The Progress in Making Figures Universally Accessible

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Abstract

Figures are an essential part of scientific literature, but people with severe print disabilities do not presently have good access to figures. The most common method by far of "making graphics accessible" is by having a human describe them. Description is often adequate for images whose content is not critical to understanding – such as photographs of the author or bar/column/pie charts with only two or three quantities charted. However descriptions are inadequate for more complicated graphics such as flow diagrams with many cells, maps, x-y graphs, electronic circuit diagrams, and multi-atom chemical molecules. Most figures are potentially very accessible through a combination of tactile and audio description, but audio-tactile technology has been considered too labor-intensive and difficult for widespread use. ViewPlus software currently in beta test could greatly reduce those barriers. The new IVEO Transformer permits quick conversion of bit-map graphics to excellent audio-tactile accessible SVG. A variety of end user hardware is available or under development that makes it easy for end users to access this information. This paper discusses the merits of various methods for making graphics accessible and describes the ViewPlus IVEO audio/tactile system in particular.

1 Introduction

Specialists in the field of information accessibility understand that different people need different formats to access information. Some of the more common formats that can make information accessible include braille, EPUB, accessible PDF, xml, html, and MS Word. In some cases it is possible to derive many such accessible formats from a single basic file. It is generally agreed that it is possible to make STEM text, tables, and formulas excellently accessible to just about anyone in several of these formats. There is no such general agreement that it is possible to make figures excellently accessible to everyone. This article discusses the author's conviction that figures can also be made accessible for everybody and discusses his company's commercial technologies that are designed to do just that.

2 Accessibility of Figures Today

Although figures are ubiquitous in scientific literature, most people with severe print disabilities have little or no access to the information conveyed by figures. The most common method of "making figures accessible" today is by having a sighted person describe the figure. Most often, figures are described by a human reader working with a blind end-user. More systematic information is possible by well-made descriptions that are included in electronic documents. The DIAGRAM (Digital Image

And Graphic Resources for Accessible Materials) Center has developed a number of tools to make images in existing documents more accessible, including the Poet (Diagram 2015) crowd-sourcing image description tool. Rules have been developed (NCAM 2015) that help description writers to describe elements in STEM diagrams. It is possible to follow these rules and create descriptions of most STEM diagrams. Just because a description can be created does not mean that it is adequate to convey the information however. “A picture is worth a thousand word” is a well-known saying, but it is not intended to be taken literally. A thousand words is never an adequate substitute for a good picture.

In principle, tactile figures can provide much better access to many STEM diagrams than word descriptions. Unfortunately, very few people can understand a tactile figure of any complexity. Even most good braille readers have difficulty understanding tactile figures, and anybody who does not read braille fluently has little or no chance of understanding a tactile figure. Sighted children begin learning to understand visual images the day they are born, but blind children seldom have tactile images much less any assistance in understanding them. So it is not surprising that so few blind people learn to understand tactile images. The Braille Authority of North America (BANA 2015) has developed guidelines for making tactile diagrams and is currently developing tutorial materials for blind people on how to learn and use tactile diagrams.

It has been understood since the pioneering work of Parkes (Parkes 1988) that tactile images are far easier to understand if the figures are accompanied by audio feedback. Parkes’ Nomad talking tablet was introduced by the American Printing House and drew considerable praise, but it was very expensive and difficult to use. In addition, content creation was laborious and very expensive. It was a technology ahead of its time and was eventually withdrawn from the market.

In subsequent years, a number of “talking tablets” have been introduced. Loetzsch (Loetzsch 1994, 1996) created and marketed a successful curriculum for health professionals in Germany, and Landau’s (Landau 2003, 2015) tablet has been used with proprietary content in several educational settings and is currently being used for a number of specialized tasks such as museum guides. The ViewPlus IVEO technology (Gardner 2005, 2014) was introduced in 2005 as a more general figure-access technology. It has been used in varied settings but mostly in elementary special education settings.

3 The Audio-Tactile method

The requirements for audio-tactile access are a tactile copy of the figure, a computer file with information keyed to location on the figure, some type of hardware device that communicates position on the figure to the computer, and a computer application that provides speech and/or braille information to the user. The Nomad pad was a touch-sensitive tablet, and all subsequent audio/tactile devices have used some kind of touch-sensitive tablet. In order to resolve small objects accurately, a high resolution, relatively expensive tablet is necessary. These typically cost $500 or more.

Other details differ among the various systems. The ViewPlus IVEO technology uses Scalable Vector Graphics (SVG) as its file format. Other systems use proprietary formats.

4 The ViewPlus IVEO Audio-Touch technology

The new third generation IVEO technology, currently in beta test, is a descendent of earlier IVEO software and hardware. It has been enhanced considerably based on feedback from users. In particular, the system should be considerably more usable than previous versions. If so, IVEO could finally be approaching the long-sought goal of a technology that makes graphics accessible to everybody.

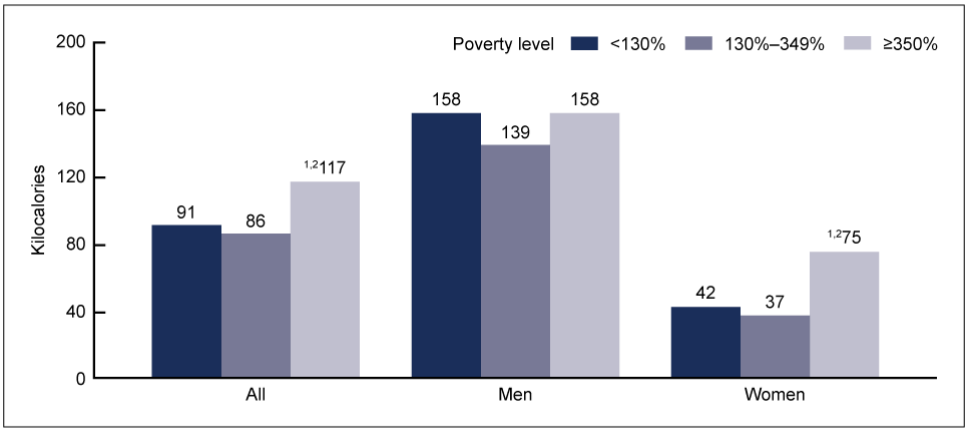
IVEO 3.0 will include two authoring/conversion applications, Creator and Transformer Pro, and the IVEO Player end-user application. A touchpad is still available, but two new hardware options are being introduced to fill needs of a variety of users.

IVEO Creator is a descendant of previous IVEO authoring/conversion software. It can be used to create simple IVEO SVG graphics, but it is largely used with pre-existing SVG files to make minor changes that will enhance the resulting tactile image and to add the meta-information that end users hear when objects or text labels are selected on the tactile copy. The tactile image is created by printing the SVG image with a ViewPlus embosser. Colored regions are embossed by default in a tactile gray scale in which light colors are represented by small dots and dark colors by large dots. Users have a number of printer property options however including ability to substitute tactile patterns for color.

Most existing graphics needed by blind users are some form of bit map image. Transformer Pro is designed to convert bit map graphics to IVEO SVG, add meta-information, and create a separate tactile image. The latter functionality provides all the options available in Creator but also includes several powerful processing options (patent pending) for simplifying the tactile image. Slider bars control “simplification” and degree of fill. There are options for substituting automatic or user-definable tactile patterns for colors as well. Simplification includes edge detection and various other techniques that enhance the tactile image. A user can also erase or create tactile features that do not affect the visual image. The tactile image is embossed, and if printed on a ViewPlus printer/embosser, the visual image is printed unchanged. Transformer Pro makes it possible quickly to convert even very complex images to IVEO SVG format easily accessible by blind people as well as a variety of other severely print-impaired users.

Figure 1 shows a graphic typical of those encountered routinely in consumer publications – something that blind people currently cannot access when reading such publications on line. Transformer Pro was used to make this image accessible and illustrate the power of the method. Figures 2-4 show tactile images obtained by printing the image on a ViewPlus Tiger embosser with various processing options. Figure 2 shows the default image with no processing. Figure 3 shows results of substituting patterns for color, and Figure 4 shows what is obtained when fill is suppressed entirely, and some superfluous parts are erased in the tactile copy to improve ease of access for blind end users. The data are used to create titles for the various bars in the graph. For example, the first bar has three sections labeled: Bar 1 is "91 kilocalories from alcoholic beverages per day among people in the lowest income level." Bar 2 is "86 kilocalories from alcoholic beverages per day among people in the middle income level.´ Bar 3 is "117 kilocalories from alcoholic beverages per day among people in the highest income level." The second set of bars is also labeled. Bar 1 is "158 kilocalories from alcoholic beverages per day among men in the lowest income level." Bar 2 is "139 kilocalories from alcoholic beverages per day among men in the middle income level.´ Bar 3 is "158 kilocalories from alcoholic beverages per day among men in the highest income level." The last set of bars is labeled, Bar 1 is "42 kilocalories from alcoholic beverages per day among women in the lowest income level." Bar 2 is "37 kilocalories from alcoholic beverages per day among women in the middle income level.´ Bar 3 is "75 kilocalories from alcoholic beverages per day among women in the highest income level." These words are heard by users who select that bar.

Figure 4. Mean kilocalories from alcoholic beverages per day among adults aged 20 and over, by sex and poverty level: United States, 2007–2010



[1] Significantly different than <130% of federal poverty level, $p < 0.05$.
[2] Significantly different than 130%–350% of federal poverty level, $p < 0.05$.
SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey.

Figure 1 . Graphic from USA Today newspaper, typical of popular information conveyed graphically.

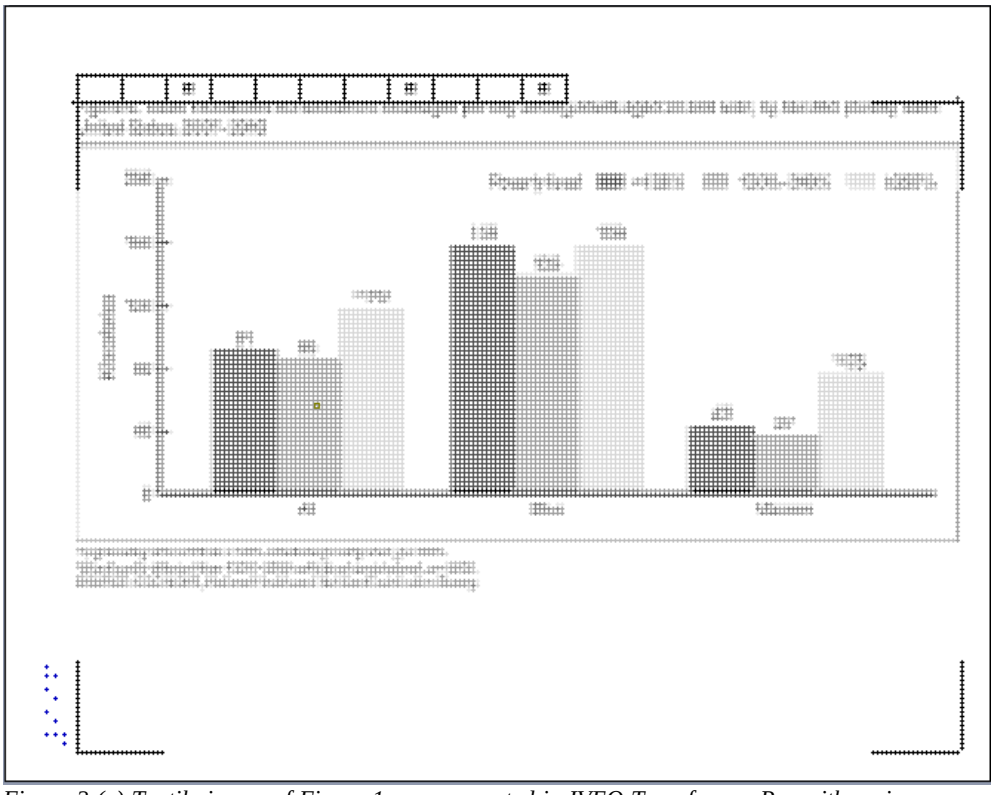


Figure 2 (a) Tactile image of Figure 1 as represented in IVEO Transformer Pro with no image processing. (b) As embossed on a ViewPlus Tiger embosser. Dark areas are represented as large dots, light areas as low dots, white as no dots.

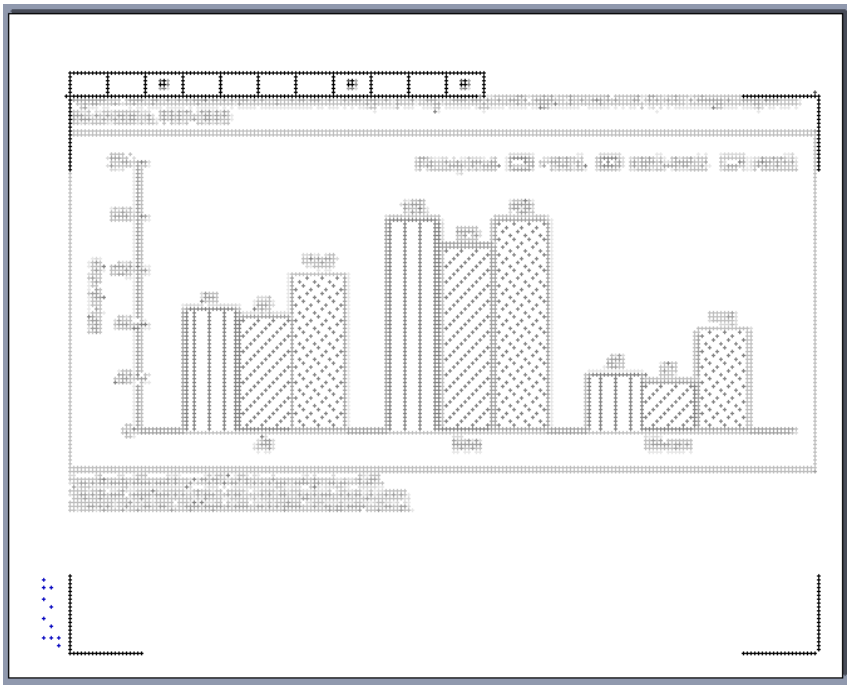


Figure 3 (a)) Figure 1 as processed with IVEO Transformer Pro to convert color fill to automatic patterns. (b) As embossed on a ViewPlus Tiger embosser.

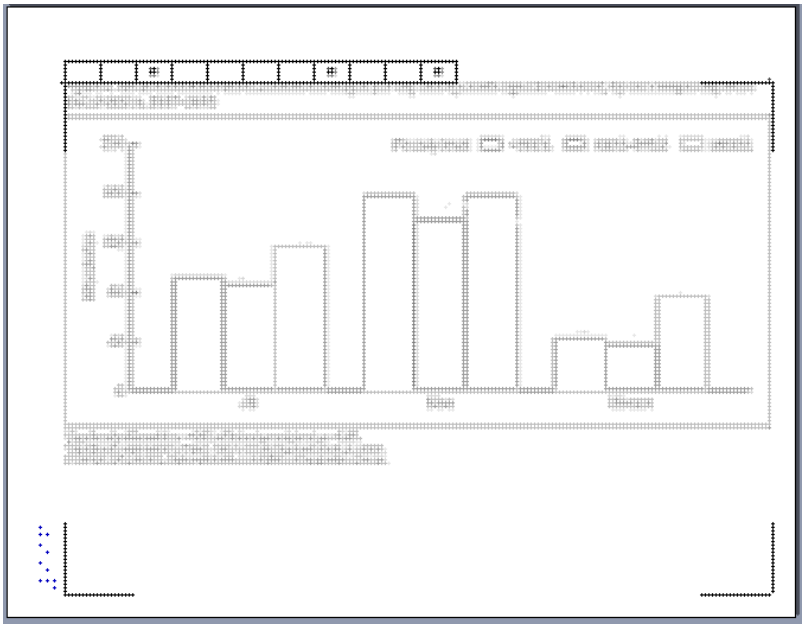


Figure 4. (a) Figure 1 as processed with IVEO Transformer Pro with fill set to zero. Also the numbers above the columns have been eliminated with the white pencil. These numbers are redundant, since the bars have titles with that information. (b) As embossed on a ViewPlus Tiger embosser.

Transformer Pro also permits one to convert text to braille and/or add braille labels. Braille is generally not used for audio-tactile images because braille is normally much too large to include, and most users (including most blind people) do not read braille. But if one wishes to make free-standing tactile copy, Transformer Pro is a convenient tool for doing so.

The new hardware being introduced with IVEO 3.0 includes a digital pen and the IVEO Camera. The digital pen is a device that is considerably less expensive than a touchpad. It uses an infra-red sender/receiver device that detects the position of the pen. A pen-follower option in IVEO Player permits the user to hear text and object titles as the pen is moved. More information is obtained by clicking.

The IVEO Camera is a new and particularly convenient option for most power users. It detects the appropriate SVG file when a tactile page is placed in its field of view, loads that page, and calibrates everything. A user typically places the tactile image on her desk and just reads it. The pen-follower option is available for the camera as well as the pen. Retail price is not yet set, but it will be less expensive than the touchpad.

References

BANA (2015) Guidelines and Standards for Tactile Graphics, http://brailleauthority.org/tg/web-manual/ retrieved December 15, 2015

DIAGRAM (2015) http://diagramcenter.org/development/poet.html retrieved December 15, 2015

Gardner (2005) “The ViewPlus IVEO Scalable Vector Graphics Technology for Universally Usable Complex Information” John Gardner, Holly Stowell, and Vladimir Bulatov, Proceedings of the 11'th International Conference on Human Computer Interaction, Las Vegas, Nevada, USA, 22-27 July, 2005, “Universal Access in HCI” ISBN 0-8058-5807-5), http://www.viewplus.com/about/abstracts/05hcibulatov.html

Gardner (2014) "Can Mainstream Graphics be Accessible?" John Gardner, International Technology and Disabilities Journal 14(1) 2014, http://itd.athenpro.org/volume14/number1/gardner.html

Landau (2003) “Use of the Talking Tactile Tablet in Mathematics Testing”, Landau, S., Journal of Visual Impairment and Blindness vol. 97 pp 85-96

Landau (2015) see company http://TactileGraphics.com

Loetzsch (1994) “Computer-Aided Access to Tactile Graphics for the Blind” Loetzsch, J., Proceedings of the 4th International Conference on Computers Helping People, Vienna. Lecture Notes in Computer Science 860, Springer 1994, ISBN 3-540-58476-5, W. L. Zagler, G. Bushy, and R. Wagner (eds), 575–581.

Loetzsch (1996) “Interactive Tactile Media in Training Visually Handicapped People”, Loetzsch, J., and Roedig, G., New Technologies in the Education of the Visually Handicapped, Proceedings of the Conference, Paris, June 10-11, 1996, Burger, D. (Ed) Published by John Libbey 1996, pp 155-160

NCAM (2016) http://ncam.wgbh.org/experience_learn/educational_media/stemdx/guidelines retrieved December 15, 2015

Parkes D (1988), "Nomad: an Audio-Tactile Tool for the Acquisition, Use and Management of Spatially Distributed Information by Partially Sighted and Blind Persons", eds Tatham AF and Dodds AG, Proceedings of the Second International Symposium on Maps and Graphics for Visually Handicapped People, King's College, University of London, pp. 24-29