explanation can be added in the stories, in extra questions and 'do'-tips, and in an annex (through QR) for parents, caregivers and anyone reading to or with the child. They may not always be aware that the blind child may not have a good mental representation of objects which are being talked about; that the child uses a word without knowing the concept.

2.9.0 Raised line graphics of photos and graphical art with perspective and shadows

A final note on perspective and shadows, two ubiquitous concepts from the visual world. If we create a realistic painting or photograph using raised lines, the depiction will only be fully comprehensible to a blind individual who has an understanding of how perspective functions.

In the Netherlands Dedicon has a series of tactile books and a course introducing these concepts to adults, that can also be used for youngsters 12 years and older. In the course, different ways to draw perspective are explained. Many sighted people without a background in designing are not aware that these differences exist and why they exist. In these guidelines and background information, it carries too far to treat these subjects, since youngsters learn about perspective, projection (shadow) and related concepts when they are older than the target group of our project (0-12). Visio developed learning materials for young children, that prepare them for these concepts. Children learn for example that things totally or partly 'disappear' behind things that are in front of them and that things that are further away seem smaller. In 'Roundy' you will find examples of this too.

'Roundy' deals also with reflection (of light) and thus creates awareness of shine and shadow. These elements are challenging to depict in tactile images and are typically conveyed through description. Only in tactile images designed specifically to illustrate how shine and shadow function are these features visually represented.

2.9.1 Conclusion

The discussion presented above has focussed on difficulties which children born blind experience with understanding the concept of a drawing, understood as a 2D representation of a 3D object. The necessary use of 'sighted' conventions is probably the biggest challenge. In other words: blind children need to learn about the concept of how seeing works – and how 'projection' works. They have to find characteristic outlines of objects; 'views' (at right angles). Luckily, solutions are also available, and several resources were discussed which take first time users of tactile graphics through basic steps, from lines and simple geometric shapes to drawings of objects and maps.

The conceptual difficulties children may have in understanding the relation between the 3D world and 2 or 2.5D tactile images, are basically the same for collage type illustrations and line drawings. The value of collage-type illustrations lies in their palpability. For young children, they are more engaging to explore by touch and easier to interpret than line drawings (often referred to as 'tactile graphics') because they offer multiple levels of relief and can incorporate real, flat objects. Raised line drawings at this early stage are suitable for representing simple shapes, and later, combinations of these shapes to build a house or another image. During the learning process children learn about concepts in the sense of things in the world around them (shapes are concepts too) and learns new words.

Designers of tactile illustrations should be aware of the function that a particular drawing or image has and of the difficulties which children may have with understanding collage type or raised line illustrations. They should include as much detail as is necessary to enjoy and understand the illustration

but leaving an option for parents (carers) reading the book to the child to show more details on consecutive contacts with the book.

The success of a book with tactile illustration depends therefore on a joint effort of the author, designer of illustrations, parents and the child. See the 'golden triangle'. You can find this in the 'Introduction'.

Finally, when the child has developed fine motor skills to read the images, memory and reasoning skills (for example top, front and/or side views) and learned to understand tactile images, these skills can support the child to learn new concepts and help the child build a correct mental representation. Especially when concepts are not available in reality or if good models are not at hand. This augments enormously the possibilities to study and get information.

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3 DESIGNING A TACTILE BOOK

3.0 INTRODUCTION

This chapter offers guidance for parents, professionals and printing houses on designing different kinds of tactile books for children with visual disabilities, including examples of tactile books tailored to different developmental age groups. It covers general considerations to address before creating a tactile book, along with specific design and production recommendations. For detailed information on the design and production of tactile graphics, refer to chapter 4, while chapters 5 and 6 explain the importance of accompanying explanations and offer ideas for story elements. Materials and production techniques can be found in chapter 7, and in chapters 8 and 9 you can read about the two tactile books which have been developed to accompany these guidelines.

Tactile books come in a wide variety of content, purposes, and authorship. Some are professionally designed and manufactured, while others are handcrafted by parents or carers. Before creating a tactile book, it is important to specify who the book is for and to clearly define the objectives.

3.1 OBJECTIVES AND CRITERIA

Who is the book for? What is its purpose? Specify the purpose of the book and the didactic criteria for the age group and/or cognitive ability so that this can be imbedded in the design. In Chapters 1 and 2 you will have read about the importance of tactile books in supporting the social and cognitive development of children with visual impairments. The purpose of a tactile book might be to:

- Encourage tactile exploration and develop fine motor skills.
- Develop braille literacy and pleasure in reading (together and independently).
- Help young children understand what a book is (letters, numbers, images, objects).
- Stimulate the imagination and curiosity of a child.
- Develop an understanding of how ‘seeing’ works, that you can draw something, learn how things work and/or what they look like, that a drawing can represent something from the ‘real world’.
- Gain understanding of concepts, emotions, encourage self-confidence.
- Learn about a specific subject.
- Revealing original Images: showing what the image in the original book looks like.

3.2 TACTILE BOOKS FOR TODDLERS AND PRESCHOOL CHILDREN

3.2.0 COLLAGE BOOKS WITH REAL OBJECTS

- For toddlers and preschool children, tactile books with collage materials, combined with real objects encouraging active engagement, are highly recommended.
- Children aged 1-4 learn through sensory experiences (moving, tasting, smelling, hearing, seeing, touching), which helps them predict how objects feel, move, or behave.
- Larger textures and shapes in illustrations work best for early exploration.
- Young children explore with both hands and mouth, grasping with their whole hand and rubbing surfaces with fingers.

- Children begin learning words for shapes, sounds, and textures, but few words describe touch, making direct exploration important.
- They learn that objects may be hidden, not gone, and blind children use their bodies as reference points.
- Tactile collage books should be fun and interesting to touch, with adults helping to make the experience enjoyable.

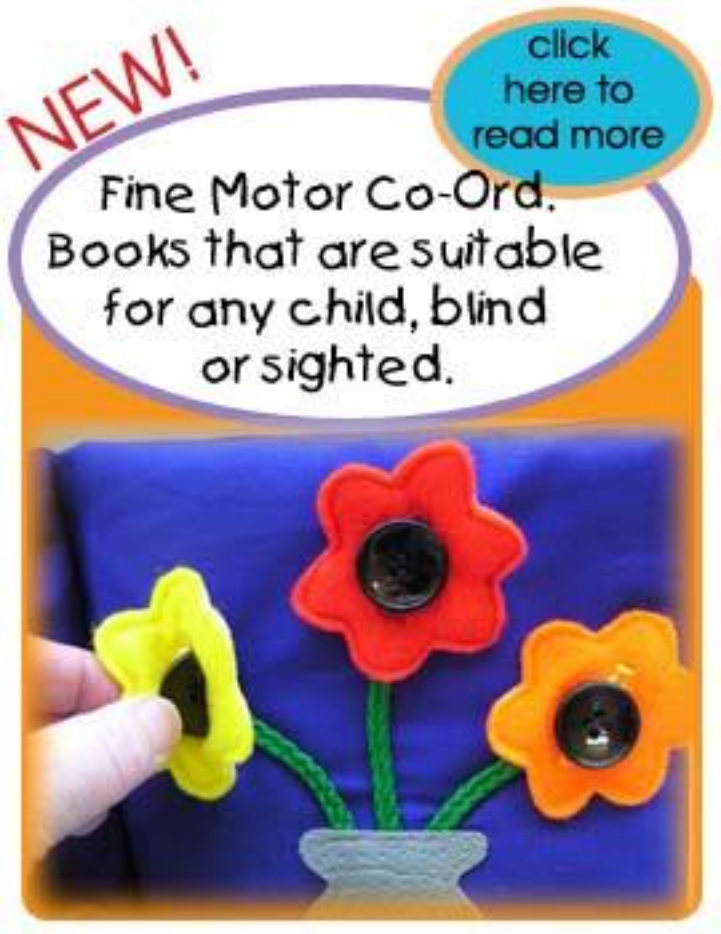

Figure 3.1: Tactile collage book by Lynette Rudman, South Africa. (Photo from the website)

3.3 TACTILE BOOKS FOR PRIMARY SCHOOL CHILDREN

3.3.0 COLLAGE BOOKS WITH ILLUSTRATIONS OF OBJECTS

- Early experiences with collage books help blind children aged 4-6 to explore and ask questions about the real world and at the same time develop the concept of 'seeing' and understanding what a drawing is.
- To read a tactile picture by touch the child needs to find some clues through own first-hand experience. Appropriate textures and shapes can provide a first clue along with language to support their actions/manipulation.
- In addition to using real objects on a page, illustrations of objects become 'symbolic references', not exact replicas of real objects, but still relatable through tactile exploration.

Learning the relationship between 3D objects and their 2D representations is important for understanding.

- Simple tactile symbols work well when paired with real objects and clear explanations.
- Movable parts and interactive elements (for example sounds) enhance engagement and ease the transition from real objects to images.
- Avoid overlapping materials/objects or partially hidden objects as this is particularly challenging.
- In terms of size, it's important, throughout the narrative sequence, to respect the proportions of the elements. If a character appears more than once in the story, it is advisable to keep the same tactile characteristics.
- Use a variety of textures to ensure high contrast and tactile sensations: use different textures for different elements of a story and also to represent different parts of an object but use the same materials and colors to represent the same things in a book.
- Collage illustrations with strong colors and bold outlines provide extra visual information for children with low vision.
- Printed illustrations can be adapted for blind children. Les Doigts Qui Rêvent from France have many examples of collage tactile adaptations in their collection.
- Once children can read independently, tactile books aid in building the mental representations needed for learning.

Figure 3.2: Collage book made by a teacher. (Photo Gyntha Goertz, Visio School Rotterdam)

Figure 3.3: Collage book from ClearVision's library for children's books in print and braille, and tactile books, London, UK. (Photo ClearVision)

Figure 3.4: A collage book, 'Tim's Birthday', made by a teacher, Jadranka Lekic, from the Visio School Amsterdam.

The story: all the children coming to Tim's birthday party are given a paper crown to put on their heads. They are then invited to look in the bag and find Tim's present, a little car, from his parents. Tim's grandparents give him a music card to open and listen to. All the candles are put upright on the cake. Before going home, Tim gives all his friends a whistle to blow on.

Figure 3.5: Cover and one of the illustrations of a collage tactile adaptation by Les Doigts Qui Rêvent (France) of 'We're going on a bear hunt' by Michael Rosen. (Photo LDQR, Solène Négrerie)

3.3.1 Raised line drawings

- As children, aged 4-6, gain the ability to explore objects with their fingers, they detect more about shapes and textures. Raised lines help early recognition of shapes (triangle, square, etc.), counting, tracing paths, and simple drawings (e.g., starfish, shell, sun, stick figure, flag, table setting).
- Be aware of the complexity and use different textures to fill raised lines. You can read more about different textures in Chapter 4 Advice on Tactile Graphics.
- Special attention is needed to explain what a drawing is and the relation between an object and a flat projection of that object.
- Avoid using perspective as this is too difficult.
- Simple graphics should be 'fun', raising curiosity about the images and talking about these together.
- At ages 7-8, children begin developing scale-thinking, understanding the size of objects relative to their own body or measurements.
- They start creating simple maps of familiar places like their bathroom or classroom.
- Tools, such as the Transfograph created by Bob Marek, can help them transition from 3D objects to 2D drawings using flat shapes, raised lines, and textures/patterns.

3.3.2 More complex tactile books

- As children develop greater sensitivity and control of their fine motor skills, they will be more able to understand tactile drawings.
- Well-designed tactile graphics and 3D objects aid visually impaired children in developing accurate concepts.
- By ages 8-12, well-trained children can build mental representations using tactile graphics, integrating navigational instructions and explanations to understand omitted details and the properties of specific elements.

- Key considerations include balancing the story and tactile graphics along with explanations, which are essential. Some books require adult assistance while others can be read independently.
- Mental representation includes more than just a mental 'image'. It is the ability to virtually touch, smell, taste, or feel objects as well as understanding how objects work and imagining them from different angles. The use of objects and physical experiences are necessary.
- Through their own experiences children will give meaning to the tactile clues of the relief drawings.

3.4 ADVICE FOR PARENTS

Creating tactile books for children who are blind or have low vision, is a fantastic way to enhance learning and engagement. You can create personalized tactile books or adapt existing children's books. Here's a list of tips for parents who want to make their own tactile books at home:

- Start with simple concepts:
  - Focus on familiar, everyday objects or basic concepts like shapes, animals, or numbers. Simplicity in the beginning helps build foundational understanding.
  - Each page can introduce one new concept or object to avoid overwhelming the child.
  - See chapter 6 for Story elements.
- Use a variety of textures:
  - Include a range of textures that represent different materials (e.g., soft cotton for clouds, sandpaper for rough surfaces). This helps the child distinguish between different sensations.
  - Consider natural materials like leaves, feathers, and fabric, as well as synthetic ones like felt, foam, or textured paper.
- Incorporate braille or large print:
  - For children who are blind, ensure the text is available in braille. For those with low vision, use large, high-contrast print.
  - You can use a braille typewriter or labeler to emboss the braille.
- Use 3D (three dimensional) elements:
  - Adding small objects, shapes, or raised outlines helps reinforce concepts. For example, glue on small plastic animals, buttons, or foam cut-outs to represent objects.
  - Ensure the elements are securely attached and safe for handling, avoiding sharp edges or choking hazards.
- Keep layout consistent:
  - Establish a consistent layout on each page to create a sense of predictability. For example, keep the braille in the same location on every page, and place the tactile elements in a similar position.
  - This helps the child become familiar with exploring the book and anticipating where to find information.
- Size and scale:
  - Ensure the tactile elements are appropriately sized for the child's hands. Larger objects or textures may be easier for younger children to recognize.
  - Use large, bold shapes rather than small or intricate designs, especially for early readers.
- Engage multiple senses:

    - Try to incorporate other senses like sound and smell. For example, use materials that crinkle or have a unique scent, for instance dried lavender.
    - Sounds could come from rattles or bells attached to a page, adding an auditory component to the story.
- Make the book durable:
    - Use sturdy materials, such as cardboard, foamboard, or fabric, to ensure the book can withstand frequent use.
    - You could also laminate pages to make them easier to clean.
- Create a story with a tactile theme:
    - If possible, create a storyline that incorporates a tactile journey. For example, a story about different types of animals can feature textures representing each animal's fur, scales, or feathers.
- Encourage exploration:
    - Allow the child to freely explore the pages and give them time to feel each texture or shape - patience and repetition.
    - Offer guidance if needed but give the child room to discover at their own pace.
- Test with the child:
    - Test each page with your child to see how they respond. Are they able to identify and explore the textures? Adjust based on their feedback or reactions.
- Label everyday objects:
    - When possible, incorporate tactile versions of everyday objects into the story, such as a raised fork for 'eating' or textured fabric for 'clothing.'

3.5 ADVICE FOR PROFESSIONALS AND PRINTING HOUSES

We strongly recommend collaborations between professionals from schools/rehabilitation centres and designers, artists and Printing Houses. The aim is to ensure that the tactile books are suitable for the intended children. These tips are essential for creating effective and accessible tactile books, allowing the children to develop their reading skills and understanding of the world through enriching tactile experiences and sharing these.

When designing more complex books, it is recommended to create a checklist, Involve the entire team *and* the intended users. This helps ensure that all requirements are considered, and the final books meet the children's needs.

3.5.0 CHECKLIST

Before developing a tactile book, whether it's an original story or an adaptation of an existing one, it's useful to start with a checklist. This will help ensure that every aspect of the book is considered and thoughtfully planned. Here's a detailed checklist you may want to explore. It can be applied to both collage type books and for books with tactile graphics. Some items in the checklist are more geared towards collage type illustrations. In Chapter 4 Advice on tactile graphics, you'll find more specific advice on tactile graphics and in Chapter 7 you'll find several techniques to make them. As you learned in Chapter 2, challenges for readability and understandability are different per age group. Even young children can become accustomed to using tactile graphics, provided these are very simple: basic shapes, letters, numbers, paths, find the difference, etc.

3.5.0.1 TARGET AUDIENCE AND OBJECTIVES:

Specify the age group, purpose and didactic criteria. Will the book focus on literacy, cognitive skills, fine motor skills, or simply be for leisure? Standalone or series: is the book for an individual child or for a group of children?

3.5.0.2 MULTIDISCIPLINARY APPROACH:

Set up a team, preferably multidisciplinary. Include someone who knows about the subject(s) and how to write for blind and visually impaired children, someone who knows how to design/draw tactile images (collage or line drawings), someone who can edit and someone who can manage the production including budgeting and planning.

3.5.0.3 CONTENT DESIGN:

- Theme, concept and storyline: what is the book about? Develop a simple and engaging storyline or concept to give direction to the design. Perhaps the book is an adaptation of an existing book (don't forget authorization). See chapter 6 about Story elements
- Tactile elements: plan which textures, shapes, and raised surfaces will be incorporated to help convey the story or concept through touch.
- Braille integration: will you include braille and printed text?
- Audio and multisensory options: consider if the book should also incorporate audio or interactive sound features for a more immersive experience.

3.5.0.4 MATERIAL SELECTION:

- Tangible materials: choose materials for their unique tactile qualities.
- Durability: choose materials that can withstand frequent handling.
- Non-toxic and child-safe: ensure all materials are non-toxic and safe, especially if the book is intended for young children who might put elements in their mouths. Consider materials als that can be cleaned easily.

3.5.0.5 TACTILE FEATURES:

- Diverse textures: incorporate a range of textures (soft, rough, smooth, bumpy) to provide a varied sensory experience.
- High contrast elements: use contrasting colours and textures to make the book more accessible for children with low vision.
- Movable parts: consider adding interactive elements like flaps, buttons, or velcro that children can manipulate.

3.5.0.6 SENSORY SAFETY:

- Test for sharp edges: ensure that there are no sharp edges or points that could hurt users.
- Choking hazard: avoid small or detachable parts for books intended for very young children.

3.5.0.7 PHYSICAL STRUCTURE:

- Size and shape: is the book easy to handle? Consider the dimensions for ease of use, especially for younger users or those with motor challenges.
- Layout: use a clear and consistent layout that makes sense to a child. The reading direction should be obvious; if necessary, use indicators to mark the top of the page.
- Avoid overloading a book with tactile information (text and images); it shouldn't be a puzzle to read.
- Binding and durability: ensure the book's binding is strong and can open flat for ease of tactile exploration.
- Weight: make sure the book isn't too heavy or cumbersome for use.

3.5.0.8 FEEDBACK AND ITERATION:

- Prototyping: take the time to make prototypes to test with the children.
- Gather feedback from both users and experts. Adjust the book's design based on the feedback to ensure it meets the intented criteria.

3.5.0.9 COST AND PRODUCTION:

- Budgeting: determine the cost of designing and producing the book, including materials, manufacturing and distribution.
- Manufacturing options: consider how the book will be produced. Will it be handmade, machine-manufactured or perhaps a combination of both?
- Sustainability: consider environmentally friendly materials or production processes, particularly for large-scale production.

3.5.1 GENERAL DESIGN CONSIDERATIONS

3.5.1.1 SIZE AND HANDLING:

- The book should be appropriately sized for a child, not too big or small.
- The book must lie flat to facilitate tactile exploration.

3.5.1.2 ILLUSTRATIONS AND TACTILE ELEMENTS:

- Illustrations should be age-appropriate (collage or raised lines/shapes).
- Tactile images are designed for touch, not sight, and should be in relation to the size of the reader's hands.
- Avoid overloading with tactile information or overlapping multiple shapes and text.
- Separate illustrations from braille/print for easier understanding by young readers.
- Prototypes should be tested with the intended audience before final production.
- Simplified layouts should be used for early braille literacy.

3.5.1.3 LAYOUT AND STRUCTURE:

- The structure should be clear and predictable for early learners.
- Reading directions should be obvious, with indicators/orientation marks if necessary.
- Sometimes a rigid layout (e.g., text left, illustration right) is needed, but aim and content should guide the design.
- Use consistent placement for page numbers.
- Production methods for binding and materials may affect layout.

3.5.1.4 BRAILLE AND PRINT:

- Use extra line spacing for early braille literacy and print on one side of the paper.
- If printed text is included, place it above the braille for teachers/parents to follow.
- Monospaced typeface is useful if text must align with braille.
- Choose a legible typeface (e.g., Arial, 20pt) and avoid decorative fonts, underlining, italics, or full capitalization.
- Recommended typefaces for visually impaired readers include APHont, Mathilda, Luciole, Atkinson Hyperlegible, and Tiresias.

3.5.1.5 EXPLANATIONS:

- Consider providing explanations for tactile illustrations via printed text or QR codes, adjusting explanations if illustrations change.

3.5.1.6 USING COLOUR

- Use attractive, high contrast colors to engage both visually impaired children and sighted peers.
- Bright, sparkly reflective materials work well for engagement.
- Use real textures and colors for authentic representation and association.
- Consider different cultural associations with colors.
- Test colored illustrations with children.
- Black and white provide the strongest contrast, with dark colors on light backgrounds for readability.
- Consider color blindness by providing alternatives like bold, underlining, or different sizes.
- Printing in greyscale helps assess tonal contrast, with adjacent areas differing by 20%-30%.

3.5.1.7 SYMBOLIC/SCHEMATIC PRESENTATION

- Focus on essential parts of the information, using solid shapes and minimal stylization; add details sparingly.
- Simplify complex images by breaking them into a sequence of simpler images.
- Do not use perspective in a drawing, unless the purpose is to explain perspective.
- When appropriate display multiple orthogonal views together with a clear explanation and with other learning materials such as a 3D object or a transfograph.
- Blind children need to connect tactile images to real-world objects, which can be challenging if unfamiliar with visual art conventions.
- Stylized elements like movement strokes or speech bubbles may be harder for visually impaired children to understand.
- When using lines and textures, balance these: avoid large grey/black areas and avoid too many differences in thicknesses and shades of grey.
- Fill shapes with textures that are both clear and pleasant to touch; avoid rough textures.
- When using textures to indicate what is within and what is outside a form use a white space (comfort zone) between the outline and the filling.
- If appropriate add an indication of size.

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4 ADVICE ON TACTILE GRAPHICS

4.0 INTRODUCTION

In our guidelines we use the term tactile images for tangible images that are meant to be explored by touch. With the term tactile graphics, we mean raised line drawings (see also 2.2 and 2.5). In tactile graphics:

- There may be some variation in height, but there is basically **one level of relief**.
- There is **one type of material**.

A general rule is: the less variation in height and materials, the fewer the possibilities to clearly display tactile details. This is further complicated by the lack of different materials.

There are many techniques to produce tactile graphics (see Chapter 7 Production Techniques and Materials). They even can be made with simple 'home, garden and kitchen tools', such as a pinwheel, clothing paste, with Wikki Stix, by sticking woolen or cotton threads on paper, using special drawing foil, etc. These are handy for quick sketches. If you want to make good quality tactile graphics that you can reproduce, swell paper is one of the most commonly used options. This chapter focuses on that technique.

Swell

- If well designed, it gives very good tactile results.
- It is a very commonly used technique, relatively affordable, quick and flexible.
- It allows to combine black and colour ink print, braille and images.
- If you have a digital original, you can make copies whenever you want; 1 or many.
- You can print QR-codes in the tactile diagram and thus attach the accompanying explanation.
- Available in A4 and A3 format, but of course it can be cut to smaller formats.
- It is also possible to paste swell images in a paper braille book.
- Swell paper isn’t cheap, a sheet of A4 swell paper costs about 1 Euro for consumers.

As with all techniques, it is important to get to know your ‘material’ before you start, especially seeing as the swelling process needs some skill. You can read about the technical side swelling in 4.4.

4.1 GENERAL PRINCIPLES FOR DRAWING CLEAR TACTILE DIAGRAMS

The first task a designer of tactile graphics has, is to make an image, that helps the fingers to easily and faultlessly identify shapes and lines and details.

- Compare it with reading text: if you cannot distinguish the letters, it is a frustrating job to try and read the text.
- Important: we’ll not be giving (many) exact dimensions for width of lines, empty space around lines and fillings (etc.), because every brand of swell oven and brand or quality of swell paper may give different tactile results.

The second task is to make a well understandable image; i.e.: use conventions or ‘underlying principles’ in order to give meaning to the lines, textures and dots.

- Compare it with reading text: in order to understand it the reader must know the words, the sentences, the grammar, the language and so on.
- Underlying principles will differ per domain, like maps, plans, structure formulas or electronic circuits, etc. For 3D-objects that is orthogonal projection, as explained in paragraph 2.9.
- Please read Chapter 2, Explaining concepts with the help of tactile images to learn how to make understandable graphics (especially 2.5 and further).

The basic rules or underlying principles to design and read tactile images are basically the same for any technique as you could read in Chapter 2.

This paragraph focuses on making easy to read tactile diagrams; line drawings.

4.1.0 Format and reading technique

- Movement and light touch are crucial for tactile reading; as for braille reading
- Working with two hands is essential for reference of distances/lengths/positions of elements on the tactile graphic
- A4 is ideal as it can be covered by two hands, larger than A3 is not convenient (Annexes techniques to the report of the Project SOCRATE-COMENIUS 3-1 1999/2000, **TACTIMAGES & TRAINING -** IMAGES TACTILES - ACCES A LA CULTURE – FORMATION).

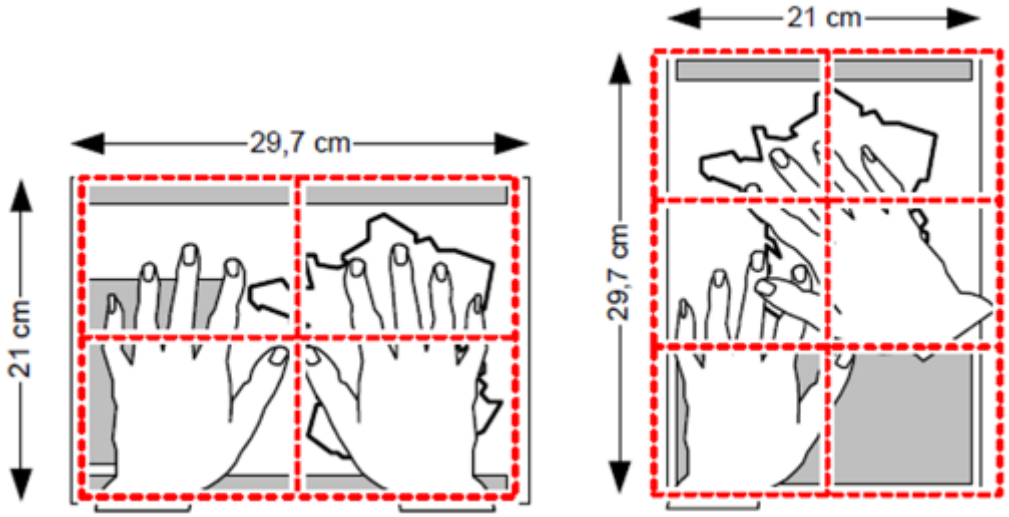

Figure 4.1: Illustrations from the 'Annexes' (see references) showing two hands exploring a tactile graphic of the map of France on A4 in landscape and in portrait format.

4.1.1 Empty space

- Empty space in tactile images is very important for comfortable legibility
- The higher an element is, the more empty space around it is needed

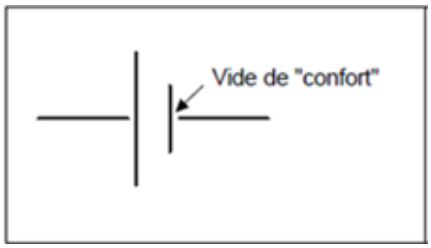

Figure 4.2: illustrations from the Annexes of 'empty space for reading comfort' (in French 'Vide de 'confort'') and an obtuse angle.

The Annexes give lots of dimensions for empty space around lines, braille and other elements. The basis is formed by the dimensions of the braille cell (https://www.ukaaf.org/standards/). The Annexes by the way is the first report on research in the use of orthogonal projection for 3D-objects.

RNIB in 2012 also advised using white space, as in the example below.

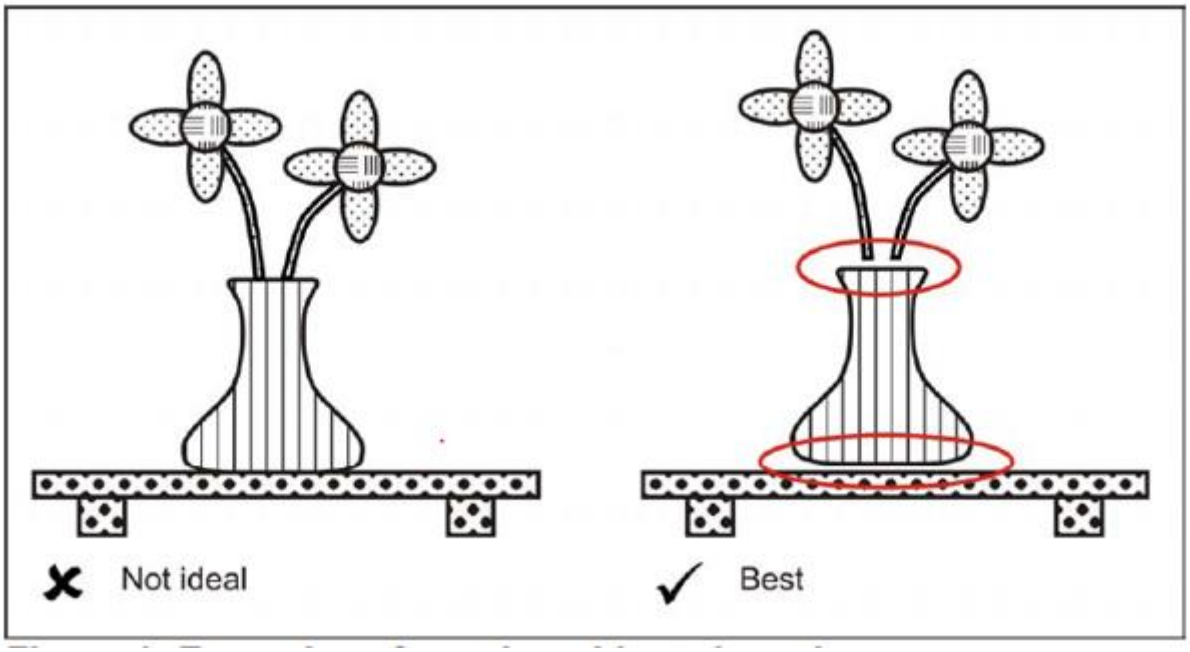

Figure 4.3: figure 1 of ImageShare Accessible image acceptance criteria, RNIB 2012: example of spacing objects in an image (also called adding empty space or comfort whist around objects.)

There is comfort white between the table and the vase and between the vase and the flowers. The vase for sighted people seems to float above the table. But to the fingers the comfort-white just makes the limits of the two separate objects very clear. Conclusion:

Seeing is very different from feeling (exploring by touch).

The next example illustrates this very clearly too: here we see two almost identical drawings. In the centre of a larger square is a circle with a 'missing bite'. We filled them with vertical lines. Around it, we put horizontal lines. The copy on the left has empty space around the contours, the copy on the right doesn't.

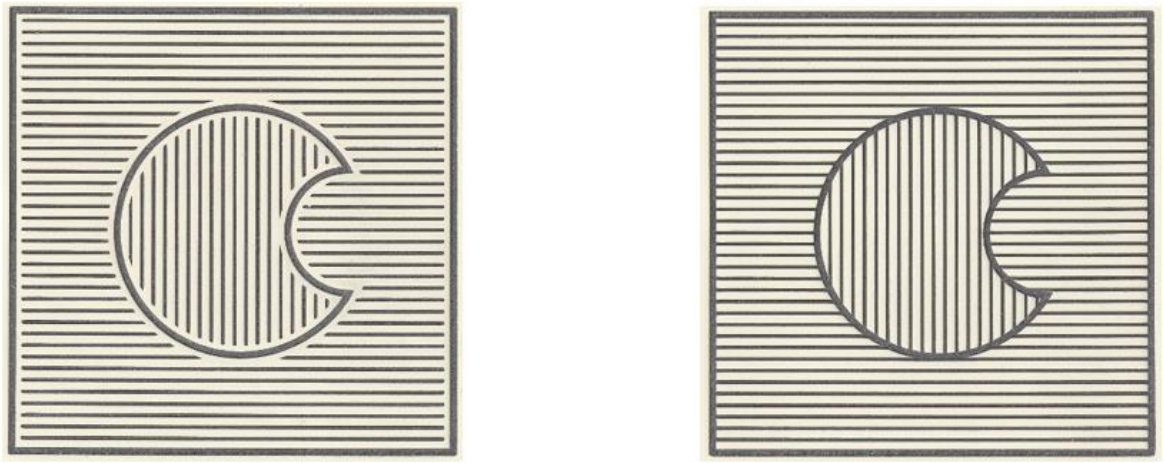

Figure 4.4: tests with a circle with a missing bite as described in the text. (Photo Dorine in 't Veld)

In a test blindfolded sighted persons and blind persons were asked randomly got these copies and were asked to tell on which side the bite was missing. Surprisingly in the copies without empty space this proved very difficult. The different fillings were hard to distinguish and the outline of the circle 'disappeared' in the pattern of almost equally high vertical and horizontal lines. With comfort white this took much less time and there were significantly less wrong answers.

This research was not published. It was done during an exhibition for AT and services for people with a visual impairment by the project '*Verken je Wereld*' (*Explore by Touch*, Esther Rieken and Dorine in 't Veld) in 2012. It gives many more examples of the importance of white space.

A funny anecdote: One of the participants was a very experienced user of tactile graphics, especially for science subjects. He was by far the fastest test person with the least of errors. Showing yet another side: practice makes perfect.

The third example you find in the Tacticos example book of Roundy. It is shown below. Roundy is in the fog. In the tactile image he is well visible. But if you close your eyes, the many clearly palpable dots make it pretty hard to find him. More dots, denser fog, make it even harder.

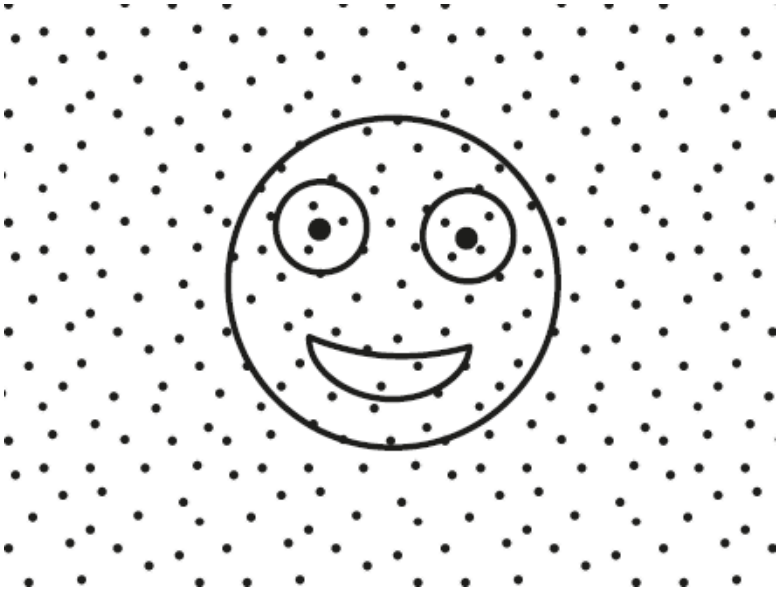

Figure 4.5: Tacticos example book Roundy: Roundy in the fog, drawing number 10.

An important lesson is: wide dots are not good for fillings! The fingers get too much information from them, whereas the drawing needs the attention. Details in outlines against a background with large dots are no longer perceivable by the poor fingers, that go tired and even get irritated with so much non-information!

Though it's hazardous to give exact dimensions we give you some figures:

- Add 5 mm or even more empty space around details or braille
- Add 2 to 3 mm or even more empty space between contours and fillings
- Add 5 mm or more empty space between two high areas (e.g. figure 3)

But please always test and proofread and keep in mind that the tactile sensibility of readers may (widely) differ, depending on:

- The size of the hand and the fingertips of your reader

- Age and health: sensitivity of the fingers like sight and hearing decreases with age
- Reading experience; 'practice makes perfect'.

4.1.2 FILLINGS FOR SOLID FORMS

- Fill (wider) solid shapes with a dense pattern where you don't feel individual dots; that way it is clear 'what belongs together'
- The fillings must feel rather smooth and preferable are a little less high than the outline. Don't forget the empty space.

Figure 4.6: a cloud with filling, from the example book of Roundy.

- You might prefer a finer dot than in fig. 11, but make sure the filling will actually rise (see 4.1)
- It is tempting to use grey, but beware with larger surfaces (see 4.1)
- It is tempting to play with different shades of grey, but it may prove very difficult to get good swelling results.

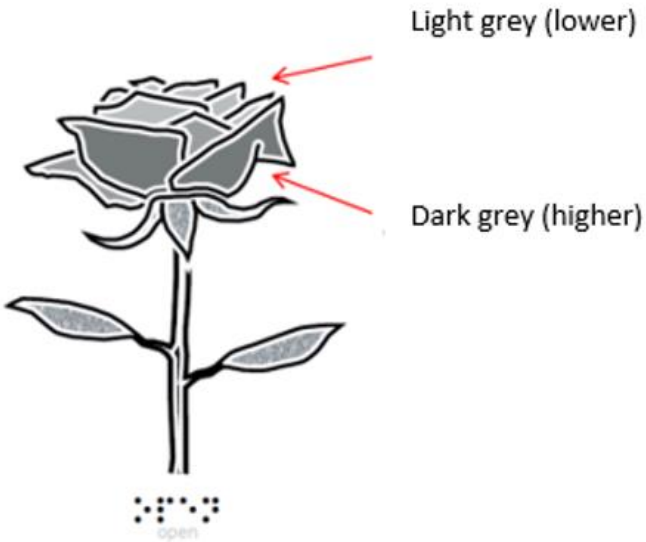

Figure 4.7: an open rose with different grey fillings. Source: Dorine in 't Veld en Esther Rieken: Richtlijnen voor het ontwerpen van tactiele tekeningen op zwelpapier. (Guidelines for the design of tactile images on swell paper). Project Verken Je Wereld. (2012).

The outer leaves are darker grey and should rise more; thus creating real depth in the tactile image. However the swelling process may require lots of time and attention and may not give the result you were hoping for.

4.1.3 TEXTURES AS LEGENDS

You also may want to use fillings for indicating some property or material, for example water, or a roof or grass or land, etc. In that case you use the fillings as 'legends' as in maps. It is tempting to choose 'visual textures' like waved lines, roof tiles or small strips. However there are two things to take into account.

1) Never overcrowd a tactile graphic. Remember the importance of white space.
2) Carefully choose fillings that FEEL differently. Remember figure 9.
3) Use max. 3 different (not-empty) fillings; empty space is a filling too.

Again: make test sheets!

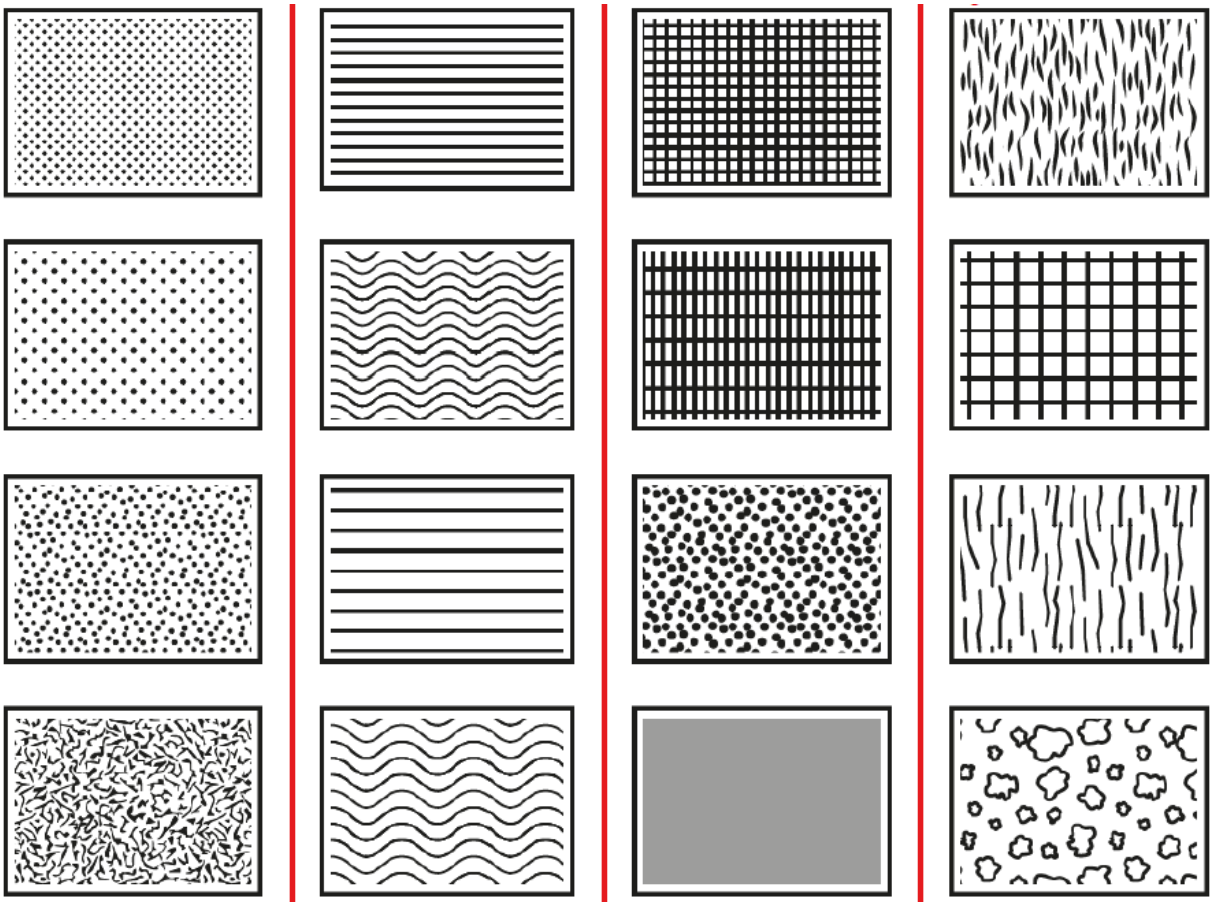

Figure 4.8: Dedicon test sheet for selecting TACTILELY different textures.

The textures in the columns are only slightly different to the fingers. Never combine them in one tactile graphic. Choose one texture from each row.

4.1.4 LINES

Preferably give every line with another function another width or structure. For example:

- The ground
- The outline of a shape
- The outline of a shape within a shape
- A schematic line or path

Use no more than 6 different line types in your tactile graphic. Standardisation by the way is hardly possible, since designers have to make many choices within the limited space of the sheet and scales may vary.

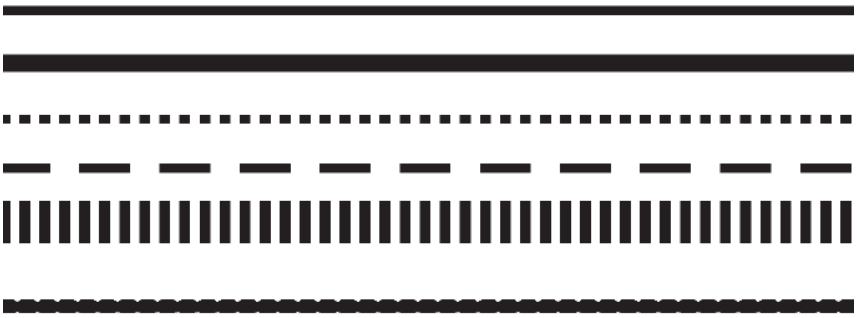

Figure 4.9: different line types.

4.1.5 SCALE AND SIZE

- A tactile graphic of for example a flower is not easily recognizable on another scale! It looks the same, but feels very differently.
- If you enlarge a drawing for a tactile graphic, the dimensions of lines and textures will change.

4.1.6 ANGLES

- An obtuse angle feels a bit like an arc unless you put a dot in the 'corner'
- Angles sharper than 30 degrees cannot be discriminated unless you put a dot

Sometimes a designer must add dots to make it easier for the fingers to recognise

- Obtuse angles

Figure 4.10: an obtuse angle will feel like a faint bow. A dot makes clear it is a line with an angle, Dedicon.

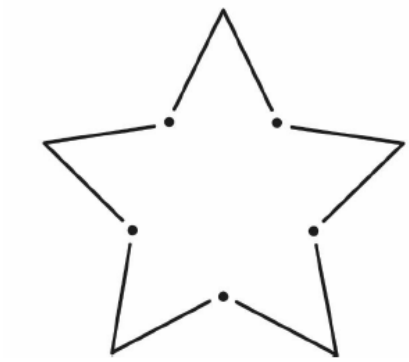

Figure 4.11: a 5-pointed star is easier to recognize when there are dots in the obtuse inner angles, Dedicon.

- (Very) sharp angles will be easier to recognize with an added dot too

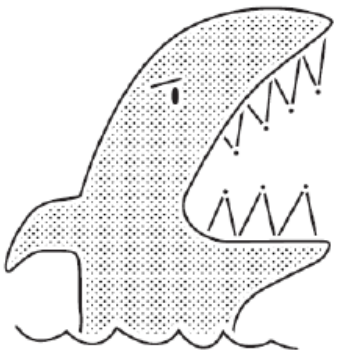

Figure 4.12: shark with sharp triangle teeth, adapted illustration, Dedicon.

- Arrows will greatly profit from a wide arrowhead with a dot in the point too. (Narrow arrows heads feel like lines with a thicker part on one end)

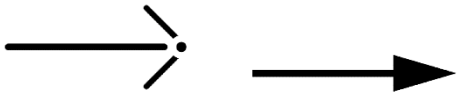

Figure 4.13: arrow with a dot in the arrowhead and arrow with closed narrow arrowhead. Dedicon.

4.1.7 BRAILLE IN TACTILE GRAPHICS

If you are not an expert adding braille can be quite challenging. Braille is different per country. Braille on paper has round tops, whereas swell paper tends to be flatter on top, which makes reading more difficult. Please consult an expert institute to find an apt font to use in swell drawings. Please note that braille has standard dimensions; do not minimize or magnify.

For standard dimensions of braille (on paper): see https://braille-autoriteit.org/algemeen-gebruik/standaardafmetingen/ and/or http://www.ukaaf.org/braille/standards/.

- Avoid using braille as much as possible; it complicates reading the tactile graphic.
- A title in braille can be helpful though.
- Avoid using lines or arrows to indicate the part that the braille label corresponds with. These lines complicate reading the tactile graphic very much.
- Put the braille, if you cannot avoid it, to the left of the corresponding part in the graphic. If there is no place then on the right. (You can imagine it is challenging to place braille in tactile graphics).
- Many blind readers do not like braille on swell paper because it is harder to read than braille on paper, because the braille dots are flat at the top, not round. Especially on a velvety quality of swell paper this complicates reading. Most blind readers notwithstanding do like to have the most important information in Braille, like the title. This avoids having to switch back and forth from tactile graphic to text. In the example book Roundy however we only used lower case braille in the title on the cover; this is an international book and even in the partner countries the number sign and capital sign is different in braille.

4.1.8 PRINT IN TACTILE GRAPHICS

- You can add (small) grey letters, for example Arial point 12, to help people who do not read braille. These do not swell; they help to assist the braille reader, and can be positioned above or under the braille.
- You find an example in the test sheet in figure 4.15 is 20%.
- In that same example you find the word 'Testblad 1' in large red letters (Arial point 20); this doesn't swell either. Ideal if you want an image to be accessible for blind and partially sighted readers.
    - If there is too much braille, there will not be enough place. It is a good option to print the tactile graphic with high contrast letters on a separate sheet.
    - If you want to stimulate braille readers, with remaining sight, to read the braille, put large printed letters underneath the braille so that these will be covered when reading.
    - If your main target is to help assistants or let blind and partially sighted readers work together, put the printed text above the braille.

4.1.9 FURTHER READING

In the references we add a few existing guidelines. It is not exhausting or complete. The most recent, very good, very broad and very extended guidelines you find on:

https://www.brailleauthority.org/guidelines-and-standards-tactile-graphics

https://brailleaustralia.org/about-braille/tactiles/

4.2 GET TO KNOW YOUR EQUIPMENT FIRST

- There are different qualities of swell paper and different types of swell ovens.
- There are velvety qualities and crisp ones; the latter allow to display more details. Smoother materials make it more difficult to feel differences between lines/textures.

The process of swelling is a craft. The result of your reproduction process depends on:

- The (ink) printer (type of ink, temperature during printing, colour settings)
- The amount of 'carbon' in the ink (this may vary invisibly!)
- The quality and age of the coating of the microcapsules
- Humidity, drafts, wind gusts or other coincidental environmental influences
- The swell oven; there are individual differences between (the lamps in) the machines
- The temperature of the lamp will rise during use

What can go wrong?

- Details don't swell (enough) (lamp is not hot enough)
- Lines or surfaces are damaged (lamp is too hot)

Both effects are unwanted

- If you cannot feel lines or textures the image may be unclear or even unusable
- If you feel grains on a line or surface, a blind person may assume they mean something

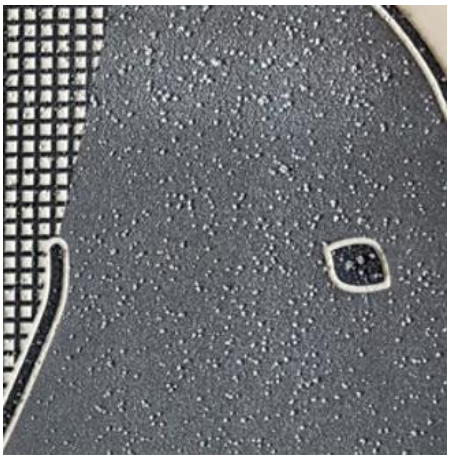

Figure 4.14: detail of an overheated swell image with small grains all over the grey surface and black lines, and even on the white space between the grid line texture. (Photo Dorine in 't Veld)

4.3 MAKE TEST PAGES

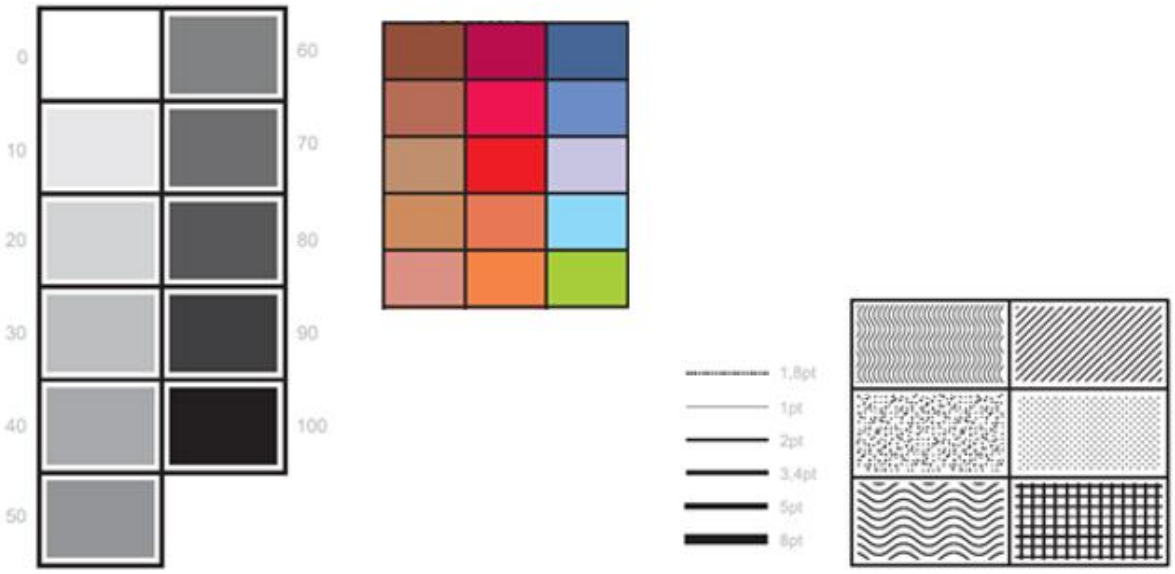

Figure 4.15: a few examples to put on a test page: a grey scale (with percentages of black), colours, lines of several thicknesses (in points), only black fillings/textures. (*Screenshot Dorine in 't Veld)*

Of course you can vary and add different line types and fillings that combine textures and colours. Test out:

- what height a black line of specific line width will get in your configuration
- what colours and greys do or do not swell

NB: larger areas may behave unexpectedly. E.g.:

- in a large surface with small dots may swell unevenly. **Test read** for you hardly see this!
- the uneven distribution of heat is very visible in the test example below

- 

Figure 4.16: example of an overheated test swell image with a dark blue surface with black in the blue colour and with different black textures. (Photo Dorine in 't Veld)

The damage (unswelled parts or grains) often is not clearly visible at a glance. So:

1. DURING THE REPRODUCTION PROCESS KEEP THE TEMPERATURE CONSTANT
2. ALWAYS PROOFREAD THE RESULT
3. TEST-TEST-TEST

4.4 REFERENCES AND LINKS

Project SOCRATE-COMENIUS 3-1 1999/2000, ***TACTIMAGES & TRAINING -*** *IMAGES TACTILES - ACCES A LA CULTURE – FORMATION*, Annexes techniques 1 : Cahier des charges des Aspects, Graphiques Spécifiques. (Also referred to as 'Annexes'. (Online these Annexes seem to have vanished, but a pdf can be obtained by e-mailing dorine@dvlop.nl: copy of Documentation Michel Bris S.D.A.D.V. CNEFEI Suresnes).

ImageShare Accessible image acceptance criteria, RNIB 2012

2010/11, *Guidelines and standards for tactile graphics 2010*, BANA

Dorine in 't Veld en Esther Rieken: *Richtlijnen voor het ontwerpen van tactiele tekeningen op zwelpapier*. (Guidelines for the design of tactile images on swell paper). Project Verken Je Wereld. (2012).

5 ACCOMPANYING EXPLANATIONS EXPLAINING TACTILE IMAGES

5.0 INTRODUCTION

This chapter provides an overview of what needs to be explained—and to whom—when working with tactile books. We illustrate this guidance with plenty of practical tips and examples. At the end of the chapter, you'll find a checklist and information for authors and publishers about where and how to include explanations.

Designing and writing a tactile book can be a multidisciplinary, interactive process. Don't forget the important role of the adult reader, who will read the book aloud to the child and guide them in exploring the tactile illustrations. Whenever possible, involve the child in the development process.

As children grow older, they will be introduced to more tactile graphics—such as line drawings on swell paper (see Chapter 4). These can be produced more quickly and at a lower cost, but they are harder to read. They offer only one level of relief and lack the rich variety of textures and materials found in early tactile books. However, by that time, the child's motor skills, working memory, and general knowledge of the world have developed, opening up new possibilities for using tactile images to explain abstract concepts. At the same time, the child must learn increasingly complex principles in order to interpret tactile graphics effectively.

Many children have limited experience in reading tactile illustrations, so adult guidance is often necessary. The key is to make it fun and engaging for the child. Learning to "read" tactile images is a gradual process. The child needs support to recognize what they are feeling and to make sense of it. The way and amount of explanation needed will vary, depending on the child's tactile skills and prior knowledge.

Keep in mind that many children with visual impairments have a natural preference for auditory-verbal learning. They rely on language to support their actions and exploration, and sound effects can be helpful in enhancing their understanding.

We strongly recommend that publishers include tips and guidance with their books—both about the overall content and about individual tactile illustrations—to support adult readers, who may also be unfamiliar with working with tactile images.

5.1 DIFFERENCE BETWEEN AN IMAGE FOR A BLIND CHILD AND A SIGHTED CHILD

A sighted child can instantly see what an image represents and may explore the details later. A visually impaired child, on the other hand, often needs someone to explain the image in order to understand it. Children with a severe visual impairment—tactile readers—must learn to "translate" three-dimensional (3D) concepts into two-dimensional (2D) representations. This process develops over time and at different age levels. Experience with tactile materials is essential when introducing such children to books or drawings.

A blind or severely partially sighted child does not have the same immediate access to information as a sighted child. While the sighted child sees an object or situation at a glance, the blind child requires

many experiences to fully understand a concept (see Chapter 2). They may not yet have formed a mental image of the objects represented in a tactile illustration.

A second challenge is understanding that a 3D object can be represented in 2D. The child must learn the concept of what a drawing is and how it works—how a real object is symbolically transformed into a flat representation, and what that representation stands for. Simply taking a visual image made for sighted children and turning it into a tactile version—for example, by gluing different fabrics onto it—is not sufficient. What matters most is considering what the child already knows and creating tactile illustrations that are meaningful from that starting point.

5.2 USING 3D OBJECTS TO ACCOMPANY A TACTILE BOOK

When available, a real object or 3D-printed model can be very helpful in explaining a subject or an image to a visually impaired child. The transition from three-dimensional (3D) objects to two-dimensional (2D) representations—such as photos or drawings—is often difficult to grasp and requires structured learning and practice.

In the Netherlands, the *Leerweg 3D-2D* ("*Learning Path 3D–2D*") has been developed to guide children step by step through this process of moving from tangible objects to tactile drawings.

As part of the 3D–2D project, a special book titled *Lap is weg* (*Lap is Gone*) was created for young children to support this learning journey. The story was written by itinerant teacher Brenda Zwijnenburg, and the book was designed by Ann Conefrey.

Figure 5.1: Book 'Lap is weg' by Brenda Zwijnenburg and Ann M. Conefrey. (Photo A.M. Conefrey)

Bob Marek has designed a special book „Teddy Bear Book“ to teach young children about the transition between a 3D object and a drawing.

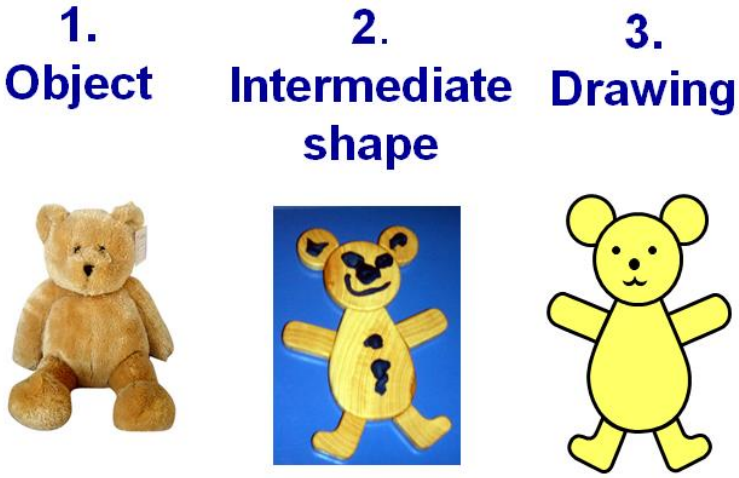

Figure 5.2. Teddy bear transition 3D to drawing (Photo Bob Marek)

5.3 EXPLANATION WHAT A CHILD NEEDS TO EXPLORE A TACTILE IMAGE

5.3.0 HOW TO HELP EXPLORE A TACTILE IMAGE.

It is recommended to guide children while they explore tactile illustrations, accompanied by verbal explanations that clearly name the elements depicted. Some children prefer to explore the illustration globally at first, and then move on to details. It can be helpful to teach them a more systematic way of exploring with their hands.

The child can be guided using either the hand-under-hand or hand-over-hand technique, depending on what suits the situation and the child's preferences. Creating pleasant, engaging experiences is essential. Overcoming tactile defensiveness—a reluctance or refusal to touch certain textures—is also an important step in developing tactile skills. The guidance techniques developed by Deborah Chen can be particularly helpful in this regard.

Figure 5.3 shows a tactile illustration in a book and demonstrates how to explore it together with the child. (Deborah Chen in Tactile strategies for children who have visual impairments and multiple disabilities)

Figure 5.3: Hand- under- hand technique, the child follows your movement and can take over if the child wants. (Photo Anneke Blok)

Once a child is able to explore objects more thoroughly using their hands and fingertips, they can begin to detect more detailed information about shape and texture. As Robin Nation explains, a young child's early experiences with collage-style tactile illustrations lay the foundation for using tactile graphics, maps, graphs, and images they will encounter later in their education. (Nation Typhlo_& Tactus guide 2008).

Bob Marek made a book together with the Eqla Library in Brussels, an adaption of the Goldilocks book (Fairy tale, published in 1837 by the British author Robert Southey)

Figure 5.4. From the book Goldilocks. (Photos Bob Marek)

Recognizing that the sets of three lines represent chairs, beds and a table, is just as difficult for a child born blind, exploring a collage type illustration as it would be in a raised line drawing. Also very often, collage type illustrations may facilitate understanding of raised line drawings when they work as an intermediate stage between 3-D objects and drawings.

Memory plays an important role in this process—both verbal memory (memory of information that can be verbalized) and non-verbal memory, including visual, tactile, and motor experiences. Working memory and short-term memory are discussed in detail in Ans Withagen's 2013 thesis *Tactual Functioning of Blind Children*.

At a certain stage, children begin to read independently. Their ability to explore tactile illustrations on their own depends on how much experience they've had with such materials. Even so, accompanying explanations remain essential. Children need help to interpret the shapes, lines, and textures they feel. To truly read a tactile picture, the child must be able to connect tactile clues with their own first-hand experiences. Textures are often the first of these clues—for a blind child, texture plays a similar role as colour does for a sighted child.

In using tactile books or tactile graphics (drawings/images) we strongly recommend that a parent or teacher, early intervention specialist or carer sits together with the child and helps to explain the images and stimulates the child to explore. This is necessary because it may not be easy to understand what the image is representing, especially when the child does not have much experience yet. The person who helps the child will have to explain what the child feels and what is meant by the image and stimulate the child to explore. To read a tactile picture by touch the child needs to find within the tactile picture some clues through own first-hand experience.

5.4 AGE RELATED ILLUSTRATIONS

For the youngest children, it is recommended to use real objects—either placed in a box alongside a book or attached directly to the page. Be mindful of very young children's tendency to explore not only

with their hands but also with their mouths, and ensure that all materials used are safe. At this early stage, children often explore using their whole hand, a natural style of exploration that helps them grasp and manipulate objects. They may also use their fingers to rub and feel the texture of different materials and surfaces.

Figure 5.5: (photo Gyntha Goertz, Visio school Rotterdam) *Figure 5.6. and Celia library Helsinki of an entry in the Typhlo & Tactus competition. (Photos Anneke Blok)*

For this reason, illustrations that incorporate real objects, large textures, and bigger shapes tend to be the most effective starting point. (Wright, Suzette in the Typhlo & Tactus guide 2008)

Figure 5.7: Tactile book made from an entry in the Typhlo & Tactus competition of the U.K (with permission to make the book) (Photo: Anneke Blok)

As children progress, the objects depicted in tactile books become symbolic representations rather than exact replicas of real objects. Unlike the first books, where real objects are used, these illustrations are similar to familiar items and can be easily associated with what the child has already experienced through touch.

As the child's tactile sensitivity and fine motor control improve, they become better able to explore the details of tactile illustrations that use flat shapes, raised lines, and outlines. Well-developed fine motor skills are essential for effective tactile exploration and understanding.

Figure 5.8 Winter Magic, designed by Irmeli Holstein from Finland. You can feel what it is like to walk on snow. The book was chosen and awarded in the Typhlo & Tactus competition. You can feel the snow when you are "walking" on it with your fingers (Photo Bob Marek)

From the age of 6, blind children at school are introduced to tactile illustrations made from line drawings, usually produced on swell paper. At this stage, they need support to learn how to "read" and interpret these images through touch.

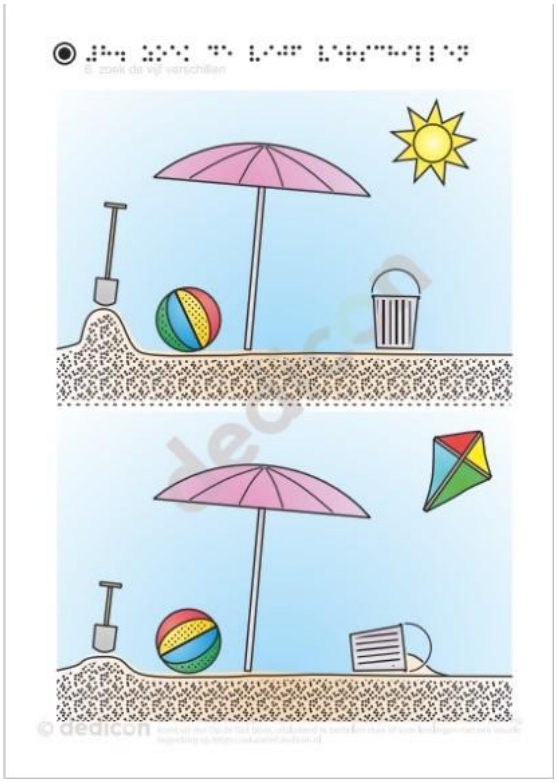

Figure 5.9: Example from "Op de tast…: Zomer", Dedicon 2018, fig. 9: find the differences; available for students in The Netherlands through https://educatief.dedicon.nl/p137710.html. All images of this book can be viewed at https://www.dedicon.nl/sites/default/files/2024-11/319535_1_Zomer.pdf.

For children ages 7, 8, 9 and up there are many possibilities. Tactile images can help a child to build a correct 'mental image' of concepts. The following examples clarify how much explanation is needed, and for whom.

- 'Reading guide' = guiding the fingers
- Interpretation = giving meaning to lines and shapes and textures
- Extra information = anything that is important but cannot be drawn
- Ask: what does it feel like (temperature, roughness, ….) what is the sound, taste, smell, weight: how heavy or light is it?, what does it look like (e.g. colour, shining, …), how does it move? How big is it in reality? Etc.

Children with cognitive challenges or learning problems may need simpler language, more time, more explanation, more experience, models, reality, other examples (that meet their perception of the(ir) world) and developmental age.

In order to keep the text short and understandable, it is recommended to use the table below, as a checklist and integrate or combine the elements as effectively as possible.

	Yes	No
Reader is good at discriminating shapes, lines and textures	Reading guide: Name the principal shapes, lines and textures	Reading guide: Guide the fingers step by step; help identifying shapes, lines & textures
Reader knows the underlying principles of the specific type of drawing	Interpretation: Just mention the main features and things that are specific for this tactile image	Interpretation: First explain what means what in this type of drawing; how are things drawn / represented
Reader knows the subject from experience	Extra information: If applicable describe what could not be drawn and refer to the experience	Extra information: If applicable describe what could not be drawn and refer to something similar that helps build a correct mental representation

Examples: images of 3D-objects will (almost) always need some reading guide and explanation. A top view, a front view and a side view of a 3D object, for example a dolmen.

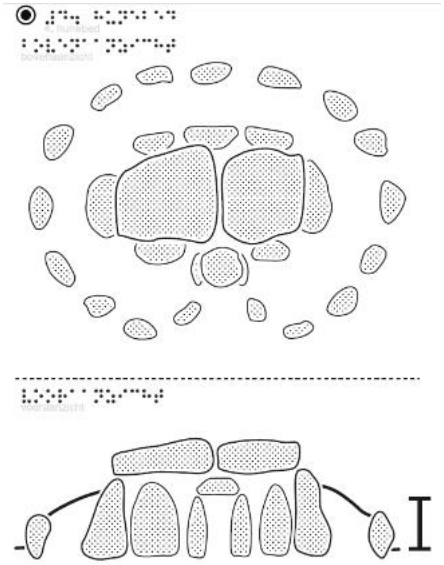

Figure 5.10 dolmen; page 6 from Op de tast…: Geschiedenis (By touch….: History), see https://www.dedicon.nl/sites/default/files/2024-11/317301_1_Geschiedenis_v06.pdf

The reader may know that a dolmen is a prehistoric structure made of large boulders. This example provides an explanation for a reader who is experienced but unfamiliar with what a dolmen looks like and how it is constructed.

The drawing is divided into two parts by a horizontal dotted line, showing two views of a dolmen. Dolmens are chamber-like structures with walls and a roof made from large boulders. They were used as burial sites, with the dead placed beneath them. The top drawing shows the dolmen from above (a top view), while the bottom drawing presents the dolmen from the front (a front view). By comparing the two illustrations, we can form a complete understanding of the structure.

Dolmens were built using large, flat boulders. The supporting stones were placed upright to form the walls, and the roof was created by laying the capstones flat across the top.

In the top view (the upper drawing), you can feel the two large capstones that form the roof of the dolmen. In the front view (the lower drawing), you can feel that these same capstones lie flat on top of the upright supporting stones. In the front view, you can feel a rectangular opening in the center — this is the entrance. To the left and right of it are two narrow boulders standing upright.

In the top view, you can feel that this entrance protrudes forward, like a kind of hallway. So, the narrow stones you feel in the front view are positioned at right angles to the long wall. On top of this hallway, in the top view, there's a small, almost round capstone. In the front view, you can feel that this small capstone is lower than the two large capstones behind it. This tells you that the "ceiling" of the hallway is lower than that of the main chamber.

In the top view, it feels like there are smaller boulders around the large capstones. But in the front view, next to the narrow stones of the hallway, you can feel large supporting stones on both sides. This tells you that the boulders around the capstones in the top view aren't small at all — you're only feeling the upper part of them, as they are standing upright.

In prehistoric times, there were no cranes — everything was built by human hands. To place the heavy capstones on top of the supporting stones, a slope of earth was built next to the outer supporting stones. In the front view, you can feel this slope as a thick, slanting line, which curves slightly.

The line curves slightly. On both sides of the front view, you can feel another small stone. In the top view, you discover that there isn't just a single stone next to the dolmen, but an entire circle of smaller stones surrounding it.

Between the dolmen and this circle of stones was the earthen slope. If you visit a dolmen today, you will discover that that slope of earth has disappeared over the centuries. To the right of the front view, you can feel a thick line with a transverse line above and below. This line indicates the size of a human being. By the way: the outer circle of stones is not drawn in the front view except for the two on the left and right; drawing the other stones would make the front view hard to read.

5.5 TACTILE ILLUSTRATIONS WITH SYMBOLIC REFERENCE

Any image can be a symbolic reference to a real object or something which is being communicated. In the following images you can see that the rabbit is represented by its ears and soft fur. The text introduces the character.

Figure 5.11 : Photo's of French books all by Les Doigts Qui Rêvent, made by and copyright Solène Négrerie

Figure 5.12 TEXT: The moon has disappeared... The moon's gone," cries Rabbit.

Figure 5.13

The Bear is represented by a thick, rounded coat; the Zebra by its stripes; the Giraffe by its height and spots; and the Wolf by its pointed snout and sharp teeth. Once again, the text introduces the arrival of the characters and names them. There are no figurative representations in texture here, so the reader focuses entirely on the textures and materials to identify the characters.

5.6 MANIPULATION IN TACTILE ILLUSTRATIONS

The tactile illustrations featured here are part of Les Doigt Qui Rêvent's adaptation of the classic children's fairytale, "Rapunzel." Many of these illustrations include moving parts, enabling children to physically engage with the story — whether it's combing Rapunzel's hair or sliding the witch down it. By interacting with the illustrations, children can act out various elements of the narrative, deepening their connection to the story. This hands-on experience can enhance the meaning of the words and significantly contribute to language development and comprehension of concepts.

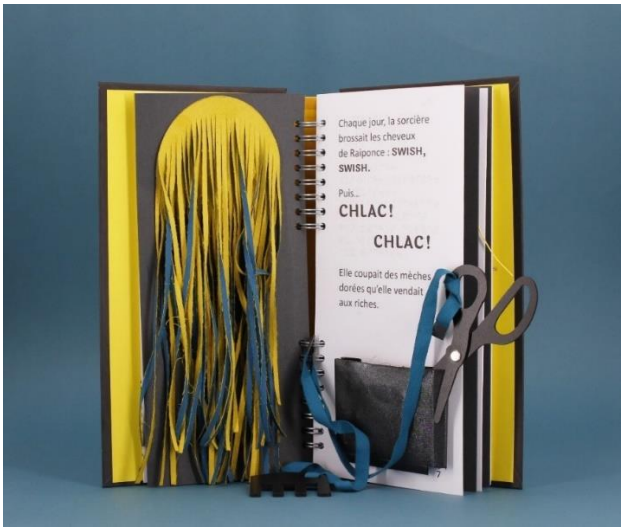

Figure 5.14

Figure 5.15 The hair of Rapunzel can be weighed and brushed.

Figure 5.16 The witch can slide along the hair of Rapunzle (Raiponce), illustrating the witch's ascent. The other illustrations are fixed. (photos Solène Négrerie)

5.7 MOVEMENT AND SPATIAL CONCEPTS

Blind children explore the world using their own bodies as a reference point. When engaging with images, drawings, or other tactile materials, their exploration is body-centred—they typically move their hands and arms outward from their body across the surface.

In learning about the world around them, it is essential that they are given many opportunities to explore actively. For example, understanding the concept of “under” may require physically crawling under a table—together with a caregiver—to experience what “under” means. In doing so, they can touch the underside of the table, which in this context becomes the “roof.” Similarly, understanding where the “top” of the table is also requires physical experience.

If a child noticed only two legs of a table represented in an image, they may conclude that a table has just two legs. Concepts like these need to be built through concrete experiences.

The idea of movement, such as a person walking, also requires explanation. Is the person coming towards you or walking away—and how can you tell? You might hear it, but how do you know which direction the person is facing in a tactile illustration? Where is the nose? (See Chapter 2.) The child must also learn to distinguish their own front and back—and that of others. To understand what it means for a person to walk up stairs, the child needs to do it themselves. In a tactile book, their fingers can be guided to "climb" the stairs as a representation of this experience.

An example comes from the book Hello Spider, written by teacher Gyntha Goertz and graphic designer Ann Conefrey. This tactile collage book won second prize in the Typhlo & Tactus competition. In it, the reader can "walk" down the stairs using their fingers.

Figure 5.17 'Dag spin' by Gyntha Goertz and A.M. Conefrey. (Photo A.M. Conefrey)

5.8 ANIMALS, DIFFICULTIES AND TIPS

Animals can be difficult to recognise in tactile images. Before a child can identify an animal by touch, they first need to know what the real animal looks like and what features it has. For example, if you want to explain what a tiger is by saying it is a big cat, you need to consider whether the child already knows what a cat is—how it looks, how it moves, how it climbs a tree. This is much easier to understand if the family has a cat at home.

Objects, people, and animals are easier to interpret in tactile form when they are shown in their entirety. Representational shapes are more effectively understood when they have solid infill and relevant textures. It is helpful if all elements are clearly defined, with separate and recognisable shapes.

Stylised illustrations—such as sketch-like drawings, thought bubbles, or motion lines—are often much harder for visually impaired children to interpret. A fish, for instance, should feel like a fish, with a texture that suggests scales.

Figure 5.18 (Photo Anneke Blok) of an entry of the Typhlo & Tactus competition

5.9 REFERENCES

Tactile strategies for children who have visual impairments and multiple disabilities, Deborah Chen 2006

6 IDEAS FOR STORY ELEMENTS

6.0 INTRODUCTION

Creating a story with your child or a child you guide is enjoyable for both the child and the storyteller. Parents and teachers sometimes collaborate with children to create stories. This practice takes place in several countries, such as the U.K. and the U.S.A. The Perkins School for the Blind and APH provide examples of such stories. Additionally, one of the winning books in the Typhlo & Tactus competition, *Crokato*, was created by teacher Claudette Kraemer and the children in her class.

Stories can also be inspired by existing books. Please note that in the Netherlands, you must obtain permission from the publisher if you wish to use an existing book.

Poems, songs, and rhymes within stories help develop a child's memory in an engaging way. Folk tales and classic fairy tales are fun to read, offering both thought-provoking themes and humor. The text of the story can also help children recognize the characters in the book.

For a child who is blind or has a significant visual impairment, it is beneficial to add Braille to the book or use a book that already includes Braille. Even if the child is not yet speaking, having the text in Braille helps build awareness of Braille dots, which form words and can be read later.

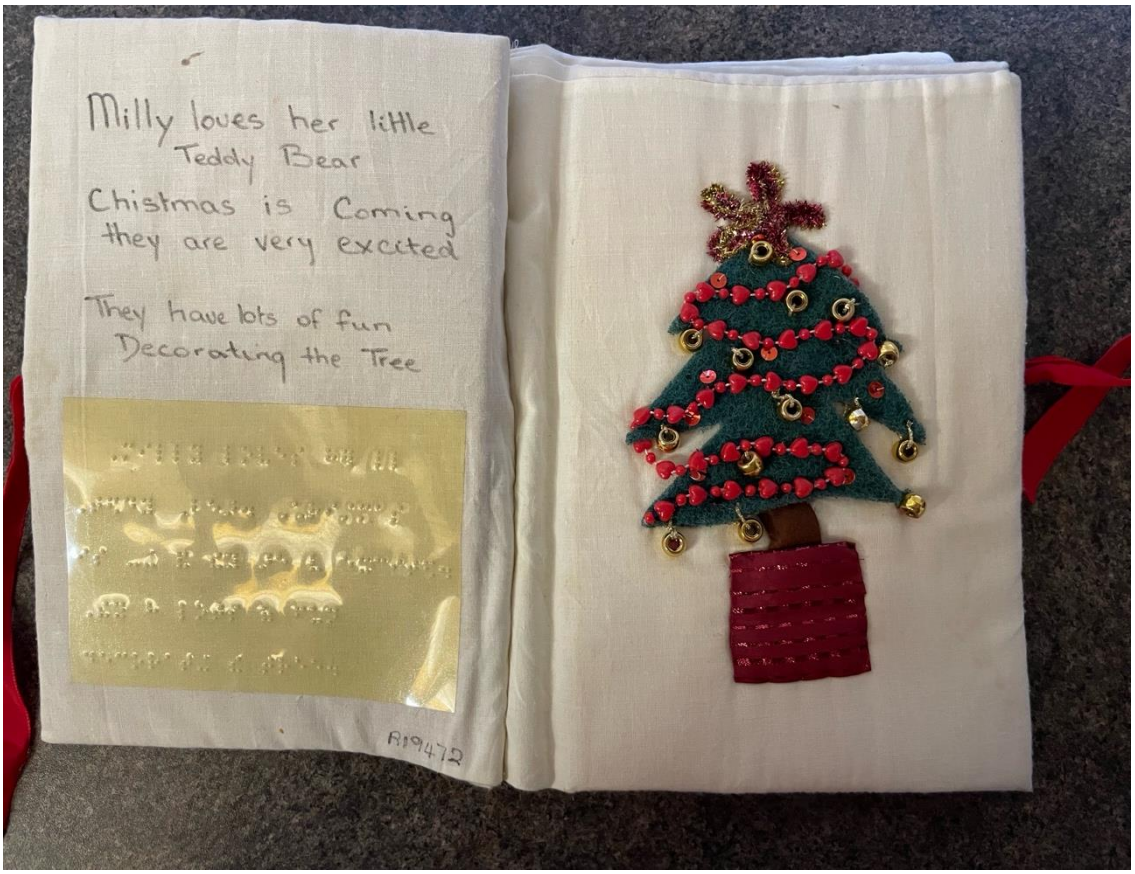

Figure 6.1. Tactile book from ClearVision's collection, London UK. (Photo Alex Britton)

6.1 RECOMMENDATIONS

Although there is not much scientific literature about the choice of a story or storyline in tactile books, some recommendations are included here.

- **Subject/ theme:**
  Books should be available for readers of different ages and developmental levels. A story for young children should focus on very familiar everyday objects and situations, such as playing with the dog, going shopping with mom or dad, staying over at a friend's house, going to the zoo, or using the washing machine. Older children, such as those aged 10–12, will have different interests. A book about a trip to the playground will be very different from a book about the planets in the solar system.

- **Aim of the book:**
  The purpose of the tactile book will influence the story. A story written for beginning Braille readers will use simpler language **than** a story meant to be read aloud.

- **Introduction of the story:**
  Before reading the book, discuss the theme—such as volcanoes or the farm. This preparation helps the child better understand the story. Using recognizable objects can also aid comprehension. For example, if the theme is "the farm," you can use a toy pig or cow. Visiting a real farm can further enhance understanding. These experiences make the story more meaningful, emphasizing the importance of verbal instructions for parents and teachers.

- **Understanding a tactile illustration:**
  In tactile books, the meaning of a tactile illustration depends on the words of the story (Stratton & Wright, 1991). If the story does not provide enough information to understand the tactile illustrations, this information should be given verbally.

- **Reading levels:**
  If the story is intended for beginning Braille readers to read independently, certain rules should be followed. For example, avoid capital letters and use short, simple words such as "the cat is red."

- **Amount of text:**
  Young children have short attention spans, which should be considered when selecting a story. If the tactile book is based on an existing story, the text often needs to be shortened. A longer version of the text can also be included as a separate supplement to the book, which can be used for reading aloud.

6.2 LEVELS FOR READERS

Belgium, France and The Netherlands have reading levels for young readers. In Belgium and the Netherlands these are called 'AVI-levels'. These books are adapted in braille for blind students.

6.3 READING STORIES FOR MDVI

For children and adults with visual and (severe) intellectual disabilities, it is often difficult to find stories that are captivating enough for them. When writing these stories yourself, keep the text simple.

For children learning to read Braille, three books were specially written by Marion Brillemans (a former teacher at the Visio School in Rotterdam) and designed by Ann Conefrey. The stories (in Dutch) were created for different reading levels. They are available at all schools for visually impaired children in the Netherlands and can be borrowed from the library at www.passendlezen.nl (available only in the Netherlands).

7 PRODUCTION TECHNIQUES AND MATERIALS

7.0 INTRODUCTION

How can you make a story accessible to a young child with limited or no vision? One effective approach is to create a tactile book featuring braille and tactile images and possibly incorporating 3D objects and audio elements.

This chapter explores well-established techniques and materials commonly used by printing houses and schools as well as introducing lesser-known possibilities employed by artists and designers, and simple materials and techniques which can be used at home.

The unique properties of materials and techniques play an essential role in how well a story or information will be conveyed to a child. What can be felt very well in one technique or material might not be so tangible in another. The design process involves making thoughtful choices regarding the suitability for different types of tactile books and tactile graphics.

Collaborating with experts in tactile design and individuals with visual impairments can help to ensure that the designs meet the needs of the intended users. Before developing a new tactile book or graphics, it is advisable to establish a comprehensive briefing outlining the specific educational and design criteria. Key considerations include:

- Determining the purpose.
- Specifying the age group and cognitive abilities of the intended readers.
- Identifying the context in which it will be used.
- Is it a standalone or part of a series?
- Available budget and other resources for design and production.

7.1 COLLAGE

Figure 7.1 Winter Magic by Irmeli Holstein. (Photo Bob Marek)

For the purpose of these guidelines, we are using the term 'collage' for tactile illustrations which are not printed but rather fabricated using different materials. There is an incredible wealth of natural and synthetic materials which can be used to make a tactile collage book / illustration. One of the most important aspects is child safety and durability. Furthermore, environmental factors play an increasingly important role.

7.1.0 CHOOSING MATERIALS

Choosing materials for their unique properties can be time consuming. Remember to think tactile. You might try closing your eyes when choosing materials, and don't forget to test these with the children. Some materials might *look* different but not *feel* different. Look for materials with specific textures which you can categorize in terms of their tactile qualities and maybe other sensory triggers such as smell or sound or another form of haptic feedback.

Figure 7.2 : Quel Radis dis-donc! by Praline Gay-Para and Andrée Prigent. Tactile adaptation© 2023 Édition Les Doigts Qui Rêvent. (Photo LDQR)

Depending on the purpose of the illustrations, the use of 'real' materials provides very direct tactile clues, drawing upon the experiences of a young child. The size, weight, texture, sound, smell, manipulation or interaction of the materials used all contribute to triggering the imagination and hopefully helping the child to build a mental image. Sometimes materials alone can be used for their affective qualities for triggering emotions, memories or associations.

Instead of using lines, tactile contrasting materials and functional spaces can be used to represent different parts an illustration.

If certain characters are repeated in illustrations children will recognize them more easily if they are always treated the same in terms of material, size and shape (and possibly positioning). This helps a child build a tactile memory.

Figure 7.3: The Cart by Marianne van der Vinne and Ann M. Conefrey. (Photo A.M. Conefrey)

Using certain materials together can enhance the meaning of an illustration, for instance a beach ball, made from real beach ball material on a sandy background or a block of cheese on a wooden plank. The combination of materials not only gives context but can also help to anchor an illustration.

For practical reasons it's wise to consider the overall thickness and weight of the materials as well as manageability during fabrication, e.g. cutting, assembling, folding, sewing, gluing and binding.

Be aware of stereotypes when representing people. Gender, skin colour, hair, clothes and so on can be reflected in the choice of materials.

Figure 7.4: Rapunzel by Bethan Woollvin. Tactile adaptation© 2022 Édition Les Doigts Qui Rêvent. (Photo LDQR Solène Négrerie)

7.1.1 Real objects

When choosing real objects for tactile illustrations, it's best to use familiar objects with distinctive textures which a child can recognize easily. For very young children, the possibility of detaching objects from an illustration can encourage meaningful interaction and play acting. Be aware of safety issues and the risk of choking on small parts.

If you are using a 3D object to accompany the story or illustration then there should be a clear relationship between the object and the illustration in terms of tactile appearance, i.e. as much as possible the same size and texture so that the child makes the connection.

Figure 7.5: Elements from The Teddy Bear Book by Bob Marek, Hungry Fingers. (Photo B.Marek)

7.1.2 Material suggestions and tips for handling

There are many aspects which need to be considered when selecting materials. The choices made will depend upon who the book is for, where and how it will be read and of course the available budget and other resources. These are some examples of materials that can be used along with practical tips for handling.

Materials:

- Handmade artisan papers from countries such a Nepal, India, Japan, China, etc, many with specific textures and unique properties.
- High quality factory produced papers are available in a large range of weights and sizes. The so-called special papers with embossing or other tactile qualities can often be purchased per sheet.
- Felts, both natural and synthetic (sometimes with an adhesive backing).
- Hobby foams: often sold in handy A4 and A3 sheets or on a roll (sometimes with an adhesive backing).
- All kinds of fabrics, including clothes which can be taken apart to re-use the materials.
- Accessories such as hair extensions and wigs.
- A wide range of foils with special finishes such as velvet, embossed, transparent, etc. These can be purchased in sheets or on a roll, often with an adhesive backing.
- Threads, strings, wool, pipe cleaners, Wikki-Stix, very fine wires, etc.
- Buttons, bells, clips, zips etc. for movement.
- Using scented markers or perfume to add scent.
- Using bells, stuffing materials or simple electronics to add sound.
- Magnetic sheets.
- Wood such as balsa which is light and easy to cut.
- Ready-made objects, such as synthetic leaves or flowers which can often be taken apart for usable components (no small parts - be aware of choking hazard).
- A lot of interesting materials can be found in DIY stores, second hand shops, hobby shops, art material shops and so on.

- With a little imagination you can find interesting materials just about anywhere!

Tips for cutting different materials:

- Round off any sharp corners and smooth sharp edges.
- When cutting by hand be aware that there are special fabric scissors and paper scissors.
- There is a wide range of craft blades and scalpels, including adjustable circle cutters.
- Laser is a very accurate way for cutting precise shapes (including very small or intricate) in a wide range of materials, even thick materials such as wood and metal. Laser is very fast and particularly handy for large amounts. It's advisable to test materials beforehand as laser cutting can leave burn marks (these can also be sharp). Some plastics, such as PVC, are not suitable for laser cutting.
- Cutting plotters are very accurate for cutting a wide range of materials and sizes. Unlike laser, they don't leave burn marks, and they can be used to cut certain plastics which can't be cut with laser.
- Cricut hobby machines are very handy and flexible machines for cutting small amounts of materials. They can also be used to draw, lightly emboss and score designs. The models and suppliers can be found at https://cricut.com
- In certain cases, it can be worthwhile (especially for large amounts) to make a cutting die or to make use of existing cutting dies (printers often have a stock of dies for cutting for instance circles).
- Fabric hole puncture works well for making small holes by hand in tough material.

Tips for fastening materials (remember child safety and durability):

- Child friendly glues and adhesive foils (non-toxic).
- Hand sewing for small details.
- Sewing machine for larger amounts; it's easy, clean and strong.
- Split pens for moveable elements; these come in various shapes and sizes.
- Velcro is strong and can be either sewn or glued to a material; is also available with an adhesive backing.

Tips for storing materials:

- Keeping track of a large amount of materials can be challenging. Categorizing and storing in separate containers can save a lot of time.
- Using a data base to record materials makes re-stocking easy: name, photograph, supplier, date and price.

Figure 7.6 The fabrication of tactile collage illustrations. (Photos: LDQR / A.M. Conefrey)

7.1.3 Benefits and possible drawbacks

Tactile collage books and illustrations provide an unmistakable and rich tactile reading experience. However, they are relatively complex, time consuming and expensive to produce due to the variety of materials and techniques used, including handwork. It can also be challenging to repair damaged books or produce later re-editions using the same materials.

7.2 BINDING

The way in which a tactile book can be bound depends on several factors such as size, thickness, the materials used, how the book will be used, whether the books comes with 3D objects or other additions, if there are electronics incorporated in the book, a collage book or a printed book (2D, 2,5D or 3D) and last but not least the available budget.

Figure 7.7: Tactile books bound using different binding methods. (Photo A.M. Conefrey)

7.2.0 BOOK BINDING METHODS

- Spiral and comb binding: A safe, cheap and easy way to bind a book involving a loop wire or a metal comb threaded through a series of holes punched into the edge of a book. Wire-o mechanisms come in an array of sizes and colours. The pages lie nice and flat which is important for reading braille and exploring tactile images. However, the presence of a spiral running down a spine can also break up a double page spread and hinder the continuity of reading. It is handy for one-offs or short runs. One drawback is that it can have associations with 'cheap' (although this depends on how a spiral or comb is used); for this reason, it isn't often used for commercial productions.
- Saddle stitch binding (stable bound): A simple and cheap way of binding a small number of folded pages. When too many pages are stapled, the pages don't lie flat. This is good for short term use only as the pages are more prone to damage.
- Singer sewn binding: This is a traditional method of stitching folded pages along the spine. No adhesives or staples are needed. It is a very elegant and strong method for thin booklets. When opened the pages lie flat. It can be safely used to bind braille without flattening the dots. One drawback is that it is relatively expensive.
- Hardcover or case binding: A sturdy, high quality option for binding single sheets or sewn sections so that the pages lie flat for touch reading and exploring with two hands. This type of binding works very well for double page spreads. Depending on the materials and techniques used for the inside pages, machine binding using pressure, glues or heat will be problematic. Binding books by hand can be a good option, especially for small quantities. A talented bookbinder will always find way to bind a book, depending on the available budget (cost might be a drawback).

7.3 SWELL

Using swell for tactile graphics is a relatively simple, fast and low-cost method of reproducing tactile graphics such as drawings, maps, diagrams and braille. Unlike other techniques, this technique is interesting for single use, small series and for prototyping.

Figure 7.8 Tactile books by Dedicon, printed on Swell and spiral bound. (Photo A.M. Conefrey)

This method works with a *swell form machine* (heat fuser) and *swell touch paper* which reacts to black ink or toner containing carbon, and heat. When a drawing on this coated paper is exposed to heat through the machine, the black areas swell (puff), resulting in raised lines, textures and patterns in slightly varying heights. It's basically a one-level relief technique. There are several brands of paper and swell ovens, which may give different results regarding crispness. This technique works well with line drawings and clear textured areas. Colour may be added to make visual enhancements; however dark colours may swell unintendedly. It's also possible to print accompanying text by giving this a percentage of black (for instance 20%) so that it remains visible but without swelling. The machine is compact and safe to use in classrooms. It has an inbuilt fan which keeps the machine cool and allows for the tactile graphics to be used instantly.

Swell touch paper, also known as microcapsule paper, puff paper or fuser paper and is available under various trade names including ZyTex, Tangible Magic Paper, Minolta Paper, Matsumoto and Flexi-Paper. As with any technique it's worthwhile investing time to discover its full potential. European paper sizes are A4 and A3. For best results the paper needs to be stored away from direct light and heat and sealed tightly to prevent it from drying out.

7.3.0 Benefits

- It is a relatively simple, fast and low-cost technique for reproducing tactile illustrations or drawings (raised lines, shapes, textures.
- It can be used for single use or small series.
- One can copy or print on swell paper, including any accompanying text (in braille and Roman), and add colour.
- One can also draw by hand on swell paper using a special marker pen with ink that has a high carbon content. There is also an electric 'heat pen' which allows you to draw directly onto the paper with a heated pen tip.
- By using different shades of grey, it's possible to swell to different heights.

7.3.1 Possible drawbacks

- The braille dots on swell paper are flatter and less crisp than embossed braille.
- Some children don't like the feel of swell prints (fuzzy, sticky).
- It can be challenging to maintain a constant temperature for the swelling machine. The machine may get too hot, causing the paper to swell which could damage your printer or copying machine.
- Temperature, humidity, draught, varying amounts of carbon all influence the swell result.
- Finding the perfect settings in your drawing program and your printer, so that the right amount of carbon is in the ink.
- Swell paper is relatively expensive.

7.4 SCREEN PRINTING

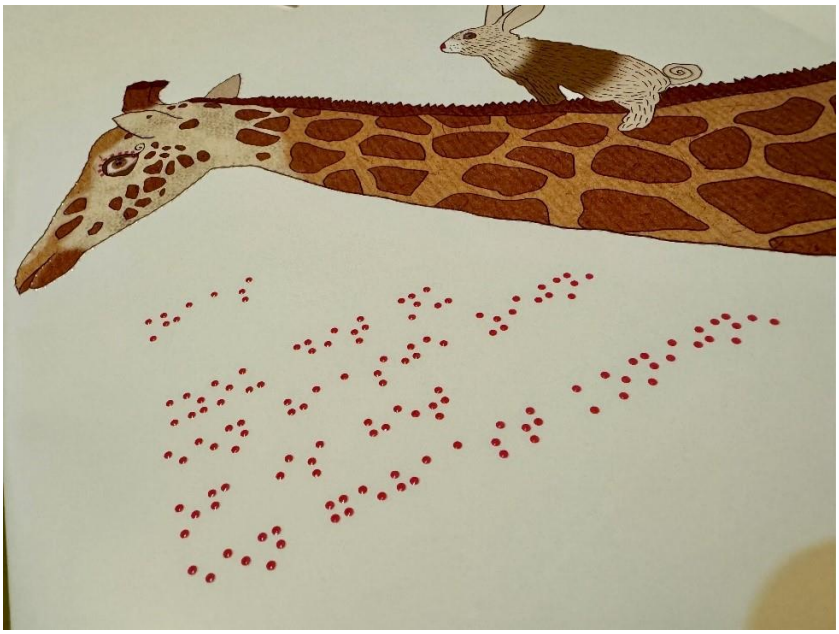

Figure 7.9 Rare Snuiters by Jan Dewitte, Freya Vlerick: offset printing combined with screen printing for braille and illustrations. (Photo A.M. Conefrey)

Screen printing (also known as silkscreen or serigraphy) is a popular and versatile printing technique used to transfer designs onto various surfaces, including paper, fabrics, wood, metal, and more. The process works by blocking or forcing ink to pass through specific areas of a fine mesh screen onto a carrier. The technique lends itself well to printing in relief and allows for durable and vibrant designs including braille. There are a wide range of inks available, also with special tactile effects such as glitter or suede and scent so it's worthwhile experimenting first to create the desired result. So-called braille ink is a transparent varnish which can be used to superimpose on an area already printed with colour inks. It's also possible to create more complex designs by building up layers of inks and effects. In terms of cost, screen printing is interesting for larger print runs.

7.4.0 BENEFITS

- Durable and long-lasting making it suitable for long-term use and frequent handling for books, maps, diagrams, or signage.
- Fine lines, text, and intricate designs can be accurately reproduced in a uniform quality.
- Specialized inks with specific properties, such as high-contrast inks, tactile inks and scented inks which can enhance the tactile experience for users.
- It can be cost-effective when producing larger quantities.
- Screen printing is versatile and can be used on a wide range of materials (both 2D and 3D), including paper, fabric, plastic, wood, metal, and more.

7.4.1 POSSIBLE DRAWBACKS

- Initial setup costs can be relatively high: cost of screens, emulsions, exposure equipment, and a printing press. For low-volume projects, it may not be the most economical choice.
- Labour-intensive in the preparation and clean up stages.
- Achieving the right thickness of ink (height) and consistent pressure to create a tactile effect or particular texture can be challenging. This may require precise alignment and multiple printing passes.

- The use of solvent-based screen-printing inks can have environmental and health considerations. Water-based inks are an eco-friendlier option but may have other limitations.
- Each colour requires a separate screen and printing pass.

7.5 THERMOFORMING (VACUUM FORMING)

Figure 7.10 Examples of vacuum forming used for maps and even a portrait of Louis Braille. (Photos A.M. Conefrey)

Thermoforming is a popular and effective method for creating tactile graphics with braille. It is a semi-automated technique which can be used for larger quantities. This process involves heating a plastic sheet and then forming it into a 3D shape, creating raised and textured surfaces that can be felt through touch. When well executed the result can be almost three-dimensional and highly realistic. It is a method widely used for producing tactile diagrams, maps, signage and even books. Thermoforming plastic sheets (for instance Brailon) are typically made of materials like polystyrene or PETG (polyethylene terephthalate glycol). The sheets come in various thicknesses, with thinner sheets suitable for simple graphics and thicker sheets for more complex, durable graphics. A mould, made from wood, aluminium, plastic, etc. is used to create the 3D shapes of the tactile graphics and braille. 3D printing, laser cutting, casting, hand crafting and real objects can be used to create moulds.

The thermoforming plastic sheet is placed into the heating unit of the thermoforming machine. The plastic is heated until it becomes pliable and soft but not melted. The mould or template is placed above or below the plastic sheet, depending on the machine's design. A vacuum system is activated, which pulls the heated plastic sheet onto the mould, forming the raised and textured tactile graphics. After forming, the plastic sheet needs to cool and solidify before being carefully removed from the mould. The vacuum form sheets should be kept away from heat seeing as they can buckle or even melt. They can also become brittle so it’s always good to keep a master copy for reference and the original mould.

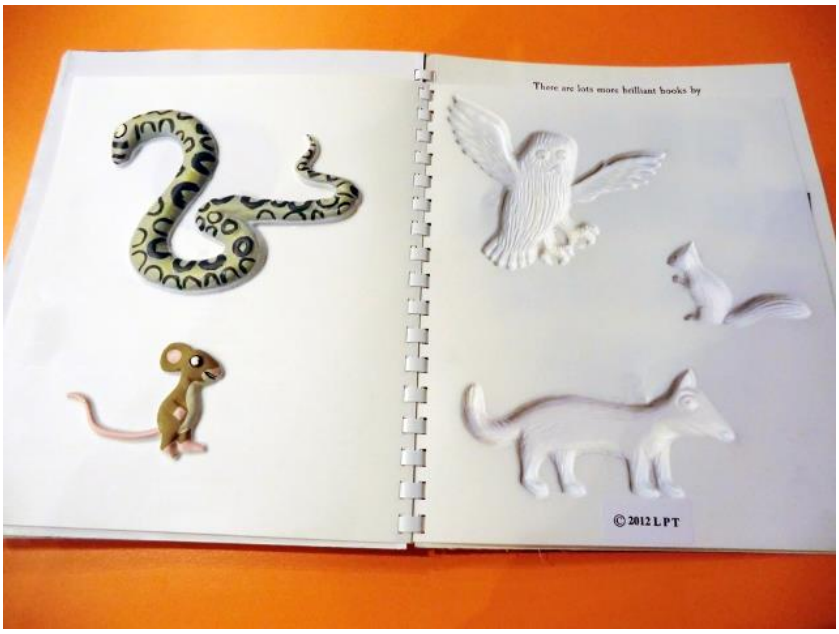

Figure 7.11 The Gruffalo by Julia Donaldson and Axel Scheffler, adapted using thermoforming by Living Paintings. (Photo A.M. Conefrey)

7.5.0 Benefits

- Thermoformed tactile graphics are known for their durability and long-lasting quality for frequent handling. It can be cost-effective for larger quantities.
- Legible braille and good-quality tactile graphics also in multiple layers, allowing for more complex and informative graphics.
- Quick turnaround and easy to update.
- Various types of plastic materials can be used offering a range of texture and thicknesses.
- 'Collage'-moulds can give very rich textures.
- The sheets can be cleaned

7.5.1 Possible drawbacks

- Thermoforming works well for clear shapes and crisp contours and details but seeing as it is hard and always feels like plastic it isn't very suitable for soft textures. The plastic can cause the fingers to slip or sweat.
- The initial investment in thermoforming equipment and moulds can be relatively expensive, making it less practical for small-scale or one-off projects.
- Thermoforming is primarily used with plastic materials, which may not be suitable for all tactile graphic applications; it's also not eco-friendly.
- Thermoforming is not suitable for objects with overhanging features or tall verticals.

7.6 THERMOGRAPHY FOR RAISED PRINTING

Figure 7.12. Thermographic machine, Bob Marek, Hungry Fingers. (Photos B.Marek)

Thermographic printing is a printing technique that can be used for braille and textured images on paper and other materials. It involves the use of special inks that contain heat-sensitive resins that bonds and expand under intense heat. Thermographic printing is traditionally known for its ability to add a luxurious touch to printed materials, such as business cards, letterheads and invitations but it is also used for printing braille and raised line drawings.

The ink used is a mixture of pigments, resins, and other chemicals. Slow-drying inks are applied to the areas selected for raised printing, followed by the thermographic powder. A vacuum system removes excess powder before the printed material is passed through a heating element or oven, causing the resin in the ink to melt and become a liquid. A raised effect is created when the resin liquefies and swells. Once the material exits the heating element, the resin is cooled and solidifies, locking the raised texture in place so that the graphics are ready to handle straight away. If colour is used (thermography powder turns transparent when heated) the pigment of the ink is sealed, ensuring that it doesn't smudge or fade. In that sense it is very durable.

In the 1980's in Canada, the Tactile Vision Printing Technology explored the possibilities of thermography and developed and later patented their own Tactile Vision Thermographic Powder for producing raised tactile materials. Unlike traditional Thermographic printing in which the height achieved is generally too low for tactile reading the formulation of their powder achieves sufficient height needed for legibility.

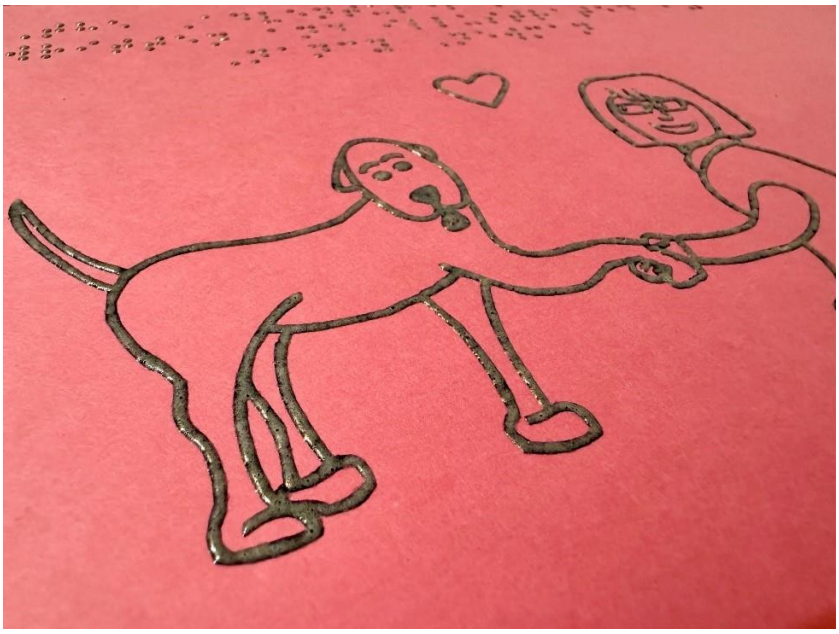

Figure 7.13: The Adventures of Cocoa by Nancy Newman, Tactile Vision Inc. (Photo A.M. Conefrey)

7.6.0 BENEFITS AND POSSIBLE DRAWBACKS

- Thermographic printing is durable and can be employed to produce braille and line drawings with a raised, tactile feel for use in books and other applications such as maps.
- Even though the braille is very clear to touch, the technology is not intended to produce pages of braille text as this would not be economical.

7.7 ELEVATED PRINTING (2.5D TEXTURAL PRINTING)

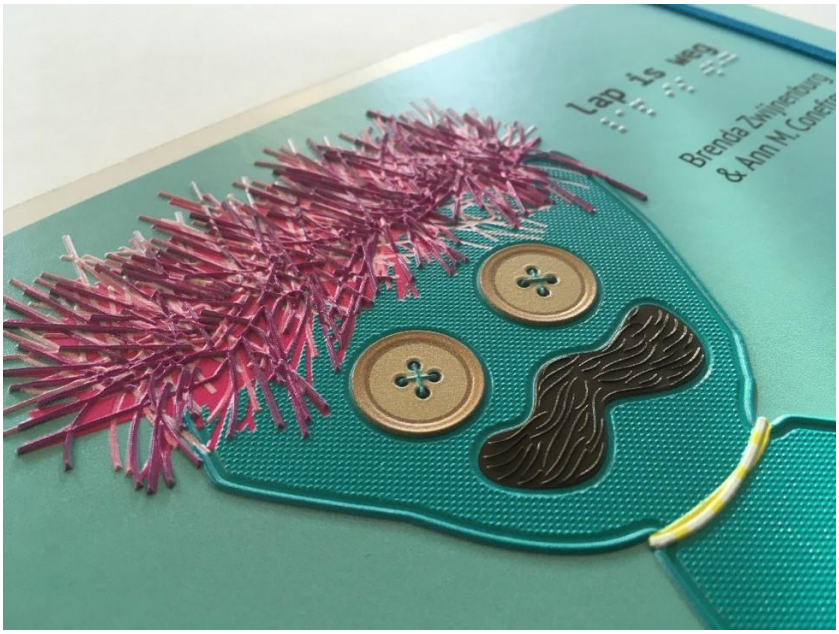

Figure 7.14: Detail cover, 'Lap is weg' by Brenda Zwijnenburg and Ann M. Conefrey, printed in 2.5D. (Photo A.M. Conefrey)

State of the art flatbed printers can now create high quality full colour elevated prints on a wide range of materials. For tactile illustrations and braille, printers with a height range of 0–1 mm or 0–2 mm should be sufficient (braille is generally set at 0.6 mm). There are flatbeds which can print up to 5 mm which can be used for signage, maps or artistic applications. Layers of white ink are applied to build up the textured height, followed by the top coloured layer and if required a final UV coating for extra protection.

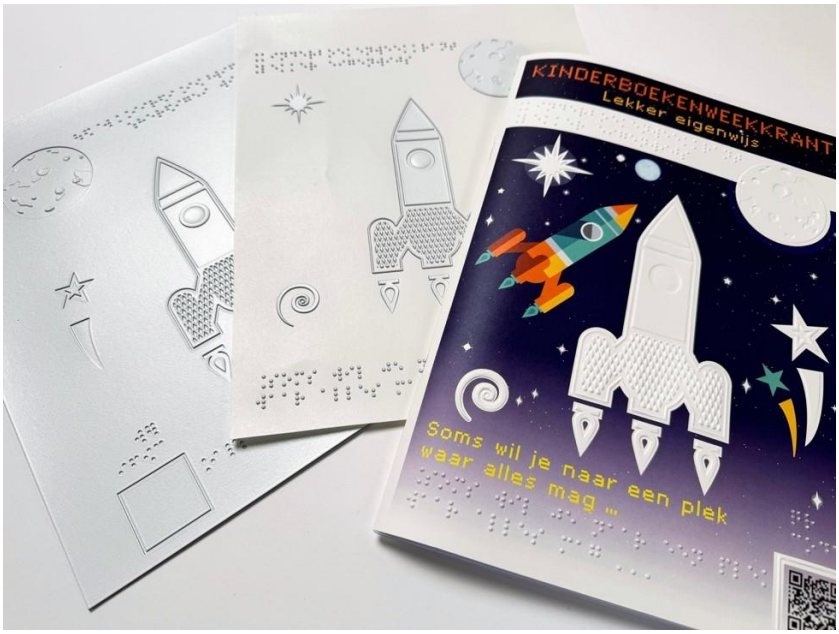

Figure 7.15: Embossing dies printed in 2.5D for a cover design, Ann M. Conefrey. (Photo A.M. Conefrey)

7.7.0 Benefits

- 2.5D printing is an extremely versatile technique which can print any kind of relief: from good legible braille to simple lines and textures or complex multi-layered relief designs, including 2D modelling.
- Apart from use in education, 2.5D can produce stunning colour prints for commercial use: from high quality wall coverings and signage to large tangible art prints.
- A wide range of non-porous or coated materials can be used, such as paper, boards, metal, plastics, glass, and so on.
- Braille and textures can be printed on 3D objects using a template to ‘fix’ the object(s) so that there is no movement during printing.
- 2.5D can be used to print your own embossing dies which can be used on a (jobbing) press for embossing braille and tactile images. It’s also possible to print moulds for multiple applications.
- There is a range of inks available for specific requirements and applications, for instance more flexible inks for use on thinner materials which can bend during use. Other inks are harder and more rigid for materials which do not bend.
- If required, it’s possible to add a transparent protective coating to your print work.
- Once printed, it’s possible to automate the finishing process using a machine cutter for accurately cutting any shape or size.

7.7.1 Possible drawbacks

- More suitable for projects with a good budget or high-volume projects.
- Specific software and technical knowledge are needed to generate the printing files.
- Depending on the intricacy of the design, it can take hours to print the multiple passes needed to build up the relief height. However, it can be left printing overnight.
- Depending on the type of inks and materials used, in time the prints can become brittle and damaged. If accidentally bent, a print can crack.
- The inks do not adhere (well) to uncoated/porous materials. 2.5D printing gives the best results on materials with a coated, smooth surface, often bought through a supplier.
- The finished prints can have a synthetic or chemical odour, especially those on paper and card without a finishing coating (lacquer).

7.8 EMBOSSING

Figure 7.16: Left: examples, A.M. Conefrey; right: book, 'It can't be true', RNIB. (Photos A.M. Conefrey)

Embossing boasts a rich history, dating back to ancient civilizations like the Egyptians who utilized this technique on metal and leather to craft intricate tactile patterns and textures. It has continued to evolve over time for the purpose of creating raised or three-dimensional patterns and designs for both aesthetic and practical applications such as embossed braille on medicine packaging. The embossing process involves exerting pressure on a material (sometimes in conjunction with moisture and heat) using a set of dies to generate a raised image or texture on the material's surface.

7.8.0 Printing House presses

Many printing houses maintain a dedicated braille printing section, where they print braille and images on small printing presses using their own custom dies or plates. Sets of dies for printing braille can simply be made from heavy duty acrylic sheets using a Marburg embosser. Dies for embossing braille and tactile images can be printed using 2.5D technology.

A press is typically used for larger print runs, in paper weights up to approximately 200 grams for leaflets and brochures and 250 grams for business cards. Additionally, braille can be punched into heavier materials, including heavy papers, cardstock, plastic, zinc and aluminium, using a Marburg Embossing Machine. Each sheet has to be positioned manually which is a time-consuming process, but the resulting braille is of a very high quality. Common uses may include books, covers, signs or other materials requiring durability for repeated use.

7.8.1 COMMERCIAL PRINTERS

Embossing is achieved by pressing the material, often paper, between a metal die and an epoxy counter die, creating the desired raised effect. Dies can come in single-level, multi-level or varied-level (also known as sculpted) forms, and different types of printing presses are employed depending on the design, size and print run. Designers frequently employ embossing (sometimes in combination with colour foils) for high-end commercial printing which is typically not intended for tactile reading due to the fine details. However, it is feasible to achieve a height of 50 to even 80 microns suitable for Braille and tactile graphics. Combining colour with an embossed image is possible but requires great precision to ensure all elements align correctly. The term 'blind embossing' describes the process of raising the paper without applying ink or foil, which is used in 'foil stamping.'

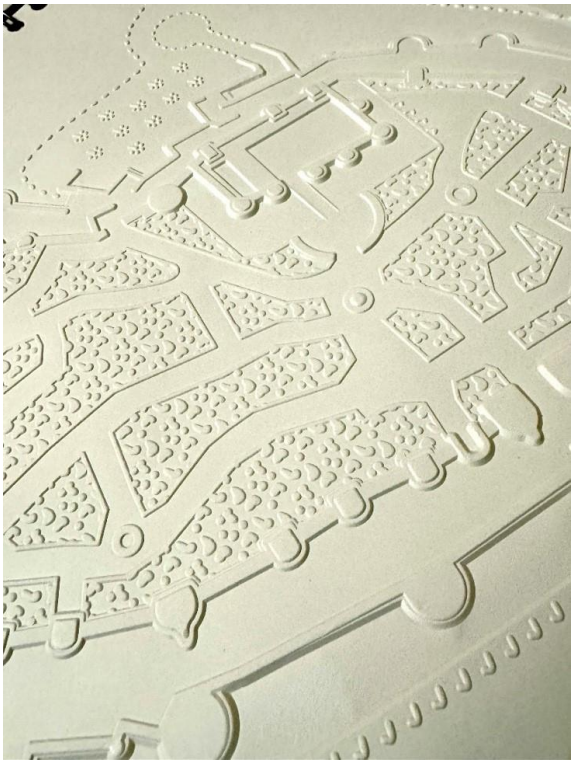

Figure 7.17: Embossed page from City of Carcassonne, Centre des Monuments Nationaux, France. (Photo A.M. Conefrey)

Creanog, a French company have created a high-quality series of tactile books highlighting the history and architecture of French landmarks such as the Pantheon and the City of Carcassonne. The tactile images (plates) are made from art engravings and embossed on heavy Japanese paper. These are particularly high and multi layered with very precise details which are a joy to touch. Each book is accompanied by an audio CD and an explanatory booklet.

7.8.2 BENEFITS AND POSSIBLE DRAWBACKS

- Printing Houses with their own press(s) and the capacity to produce their own dies can use embossing to customize certain products, for instance business cards with braille or leaflets and brochures with braille and tactile images.
- Embossing on natural materials (quality papers and cards) can give striking results which are particularly pleasant to touch.
- For more luxurious applications it can be combined with other finishing techniques, such as foil stamping.
- Commercial printers use embossing for adding braille to medicine packaging. Obviously larger amounts are relatively cheaper than limited print runs: the dies used are expensive and the

process requires more steps, specialized materials and expertise. Changing a design requires creating a new die.

- A heavy-duty Marburg Embossing Machine can be used to make braille dies for use on a jobbing press and also for embossing braille directly onto heavy materials such as card, acrylic sheets and aluminium. This technique is time consuming as it requires handwork to (re)position the material each time. Software (for instance TactileView) is needed to drive the machine so that whole letters or separate dots (much slower) are embossed. There can be our restrictions in terms of size, although there are ways to get around this.

7.9 UV AND LED-UV (ULTRAVIOLET) DIGITAL PRINTING

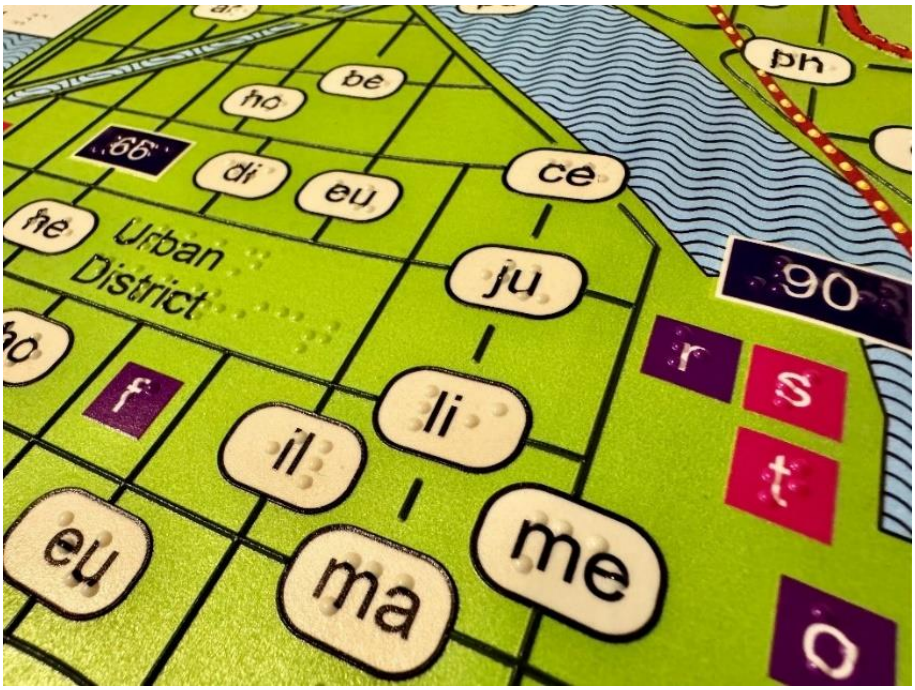

Figure 7.18. Tactile map produced by Dedicon, the Netherlands. (Photo A.M. Conefrey)

There is a wide range of UV and LED-UV digital printers that use ultraviolet light to cure (or dry) inks for fast and versatile printing. Specialty inks, varnishes and lacquers are often used commercially for special effects on packaging. Some printers can also be used for tactile graphics and braille.

7.9.0 SPECIALITY INKS

Depending on the type of printer, there is a range of inks, varnishes and lacquers which can be used to give a textured, tangible effect. The above example, printed on a Mutoh, shows the use of flexible inks for printing tactile maps on lightweight coated paper which can then be rolled up for traveling. The embossed effect for braille, lines and textures has been built up in layers.

7.9.1 SPECIALITY VARNISHES AND LACQUERS

Matt, semi-matt or gloss varnishes can be applied to a specific area (known as 'spot' varnishing) resulting in a relief effect which, if the contrast is high enough, can be felt under the fingertips. Some printers only reach 0.3 mm in one pass which is not sufficient for tactile reading, but it is technically possible to add a second layer. Other varnishes and swelling 3D lacquers can be used to add tactile qualities: soft touch, as the name would suggest have a warm, velvety feel; grip varnishes have a

rubbery feel, gravel lacquer gives a rough, sandy feel and scented varnishes (these contain micro-fragrance capsules) can add an extra dimension to relief printing; when scratched they release a fragrance (known as Scratch 'n sniff). Many of these techniques can be used on a variety of materials ranging from papers to plastics and even metals.

Figures 7.19. Left: Cover, Ann M. Conefrey; right: 'Tiere im Meer' by Antje Möring, DZB lezen. (Photos A.M. Conefrey)

7.9.2 BENEFITS

- Depending on the model, it's possible to print braille, tactile illustrations or drawings in combination with colour on paper, plastics and other materials, including objects.
- There is a wide range of speciality varnishers, lacquers and inks for different applications, for instance flexible ink can be used for printing braille and tactile images on lightweight coated papers.
- Personalized print runs and one-off prints which can be used directly after printing because the ink dries instantly.
- The prints are incredibly durable and can be used for signage. It's possible to print on a wide range of low porous surfaces, and in the case of LED-UV on heat sensitive materials such as plastics or thin films.
- Smaller machines cater for A4 and A3 sizes and are suitable for small print runs and single items.
- Relatively environmentally friendly in terms of emissions and energy.

7.9.3 POSSIBLE DRAWBACKS

- Each layer is printed separately with the printhead passing over the entire surface (including areas which are not being printed) which can be time-consuming depending on the number of layers needed.
- Industrial machines cater for bigger sizes and are suitable for large print runs.

7.10 BRAILLE IMAGES

Figure 7.20: Tactile book developed Dedicon, the Netherlands, printed on an Everest D5 embosser using TactileView software. (Photo Dedicon)

Creating images using braille dots, sometimes in combination with written information in braille has a long history and can be found in books and standalone pieces. Braille designs can either be created by hand or printed digitally.

7.10.0 BRAILLE IMAGES: BY HAND

Using a pattern and a braille writer or a slate and stylus, teachers, parents and children can create their own tactile images. An extensive library of existing patterns as well as instructions for making your own drawings can be found online, for example:

https://www.pathstoliteracy.org/just-fun-braille-designs/

https://www.perkins.org/resource/braille-drawings/

https://sixdotsart.com

https://www.brailleart.org/en/

7.10.1 BRAILLE IMAGES: DIGITAL

There is a growing range of braille embossers (printers) available on the market. For production purposes there are heavy-duty, multifunctional embossers, while for home use there are small, affordable embossers. Using special software these embossers can print braille and images. Depending on the model, some embossers can print images with up to 8 levels of braille dots, combine braille with colour print, print music notation and so on. The following overview gives some examples of available embossers. Their software supports various tactile graphic editors such as TactileView, Duxbury and so on. Please note that this is not meant as a complete overview.

- Index Braille: https://www.indexbraille.com
  Embossers: Basic-D V5, Everest-D V5, Braillebox V5, Fanfold-D V5.
  (Including idB Print software).
- ViewPlus Technology: https://viewplus.com
  Embossers: SpotDot, Embraille, Premier, Elite, Columbia, Rogue, Delta. (Including the Tiger Software Suit).

- TactPlus: https://www.tactplusprinter.com
  Small, mobile braille and tactile image printer which uses thermal technology and capsule paper. The prints are colourless as there is no ink involved.
- Humanware: https://www.humanware.com
  Embossers: PIAF, Phoenix, Romeo 60, Juliet 120
- Blista Brailletec: https://en.brailletec.de
  Embossers: Btec 100, Elotype 5, Puma VII (Marburg Embossing Machine: for Printing Houses).
- American Printing House: https://www.aph.org
  Embossers: PixBlaster and PageBlaster
- Irie: https://irie-at.com
  Embossers: Braille Buddy, BrailleSheet 120, BrailleTrac 120
- Harpo: https://mountbattenbrailler.com
  Embosser: Mountbatten Braille
- Nippon Telesoft: https://www.nippontelesoft.com
  Embosser: Gemini
- TactileView: https://www.tactileview.com and https://www.thinkable.nl

TactileView Drawing software: tactile graphics editor for printing on the TactiPad drawing board with motorised drawing arm (MDA), swell paper and a wide range of embossers.

7.10.2 Benefits and possible drawbacks

- Encouraging braille students to create their own tactile images is a fun way to motivate braille students and encourage literacy.
- Braille images demonstrate how versatile and creative one can be with braille; it is not only a writing system, but it can also be used to create drawings.
- Following patterns to create braille images using a braille writer or slate and stylus can easily be incorporated into the process of learning braille and practising navigational skills.
- It's good to be aware of personal preferences and tactile skills. Whilst some braille students might have a preference for images made from braille dots, others might prefer different kinds of tactile illustrations.
- Schools and printing houses have embossers, but few young braille students will have one for home use, simply because they are considerably more expensive than colour or b/w printers.
- Even though the software for embossing images has been designed for accessibility, learning to work and explore all the possibilities requires time and commitment.

7.11 TACTILE BOOKS WITH AUDIO

An innovative way to integrate audio files within a tactile book is by using an audio pen device with a built-in sensor in the tip. This is activated when placed on an audio orientation point (AOP), a raised block or circle which can be found in the same position on each page. The device can be used for describing images or for adding additional information, as well as reading the story. The pen has simple buttons so a child can adjust the volume and speed; it can also be used with headphones.

Figure 7.21: Tactile book with 'SAM audio pen', developed by CBB, Ermelo in the Netherlands. (Photos A.M. Conefrey)

An audio file can also be put on a (Daisy) CD as an accompaniment to a book. Adding a QR code to a tactile drawing allows text embedded within images to be read and voiced by a mobile device such as an iPhone or Android phone.

NFC (Near-field Communication) can be used to add audio. NFC enables data exchange between two devices, for instance an NFC-tag or card and a smartphone.

7.11.0 Benefits and possible drawbacks

- Audio pens are easy-to-use, flexible devices that children can operate independently without additional steps. However, one potential drawback is their cost, making them more suitable for projects with a larger budget or high volume. Additionally, the built-in battery requires regular recharging, and a low battery can impact performance.
- QR codes are affordable and highly versatile. They can be printed on various surfaces and hold diverse types of information. Unlike audio pens, they do not require a power source, but they do need a mobile device camera for scanning. Raised lines and consistent positioning can help children locate the codes, though they may still require assistance with scanning and subsequent steps.

7.12 MICROBEADS FOR BRAILLE

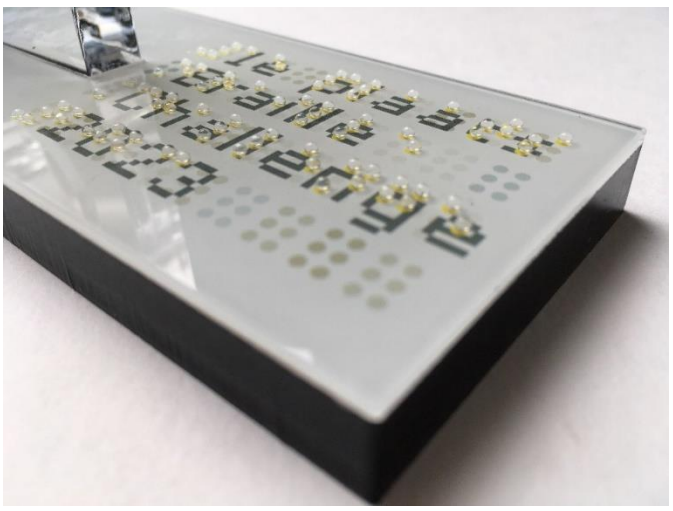

Figure 7.22 Trophy design Ann M. Conefrey, print and braille using microbeads. (Photo A.M. Conefrey)

Microbeads, also known as microspheres or microdots can be used for creating tactile braille characters, especially in situations where other methods might not be feasible or offer enough durability. The small beads are made from plastic, glass or metal which are carefully applied to the etched-out braille characters in a base material such as glass, wood or plastic.

7.12.0Benefits and possible drawbacks

- This method lends itself well to the production of indoor and outdoor signage for an array of materials.
- Microbeads have a smooth, round shape that can provide a pleasant tactile experience for Braille readers.
- Over time, microbeads can become dislodged, reducing the tactile quality and longevity of the Braille representation.
- There is a lack of customization in terms of size, material, and adherence methods, which can affect compatibility.
- It has a high-quality appeal for a commercial price.

7.13 3D PRINTING

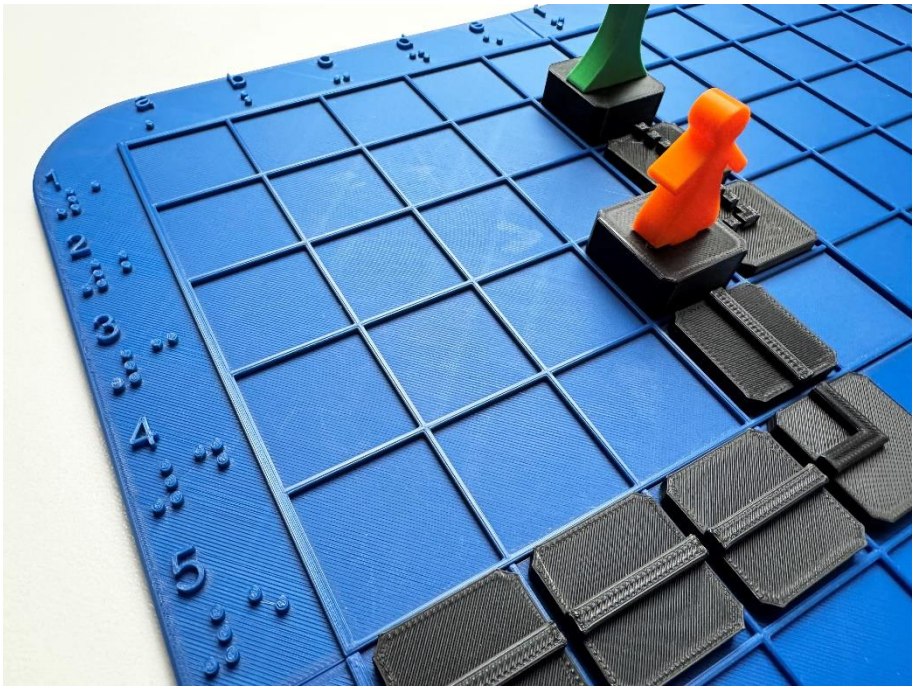

Figure 7.23 'An en Jan': 3D printed topography learning material developed by Visio, the Netherlands. (Photo A.M. Conefrey)

A comprehensive guideline for the creation of tactile models using 3D printing has been published in May 2024. You can access and download these guidelines at:
https://printdisability.org/guidelines/3d-prints/

Published by Round Table on Information Access for People with Print Disabilities Inc. Australia.

The guidelines explain what 3D printing is and how it can be used to make accessible models including a wealth of examples and practical and technical information regarding options for software, hardware, materials and so on, as well as useful web links.

At Thingiverse.com (https://www.thingiverse.com) you can find a large collection of readily available 3D models.

Another extensive database of 3D-models including guidelines on how to design and print models for visually impaired students can be found here: https://tactiles.eu

7.14 HANDWORK FOR BRAILLE AND RAISED LINES

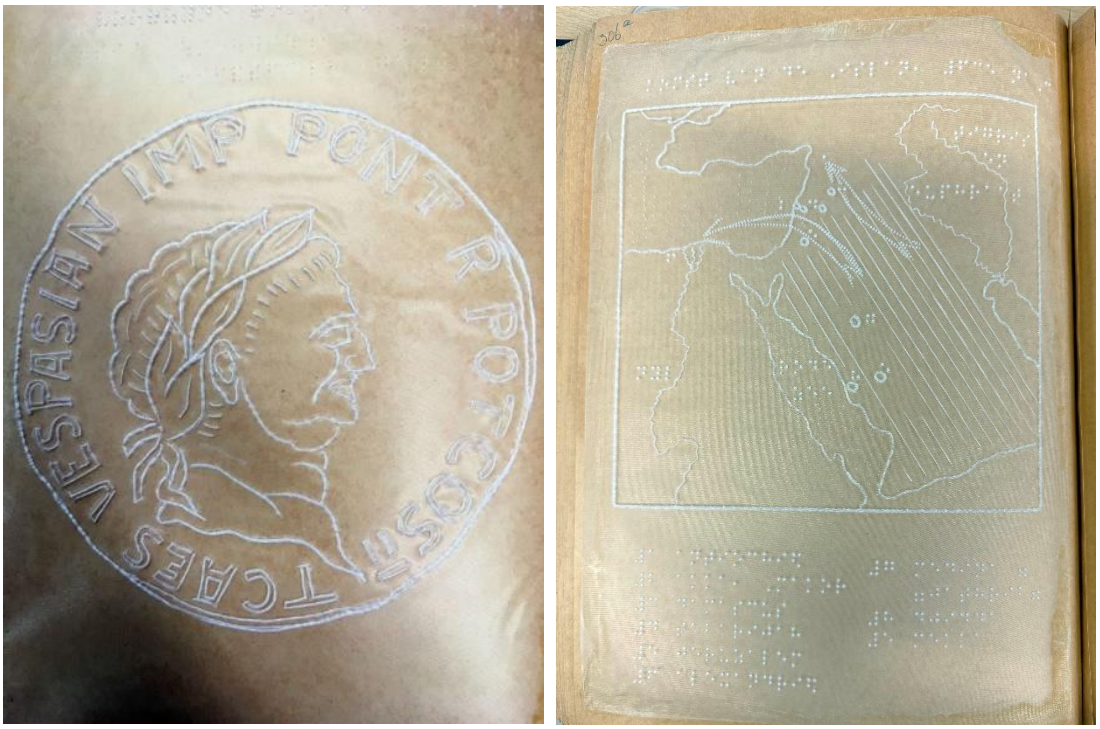

Figure 7.24: Hand drawn raised line image, Blindenmuseum, Netherlands. (Photo A.M. Conefrey)

There are many simple techniques for making raised line drawings and braille by hand.

7.14.0 BRAILLE

- Braille writer: for typing braille on paper or thin plastic sheets.
- Slate and stylus: a portable and cheap way of writing braille by hand.
- Braille Dymo Tape Labeler: handy for making labels (the letters on the dial are in braille and print).
- Braille embosser (printer): there are smaller, more affordable models available which print braille and tactile images.
- Tactile paints: the paints work best on smooth, coated materials, and require a very steady hand.
- Beads: there are small beads with flat self-adhesive backs available and also small beads which can be sewn very carefully by hand.

- Thread: with practise and patience it's possible to sew braille.

7.14.1 RAISED LINE DRAWINGS

- Tactile drawing board: use a ballpen or stylus to draw tactile images directly onto paper or embossing film (also known as German film). There are several boards on the market but it's possible to make your own using a rubber mat or silicon baking mat.
- Tactile paints such as 'Blob Paint' (ViVa), 3D Liner (water based; some have glitter added for a slightly rougher texture), fabric paints.
- Gluing string.
- Pipe cleaners.
- Wikki-Stix.
- Water soluble markers on Quick-draw paper (this is in fact compressed sponge).
- Spur wheel to create a texture or line.

7.15 FURTHER READING/REFERENCES

S. Wright, (2008). *APH Guide to Designing Tactile Illustrations for Children's Books*, https://sites.aph.org/files/research/illustrations/

Les Doigts Qui Rêvent www.ldqr.org

A.M. Conefrey www.tactiledesign.nl

Dedicon www.dedicon.nl/producties (in Dutch)

Créanog www.creanog.com

http://www.clearvisionproject.org/resources/Tactile-book-makers-guide.pdf

https://www.statped.no/tactile-reading-2021/tactile-reading-2021-conference/video-transcription-antje-monnig/

Large collection of tactile graphics for 3D, swell, braille and cutting machines: https://btactile.com

8 DESIGN AND PRODUCTION OF THE ILLUSTRATED TACTILE BOOK "A LONG JOURNEY.

Figure 8.1: A Long Journey, (Photo Solène Négrerie / Tactile designer for Les Doigts Qui Rêvent)

8.0 INTRODUCTION

This illustrated tactile album is the result of a co-design and iterative process involving the various partners of the Tacticos project. Each partner, with their own culture, creativity, skills, knowledge of visually impaired children and manufacturing techniques, played a role in the design of this album. The writing of the guide also provided input into the design and production of the book.

Here are the various stages in the design and manufacture of the prototype tested by children and professionals.

8.1 CONCEPT AND AUDIENCE

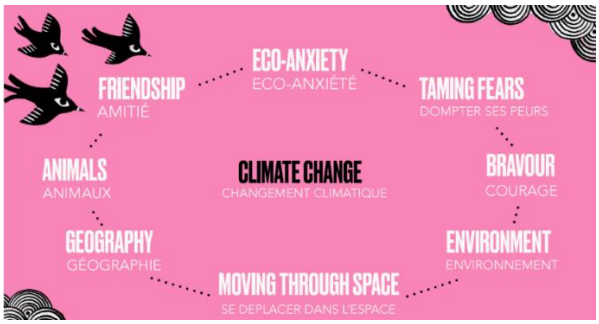

Figure 8.2 The Long Journey; the concept, Cerize Fournier

It was during one of our group meetings that we decided on the concept for the album**: climate change.** This concept subject was chosen by the whole group, because to our knowledge it had not been dealt with in the adapted edition, and yet it was such a topical subject. This concept also made it possible to associate other concepts with the narrative, such as friendship, courage, fears, animals, etc.

The age range for writing the book is 5-6 years (assisted reading), as the child does not yet know how to read. The child listens attentively and is generally interested in the tactile illustrations at the same time. That's why we prefer short books, with illustrations on every page and short sentences. The words used should also be simple and reflect the everyday life of their age.

Once the concept had been defined, author Cerize Fournier devised a text and a narrative scenario that included the principles of illustration.

8.2 THE NARRATIVE SCENARIO

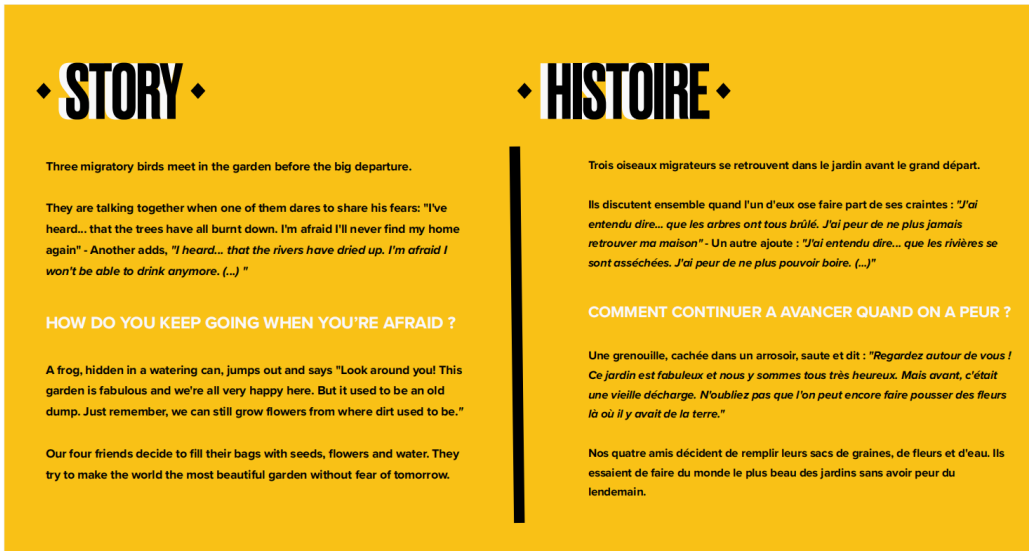

Figure 8.3 The Long Journey, the story

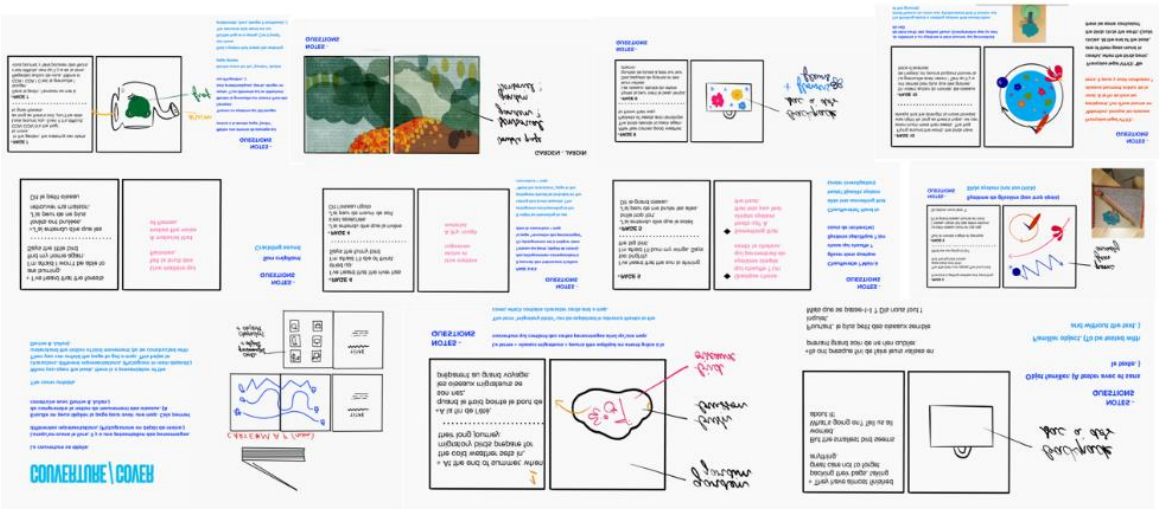

Figure 8.4 The Long Journey; the narrative scenario

When developing the text and narrative scenario (above), the author had to take into account the constraints associated with the illustrated tactile book, which is accessible to blind people.

Tactile illustrations, with textures of varying thicknesses, can often become very bulky, making them difficult to assemble and handle. You therefore need to bear this constraint in mind and define the maximum number of pages accordingly. What's more, the size of the Braille characters cannot be reduced, so the Braille layout has an impact on the format of the book, and this must also be taken into account in the design. A cross-sectional sketch of the anticipated page thicknesses is a valuable aid in anticipating the rest of the project.

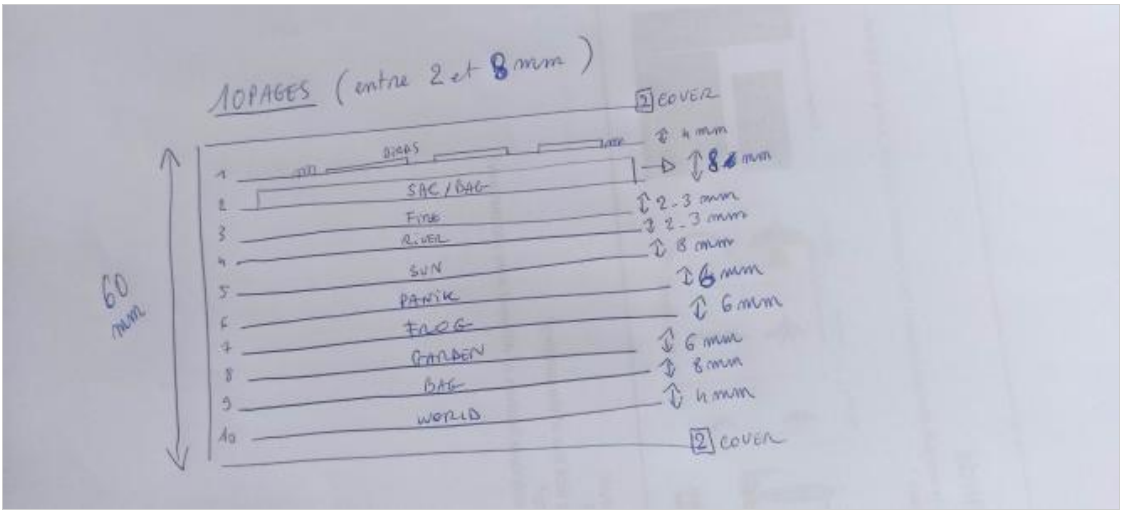

Figure 8.5 The Long Journey; calculation of the thickness

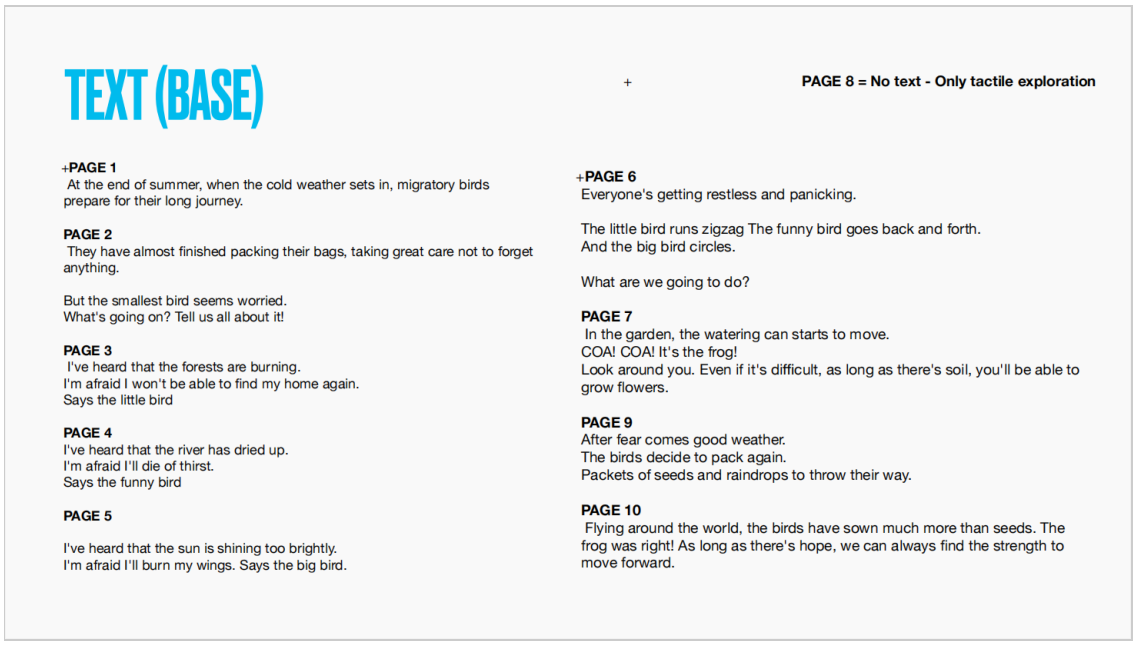

Figure 8.6 The Long Journey; text base, Cerize Fournier

8.3 FORMAT AND LAYOUT

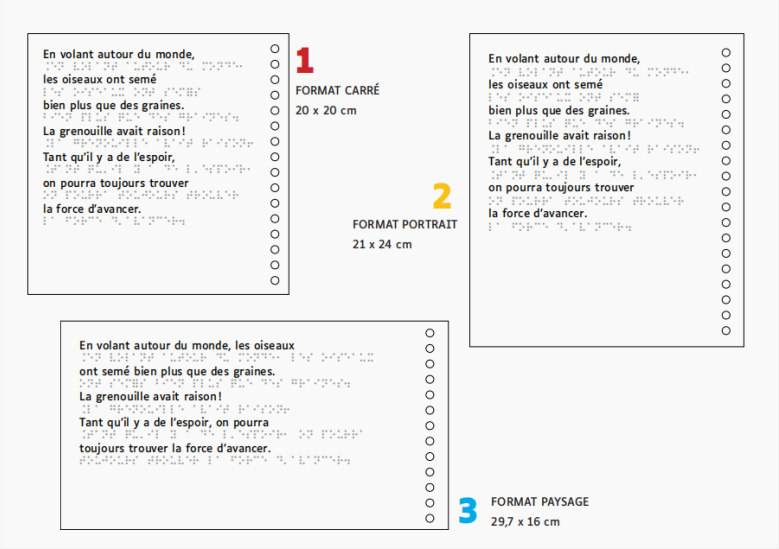

Figure 8.7 The Long Journey; formats

The page layout in large-print black and Braille was produced by a transcriber. It offers three formats starting from the page with the most text: square, portrait and landscape. The holes on the right represent the location of the spiral binding

Here are the questions we asked ourselves before starting on the layout, concerning the ergonomics of reading.

- **How should Braille and print be arranged?** Given the number of words, it was decided that the Braille would be placed under the black text, enabling sighted and blind readers to read

together. As a result, double line spacing is possible, making it easier for novice Braille readers to read digitally.

- **Which font should be printed?** The Luciole font, specially developed for the visually impaired, is sans serif, free and easy to download.

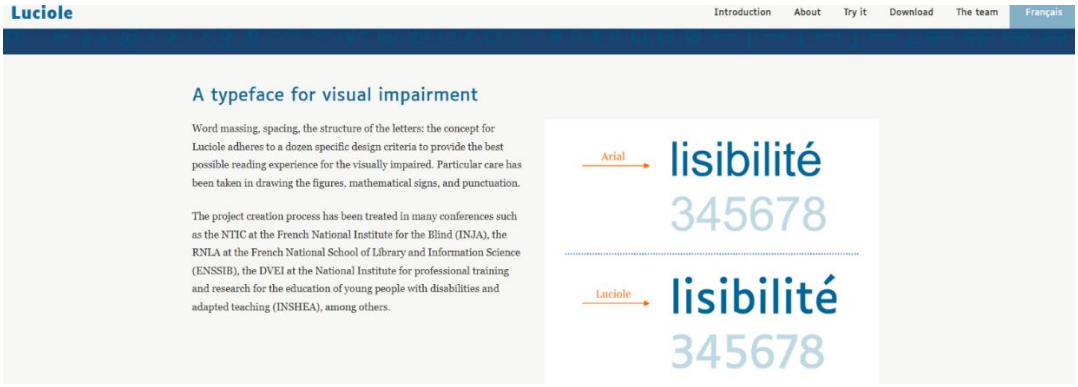

Figure 8.8 : Luciole typeface (www.luciole-vision.com)

- **What format and orientation for the pages?** For the prototype produced, we collectively chose the landscape version. This allowed us to have sentences with fewer hyphenations, and the long format suited the spirit of the book, which was about migration, and therefore displacement. However, the format of the book will be a subject for post-test modification, as this format, even if small, is not easy for some children, who will only be interested in the right-hand side with the illustrations and not in the left-hand side with the text. Choosing a square or portrait format limits the space for tactile discovery and highlights the text on the right. We have decided not to use pagination for this age group.

8.4 ILLUSTRATIONS

When designing tactile illustrations for a book for visually impaired or very visually impaired children, you might wonder about the need to represent visual codes. This album is not a documentary, and the technique of embossing is possible with glued or manipulated textures. The story can therefore be illustrated in a wide variety of ways. The choice of materials, shapes, sizes, volume, thickness and systems used in the illustrations must always be considered in relation to the way in which the hand will explore them. Below is a diagram that is useful when designing illustrations.

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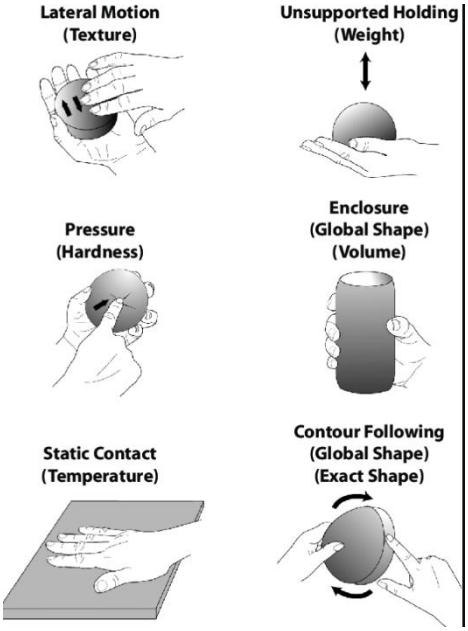


Depictions of six manual "exploratory procedures" and their associated object properties (in parentheses). From "Hand Movements: a Window into haptic object recognition," by S. J. lederman and r. l. Klatzky, 1987, Cognitive Psy chology, 19, p. 346. copyright 1987;

Figures 8.9: Types of exploratory procedures to take into account when designing

Here are the choices made by the design group for certain pages.

8.4.0 THE PROTAGONISTS OF THE STORY

It was decided that the most important thing was to differentiate the characters tactilely; the visual form was secondary. Recognise and differentiate between the characters: Little bird, funny bird, big bird.

- **Choose the textures:** they are very important and if they are well contrasted, they allow the three characters to be distinguished quickly and easily. It was decided that it was not necessary to use the "feather" material to illustrate the birds. The children's pleasure lay in discovering different textures, and the understanding of the characters as birds was made clear by the text. The textures could be very different and contrasting: smooth, rough, striated, soft, soft, hard, thick, thin, soft... The group chose a rough material for the large bird, a smooth/velvety material for the small bird and a hairy material for the funny bird. The beaks are made of identical materials.
- **Choose the size:** two of the characters are named by their size, "the little bird" and "the big bird", which is an excellent tactile recognition cue. The three birds will be distinguished by three different sizes: small, medium and large. The size of the tactile elements.

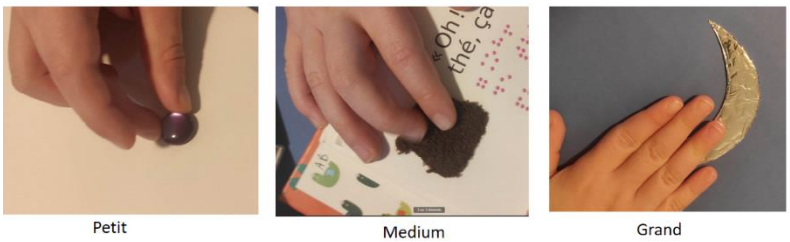
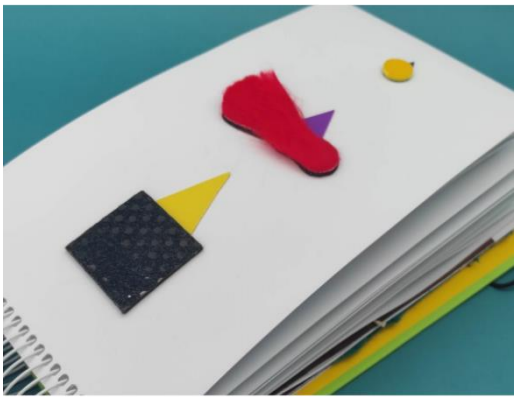


Figure 8.10 Photograph of a 5-year-old child's hand touching items of different sizes and shapes, presented at a meeting.

- **Choosing the shape:** several styles of shape were suggested during the discussions. The group decided to keep the shapes of the bodies simple and non-figurative, but to associate them with a beak. The results of these combinations are shown below:



Shape, size and texture of the three figures.

- **Large bird:** A large rough square (naughty fabric glued to 2mm cutting foam) with a long plastic beak (priplak).
- **Funny bird:** An elongated undulating shape in red fur on 2mm cutting foam, medium plastic beak (priplak) and a small round.
- **Small bird:** velvety paper (flocking) on 2mm foam. Small plastic beak (priplak)

Figures 8.11: Shape, size and texture of the three figures.

During the discussions, it was suggested that a caption should be placed under the characters to combine text and illustrations in the same space. This proposal was not adopted for this version.

- **A legend**: The text on page 1 says: "The migratory birds are getting ready…" and the illustration shows 3 different birds. Later the text will name the different birds: the little bird, the funny bird, the big bird.

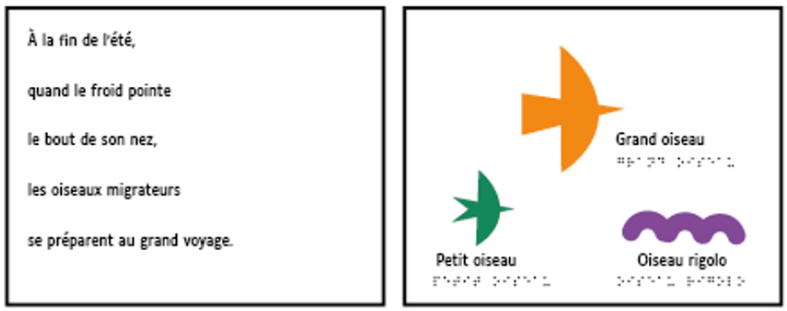


Figure 8.11: the Legend

8.4.1 THE TRAVEL BAG AND ITS ITEMS

Below are a few examples of the research boards: materials and system per page and the result.

8.4.1.1 THE STARTING CASE

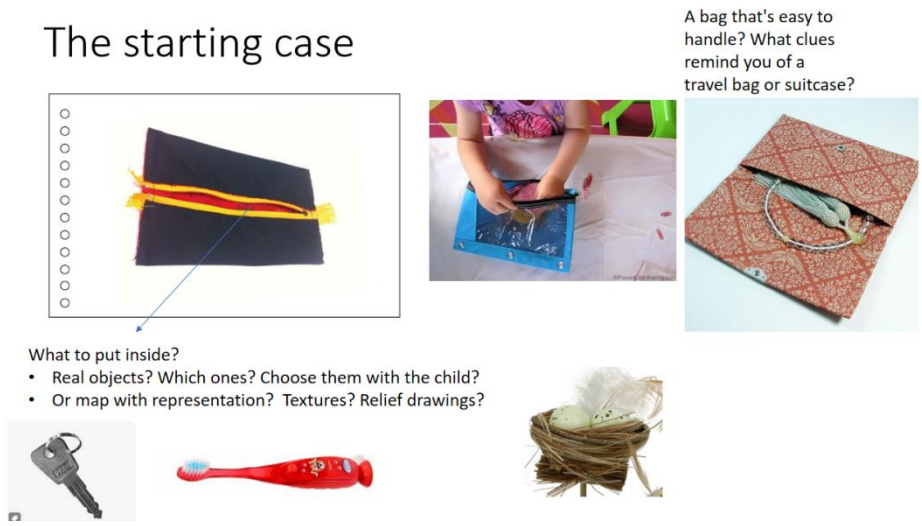


Figure 8.12: The starting case

Different opening systems for the travel bag were presented to the group. It should be easy to use and evoke a familiar gesture. The bag contains objects that can be taken on a trip.

The group suggests illustrating travel objects on cards to be handled: sunglasses, a toothbrush, a scarf, a teddy bear.

The shapes are a projection of the textured 2D object.

Miniature 3D versions of these objects are readily available on the market.

Activities can be carried out to move between the 3D object and its textured2D representation.

The pocket opens towards the front for easy handling.

Materials:

- Waxed tablecloth on the outside of the bag and cotton on the inside
- Furry teddy bear (different from the funny bird)
- Microfibre scarf
- Plastic toothbrush handle, faux grass bristles
- Plastic bezel

Figures 8.12: travel bag contents

As a group we discussed about what should be inside the bag and in what form (e.g. miniature 3D object or textured illustration on cards). The text does not specify the contents of the bag, but can be an invitation to the imagination.

8.4.1.2 THE FIRE

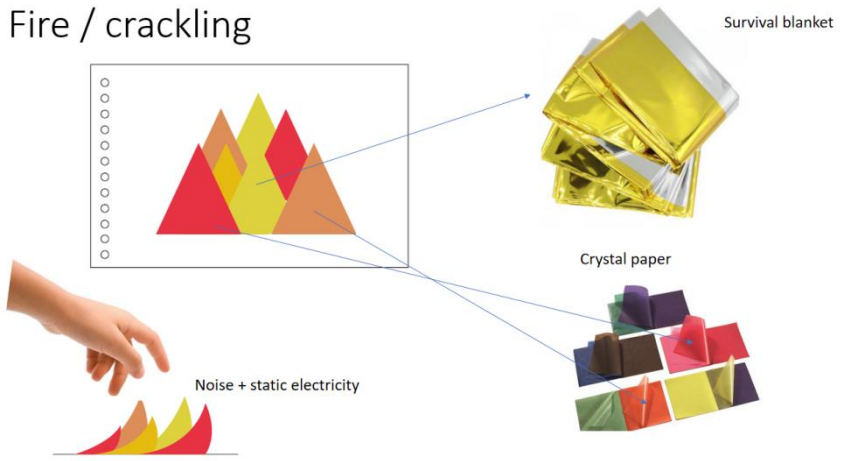


Figure 8.13: The composition of the Fire

For this illustration, a sound texture manipulation was proposed. The movement of the fingers on the crystal paper and survival blanket produces a crackling sound. To achieve this sound, the papers have been crumpled beforehand and glued to strips that raise them above the ground.

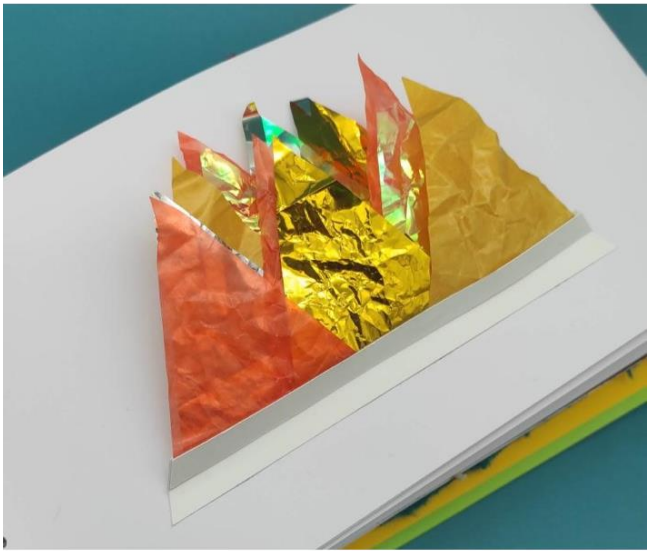


Figure 8.14: Fire in the Long Journey

8.4.1.3 THE DRY RIVER

Here a simple rough hessian material has been glued on to represent the dried-up river.

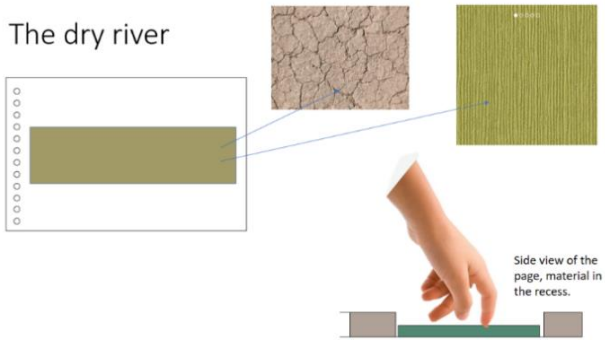


Figure 8.15: The composition of the dry river

Figure 8.16 The dry river in the Long Journey

8.4.1.4 THE BURNING SUN

To achieve a warm texture, we decided to test a heater in a microfibre fleece pouch. To recall the crackling sound chosen for the fire, a piece of survival blanket was inserted.

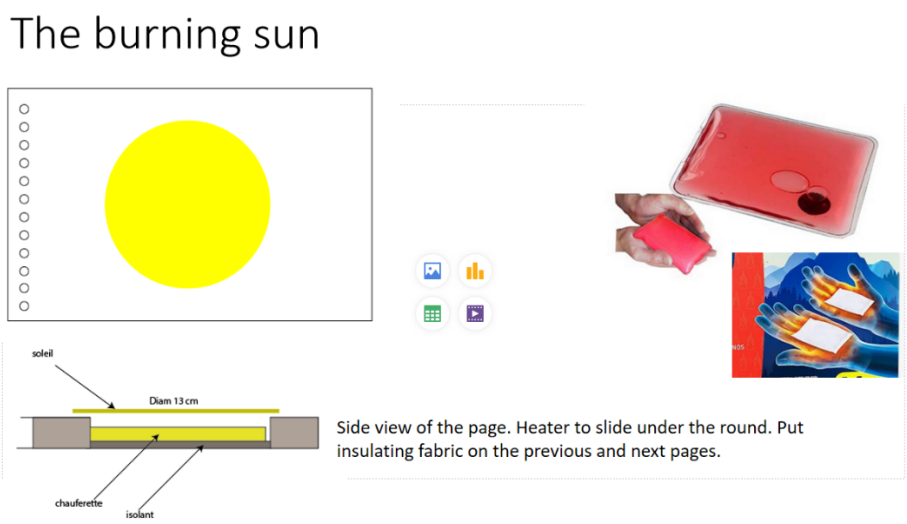


Figure 8.17: Composition of the burning sun

Figure 8.17: The burning sun in the Long Journey

8.4.1.5 THE PANIC

Inspiration and search for systems to illustrate movements of panic and agitation: zigzag, back and forth, turn

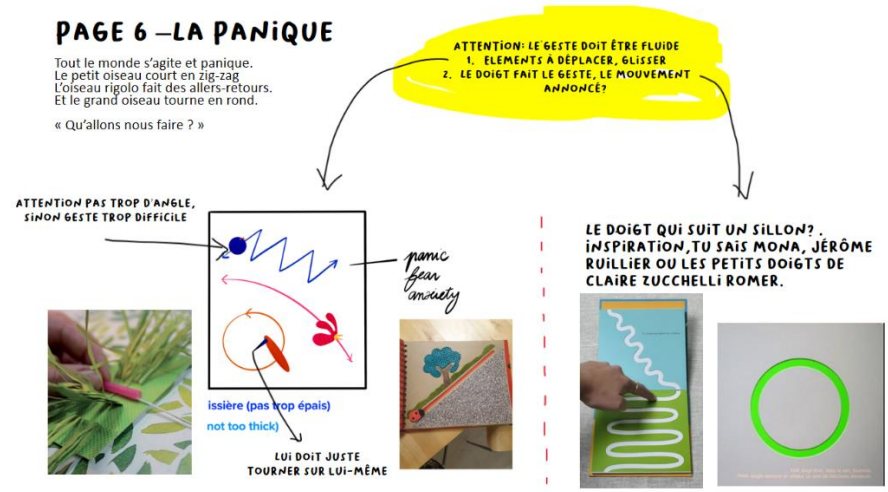


Figure 8.18: Composition of Panic

Figure 8.19: Panic in the Long Journey;

A slot system allows the three birds to glide along and follow the movement. The large bird turns on itself.

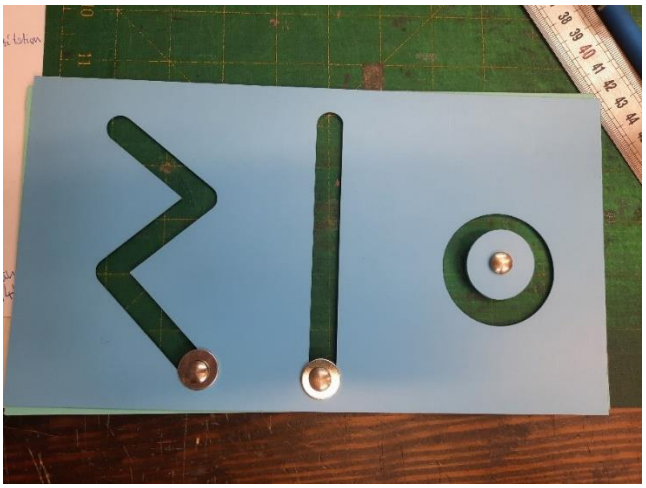


Figure 8.19: Mounting system.

8.4.1.6 THE WATERING CAN AND THE FROG

Figure 8.20: Watering Can

A watering can that you can shake to hear that something is inside. Initially, the frog was represented by a circle made of slightly sticky material. Eventually a member of the group suggested a 3D frog.

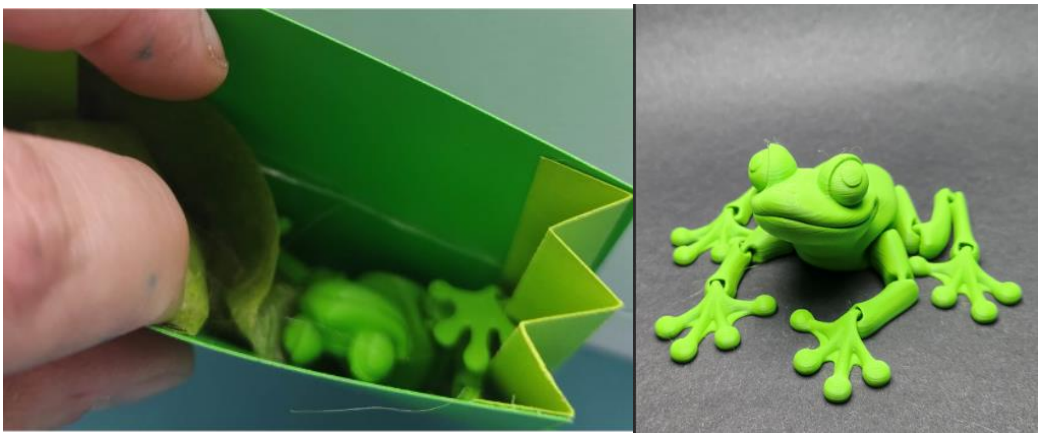


Figure 8.21: The Frog

The 3D file was purchased on the internet. A service provider with a 3D printer produced it.

8.5 MANUFACTURING

To make a tactile work, you first need to buy or collect all the materials. You can find them in various shops: hobby and craft fabrics, wallpaper, kitchen fabrics, bric-a-brac, etc. Recycling materials or objects from home is a good solution when you don't have many items to make. The shapes (of each tactile part) should be drawn on card or tracing paper.

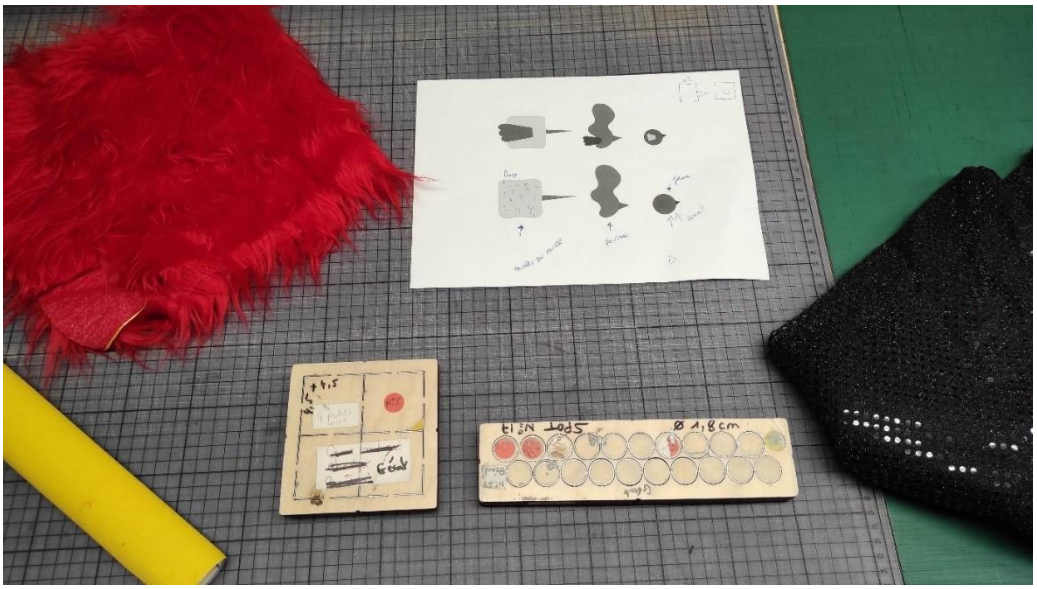
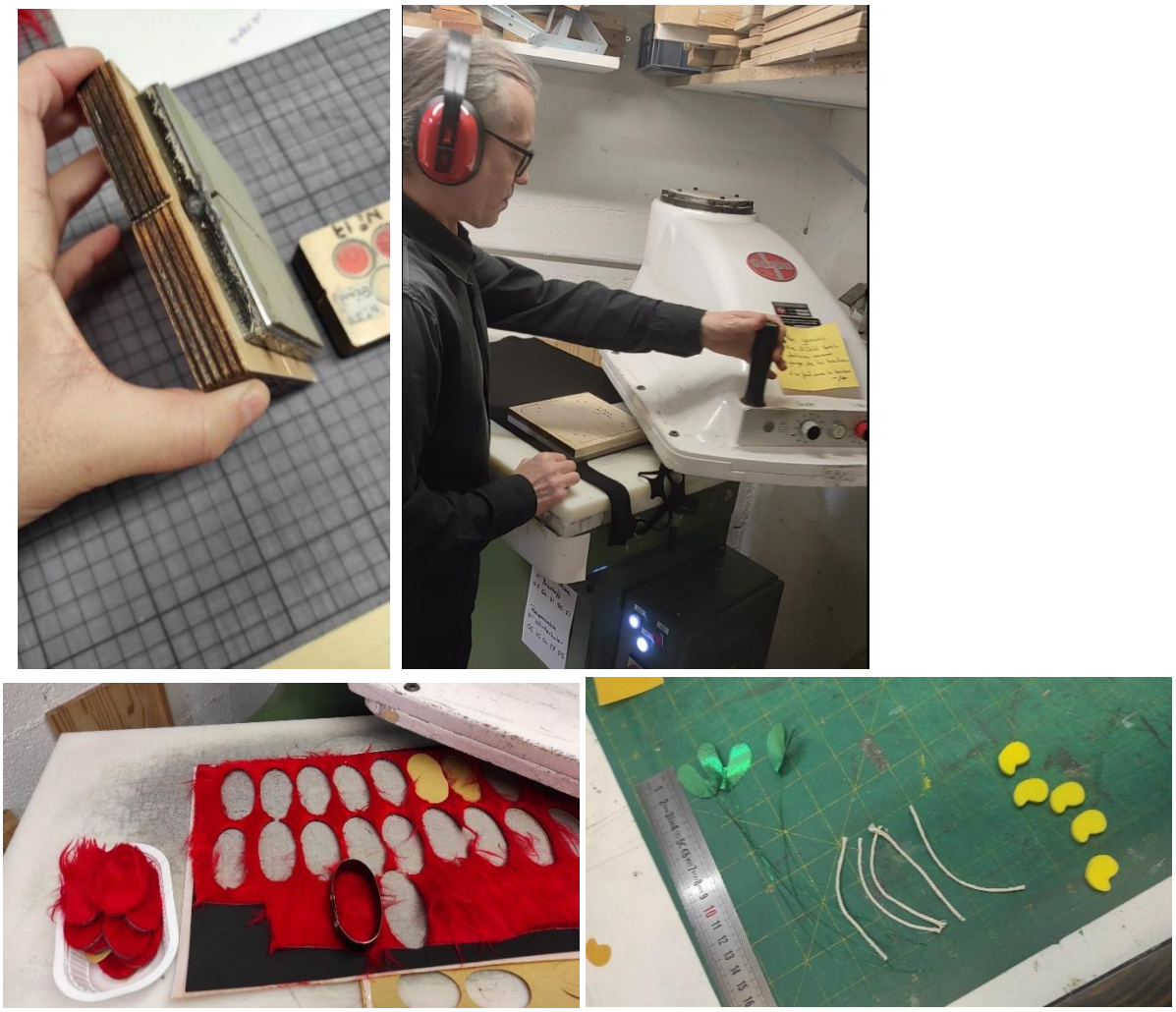


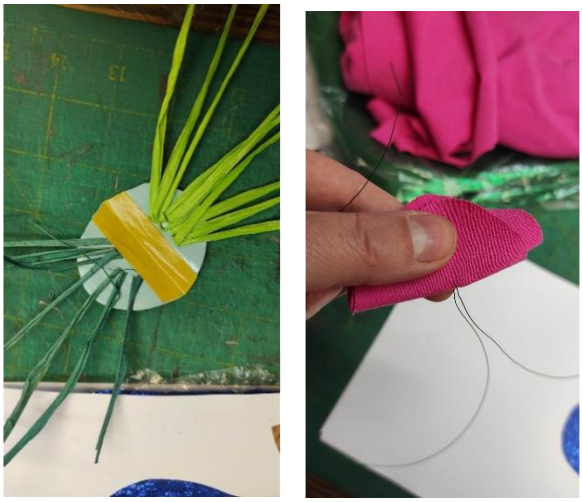
Figure 8.22: Materials and drawn shapes

The materials to be glued into the book are first glued onto adhesive. Then, using cutting templates or cutting tools, each element is cut out using scissors or a machine (in this case a die and a cutting press).



Figures 8.23: Cutting the materials

Assembling the parts may require a variety of skills, such as gluing and sewing.



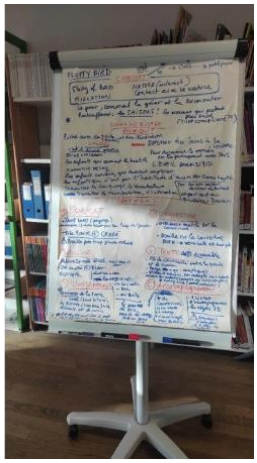
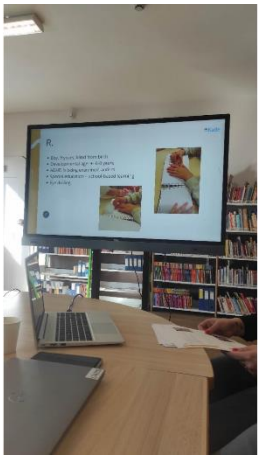
Figures 8.24: Assembling the materials

Once all the pages are finished, the cover is made and the book is pierced and bound.

Figures 8.25: Book binding

8.6 FEEDBACK FROM PROFESSIONALS

The first version of the prototype was produced in 10 copies and sent to the various partners in charge of testing with children. It was at a meeting in Dijon in March 2024 that the professionals were able to give their feedback on the use of the system.

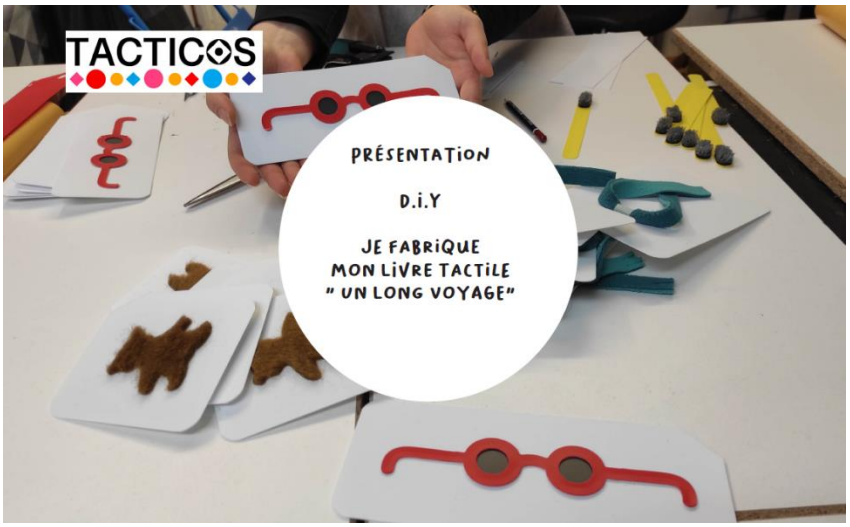



Figures 8.26 Feedback sessions

Based on this feedback, a brainstorming session was held to collectively consider the changes (see below) and come up with version 2.

8.7 BOOK KIT

To reduce manufacturing costs. A DIY kit version is currently being designed.



Couverture cartonée
Reliureapparente métallique hélicoïdale
Format à modifier (privilégier un format carré ou portrait)
Braille titre

Illustration 1: les 3 personnages tactiles à coller
- 6 matières sur DF
- 6 découpes
- technique utilisée: découpe ciseaux+ collage

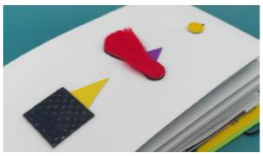


Illustration 2 personnages mobiles
- 9 matières (8 surDF)
- 16 découpes
- technique utilisée: découpe ciseaux+ collage

Illustration 3
pochette + carte tactile+ liste à ne pas oublier
- 12 matières (8 sur DF)
- 18 découpes
- technique utilisée: découpe ciseaux+ couture + collage

TACTICOS

i'm making my "long journey" tactile BOOK

Tactile book cover with binding or qr code for page layout file + downloadable Braille + instructions I make my cover all by myself and I know how to bind it.

Layers with shapes (pencil + fabric pencil required)

Material in pouch

- **A black and Braille book to fill in:** Large-print black + embossed Braille + spiral binding (soft cover or hard cover).
- **Layers** with cut-out shapes
- Cutting **materials**
- **Instructions for use**

A pocket for everything

Step-by-step instructions

Materials with or without double face

Proposed layout :
3 formats
1. SQUARE: 20 x 20 cm
2. PORTRAIT: 21 x 24 cm
3. LANDSCAPE: 29.7 x 16 cm

Braille online to online
Font : Luciole 24 pts

Figures 8.27: DIY kit

9 THE MAKING OF ROUNDY

9.0 INTRODUCTION

The project Tacticos required the development of two 'example-books'. The purpose being to show how tactile images and accompanying explanations can be used to explain concepts to blind and visually impaired children. These books are:

- 'A long journey', for children aged 5-6 years, by Les Doigts Qui Rêvent
- 'Roundy', for children aged 9-12 years, by Dedicon

The theme the project members chose was 'climate change'.

Like 'A long journey', Roundy was the result of international team work and the process of the production of this book is described in chapter 8 of these guidelines. Differences are:

- The technique: tactile graphics instead of collage
- The age of the readers

At the age of 9 to 12 years the level of experience and knowledge of the readers is much more advanced, hence the concepts to explain are much more complex. Motor skills, reading skills, language skills, knowledge of the world around them: they all are much more developed. These children are generally not being read to (so often) anymore; they read themselves. Yet their development and interests may vary widely, not in the last place their skills in reading tactile graphics.

This chapter describes the main stages of development for the book Roundy.

9.1 IDEATION

9.1.0 TARGET GROUP

- Blind from birth (or low vision as some 80% of blind children has some vision)
- Developmental age of 9-12 years
- No additional cognitive or other serious learning difficulties
- Independent (good) braille-readers, from paper or from a braille-display
- May or may not have experience reading tactile images
- May or may not understand the concept 'image, drawing, seeing, …'
- May or may not have knowledge about the subjects in the book
- In Belgium, France and The Netherlands

So a very diverse population – and a rather wide age range.

9.1.1 BRAINSTORMING WITH THE TEAM

The chosen topic was climate change. We studied for example 'school TV' (in The Netherlands) to see what sighted peers would know about climate change and how it was explained.

We listed what might not be 'obvious' knowledge for blind kids, because they usually only have descriptions and audio information. We listed which books about climate change were available for children aged 9-12 years.

We discussed how one could draw the candidate subjects and above all 3D-subjects. Dedicon uses ‘orthogonal projection’, where the reader can build a correct mental representation based on a top view, front view, and side view, all under a right angle, as explained in the guidelines. Though this is not a new ‘method’, it is not always used in this context. Perhaps this is due to its rather technical sounding name. Or perhaps because a child needs to learn and practice it. We had lots of discussions about which children and age group could make use of this method.

Visio has developed a method for understanding the transition from 3D to 2D – and visa versa – using a lot of ideas from Bob Marek. (See the chapter 2 ‘Explaining concepts with the help of tactile images’). In fact the methods of Bob and Visio are the first indispensable steps towards explaining the more complex ‘method’ of orthogonal projection. The discussions step by step led to a better understanding, experimenting and acceptance.

It also became clear that parents and maybe also professionals and designers should become more familiar with this approach. This might prove to be another challenge, since caregivers and ‘non-expert’ teachers in mainstream schools are not always familiar with working with tactile images.

Another difficult question was whether we should make a story plus explanations of the tactile graphics for the children, or if should make a story for the children to read plus explanations and additional tips for adults reading with the children.

In short Roundy should:

1. be an example book, showing how concepts can be explained with tactile images
2. explore concepts in a wide sense, from ‘what is a drawing’, to climate change, to objects and animals and clouds (etc.) and how things work, allowing for a better understanding of the world around
3. show what ‘interwovenness’ of concepts means
4. show how knowledge gained in a preceding image can be used and built upon in a next one
5. make both adult readers and children aware of different types of images
6. teach children (and adult readers) to work with top, front and side views
7. make clear that each type of (tactile) drawing has its own ‘underlying principles’ that one must understand in order to give meaning to shapes, lines and textures
8. help readers of various levels of experience to read tactile graphics
9. make reading enjoyable and interesting for the target group
10. guide adults who read the book and/or help children explore the tactile images

Points of doubt:

- should Roundy be a story and/or a ‘do-book’ with stories and tips for activities?
- should we address the adult assistants ‘through’ the texts for children?
- how much text?
- what about translations? A children’s book requires a good translation.
- do we put braille in the graphics; that would mean much more work and costs. Braille is different per country, we would need to make different versions for English, Dutch and French. (Dutch and Flemish braille is identical, but the languages differ slightly).

So we faced a lot of challenges. But one decision was relatively simple. One of the project goals was to find ways to reproduce affordable good quality tactile books. As Dedicon was going to produce and reproduce the books, it was decided to set up Roundy the same way as other series, such as ‘By touch…:’, followed by the subject of the book, a series of tactile books explaining concepts.

The (re)production-line for ‘By touch…:’ is set up for quick and economic reproduction. We produce a book, put it in our web shop, and registered students can order it. We generally make one copy at a time. Reproducing and storing large amounts of copies proved too costly in the past.

‘By touch…:’ titles consist of:

- A volume with tactile swell images in a ring binding
- Printed braille and digital text
- Sometimes 3D prints
- Pdfs with text with the same lay out as the printed braille text for assistents

Dedicon also produces thermoform ‘Twin Vision’ (high contrast printed ink covered by a transparent relief layer) and flexible UV-print for special products, and swell images with colour. (See some examples in Chapter 7 Production Techniques and Materials.)

We also wanted to test if UV-print, which feels (and looks) very different from swell, would be appreciated by the target group. Reproducing UV-print is much slower and much more expensive than reproducing swell paper.

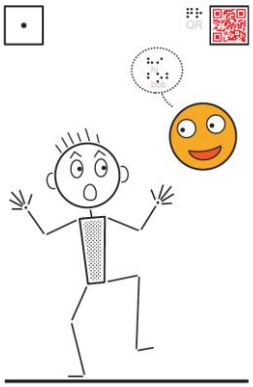
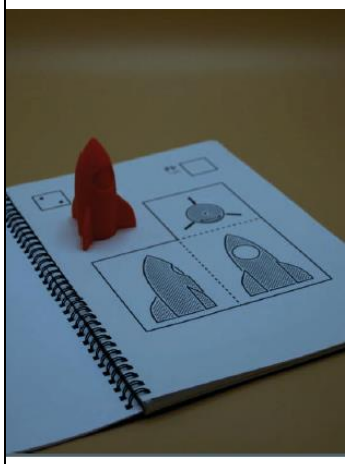
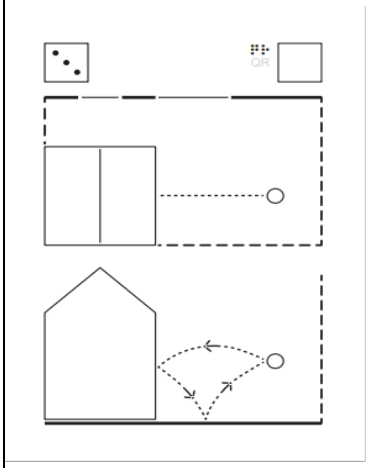
We decided to use colour in Roundy, because:

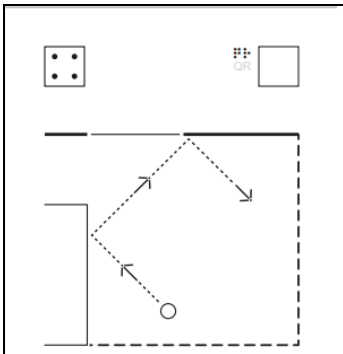
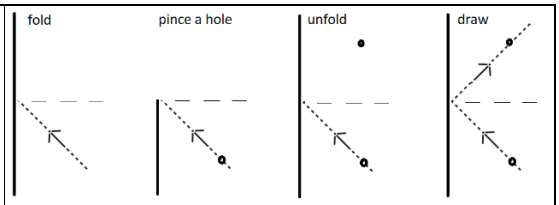
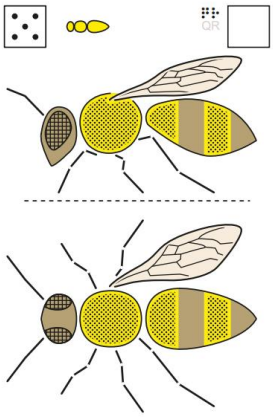
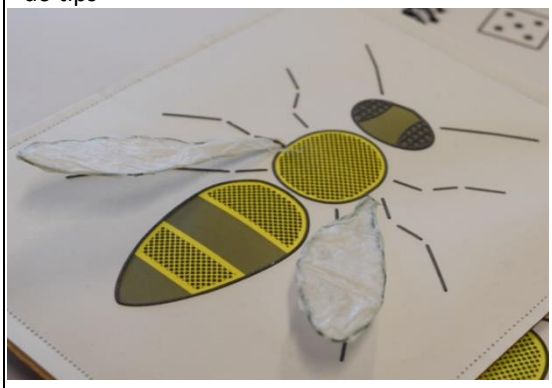
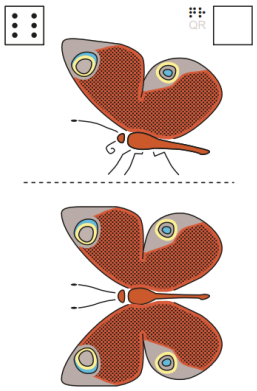
- Colour may help partially sighted and CVI readers.
- Colour makes the books more attractive for sighted peers.

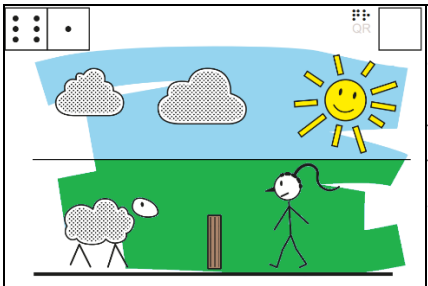
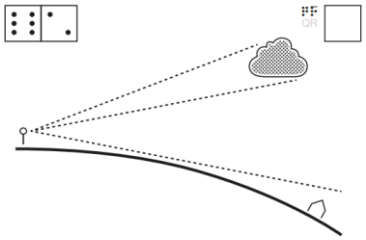
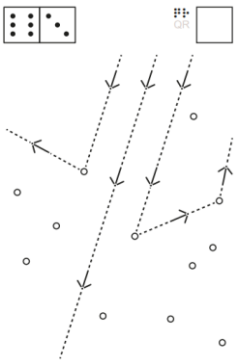
9.2 CREATION - STORYBOARD

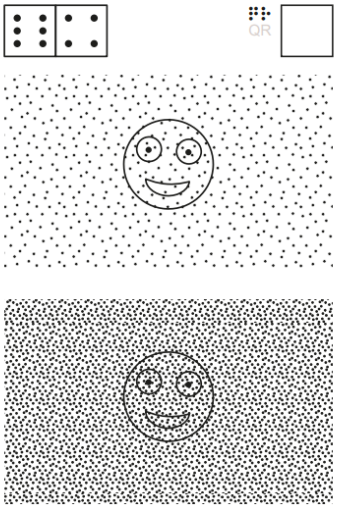
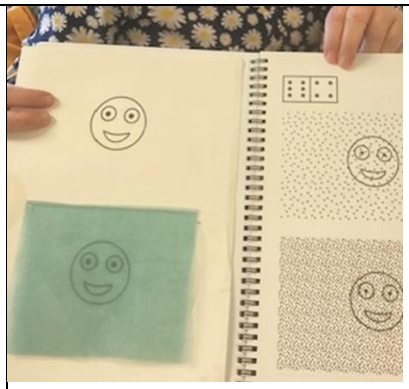
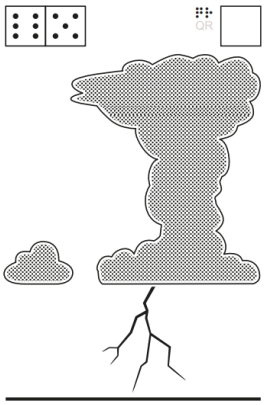
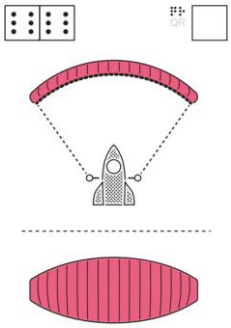
It was decided Roundy would have 15 tactile graphics, 14 swell, 1 UV-print, each with a story and explanation. Dorine in ‘t Veld then worked out an idea for ‘Roundy’: story, tactile images, explanation of the tactile graphics and/or the subject and concepts in the tactile graphics, which saw the light in October 2023.

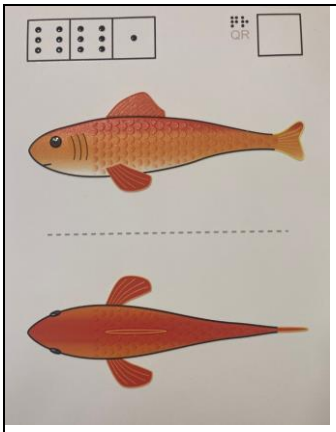
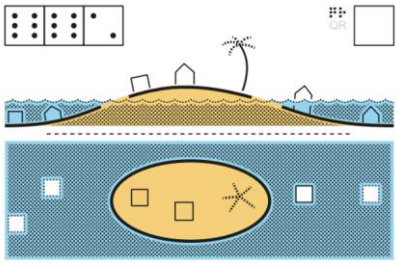
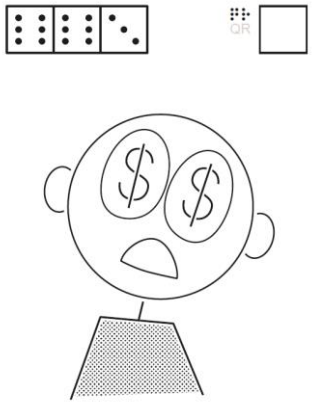
Tactile graphic	**Story**	**Concepts**
Cover 	Introduces Roundy, a die with one dot, ‘round’ braille, QR (not tactile: the Tacticos logo)	Emoticons Die patterns QR How to explore and navigate; don’t miss elements Playing with braille
Bob meets Roundy (1)	Bob, blind, alone in the garden (no plants, stones and tiles)	Cartoon Emotions expressed in Mimics

	Suddenly, out of the blue, he hears 'Hi Bob!' He is startled and almost jumps in the air. Roundy is amused and shows Bob in a tactile image what the funny situation looked like	Body language Orientation of the image (think it upright)
The rocket + 3D-object (2) 	Roundy is an extra terrestrial who came in a rocket, driven by a mysterious energy and with very peculiar characteristics; like Roundy it can change dimensions and shape easily.	A 3D-Rocket will come with the book. Orthogonal projection to explain the dimension and position of the rocket How does a rocket 'fly' Top view, front view, side view + do tips ('half box') 
Roundy changes into a baseball (3) 	They play ball in the tiled garden; Bob bounces Roundy to the wall of the shed. (normally this won't work since the ball (with a bell) rarely comes back in Bob's hands, but Roundy helps	A plan (top view) showing garden and shed and the path of the ball (straight to the wall) A front view showing the path of the ball: in a bow to the wall and back with a bump Different lines have different meanings: a schematic drawing A line you don't see in reality (showing the path the ball took) A circle indicates Bob's position
Bob rolls the ball (4)	Very much the same as 3, but now Bob rolls Roundy	As 3 + when bouncing the angle of ingress is the same as the outgoing angle + do tips 

		 Symmetry
A noisy bee (5) 	A loud bee passes Bob; he is afraid, thinks the noisy bee is very big. He knows bees can sting. The bee complains that there are not enough flowers in this nasty garden.	Anatomy of a bee Occlusion (leg under wing in top view) What is a bee made of concept of flying: how does a bee fly (different from a rocket) + do tips 
A silent butterfly (6) 	She complains too about not finding flowers; are seasons earlier? Bob thinks he should tell his parents to change the garden and help nature	concept of flying: how does a butterfly fly. Symmetry again Anatomy of a butterfly (From the text: climate change)
Ann gives Bob a present (7)	Ann made a tactile image with wool and wood and cottons of	A children's drawing

	her and a sheep and a fence in the meadow. There are two sheep clouds in the sky. The sun is shining and has a happy face. Now Bob is happy too.	A sun with rays and a face (semiotics) Relationship sheep and sheep clouds The horizon This image is not a top or front or side view; it combines a part that is horizontal (the meadow) and a part that is 'vertical' (the air) + do tips, not illustrated here
The horizon (8) 	Bob asks Roundy to explain clearly 'horizon' as it still is a riddle to him.	Another schematic drawing Sight lines How does 'seeing' work: what part of a cloud do you see. What is the horizon. A ground line and a horizon line
Water droplets make clouds (9) 	Bob and Roundy go into the rocket. Roundy explains what clouds are and why their top sides are shiny white and the bottom often grey. This depends on how much light is reflected or blocked by tiny water droplets – that you cannot see individually.	Another schematic drawing Light lines ('rays') and water droplets. The constantly moving water droplets reflect light rays chaotically. Some make it to the bottom of the cloud, many -depending on the number of water droplets – will be reflected sideways or up again.
Fog (10)	In a cloud, in the fog you cannot see far and you cannot see all details. This too depends on how the light rays can reflect. The more water droplets, the less you can see	To be used with eyes closed only!! Shows to the fingers the effect that fog has on seeing. In the image with fewer droplets it is still possible to distinguish Roundy's face. In the image with more droplets sighted people can see Roundy's face quite clearly, but the fingers can hardly distinguish it anymore. + do tips

		
A sheep cloud and a stacking cloud (11) 	Roundy tells the rocket to lift off. They fly through a sheep cloud. Roundy tells the rocket to fly horizontally and look for a stacking cloud (thundercloud). When they find one Roundy says “Rocket: engine off! Sail out!”	The tactile image conveys the shape and dimension of a stacking cloud in comparison with a sheep cloud. It shows lightning that finds its way to the earth.
A wild ride, thunder and lightning (12) 	There is a lot of turbulence. The rocket hanging on the sail sways and moves wildly up and down. Bob hears hail and hears dreadful thunder. He is safe in the rocket but almost gets sick.	The tactile image shows the rocket hanging on a paragliding sail, front view and top view The story explains turbulence; weather conditions are rough in this type of clouds.
The fish (13)	They descend and see a big fish in a stream. It tells there has been a flood.	You cannot see through fog but you can through clear water. Transparency (only part of the light rays (see 9) are reflected by the surface of the water. Most go

	And next the river was almost dry.	to the bottom. So we see the bottom (and the fish) and not the water surface. Fish have scales Fish have fins to swim (under water). Top view and front view show its dimensions and proportions.
The sea level is rising (14) 	They fly on and see an island. It used to be bigger; there are houses round in and under the water. Bob heard of a climate summit and wants to go there with Roundy to tell the world leaders they must not talk but act.	The font view shows a not very steep mountain with a tree and houses. Part of the mountain is under sea level. There are houses (partly) under water. The top view shows clearly how small the part is that still sticks out of the see.
The climate summit (15) 	Bob wants to give a speech to the world leaders, but they get dollar signs in their eyes. They think they will be the most powerful person on earth if they will possess the knowledge about the energy that moves this unusual rocket and this unusual floating ball… They jump on Roundy.	Cartoon Dollar signs in the eyes Unfriendly facial expression (mouth with corners bent downwards)

The story ends well: Roundy locks up the world leaders behind a mysterious energy field; they will be released when they cooperate and come up with effective measures. Then he brings Bob home. His parents await him since Roundy had already sent a message. Bob is famous now; they were on the television all over the world. He and Roundy did something very important to save the world. And he obviously inspired his parents, since his sister says: “Oh and Bob, this holiday we’ll go biking!” says Ann. “A fossil fuel free holiday!”

The last sentence is: How would this story continue? What do you think? It would be nice if children can send their answers and win a prize and give feedback for new titles.

9.3 TESTING

The first version went to several stages before we finally made a test version. We made a selection and tested the following:

- The cover
- Bob meets Roundy
- The rocket (top, front and side view)
- The bee
- The fish (UV-print with flexible ink on paper)

9.4 EVALUATION

Many children thought the graphics were quite difficult, but when well explained (for example when the testers did the do-tips as shown in the storyboard) they actually quite enjoyed them.

The testers were also positive about Roundy, but thought it would be better if the chapters were more of equal length and if the stories were aimed at 9–10 year old children rather than 11–12 years.

This was done. The tactile graphics here and there changed places. The story was changed a bit to make it more appealing for children aged 9–10, yet keeping the extra explanation of the concepts.

The stories were translated by native speaking participants, and we were pleased with the result.

In our international team we had a lot of discussions about ‘what actually is a concept’, ‘how can a tactile image help a child understand things better, and at what age?’. We got to know each others opinions, ideas, experiments and learned lessons from these. Thus the team members gained a much better understanding of the subject, and also of each other. It was a very enriching experience working together. You can find the reflections in the guidelines and articles.

9.5 PRODUCTION

At the time of writing this chapter, February 2014, it looks like we can produce all copies of Roundy, comprising of the books with the tactile graphics, the braille books with the story and accompanying explanations and exercises, and the 3D-rockets within budget. In addition we will make the complete Dutch, Flemish and English versions available at cost price in the Dedicon webshop (https://educatief.dedicon.nl/). Everything will be downloadable from the Tacticos website for people who can reproduce Roundy at home or in school.

There is/will be:

- 1 international volume with tactile graphics
  (with QR codes, and only words that need no translation (like ‘Roundy’) in lower case braille letters)
- A braille version per country
- A digital version per country
- A 3D printed rocket

- For the project only: a laser cut 'halfbox' (see image 3 in the storyboard)
- Soon all will be downloadable from the Tacticos website.

Dedicon will make it possible to order the book in The Netherlands within the subsidy for Dutch children who are registered with Dedicon. If possible Dedicon will offer the tactile volume and the Dutch, Flemish and English braille versions at cost price to non-registered people (internationally).

9.6 FUTURE ECONOMIC PRODUCTION

If this 'concept' of internationally usable tactile graphics or images is adopted, it will be possible to produce them at a price that is comparable to 'normal' children's books. The conditions are:

- More countries cooperate
- Each pay for a number of copies that are for example pre-ordered by and distributed to libraries and educational institutes for the VI in that country
- QR to downloadable texts
- Production houses for braille and libraries for the blind print the braille text and/or 3D-items
- The books are embossed (see Chapter 7.8 Embossing).

The cost for the moulds are relatively high, but the costs for the reproduced pages is relatively low. There are printing houses specialising in relief printing for affordable costs.

This will greatly stimulate the number of available tactile books.

It will make it possible for blind children:

- To read books of their interest
- Practice reading tactile graphics
- Get access to any subject they want to develop deeper understanding

"Description alone often leaves me with a vague impression and lots of questions. When it is supported by a well-designed tactile image, it gives me precise understanding. I cannot describe the pleasure that brings!"

"Thanks to tactile graphics I can study any subject I'm interested in".

"Tactile images opened a world for me".

(Generalized quotes from blind readers participating in workshops and surveys by Dedicon)