Learning to draw with the HIPP application

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ABSTRACT
In this paper, we describe an audio-haptic drawing application prototype that has recently been tested by five pupils who are 8-13 years. The application has been used by pupils, assistants and teachers to access graphics and create graphics that are accessible for pupils with severe visual impairment or blindness. We have observed a spread in the actual use of the system that seems to depend, for example, on the special pedagogical knowledge of teachers and assistants, their learning focus, and the age of the pupil when they start using the system.

Categories and Subject Descriptors
H.5.2 Information interfaces and Presentation: User interfaces: *Input devices and strategies, haptic output, voice output* **K.4.2 Computers and Society:** Social issues*: Assistive technologies for persons with disabilities* **K.3.2 Computers and Education:** Computer Uses in Education: *Computer assisted instruction*

General Terms
Design, Human Factors

Keywords
Haptic, audio, multimodal, non-visual, blind

1. INTRODUCTION
Persons who have visual impairments are excluded from accessing certain types of information that are accessible to the general public. Today, screen reading software and Braille displays or text-to-speech systems are used for enabling access to text. For accessing graphics, and especially digital graphics, no standardized technology is in widespread use. In education, preprinted material is often used, which forces teachers to plan well ahead of time to be able to produce or borrow the material they need. This makes the learning situation less dynamic, and it is hard to produce tactile material on-the-fly. Because of this, pupils with severe visual impairments also get less trained in the reading and understanding of graphical material which will exclude them from certain information in their grown-up lives.

The emergence of haptic hardware and the possibility to create interfaces for non-visual audio-haptic interaction has opened a door to the access of digital graphics and 3D models. Still, the relatively high price of high-precision haptic devices is a hindrance, as well as the lack of useworthy applications.

2. METHOD AND SYSTEM DESIGN
We have used a participatory design process in a school context to develop an audio-haptic non-visual image editor and explorer, which may also be used collaboratively [1][2]. The system, called HIPP (Haptics In Pedagogical Practice) and the methods around it, while undergoing continuous improvement, are evaluated in four schools by five pupils with severe visual impairment or blindness, their teachers and assistants. The different pupils and teachers have chosen to use the system in different ways, according to their own needs and wishes.

The drawing application is written C++ and Python on top of the H3D API [3], and Cairo graphics [6], and is available as open source code [4]. It uses a combination of haptic and sound feedback to display information to the visually impaired user. The haptic feedback is displayed via the PHANToM OMNI device. A sighted user can simultaneously use the mouse to interact with the application.

The virtual environment consists of a virtual sheet of paper. The PHANToM user draws on the paper by pressing the front switch when in contact with the paper. The mouse user draws while pressing the left mouse button. The users can choose to draw the line in either positive or negative relief. A combination of positive and negative relief can be used to display different features in a drawing. The PHANToM user can feel the lines while drawing. Each line is tagged with a number and text string which is spoken by the application each time a user selects an object by touching it with the PHANToM pen or hovering over it with the mouse cursor, or, it can be tagged with a sound effect.

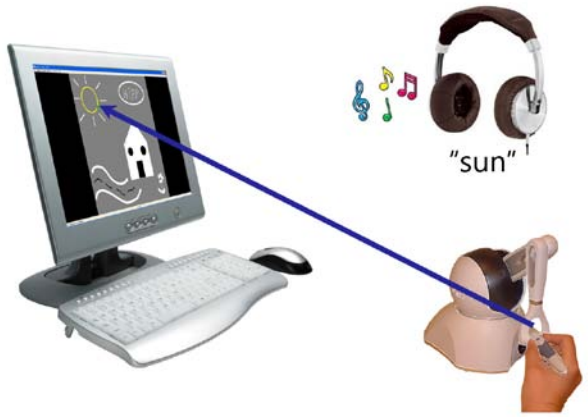

Figure 1. HIPP concept picture. The pen for haptic feedback, the earphones for spoken feedback or sound effects.

Objects can be manipulated in different ways; moving, resizing, copying, pasting and deleting. Additionally, text tags for the shapes can be changed, and shapes can be transformed into straight lines, rectangles or circles. The manipulation tools are fitted with auditory icons, which are feedback sounds designed to resemble a real world manipulation of similar nature [5]. E.g. the copy function sound effect is a camera click.

3. RESULTS

The extent and mode of use of the HIPP system has varied for the different pupils. It has been used both for the own creation of drawings (made by the pupils) and exploring of school material, such as diagrams, maps or other illustrations. The preconception of the teachers' was such that they were very focused on teaching: *transferring* knowledge in pictures *to* the pupils, and would start talking about maps and mathematics figures as being the biggest problem in school (for pupils with visual impairment). This seemed to get more prominent the older the pupils got, and the playful experimentation with the digital material (in the form of the HIPP system) was not pursued as much. For the younger pupils, an approach of playing with sounds, drawing and simultaneous use of normal tactile drawings on paper seemed to come more natural.

However, asking pupils with severe visual impairment or blindness to draw is not without its problems. How do you go about teaching drawing to someone who does not see and cannot as yet interpret tactile drawings very well? It was also seen that while some pupils have a wish to draw as their sighted peer do, others are reluctant to try. When one of the pupils (with blindness) was asked to draw something, the pupil answered: *"I have to say thank you, but I'd rather not"*. It is also important to note that blind pupils (as a rule) have as yet tried very little to do drawings at all. The available aids for non-visual drawing are limited and non-dynamic and they also do not help the pupils do nice drawings (as computer-aided drawing applications do).

The approach that showed to be fruitful for the reluctant pupil in the end was to let the pupil do doodle-drawings with the HIPP system, much as younger sighted children do when learning to hold a pen at 1-3 years of age. These doodles were then interpreted by an assistant who would say things like: *"Oh, what you are drawing there looks like a rose, would you care to bring it home to give to your Mom?"*. And then they would print the drawing on swell paper (which raises the black lines on the paper) and explore it as well. When the pupil later took the initiative to draw something, visual interpretation and communication around 2D drawing conventions were discussed.

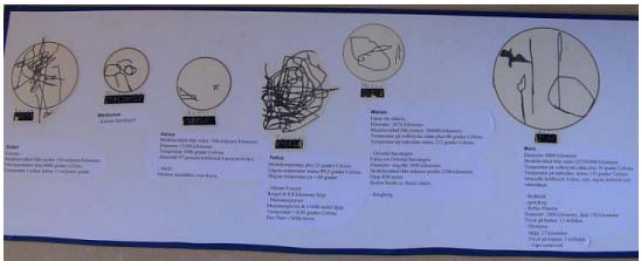

Figure 2 Solar system printed on swell paper.

For example, the pupil would like to draw a planet from the solar system. Therefore, the pupil started to ask question like: "*How do you draw a planet? And how do you know that at planet you draw as a circle, is in fact a sphere? And how do you draw the craters on the moon? How about the mountains?"* From the pupil's initiative, a whole wealth of discussion topics around 2D drawings, scaling and perspective came naturally from working with the system in a real activity. Also, the fact that the drawings were not kept in the digital format, but also printed on swell paper and examined, probably helped to convey the meaning and importance of graphical images.

The examples above cover the personal learning for the pupil, learning to draw and understand drawings. In the particular case, this learning took place in a special session with specialists that had deep knowledge of both the HIPP system and of visual interpretation and tactile material use. This is not always the case, since specialists are hard to come by in a school that maybe has one single pupil with visual impairments in maybe a 20-year period.

Another issue with pupils who are visually impaired is that they sometimes have problems collaborating with their sighted peers in class (in Sweden, most pupils with visual impairment are integrated in a regular class). Since they have different learning material (the tactile material and the visual material differs) it is hard to collaborate in certain tasks. It is also difficult to take part in the creation and exchange of graphics, which is important as a learning tool especially for the younger children. In one school, the assistant and the pupil used the HIPP system to create such material, which was going to be used in a visual exhibition in the classroom. This was done on their initiative, and since it was for an exchange with peers, the usefulness of HIPP was clear to everyone involved. However, there is still the problem of the communication of the sighted pupil's graphics to the pupil with visual impairment.

Figure 3 A part of an ocean collage in the classroom. The shell and the bird above it are created with the HIPP application.

4. DISCUSSION & CONCLUSIONS

As can be seen from the examples above, and also inferred by similar examples from other schools, the HIPP application, which is in many ways still quite simple (we sometimes refer to it as a non-visual "Paint" application), has sufficient functionalities to be of use in the classroom. It puts some demand on the pedagogical personnel surrounding the child, however, and we have seen how the computer skill and the knowledge of special pedagogy have a big impact on how often the tool is used and in what situations. However, this is the case, we believe, also with other material and pedagogical situations. We hope to solve some of this problem by creating good introductory material and example graphics to start with.

Learning to draw, and also being inspired to draw is indeed possible with the help of HIPP, and by printing swell paper copies of the drawn pictures, sometimes in several stages before the picture is finished, helps making the build-up of pictures more clear to the pupil. We have also seen how the task of drawing something triggers questions about 3D-2D projections, and about certain conventions in drawing, for example how you usually draw a car from the side, and not from the top.

With the younger children, a playful approach has been more pronounced, and we guess that this is one reason that has worked better with them. The root cause for the playful approach can be the pedagogy for smaller children as such, but it may also have to do with the escalating demands on the pupils' as they grow older. They simply have no time to learn a new tool in a playful manner. This indicates that learning a new tool like HIPP should be scheduled in the lower classes; however, we have also experienced clashes with other new tools being learned such as Braille displays or new keyboards.

We infer that the use of HIPP as only a transmitter or conveyor of school material such as maps, drawings and diagrams, will not work well. In the classes where the conveying of material has been the focus, it seems the HIPP application has been used less. Partly, we believe, because without the knowledge of what a picture is and how you create it, the decoding and understanding of pictures is harder. But also because this then puts a greater demand on the assistants or teachers actually creating the material, and spending preparation time working with HIPP. The time needed to spend on a new tool, even if it is seen as useful, is hard to add on top of the other work that is already done in school.

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