

Two APICADEV members, Laura and Elizabeth were especially involved in our research project (the names have been changed for anonymity purpose). They discovered Tactos with the research project. They have taken part to all the phase of the participatory workshops. Laura has been blind since she was in her teenage, while Elizabeth progressively lost her sight. They are practicing regularly travelled routes, such as the route from their respective homes to the APICADEV headquarters. Laura is using a white cane whereas Elizabeth is accompanied by a trained guide dog. Cedric is a Tactos expert who learned the system at school on the occasion of a former research project [14]. He joined 5 times the participatory workshop after nine months the project was running and we were working on the system deployment in the field. As he lived at more than 150 km from the research lab, he has been able to be present three times at our office but at the end of the refinement phase the Tactos and Intertact.net system were sufficiently robust to allow at a distance participation over the Internet with the use of a teleconferencing system in parallel. Marie was an APICADEV member who have joined us 4 times as she heard about the project from Laura and wanted to learn the system.

All of them have access and use the Internet with a screen reader software. Laura and Cedric have a good knowledge of the Braille writing system and use it on a daily basis. Elizabeth was less familiar with the Braille and prefers audio content reading. Marie was not Braille literate as her sight no more allows her to read printed characters since one year at the time of the project.

Through the deployment of a participatory design approach the stake is to develop content and application which usable and relevant for end users. To this extent methodological adaptations are needed for engaging blind persons in a participatory design approach [18-20].

End users participation is also an opportunity to invite the participant to act as door opener and invite other persons to try and use the system. This appears as an efficient way to progressively build a users' community. Thus providing tools for end-users to share with peers their experience of accessing digital content through touch, and to help them to teach and spread this practice is what we are developing with the ITOIP project.

3. RESULTS

We present the implementation and the results of the participatory workshops we have conducted and the two tools we developed on this occasion with the aim to enable blind persons to learn and develop a practice of Tactos: an interactive tutorial and a cooperative tutoring setup.

3.1 Tactos workshops

The room where our Tactos participatory workshops took place is four persons open space with a big central table for prototype tests. Each design session took on average 3 hours. It usually starts by the agenda of the afternoon as the lead designer presents the new application prototypes or their latest updates to the blind persons who took part to the workshop.

These workshops were intended on one hand to collect feedback and open the design to end-users, on the other hand

they were seen as a way to initiate a community around the practice of using Tactos to explore graphical content. These participatory design workshops were organized in three phases during the project:

- **Discovery:** The first six months, the blind persons were invited to come twice a week in order to learn the Tactos system and take part to the design of digital content prototypes. At the end of this period the more promising content were selected with the participants in order to improve them. The content selected was concerned with three types of application: interactive geographical map, graphical drawings exploration and games.
- **Refinement:** The next six month were dedicated to the iterative development of the selected applications. We met with end users once in two weeks over the period to refine the applications.
- **Deployment:** The last period was dedicated to export the use of Tactos and Intertact.net outside the University to the APICADEV office.

One or two applications were tried out during each session. The users with the help of the lead designer explore each application. The participants are let free to explore the prototype on their own at first. Then they are invited to report on their difficulties and experience with the application. During these discussions they mention encountered usability problems and express their opinion about the usefulness and the relevance of the proposed functions for their daily life. At the end of the session, the lead designer writes a synthetic note. These notes record a set of improvements to be implemented for the next design sessions as well as the ideas for new applications discussed with users and the team. This assisted adaptation process helps us from week to week to adjust applications' usability and functions. It also allows us to grasp their usefulness from the users' point of view.

3.2 Interactive tutorial

The experience of graphical content with Tactos involves giving meaning to the shapes explored through the tactile interface by the subjects.

Most of the available content is concerned with 2 dimensional shapes however the background of blind persons in basic drawings is very limited. For instance a triangle sat on the top of square did not evoke at all a house to the blind persons who have worked with us. Later, with the use of Tactos one of their interests was on making meaning of complex drawing from their exploration with Tactos. For instance, a complex content is to develop an idea of the shape of an airplane by locating the wings and the cockpit. To this purpose the adjunct of speech synthesis with active area triggering the name of the part currently explored is especially useful.

Thus in order to define an adapted tutorial our participants has made several suggestions:

- Horizontal and vertical lines are easy to recognize with Tactos and should be the two first steps of the interactive tutorial.
- Making sense of the explored graphical content is essential for the user to find an interest in Tactos, even if complex shape takes time to master. The blind persons who took part to our workshops have chosen capital letters as the main content for the tutorial. They explain their choice because of Latin alphabet letters are shapes most of the blind persons already learned or know

basically, for instance in order to sign document themselves.

- The letters have been ordered according to the difficulty they present through Tactos: number of segments and line orientation. From the feedback of the participants, we ordered the tutorial content the following way: L, T, F, E, N, Z, V, X.
- The importance of providing a guidance system to Tactos newcomers in order to help them to find the shape to explore on the screen. Speech synthesis was chosen for this purpose so it does not interfere with tactile sensation. The voice guide the user by telling her or him whether the shape is on her/his left or right, and also nearer or farther from her/him. The last point is interesting as the idea of top and bottom of the capacitive screen was judged as not intuitive at all by our participants.

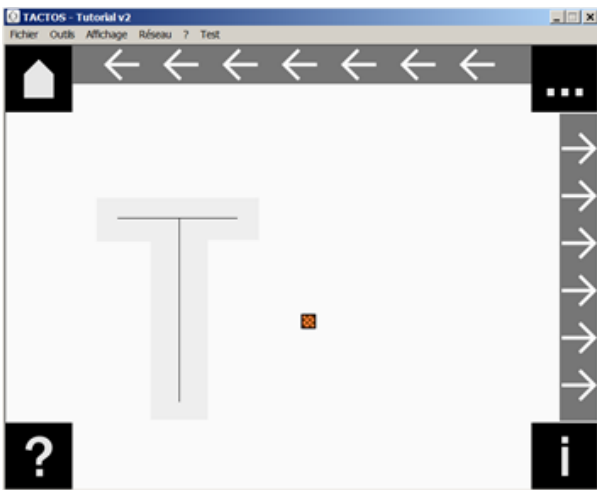


Figure 2. A screenshot from the interactive tutorial on the exploration of the letter “T”

The interactive tutorial was then deployed as a room available from the landing screen on Intertact.net. The application was used on the Tactos workstation installed at the APICADEV.

3.3 Cooperative tutoring between blind persons

In order to enable a blind person to teach the use of Tactos and Intertact.net to another blind person, we achieved a specific device that we present in this section.

The teacher supports the learner in her/his exploration of the screen while receiving the same tactile signals. Indeed, the touch interaction module used includes two tactile arrays, one for the learner and the other for the teacher in the current situation.

The teacher places his hand underneath the module on the first tactile array and the learner places his hand on top of the module on the second tactile array. The two tactile arrays trigger exactly the same signals. The learner explores the image on the screen while listening to the advice of the teacher who receives exactly the same tactile information than him. This way they feel they “touch” the same thing at the same time. A situation which overcomes physical constraints since two persons can never touch simultaneously the same point.



Figure 3. Learning session: while a blind learner (in pink) explores virtual forms, she can be guided by her blind teacher (in white) that shares the same tactile signals

The first uses of this device are particularly encouraging. Two new Tactos users have so far followed a series of more than 4 sessions on the occasion of the deployment phase. Their already enthusiastic feedback and their requests for improvements show the benefits of this cooperative tutoring system in order to teach the use of Tactos and trigger interest for the system. The current session were using mostly the interactive tutorial and simple shapes. The next step is to use this setup in order to teach the use of several existing Intertact.net application using complex shapes and layout, especially a multiplayer online game (Battelship) and Tactos Map [4].

4. CONCLUSION

Many support systems turn out to be invalidating if they increase the awareness of disability by making the user dependent on learning from a non-disabled person. The situation of an independent learning of our tools in the community of blind people seems to us crucial. In this paper, we have presented the approach we developed in order to design a learning environment for touch access to digital content. By organizing participatory workshops with blind persons and developing tools to support independent learning of our technology, an interactive tutorial and a cooperative tutoring setup, we enable our participant to spread their practice of Tactos with peers.

On one hand, it signifies the maturity of an aid project that does not have the former drawbacks. On the other hand, we are confident that this learning process will allow the development of users' communities that can then autonomously improve the system.

A perspective for future work could be to support the distribution and making of a more important number of tactile interaction module MIT. This would be essential to develop a bigger Tactos and Intertact.net users group. Leaving apart the cost of the research associated with their design, the expense for buying the electronic component of these systems opens the possibility for these systems to be reproduced on the framework of local association or with the help of technology literate people. The current DIY and maker movement [21-22] show such development is today realistic. To this extent the question of sharing the design documents and associated software with the public, for instance through Open source hardware [23] and software [24], is an entire project in itself.

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