Software for the blind

Seeing Mathematical Formulas

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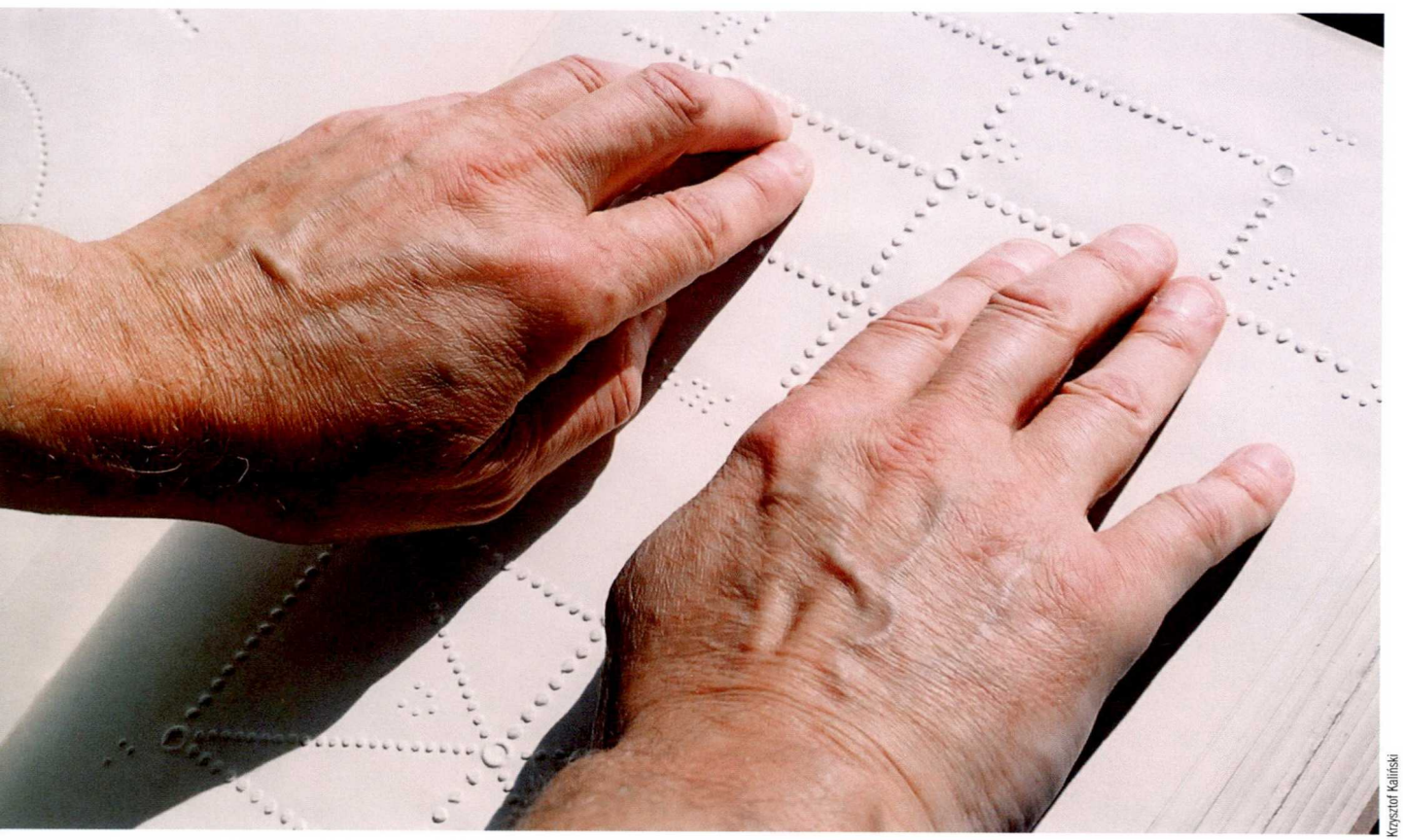
New software makes it possible for the blind to access scientific information written in mathematical notation

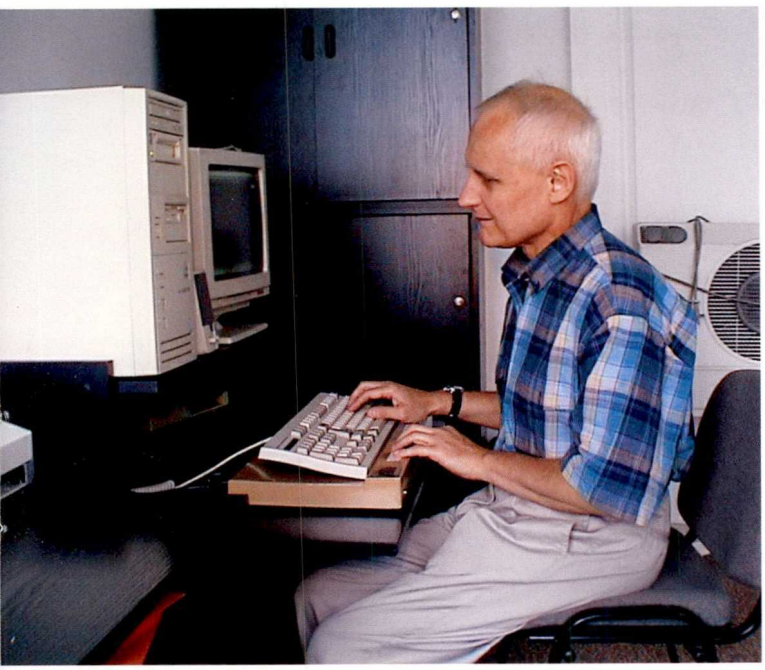
The goal of ensuring blind individuals the same opportunities in life as are enjoyed by the non-blind serves as a constant inspiration for specialists in many fields of invention. We are seeing incredible progress in the professional rehabilitation of the blind, a process first initiated by the invention of Louis Braille. Nowadays, we have computer systems that make it possible, in many cases, for blind and non-blind users to access the same digitally recorded information. Modems, computer networks (the Internet), character and voice recognition techniques, used in combination with special preferential devices for the blind (voice synthesizers, and Braille-based monitors, notebooks, and printers) have vastly changed the lives of those for whom ordinary monitors and typographical books used to be out of reach. Despite such great progress, there are still many issues to be solved. Worthy of particular attention is the problem of how the visually impaired can access scientific information written in special mathematical notation.

Current programs for converting LaTeX program source files into Braille forms have serious imperfections. For example, the latest version of the very popular program Duxbury Braille Translator, available on the US market, encounters problems when processing



Krzysztof Kalinski

The blind are able to read mathematical figures and formulas in the form of Braille printouts



Tomasz Paczkowski

Thanks to new computer programs, the electronic versions of generally available mathematical publications can be automatically translated into a system accessible to the blind

multi-line mathematical structures (even simple matrices). In such cases, the program frequently freezes up, and work can only proceed once a non-blind individual makes the necessary modifications to the source file. A similar intervention may be required for writing multi-line expressions in Braille format. Duxbury Braille Translator software has been developed for American (Nemeth Code), French (French Math Code), British (BAUK Maths Code) and experimental notation (UEBC - www.iceb.org). All of these notations, however, are less robust than the new Polish-developed *Mathematical Raised-Dot Writing System for the Blind*, developed by the PAN Institute of Computer Science.

In the years 2000-2002, the Institute carried out the Translator System Research Project - "Translator" being a joint name for two programs (BrTeX and BrLaTeX) used for converting documents in the form of TeX or LaTeX source files into representations in the raised-dot writing system for the blind, as well as into verbal representations to be fed to a voice synthesizer. (TeX is a refined program for handling the electronic typographical layout of publications containing complicated mathematical expressions. The LaTeX Document Preparation System was created on the basis of the TeX program, with the addition of commands to simplify the layout of text and enable the user to concentrate on the text being created.)

BrTeX and BrLaTeX were integrated with the fully sound-enabled editor TransEd, an interface between the user and these programs, which was also produced as part of a special project. The editor also enables communication with specialist devices for the blind (monitors, printers, notebooks, voice synthesizers).

In order for the Translator system to be able to perform conversions into Braille formats, a special mathematical notation for the blind was first required, which the project implementers also developed. The results of such work were published as a two-volume book entitled *Mathematical Raised-Dot Writing System for the Blind*, which sets forth and explains a set of rules for writing mathematical expressions of arbitrary complexity. It also provides ways of representing tables of complex hierarchical structure.

The Translator system can operate in one of two modes. In the ordinary, automatic mode, it enables blind users to access information written in Polish or English, saved on digital media in the form of TeX or LaTeX source files. In the second, interactive mode, it enables users to independently produce and print various documents containing mathematical expressions of arbitrary complexity. In short, source files processed by the Translator system take on a Braille or verbally spoken form. In the latter case, we have been successful in achieving a very close correspondence between the text as spoken by a voice synthesizer and the same text as read out by a lecturer.

The Translator system can be used to publish, at low cost, a new format of school textbooks and specialist books written using mathematical notation - i.e. CDs containing publications in three forms: typographical, Braille, and spoken. Blind individuals can then print out certain fragments of the texts on Braille printers or read them on Braille monitors, while others can read the materials by using speech synthesizers. Based on our calculations of the costs of publishing such CDs, a high school mathematics textbook, for instance, can be produced for at most 25% of the expense entailed by the traditional method of Braille printing. The Translator system may also potentially be adapted, in a simple way, for use with other European languages that employ the Latin alphabet.

The PAN Institute of Computer Science is currently working on another research project: the Homer system for converting Braille formats into typographical type. This will break down even more communication barriers between the blind and the world of the non-blind. ■

Further reading:

Wysocki W., Kalbarczyk M, Busłowicz I. (2002). *Matematyczne pismo punktowe dla niewidomych (Mathematical Raised-Dot Writing System for the Blind)*. Fundacja Szansa (published in Braille).