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Technical Assistance for Severely Motor- and Multiple Impaired Children

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Up from a certain degree of impairment motor- and multiple disabled children rarely are able to use conventional environmental control and augmentative communication systems. To attain this ability, in many cases customer tailored user-interfaces plus a long-time training process is necessary. Even learning the relation between reason and effect and experiencing self-effectiveness (being able to make something happen in the environment) is the first big challenge and often an entire new experience.

Hence, a technical system capable to meet the needs of these users has to fulfill three criteria: (1) give optimal support to the training-process; (2) support the facilitators with a tool to easily adapt the system to the rapidly changing user needs; (3) be capable to grow from first experiencing self-effectiveness up to a multi-functional multi-purpose technical aid.

The paper discusses an innovative technical assistance system developed at the Vienna University of Technology which especially has regard to multiple impairments and the training-process. Presently the authors look back on one and a half years of practical evaluation of the technical assistance system in a support center for motor- and multiple impaired persons. After introducing the concept of the technical assistance system and pointing out its special features two case-studies illustrate the practical application of the system.

1: The special situation of motor- and multiple impaired children

One of the main reasons for severe motor- and multiple impairments in childhood is cerebral palsy. Here different brain regions can be affected resulting in random combinations of disabilities (motor, cognitive, intellectual etc.). Experiencing no or only little self-effectiveness and self-determination these children often encounter restricted chances for the development of abilities. Given the proper education (the majority of these children receive special education) and offering the right challenges these children will (more or less) quickly develop resulting in changing demands on the educational and therapeutical environment.

2: Basic demands on the design of the technical assistance system

A technical assistance system may be defined as a set of hardware and software components by means of which a disabled person can, to a certain extent, compensate handicaps concerning communication and environmental control. Doubtless the most critical part of the system is the user interface which has to accommodate the disabled user's needs and abilities.

A system which takes into account the situation of severe motor- and multiple impaired children must offer the following additional features:

- Actions of the user must immediately result in clear and easy to comprehend system responses (e.g. for basic training of switch usage unmistakable stimuli like turning on lights in a dark room or switching on loud music are necessary).
- The variety of possible system (user interface) configurations must range from absolutely simple to rather complex (including playing, multimedia and multimodality).
- As children can develop rapidly the system must support easy and frequent modification and updating of user configurations directly by the teacher or therapist without the need of calling a technician
- User and facilitator may use the system even in an experimental or playful manner without running the risk of fatal and unrecoverable results.

3: The basic design of the technical assistance system

AUTONOMY is based on a PC hardware platform (e.g. a laptop or a handheld computer) and on the MS-Windows operation system. The input/output hardware can be chosen from a wide range of standard and special devices to meet the specific needs of the disabled user. A set of peripheral hardware components links the system to the physical environment [1], [2].

As a main innovation AUTONOMY offers three different user-interfaces for the three distinctive user groups working with the system (Table 1) [3]:

- The **end-user** (the person with special needs, who is using the assistance system).
- The **facilitator** (e.g. a therapist, pedagogue or family member) responsible for the configuration and adaptation of the user-interface.
- The **integrator** carrying out the technical set-up of the system.

ROLE	TASK	TOOL	REALIZATION
End-User person with disability	Using the functions of the technical assistance system	***User-Interface*** individually adapted	*Operation program* generating the individual user-interface according to the configuration database
Facilitator caring for the person with disability	Configuring the individual user-interface in co-operation with the end-user	***Configuration Tool*** simple but efficient, no technical expertise necessary	*Configuration program* for creating the configu-ration database which is defining the user-interface
Integrator technical system administrator	Setting-up the technical basic configuration, installation, maintenance	***Setup- and Test Tool*** for all technical tasks	*Setup-Program* for building the meta language interface

Table 1: User groups, tasks and individual interface solutions

The cooperation between these three groups of users is essential for optimization and successful use of the system. The three interfaces/tools (user-interface, configuration tool and setup/test tool) are tailored to the very specific needs and abilities of the three different user groups according to the specific roles they play in setting up, configuring and operating the entire system.

Figure 1 shows the interaction between the system components and how the different user groups utilize dedicated user-interfaces. The user-interface-manager and the application-manager are internally linked with one another by an easy to understand meta language. This

ensures that after the integrator (= system administrator) has set up the application configuration and the peripheral hardware the facilitator (= care person) can refer to non-cryptic (non-technical) terms when configuring the user-interface.

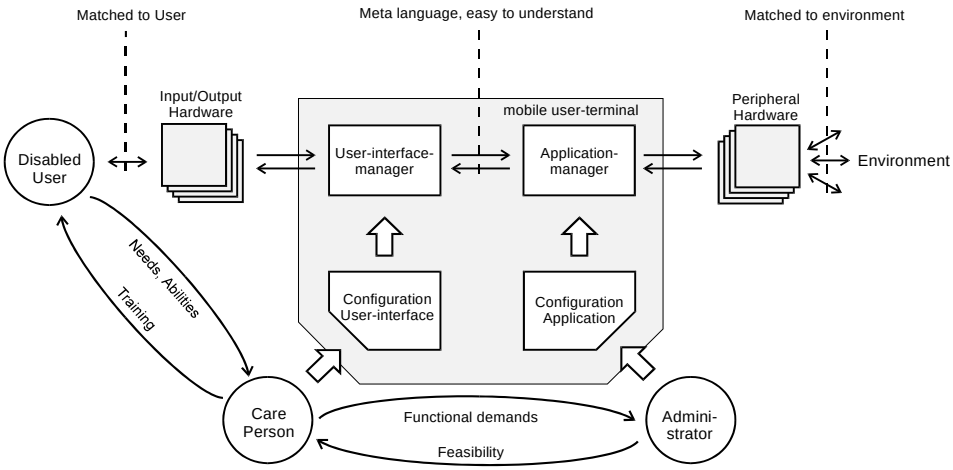

Fig. 1: Interaction between system components and user groups

Another innovative aspect of AUTONOMY is the concept of „bi-directional, multi-modal icons“ developed by the authors. These icons which can be arranged in hierarchical menus are the basic elements of the user-interface. Each icon representing a command to or a message from the computer may consist of a combination of text and graphic on the screen plus a speech or sound event from the speakers. Activating a command icon can be done either directly or by scanning. In the latter case the „focus“ (= icon-cursor) automatically jumps from one icon to the next with a preset timing. An icon is selected by the user by closing a switch during the time interval the focus is on the icon which represents the desired command.

4: The role of the facilitator and the configuration tool

The task of the facilitator is to enable the disabled child to discover and exploit new areas of self-determination and independence. He/she will need a versatile and easy-to-use tool which enables him/her to create not only various user interfaces but also creative procedures for working with the communication and environmental control functions in a didactic and therapeutic manner.

5: Field trial

In late 1995 fortec could establish a fruitful cooperation with a Tyrolean education and support center for disabled children [4]. There a dedicated training room was equipped with a prototype of the AUTONOMY system now serving as a test-bed to find answers to the following questions:

- What are the main problems for novice end-users and therapists?
- How can severely disabled children best be trained to handle an environmental control and alternative and augmentative communication (AAC) system?
- How do the facilitators accept and handle the configuration tool?

- How can the cooperation between end-user and facilitator be augmented by a technical assistance system?
- Which methods do the facilitators use to introduce and train the disabled children and how can this process best be supported by the system?
- Is the system able to improve and accelerate the rehabilitation process?

Now, 18 months after starting the field trial almost 10 teachers or therapists regularly use the AUTONOMY prototype. By creating more than 130 different user-interface and system configurations they have trained a dozen quite differently disabled children. The reports and the evaluation of the system logbook (a file where performance data of all users can be stored) proved the usability and functionality of the system. Figure 2 shows the increase of configurations created during the first 18 months of the field trial.

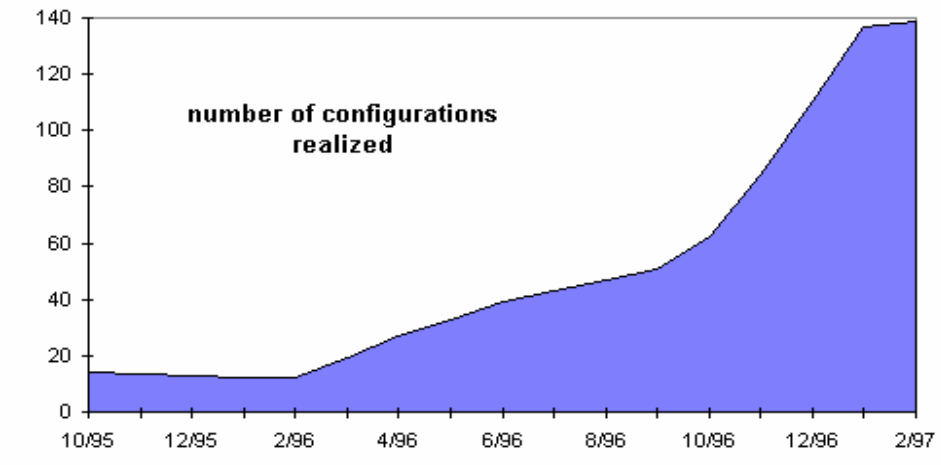

Fig. 2: Number of configurations realized during the field trial

6: Case-studies and examples for using the system in ADL

The disabled children observed in the case-studies suffer from high-grade motor and/or cognitive impairments. It could be demonstrated that a technical assistance system can be used to improve the rehabilitation-process on a very basic level. Two cases are reported here.

6.1: Case-study „Gerald“

Gerald (10 years of age) suffers from both, a severe (visual) cognitive and motor impairment. He is not able to move his wheelchair without external help. His first experiences with the environmental control functions of AUTONOMY he made by switching on and off the room light and the CD-Player. Obviously he loves music and so he evidently enjoys listening to his favorite songs after having successfully activating the icons which control the CD-Player.

Gerald handles the system via a two-switch interface assisted by his therapist. The two large area switches represent the functions „YES“ and „NO“. Pressing the „YES“-key will activate the function associated with the presently focused icon. The „NO“-key causes the focus to move to the next icon. The therapist usually will have Gerald sitting on her lap. Holding the two keys within the reach of Gerald’s hands she supports the selection process by asking Gerald definite questions like: „Do you want to hear some music?“

Up to now Gerald uses a rather simple configuration offering only one menu showing icons for the functions „LIGHT“, „MUSIC“, „TOY-TRAIN“ and „OFF“ (Fig. 3). All four icons are

linked to significant sound events which are released when the icon is focused or selected thus assisting Gerald's restricted perceptual abilities.

6.2: Case-study „Irene"

Irene (12 years of age) disposes of well developed language-, symbol- and text-competence, but, due to her spastic condition, she is unable to speak. From her wheelchair she is operating AUTONOMY via a single proximity sensor activated by turning her head. The main goal of her therapeutic efforts is to improve her head movement control, the correct use of different symbols and increasing self-determination.

Very soon Irene started working with complex and deep structured configurations for environmental control purposes like CD-Player (almost all functions), television (all functions), different lamps and the toy-train. Some months later the graphics used for „LIGHT", „TV-CONTROL" etc. were replaced by their respective BLISS symbols (Fig. 4).

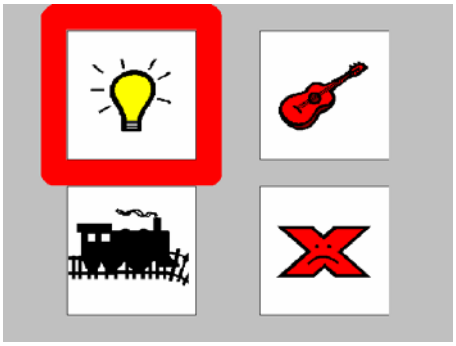

Fig. 3: Gerald's configuration

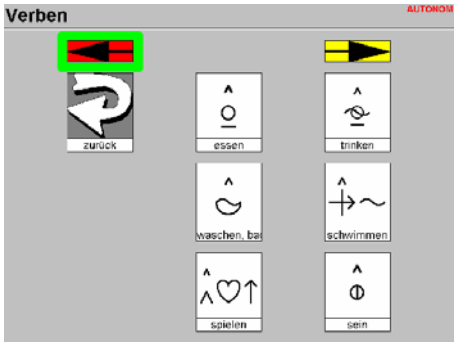

Fig. 4: User interface with BLISS

The therapists report about Irene's high degree of motivation. As the system contributes much to her self-determination she often spends time with the AUTONOMY system even during her leisure hours. Together with an improved version of AUTONOMY Irene received a configuration containing some 250 BLISS symbols.

In addition to communication and environmental control Irene started using AUTONOMY to operate conventional educational multimedia software on a standard PC.

7: Improvement of the technical system in course of the field-trial

Hand in hand with the on-going field-trial, the technical assistance system has been further developed. Main improvements concern the expansion of the AAC capability (e.g. BLISS functions for Irene containing multi-page menus) and the usability of the configuration program (import and export functions for easy and quick compiling of new configurations from existing ones). The field-bus link to the physical environment now is capable to unrestricted control any user PC by emulating its keyboard and mouse.

8: New aspects of an integrated rehabilitation process

Four application areas of a technical assistance system were found to be part of an integrated rehabilitation process especially for severely multiple disabled children:

a) The use of the system as a prosthetic device.
b) The system serving as a therapeutic aid.

c) A tool for increasing the user's awareness of independence and self-determination.
d) Covering pedagogical aspects by offering access to multimedia educational software.

9: Further Improvements which are in State of Discussion Now

The development of AUTONOMY is planned to go on. In close cooperation with the users and the facilitators at the support center the following improvements and additional functions were found to be desirable in near future:

- Saving and printing out the buffer-line of the iconic editor (including auto-save at the end of a session with automatic restore when the system is booted again, infrared link to the printer or to a Fax machine, e-mail capability for iconic messages).
- Improved focus perception for cognitive impaired children (blinking focus, changing colors, various other focus animations to rise awareness).
- Algorithm for automatic adapting some timing parameters according to the momentary performance of the user.

10: Conclusion

The concept of AUTONOMY acknowledges and supports the immense importance of the rehabilitation experts (teachers and therapists) for the satisfactory implementation and use of a technical assistance system. Thanks to the extraordinary motivation of these experts at the trial site about ten children with severe cerebral palsy (resulting in tetraplegia, speech, language, sensory and cognitive impairments) were trained to use the system. Within the 18 months of trials it could be proven that:

a) the technological concept satisfied all expectations of the users and facilitators and that essential drawbacks of existing systems could be avoided.
b) integrating a technical assistance system into the rehabilitation process (mainly in the areas independence, self-determination and development of residual functions) is a factor to speed-up rehabilitation.
c) these results are positively assessed by the disabled users themselves and lead towards an increase in quality of life.

11: References

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