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## Mind's Eye: Science & Math Before and After Assistive Technology

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## Meaning of Blindness

The U.S. Social Security Administration (SSA) defines legal blindness as follows:

- 1. Reduced central visual acuity of 20/200 or less in your better eye with use of the best eyeglass lens to correct your eyesight; or...
- 2. Limitation of your field of view such that the widest diameter of the visual field in your better eye subtends an angle no greater than 20 degrees.

## Fear of Blindness

□ Most children are afraid of the dark

- Basic human fear
- Stems from loss of situational awareness
- Many excellent evolutionary reasons

□ Transference is a normal aspect of human psychology

□ Many people cannot imagine functioning without vision

- Blindness can be debilitating, especially when combined with other factors
- Often the only experience with blindness is someone who has not adapted.
   Such experiences feed preexisting fears

## **Blindness as an Engineering Problem**

Loss of signal

- Visual inputs are blocked
- Loss of access to information

□ Impact on actuators – examples of affected activities

- Driving
- Walking
- Writing
- Brain surgery

## **Approach to Solutions**

Define the problem

□ Assess impacts

□ Identify and implement work arounds

- Mobility: Learn independent travel skills
- Reading: Alternative media, e.g. recordings, Braille, digital, the internet
- Writing: Typing, word processing, specialized tools

□ Identify and exploit talents and interests

 Level the playing field. Find areas that present problems for most humans but which are largely unaffected by blindness

#### Early 1960's

Classic Perkins Brailler

> Smith Corona Typewriter





Talking Book Machine

> Reel to Reel Recorder



1967 - 1975



#### Rice University Chemistry Building



Rice University Chemistry Building



IBM Punch Card

#### **Robert & Linda Shelton 1969**







#### 1971 Mission Control Manned Space Center









#### **Princeton 1975**





A&S PROFESSOR **BRANDON LOOK** HAS BEEN INVITED TO BE THE **HANS KOHN MEMBER** OF THE SCHOOL OF HISTORICAL STUDIES AT **THE INSTITUTE FOR ADVANCED STUDY** IN PRINCETON THIS YEAR.



#### 1979 University of Tennessee









Michigan Tech Winter Carnival



Commodore 64



The family



Amiga



Nec Spinwriter



1987 Mission Control Johnson Space Center

Mission Control supporting Space Shuttle





Kurzweil Reading Machine (circa 1978)



DecTalk

1987

#### LaTeX Demo

\The quadratic formula applies to second degree polynomial (or quadratic) equations of the form: \begin{equation}  $ax^{2} + bx + c = 0$ \label {quadratic} \end{equation} Solutions  ${x_1, x_2}$  to ~\ref{quadratic} are given by \begin{eqnarray}  $x_1 \& = \& \frac{b+\sqrt{b^2-4ac}}{2a} \$  $x_2 \& = \& \frac{-b - \sqrt{b^2 - 4ac}}{2a}$ \label {quadratic\_formula} \end{eqnarray}

#### LaTeX Demo Cont.

The vector form of Maxwell's equations, formulated from Maxwell's original

version by Oliver Heavyside relates the partial derivatives of the electric

field  $\ensuremath{\mathbb{E}}\$  and magnetic field  $\ensuremath{\mathbb{E}}\$  to the distribution and motion of

electric charges as follows:

\begin{eqnarray}

```
\B \& = \& 0 \ \nonumber
```

\nabla\times\vec{E} & = & -\frac{1}{c}\frac{\partial\vec{B}}{\partial t}

\\ \nonumber

 $\ \B = & \G =$ 

\frac{\partial\vec{E}}{\partial t}\right )

\label{Maxwell\_equations}

\end{eqnarray}

#### LaTeX Demonstration

Robert Shelton Simulation and Graphics Branch (ER7) NASA Lyndon B. Johnson Space Center

February 27, 2018

The quadratic formula applies to second degree polynomial (or quadratic) equations of the form:

$$ax^2 + bx + c = 0 \tag{1}$$

Solutions  $\{x_1, x_2\}$  to 1 are given by

$$x_{1} = \frac{-b + \sqrt{b^{2} - 4ac}}{2a}$$

$$x_{2} = \frac{-b - \sqrt{b^{2} - 4ac}}{2a}$$
(2)

The vector form of Maxwell's equations, formulated from Maxwell's original version by Oliver Heavyside relates the partial derivatives of the electric field  $\vec{E}$  and magnetic field  $\vec{B}$  to the distribution and motion of electric charges as follows:

$$\nabla \cdot \vec{E} = 4\pi\rho \qquad (3)$$

$$\nabla \cdot \vec{B} = 0$$

$$\nabla \times \vec{E} = -\frac{1}{c} \frac{\partial \vec{B}}{\partial t}$$

$$\nabla \times \vec{B} = \frac{1}{c} \left(4\pi \vec{J} + \frac{\partial \vec{E}}{\partial t}\right)$$



#### NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



Learning Technologies

## MATHTRAX

MathTrax works with screenreaders!

The MathTrax website has two modes:

<u>Visual MathTrax</u>

Text MathTrax



Accessible Math and Science for 6th-12th Grade Students

#### Tell Us How You Use MathTrax!

MathTrax and the MDE SDK received a 2007 <u>Tech Museum</u> <u>Award</u> and named the 2006 NASA Software of the Year runner-up!

MathTrax is a graphing tool for middle school and high school students to graph equations, physics simulations or plot data files. The graphs have descriptions and sound so you can hear and read about the graph. Blind and low vision users can access visual math data and graph or experiment with equations and datasets.

https://prime.jsc.nasa.gov/mathtrax/

#### Robert & Linda Shelton 2010



## **Space Center Houston**

# Summer Camp for the Blind/Visually Impaired

August 8 – 10, 2018 Houston, TX

https:/spacecenter.org/space-center-u/visual-impairment-program/

Ages 15 - 18