

Assistive Technology Introduction

Overview of Tools and Terms

What is Assistive Technology? Who needs it? How does it help people with handicaps?



What is disability?

- Disability is defined as physical, mental or psychological condition that limits a persons activities
- long term condition - distinguishes disability from disease
- Disabilities can be
 - Inherited
 - or acquired for example via an accident or disease



Causes of disability

- Inherited: genetically transmitted
- Congenital: conditions resulting from infection during the mother's pregnancy, or injury during or soon after birth
- Acquired: resulting from accident, intentional injury, substance misuse or illness during life
- unknown origin



Major Forms of disability

There are different classifications, summed up into four major forms:

- Motor and physical disability
- Sensory disability
- Mental disability
- Nonvisible disability



Motor and physical disabilities

- Damage of central nervous system
 - Hemiplegia, Tetraplegia
 - Multiple Sclerosis
 - Cerebral Palsy
 - Parkinson disease ...
- Damage of skeletal system
 - Deformation or malformation of skeletal system
- Amputations
- Muscle disorders
 - ALS
 - Muscular Dystrophy
- Inflammatory conditions of bones and joints (arthritis)



Sensory disabilities

- Vision impairment (Low vision or blindness)
- Hearing impairment
- Olfactory and gustatory impairment
- Somatosensory impairment (impairment of the tactile sense)
- Balance disorder (impairment of the vestibular system)



Mental disabilities

- Limitations in intellectual abilities
- Impairments to the brain or CNS
- Cognitive Disabilities:
 - Learning disabilities (Dyslexia), Traumatic Brain Injury, Dementia, ...
- Mental illness
 - Depression, Psychic disorders, anxiety-related disorders, ...
- Developmental disabilities
 - Down syndrome, Cerebral Palsy, Autism or Asperger Syndrome, Attention Deficit/Hyperactivity,...



Nonvisible disabilities

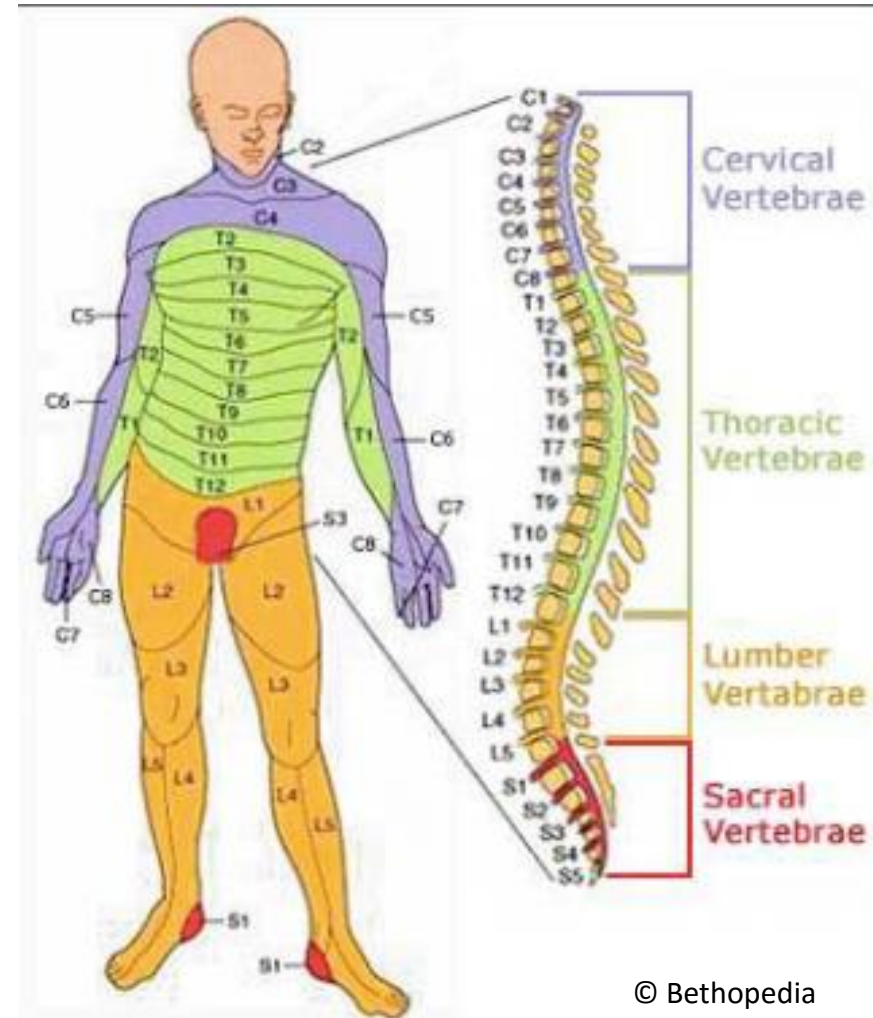
- Invisible or hidden disability – not immediately apparent
 - no sharp border to visible disability

- Some examples for non visible disabilities
 - Tinnitus
 - Sleep disorder
 - Chronic back pain (sitting disability)
 - Chronic diseases
 - Learning disabilities
 - ...

Examples of causes for Physical Disability

Spinal cord injury

- Level of lesion
- Complete/incomplete
- Plegia (complete paralysis)
- Paresis (weakness)
- Hemi- = half of the body (l/r)
- Para- = only lower body
- Tetra-/quadri- = all four limbs



© Bethopedia

Cerebral Palsy

- Lesion in immature brain leaving children with permanent motor impairments
- Group of disorders concerning the development of movement and posture – causing activity limitation
- CP is persistent but not unchangable – motor and non-motor disorders provoked by CP can improve or worsen
- Diverse symptoms:
 - Abnormal muscle tone, reflexes, coordination
 - Joint and bone deformities
 - Spasticity, spasm, involuntary movements, unsteady gait, balance problems, scissor walking, toe walking
 - Irregular posture
 - Speech and language disorders
 - Deafness
 - Chronic sleep disorders
 - Pain!
 - ...

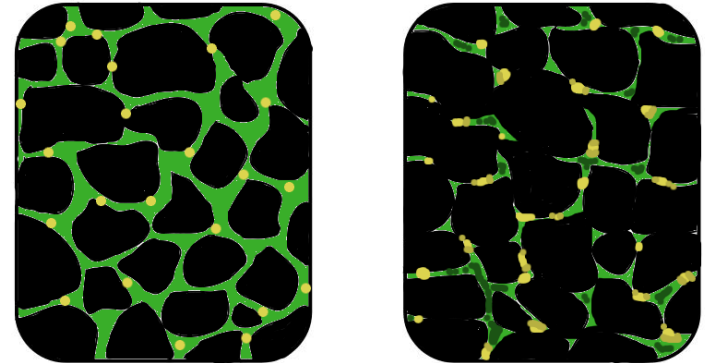
Cerebral Palsy



AsTeRICS User Stefanie controls environment with just one button

Muscular Dystrophy

- Is a group of muscle diseases
 - Most frequent is Duchenne MD
 - 6 major forms delineated on the basis of distribution of muscle weakness (next slide) & congenital dystrophy (7 major forms)



(Reprinted from en.wikipedia.com)

- Is a genetic mutation on the X-chromosome and inherited
 - Lack of dystrophin (a protein), which helps muscle cells to keep their normal shape and function (Duchenne and Becker's MD)
 - Boys are affected more likely, girls are carrier and might inherit, nevertheless as carrier they can have a mild form of dystrophy (Duchenne)
- Most common muscular disease in childhood age: about 1 of 3500 male kids affected

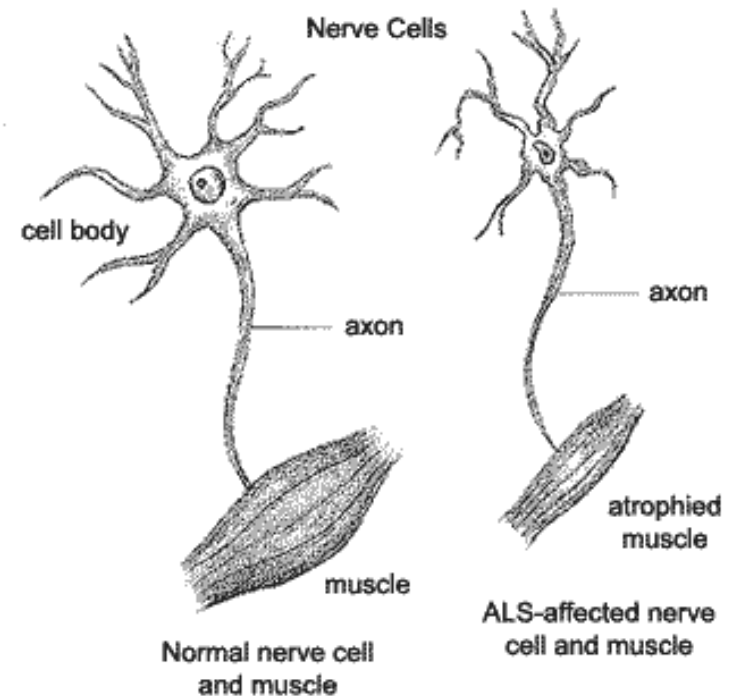
Muscular Dystrophy

- General symptoms
 - Problems with coordination and mobility
 - Muscle weakness
 - Joint stiffness
- Affected muscles
 - Face, arms, legs, spine, heart
- Progress of Duchenne MD
 - Symptoms appear at the age of 1 to 6 years
 - Wheelchair needed by the age of about 12
 - Severe cases are lethal (insufficient heart- or lung movement)



ALS – Amyotrophic Lateral Sclerosis

- Motor neuron disease
progressive, neurodegenerative disease affecting nerve cells (motor neurons)
 - Motor neuron degenerates and is replaced with scar tissue
- Spastic muscle reflexes, peripheral signs of paralysis with muscle atrophy



ALS – Amyotrophic Lateral Sclerosis

- Results in muscle weakness and loss of voluntary control, affects
 - Arms, Legs, Speech, Swallowing, Breathing
- More common in men, begins typically between 40th and 60th year of age
- Leads to death within a few years
- Stephen Hawking has a very slowly progressing form of ALS, was diagnosed in the age of 21



Disability worldwide

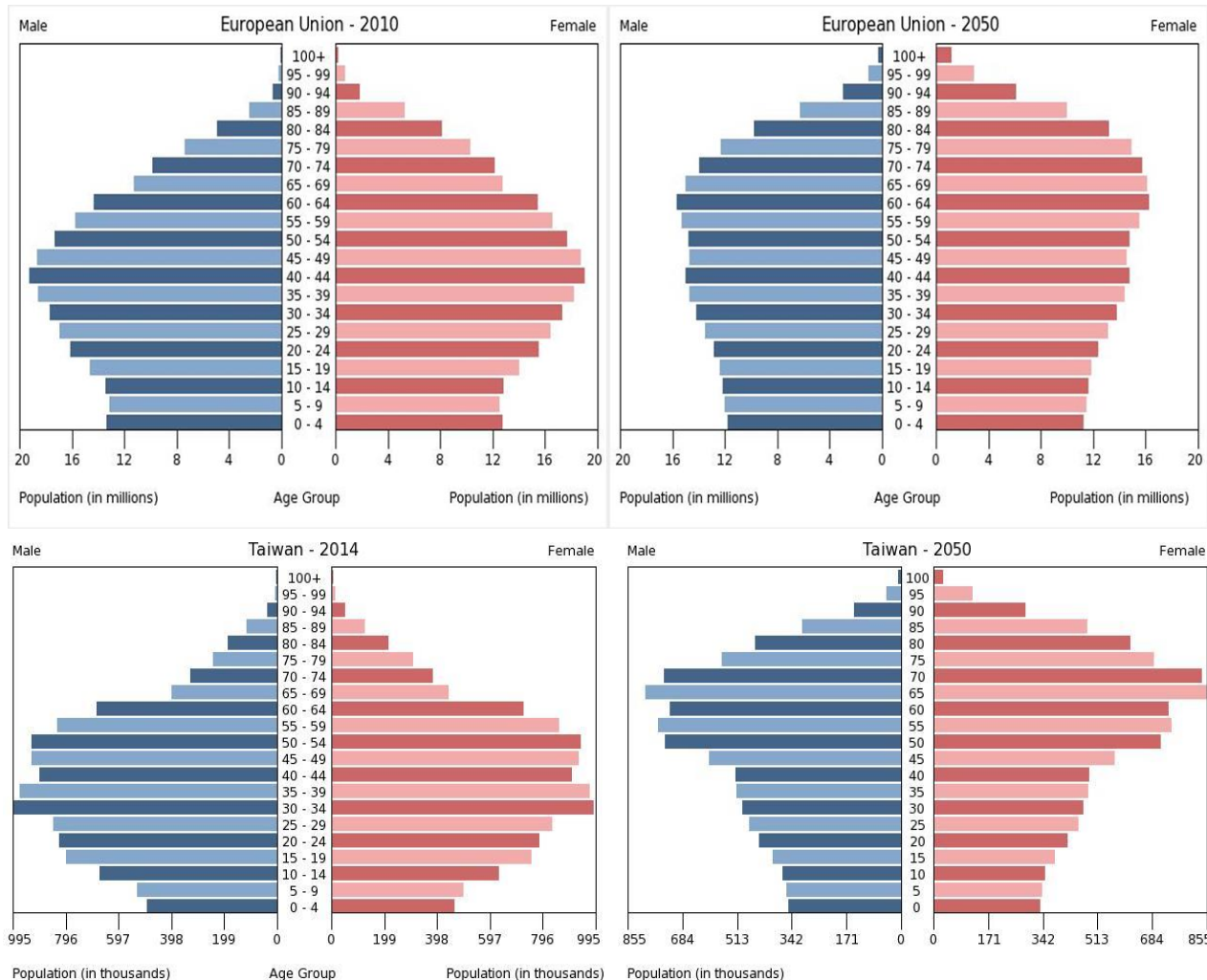
„WHO World Report on Disability“, 2011:

- About one billion people worldwide live with some form of disability
- Nearly 200 million experience considerable physical or mental difficulties
- for a majority of these people, assistive tools are not affordable or available ...



Due to ageing populations as well as the global increase in chronic health conditions such as diabetes, cardiovascular disease, cancer and mental health disorders these numbers are on the rise

Demographic Change



... a challenge for our Societies

Another view on Disability

UN - Convention on the Rights of Persons with Disabilities (CRPD):

- Disability is **NOT** an attribute of the person.
It results from interaction between persons with impairments and attitudinal and environmental barriers
- *Improve social participation
by removing or reducing the barriers*
- *Improve Accessibility*



There is ability in disability !

People with handicaps often have special abilities:

- Blind people have extraordinary hearing- and sensoric capabilities
- Autistic persons often have very special skills like enormous memorization, language learning etc.
- Emotional sensitivity of people with Trisomia 21

ICT for inclusion

Digital Media has changed the way how we communicate and share knowledge in less than 3 decades !



- For people with disabilities, computers and the internet have the potential to:
 - Unlock capabilities and creativeness
 - Increase personal autonomy
 - Enable leisure activities
 - Allow participation in work and social life



.. if the devices, services and content are designed in an accessible way !

Assistive Technologies

„low tech“ and „high tech“ solutions



Assistive Technologies

“...any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to **increase, maintain, or improve functional capabilities** of individuals with disabilities.”

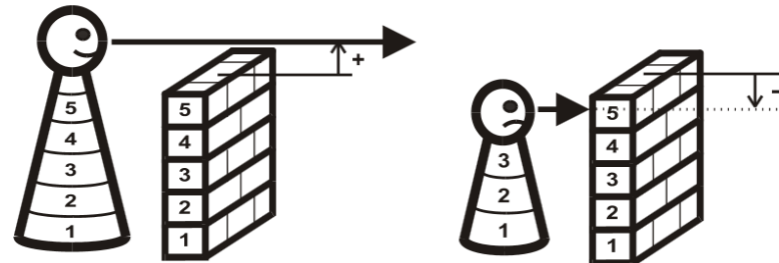
Assistive Technology Act 2004, USA Public Law

... including „low tech“ and „high tech“ tools ...

Assistive Technologies

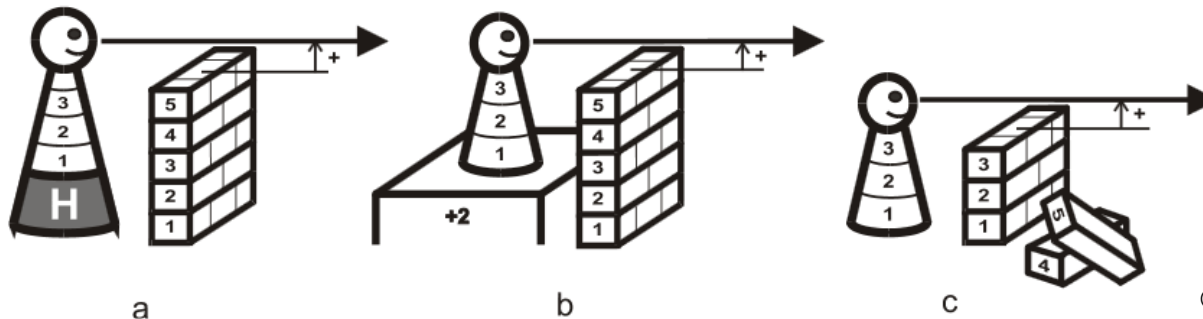
Problem:

a difference in performance and requirement:



© Zagler W.

Solutions:



© Zagler W.

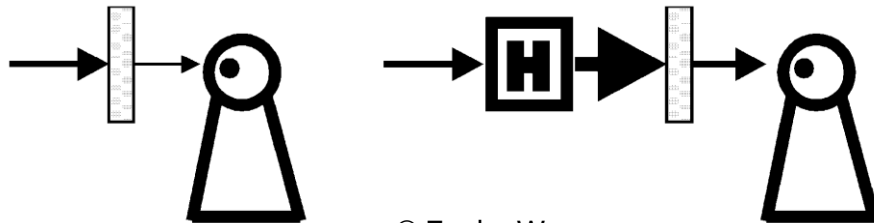
Restore a function

overcome a barrier

remove the barrier

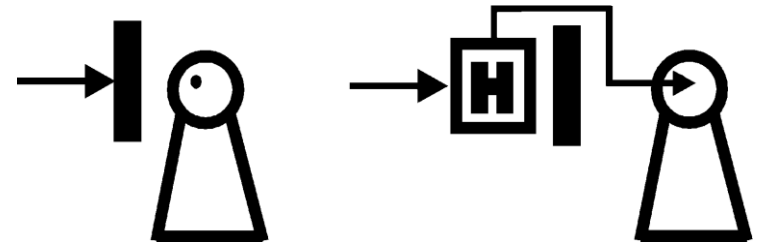
Assistive Technologies

Classification of technical Aids:



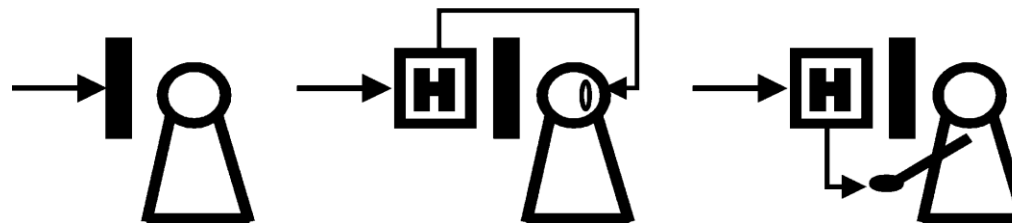
© Zagler W.

Amplification of the stimulus



© Zagler W.

Bridge / bypass a broken function

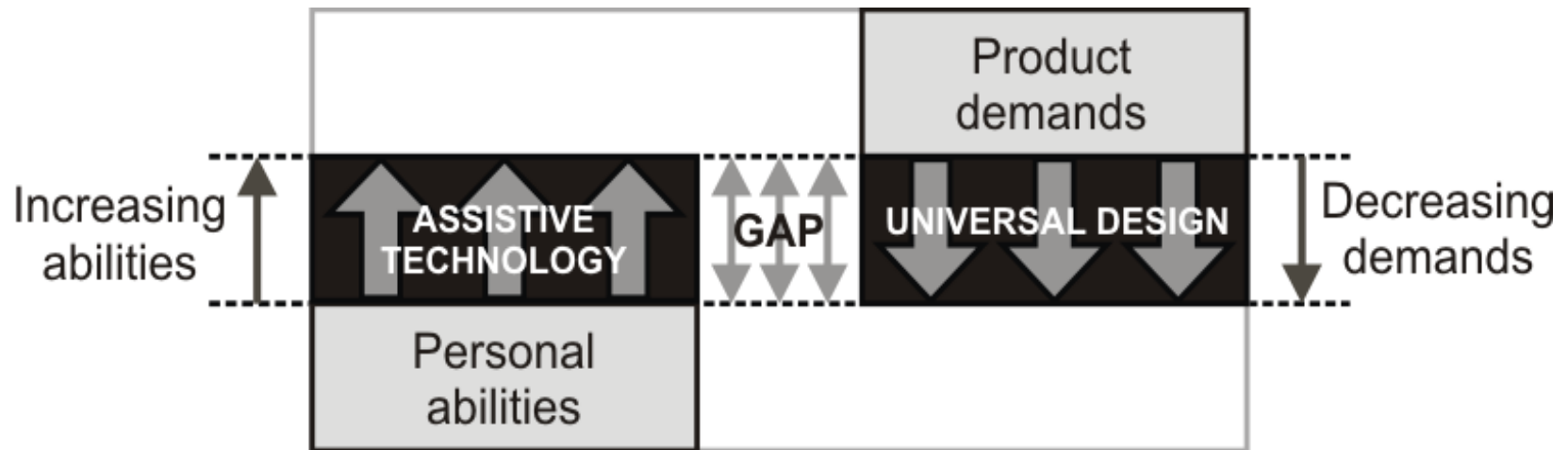


© Zagler W.

Conversion and redirection of the stimulus

AT – Gap Theory

- A matter of design - Narrowing the Gap
 - Two directions to close the gap: **increase personal abilities** or **decrease demands** of a product or the environment



© Zagler W.

[1]

Narrowing the gap

- Design approaches:
 - Barrier-free Design
 - Adaptable Design
 - Design-for-All
 - Universal Design



One Goal:
Narrowing the Gap
between abilities and
demands

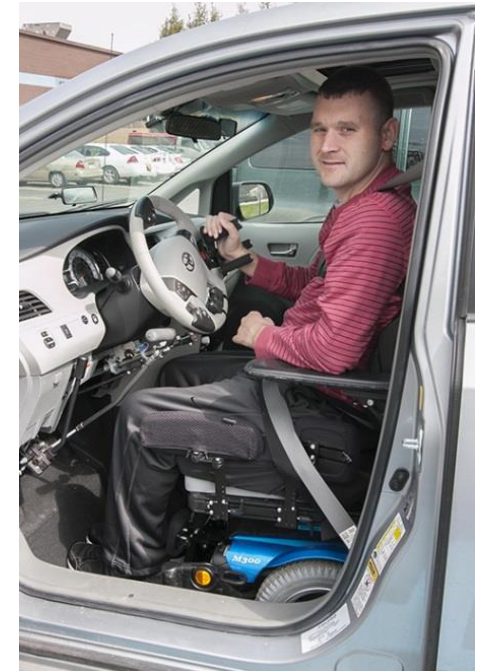
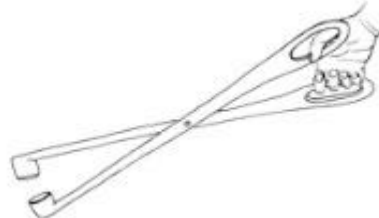
Each philosophy has its own definition and its own approach
Universal Design has become most preferable

Examples of Assistive Technology Tools

AT examples

Aids for daily living - provide as much independence as possible

- mechanical aids for walking, eating, dressing, hygienic needs etc.
- Reading aids and eyeglasses
- Vehicle Modifications
- Adapted Switches, handles or grips
- Safety alarms, emergency calls



© West Virginia Division of Rehabilitation Services

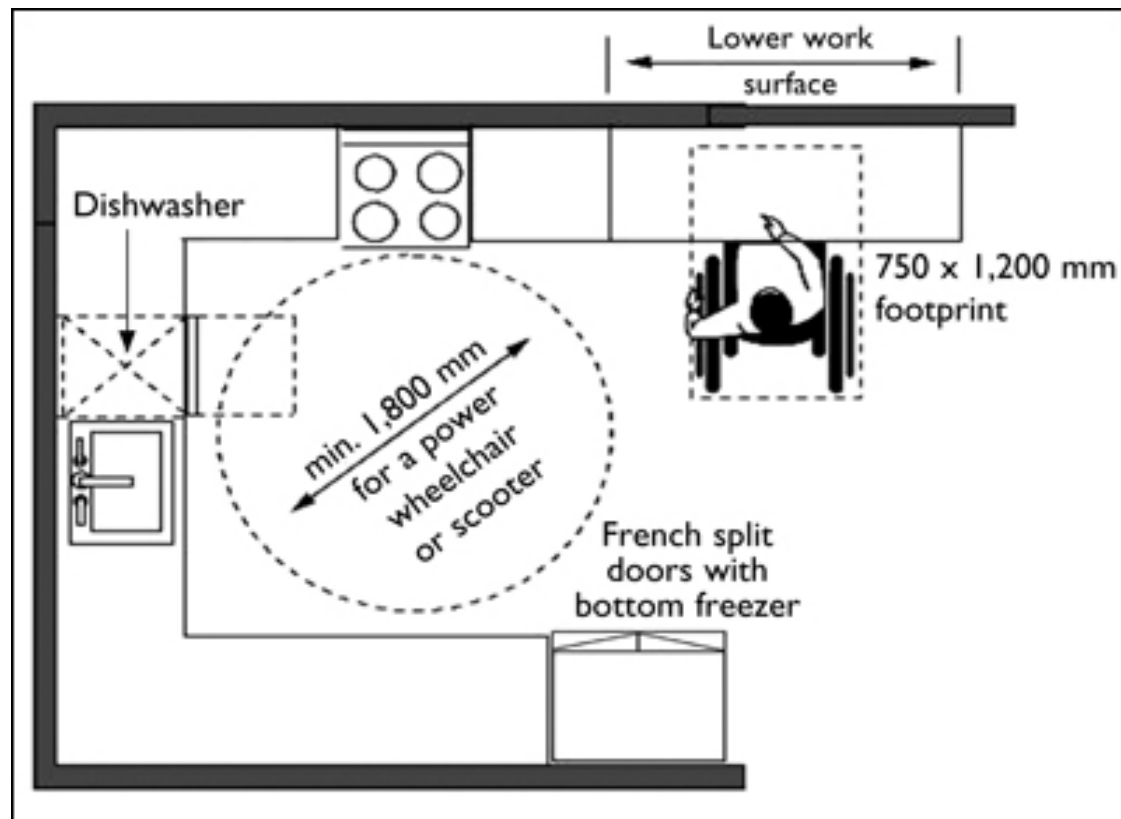
AT examples

- Home/worksite modifications
- Prosthetics and Orthotics
- Seating and Positioning
- Wheelchairs/Mobility Aids



AT examples: Accessible and Adaptable Housing

- Accessible kitchen design



AT for communication

- Augmented and Alternative Communication (AAC) devices

- communication boards
- structured selection sets

- Symbol based communication for dyslexia and cognitive impairments

- Minspeak
- Bliss

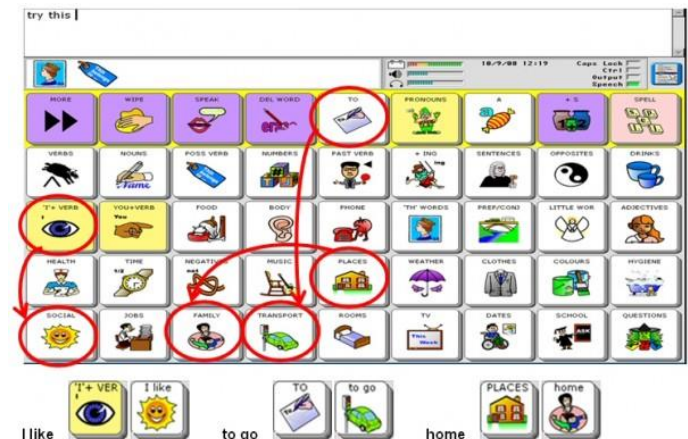


- Speech output / voice synthesizers

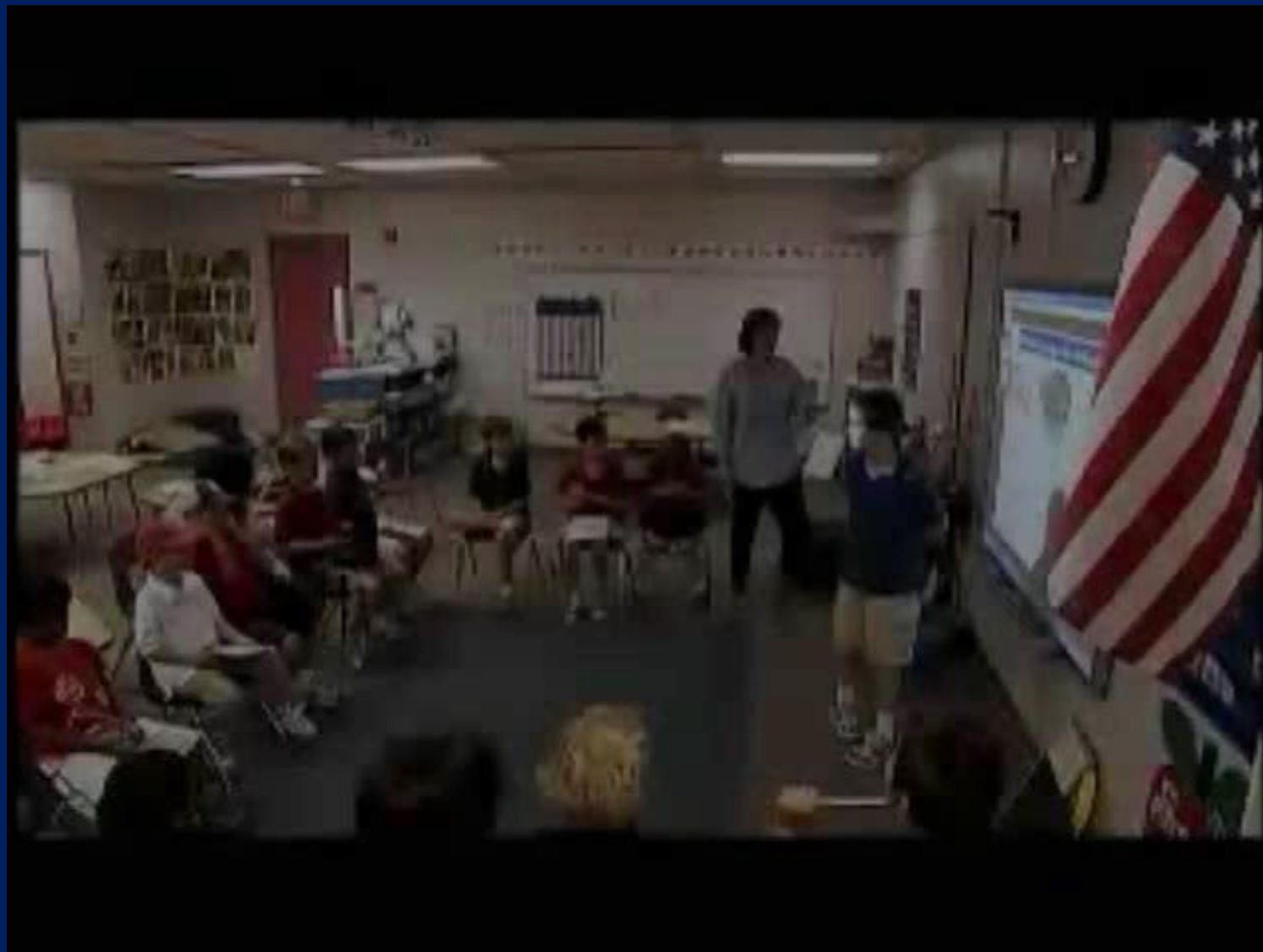
- Text entry or symbol entry
- Word prediction / phrase learning

- Examples:

Dynavox, LightTalker, TheGrid
iPad / Android app: Speak-for-yourself

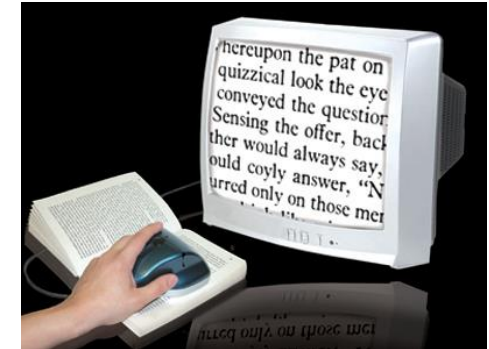


Video: Alternative Augmentative Communication (AAC)

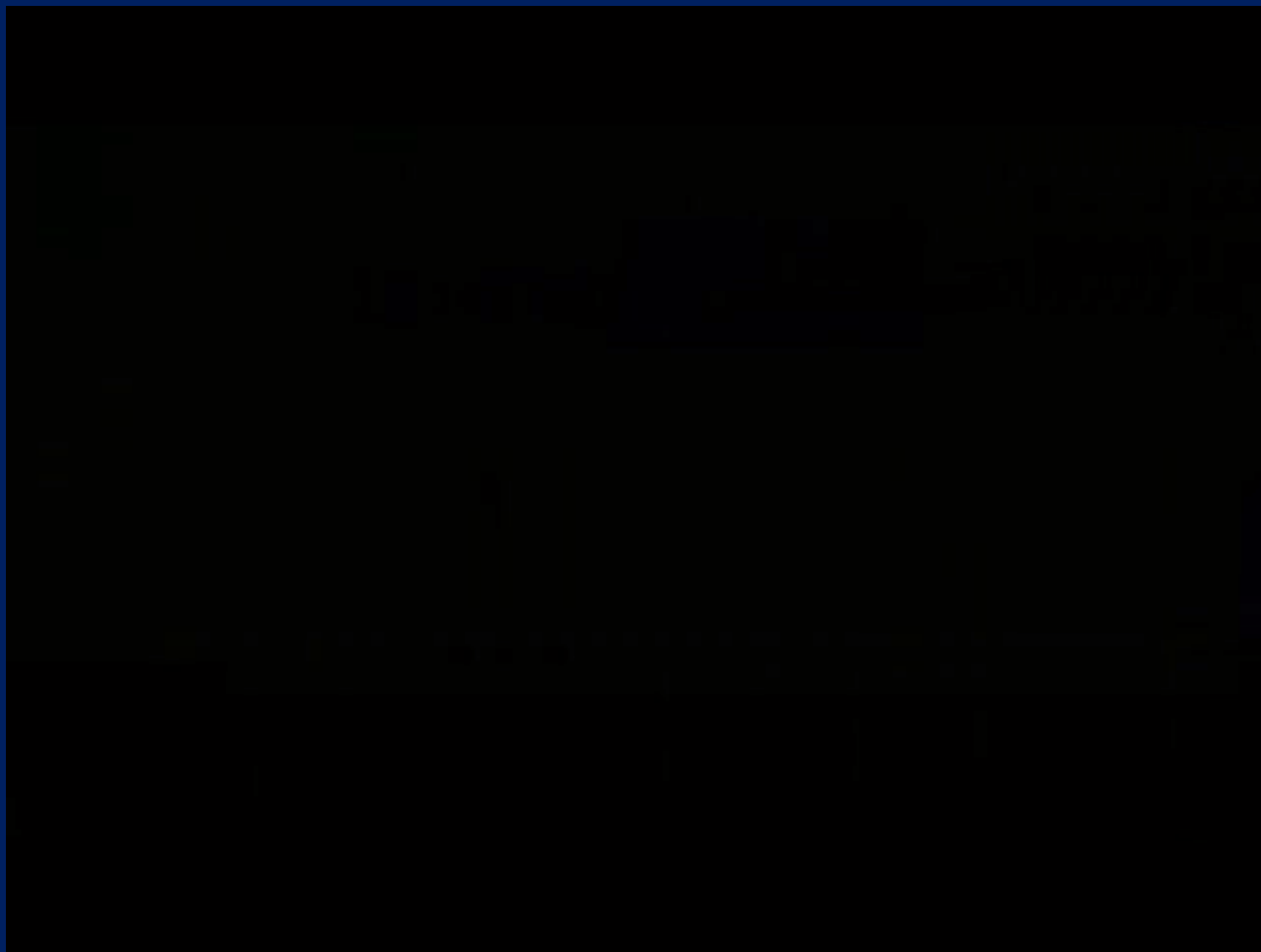


AT for low vision / blindness

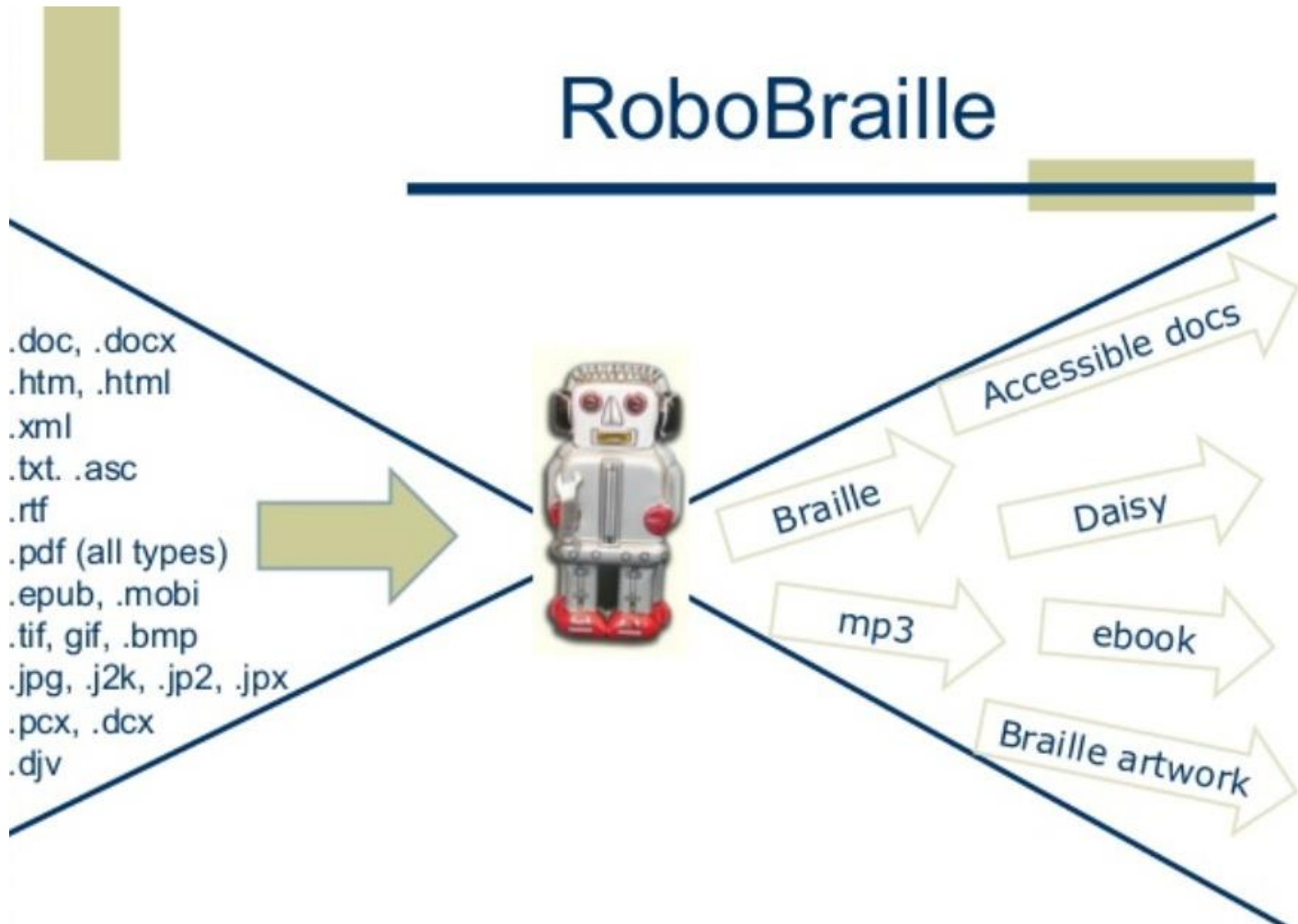
- Special magnifiers / reading devices
- Text-to-Speech
 - Screen readers, for example [NVDA](#) or [JAWS](#)
 - Transformation of documents into speech, braille, or accessible formats
- Speech recognition (for writing, device- or environmental control)
examples: [Dragon Naturally Speaking](#), [Microsoft Speech Server](#)
- Braille devices
 - Refreshable braille displays
example: [BraillePen](#), [FocusBlue 14](#)



Video: FocusBraille refreshable braille displays



AT for low vision - example



AT for low vision - example



Follow us:  

Convert a File

Follow the four easy steps below to have your document converted into an alternative, accessible format. The result is delivered in your email inbox. You may upload a file, enter a URL to a file or simply type in the text you wish to have converted. The form expands as you make your selections.

Source

- ☒ File
☐ URL
☐ Text

Step 1 - Upload the file

Select your file and upload it to the server (max 32 mb). Supported file types are .doc, .docx, .pdf, .ppt, .pptx, .txt, .xml, .html, .htm, .rtf, .epub, .mobi, .tiff, .tif, .gif, .jpg, .bmp, .pcx, .dcx, .j2k, .jp2, .jpx, .djv and .asc

File name: Keine Datei ausgewählt.

AT for low vision - example

Step 2 - Select output format

Specify the target format of your document. For this document type, the following formats are available:

Target format

- ☒ mp3 audio
- ☐ Braille
- ☐ e-Book
- ☐ Accessibility conversion

Step 3 - Specify audio options

Specify the natural language of your document and how fast you want the speech.

Options

Language:

Speed:

Step 4 - Enter email address and submit request

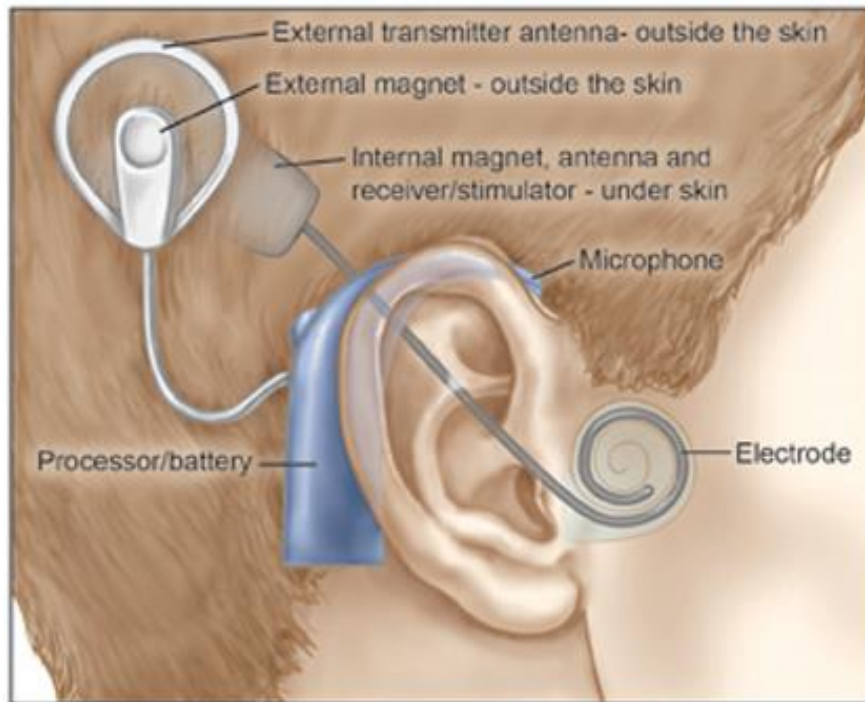
Email address:

AT for hearing impairments

- Hearing aids / amplifiers (in-ear, behind-the ear)
 - Hearing loops, infrared or RF transmitters / receivers
- Hearing prosthesis (cochlea implants)
- Augmentative and Alternative Communication (speech synthesis)
- Captioning (for movies)
 - Youtube automatic captioning system
- Sign language to speech converters (ongoing research)
 - Camera based e.g. [MotionSavvy](#)
 - Gesture based e.g. [Google Gesture](#)

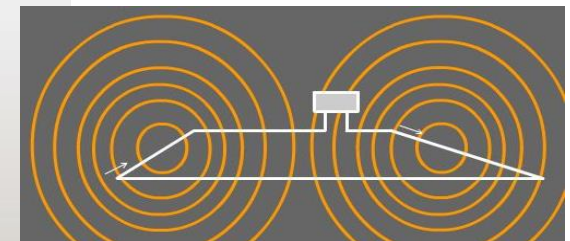
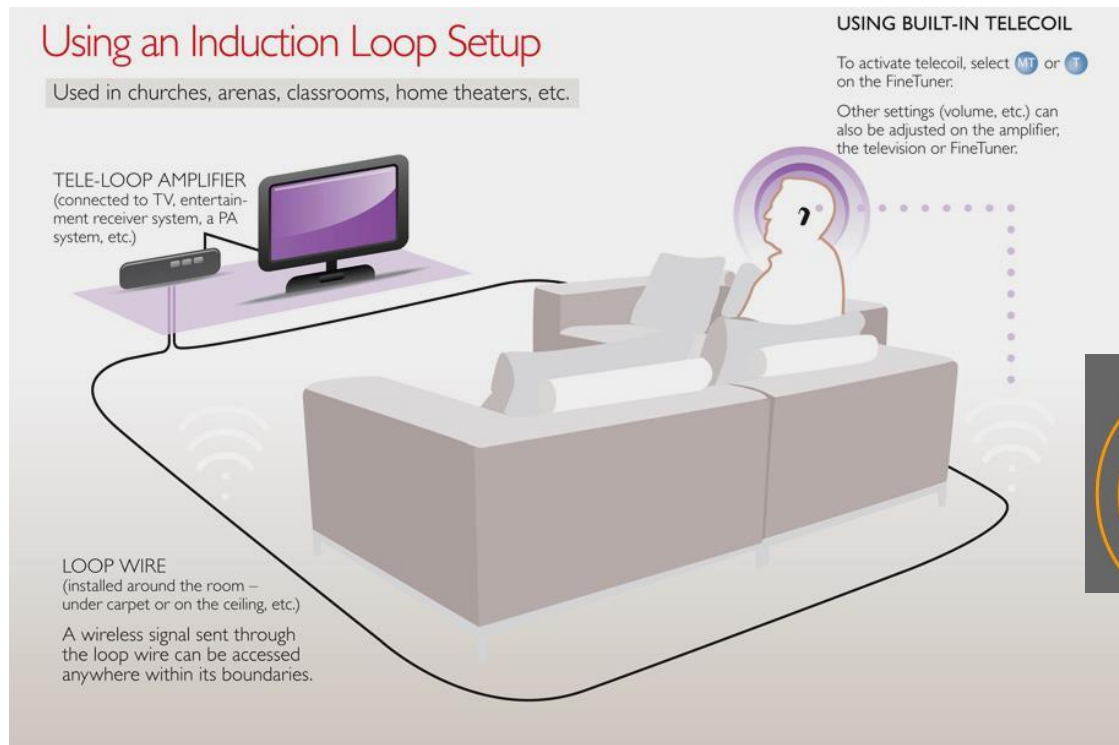
AT for hearing impairments

Hearing prosthesis (cochlea implant):



AT for hearing impairments

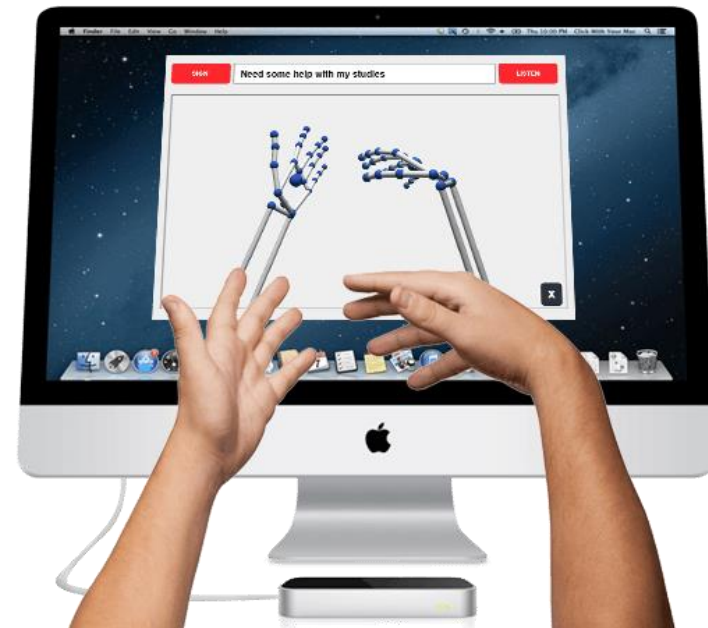
- Hearing Loop / Induction Loop Setup
 - Transmit sound via electromagnetic energy
 - Wire loop around the room, in-ear-receiver / headset



magnetic field

Motion Savvy

- MotionSavvy's New Sign Language App
- <https://www.youtube.com/watch?v=Kj51RNZAM9k>
- UNI Basic & Pro
use of Leap Motion
and Tablet or PC



Video: MotionSavvy



Computer Access for People with Motor Disabilities



Assistive Tools and alternative input methods for computer access

- Headpointers and Mouthsticks
- Switches
- Special Mice and Trackballs
- Joysticks and Mouth controlled devices
- Special Keyboards
- On screen Keyboards
- Scanning methods
- Head Tracking devices and Head controlled Mice
- Eye- and Gaze Tracking devices
- Biosignal-based Input Systems and Brain Computer Interfaces

AT for computer access



Headpointers
and mouthsticks



AT for computer access



Ribbon switch



Tactile
sensor switch



Micro light switch



JellyBean accessible switch



Sip and puff switch

AT for computer access

Special mice and trackballs:

Thumb trackball



foot-controlled mouse



InfoGrip BigTrack trackball

AT for computer access

Mouth-controlled mice

QuadJoy



LipStick



IntegraMouse



LipSync

Lipmouse - Prototype

computer control for people with
severely reduced motor capabilities

UAS Technikum Wien, 2014

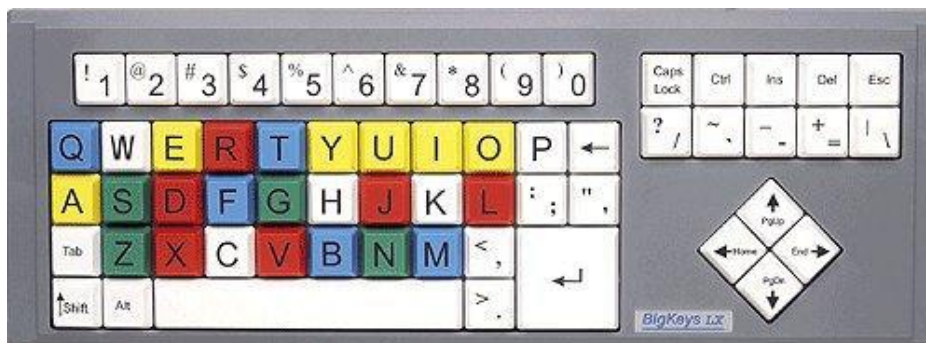
<http://asterics-academy.net>

AT for computer access

Special keyboards



Ergonomic, big- and littlekey devices

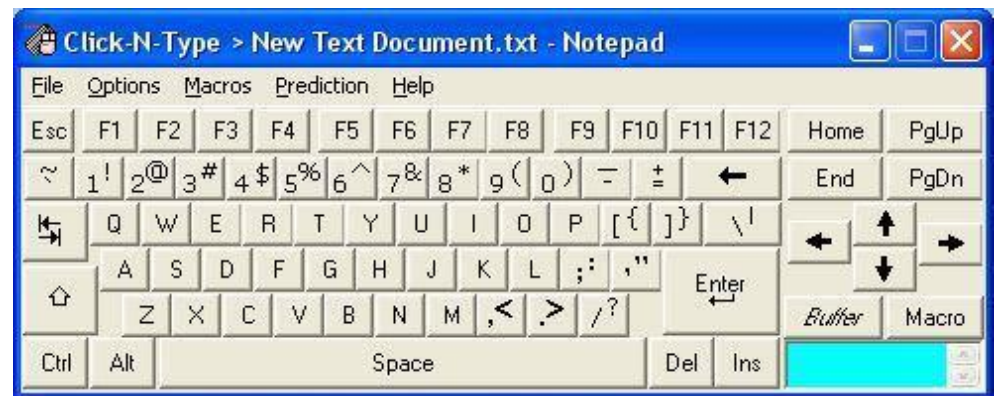


Twiddler-2 one hand keying



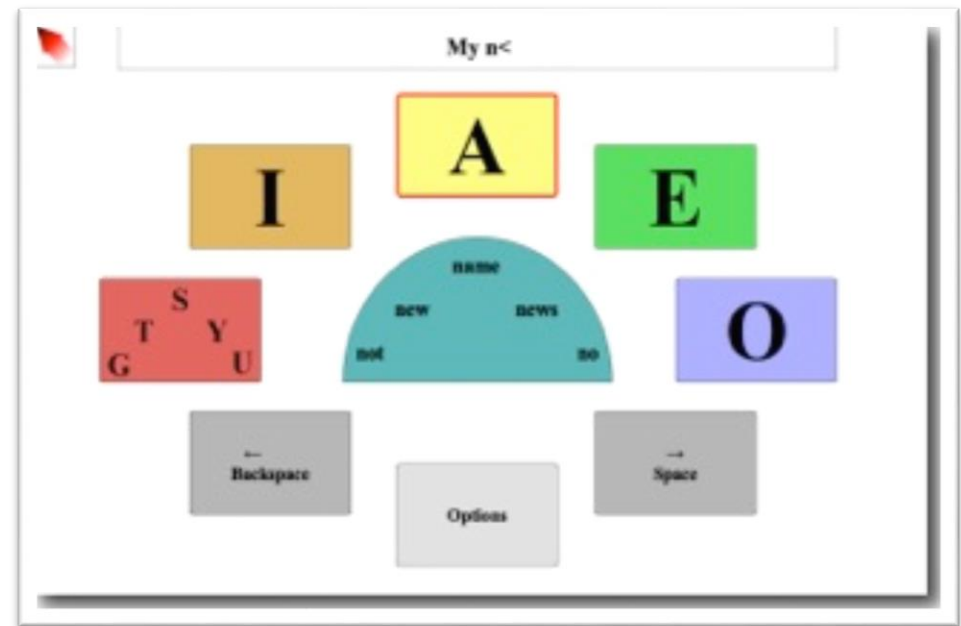
AT for computer access

- On-screen Keyboards
 - Windows built-in
 - Click-N-Type
 - SAW



Dynamic Keyboard (CanAssist)

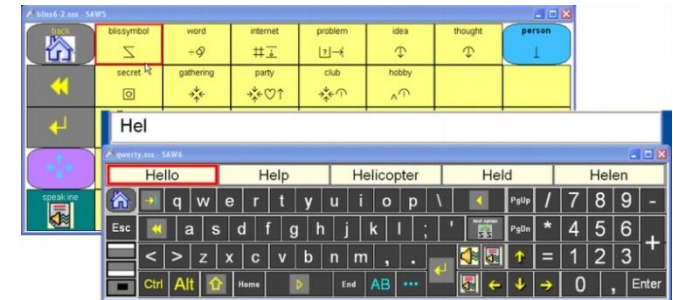
- Anticipates what user is trying to write
- Remembers words
- Predict their choices
- Improved typing speed
- Large, easy to hit buttons
- Large font



- Download:
<http://www.canassist.ca/EN/main/programs/free-downloads/dynamic-keyboard.html>

SAW: an open source On-Screen-Keyboard

- **Special Access to Windows**
- Writing, special key creation
mouse click creation, speech output,
word prediction, scanning
- Editor for custom keyboards, ...
- Ready-to-use keyboards freely available
- Will be used in the hands-on part of our workshop!!
- Download: <http://sourceforge.net/projects/sawat/files/latest/download>



SAW is available on the AsTeRICS academy USB stick
 (/Software/3rdParty/OnScreenKeyboards)

AT for computer access

Eye- and headtracking

head mounted
eyetracker

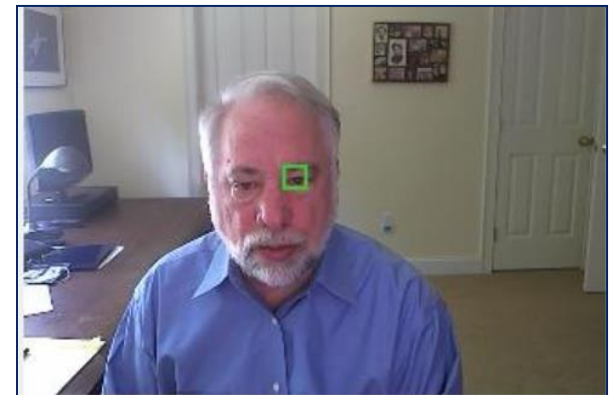


Webcam-based
facetracking

eViaCam

CameraMouse

Tobii EyeX
remote eyetracker



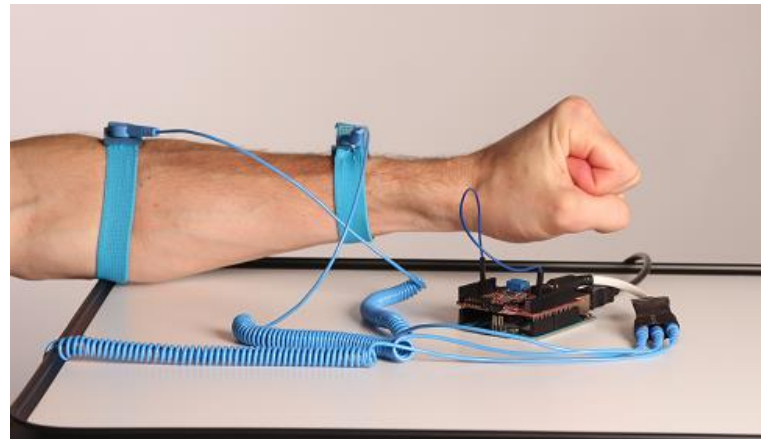
Video: Eyetracker based computer control



AT for computer access

Bioelectric Interfaces

- Biosignals (EMG, EEG, EOG) are used as input method
- Brain-Computer Interfaces: detection of certain brain activities
- Signal processing and classification



Mobile Device Accessibility



- SmartPhones and tablet computers :
 - cheap smart phones are available also for low-income families
 - Android and iOS devices offer thousands of apps
 - Easy useable - even for a child
 - E-Health applications, learning tools
 - Translation / communication aids
 - Many affordable accessibilty tools & apps available
- This actually changed the AT-industry a lot ...

Mobile Device Accessibility



AT-devices which costed several thousand \$ 5 years ago are now available as affordable apps for iOS or Android (some are completely free)

Web Accessibility

Accessible web pages are:

- Perceivable
- Operable
- Understandable
- Robust



-> descriptive image captioning, keyboard navigation,
meaningful reading sequence, ...

A separate document on accessible website design is provided on our USB Stick:
[WorkshopDocuments/Theoretical-Part/WebAccessibility.pdf](#)

see also: Web Accessibility Initiative – Web Content Accessibility Guidelines (WCAG):
<http://www.w3.org/WAI/intro/wcag.php>

Problems of existing AT-solutions:

- „**off-the-shelf**“ **products** are often optimised for particular applications and expensive
- **Limited adaptability** or unaffordable costs of the necessary adaptations



Consequences:

- Some people with disabilities are not as independent as they could be with **individually tailored** Assistive Technologies

What about ?

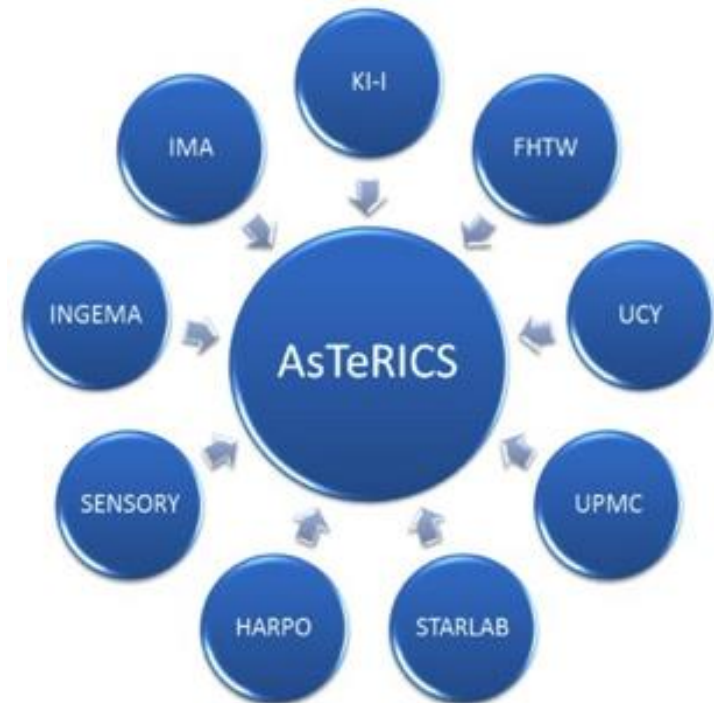
... a flexible AT prototyping tool, capable of dealing with...

- **unique sets of capabilities** of each individual
- **changing capabilities** over time
 - Degenerative diseases
 - Rehabilitation progress
 - Fatigue (on a single day)
- **changing needs and wishes**



The AsTeRICS Project

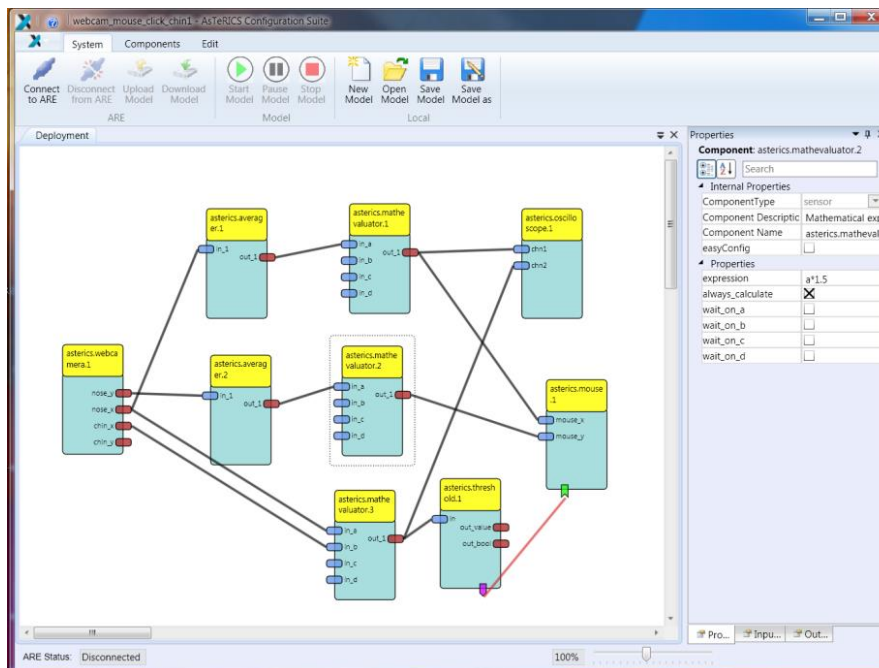
FP-7 funded EU-STREP-Project
2010-2013



AsTeRICS Project was implemented 2010-2013
by 9 European partner organisations and was
partially funded by European Commission
under the 7th framework programme

Assistive Technology Rapid Integration & Construction Set

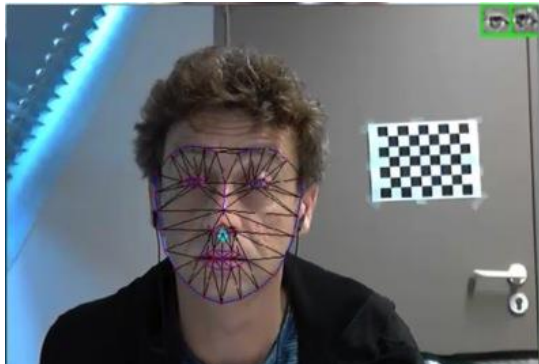
- Assistive solutions can be created via graphical connection of different plugins using the ACS editor (AsTeRICS Configuration Suite)
- Create assistive solutions using a graphical designer
- Flexible JAVA/OSGI Software Architecture



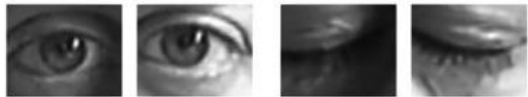
- 160 functional plugins that enable computer vision, eye- and facetracking, bioelectric interfaces, mouse/keyboard emulation, environmental control ..
- Assistive solutions can be adapted directly at the users site without programming effort

Alternative Input & Smart Home Integration

- EEG Analysis and Computer Vision
- KNX / EnOcean / FS20 standards
- HiFi / Stereo / DVD / TV via Infrared
- Door Opener, Pneumatic Gripper, ...



- On-screen-keyboard and graphical icons
- Stepwise selection of items



- Windows Mobile and Android Smart Phone support
- Make / Accept Calls, Send / Receive SMS
- GSM USB Modem Integration
- Usage of Smart Phone as Sensor (e.g. Accelerometer) or configurable Touch Pad (multitouch / gestures)
- On-Screen-Keyboard with scanning for Android

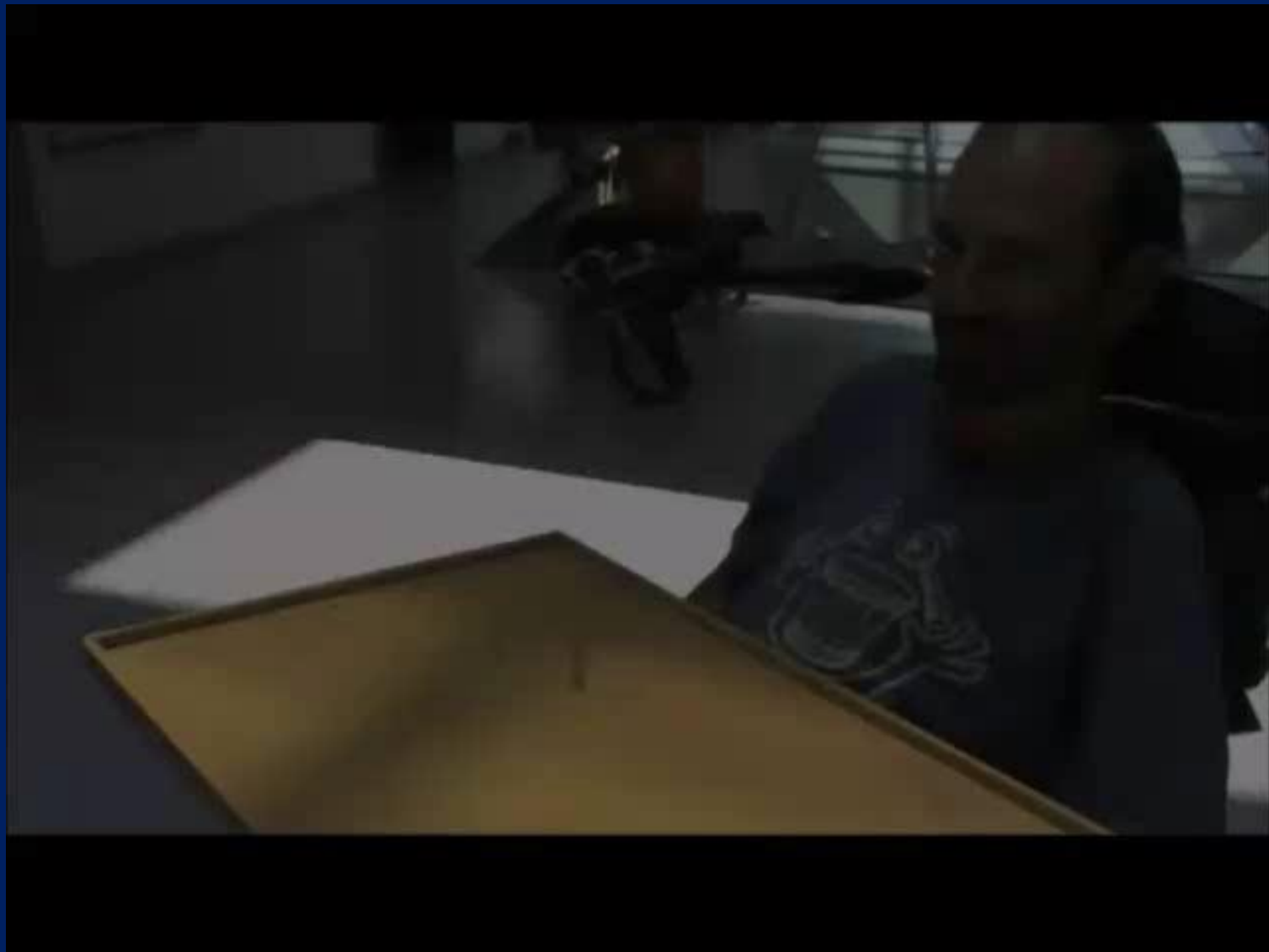


Control of a toy helicopter by a tetraplegic user

- Infrared control command generation by IR-module
- Integration of the wheelchair's bluetooth joystick (via mouse capture plugin)
- EMG or Sip/Puff sensor for controlling up / down
- 4 degrees of freedom



Video: AsTeRICS-based accessible toys



The GPII & Prosperity4All

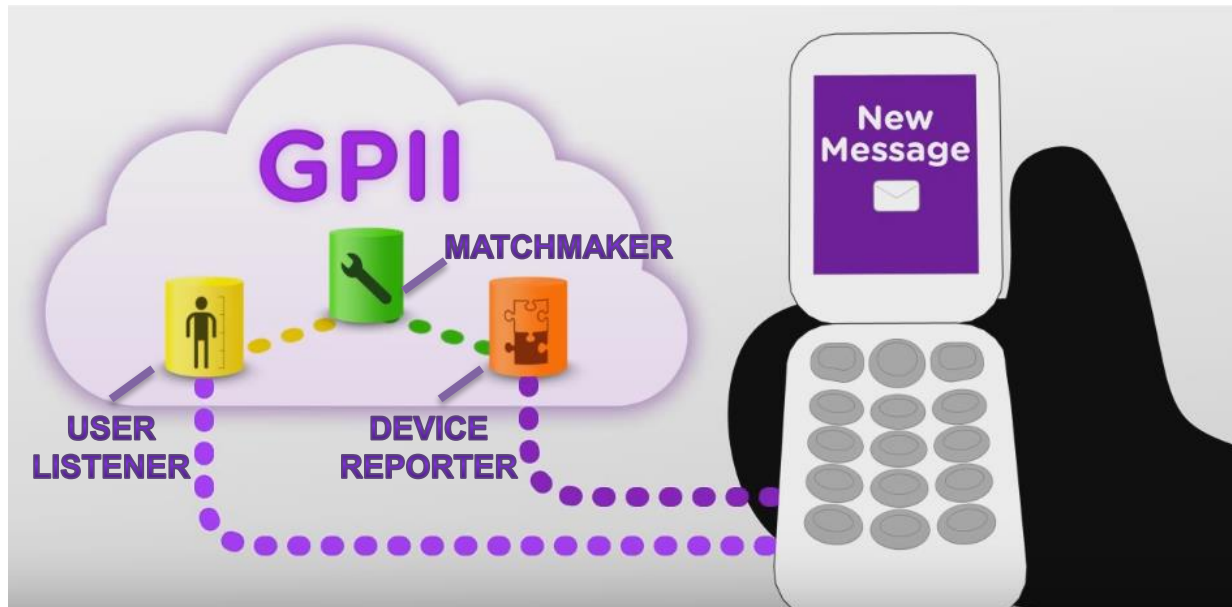
- Create a **G**lobal **P**ublic **I**nclusive **I**nfrastructure (GPII)
- People with disabilities
 - Find AT-products that match a user's needs
 - „Auto-Personalisation“ of electronic devices and user interfaces (e.g. change screen magnification)
- AT companies
 - Create, test and sell AT solutions
 - Easier
 - Faster
 - Cheaper





We all use technology every day.

The GPII & Prosperity4All



- Cloud4All & Prosperity4All: EU-funded research projects
- Total volume about 25 Mio €
- User Profiles and Device Capabilities are stored in the Cloud and matched automatically via the framework

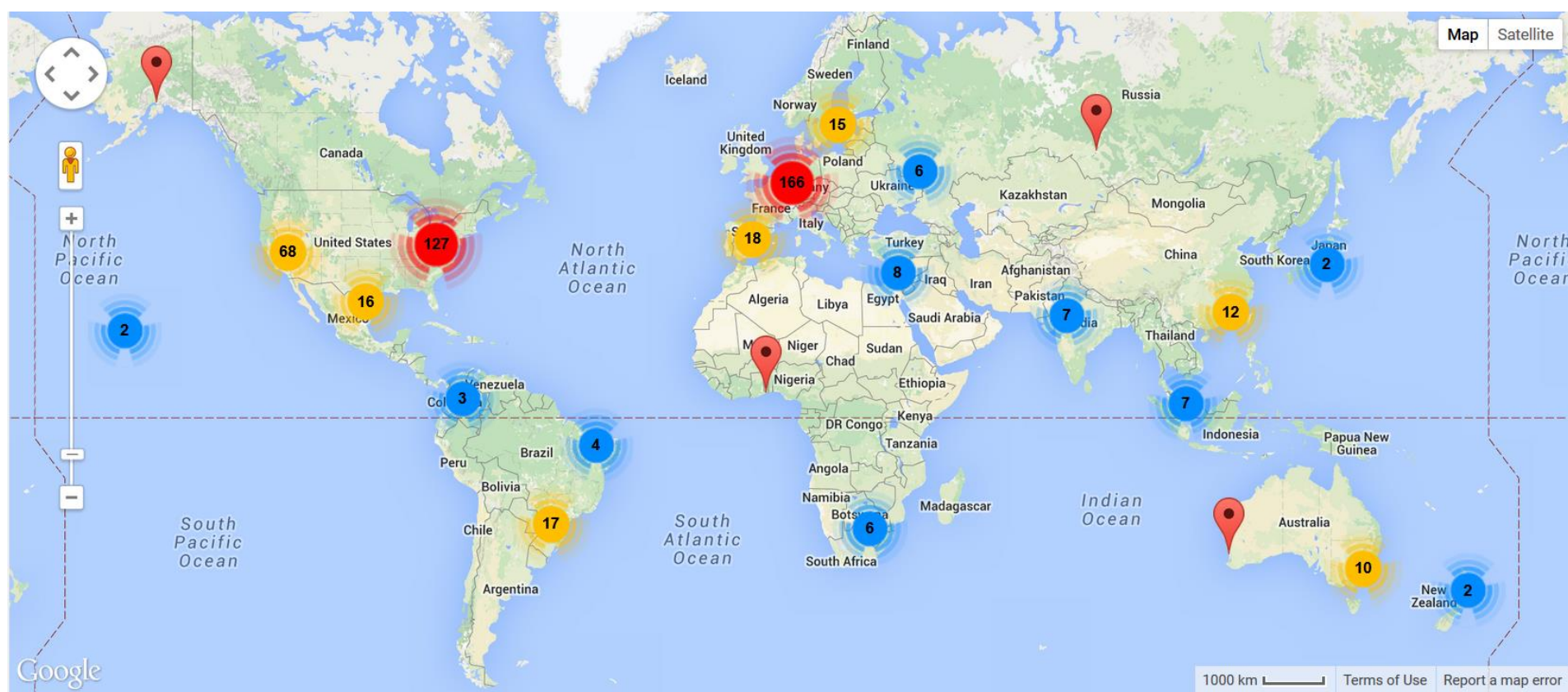
Open Source Assistive Technology

The Impact of Open Source and Maker Communities:

- The DIY-scene grew enormously in recent years
- Hackerspaces and FabLabs empower the DIY-culture
- Open Source opens up access to knowledge which was locked in companies before



Hackerspaces worldwide !



In and around Zimbabwe:

Area 46 | Harare, Zimbabwe
<https://www.facebook.com/myarea46>

TechZim
<http://www.techzim.co.zw/>

Sambia: BongoHive Lusaka
<http://bongohive.co.zm/>



Open Source Assistive Technology

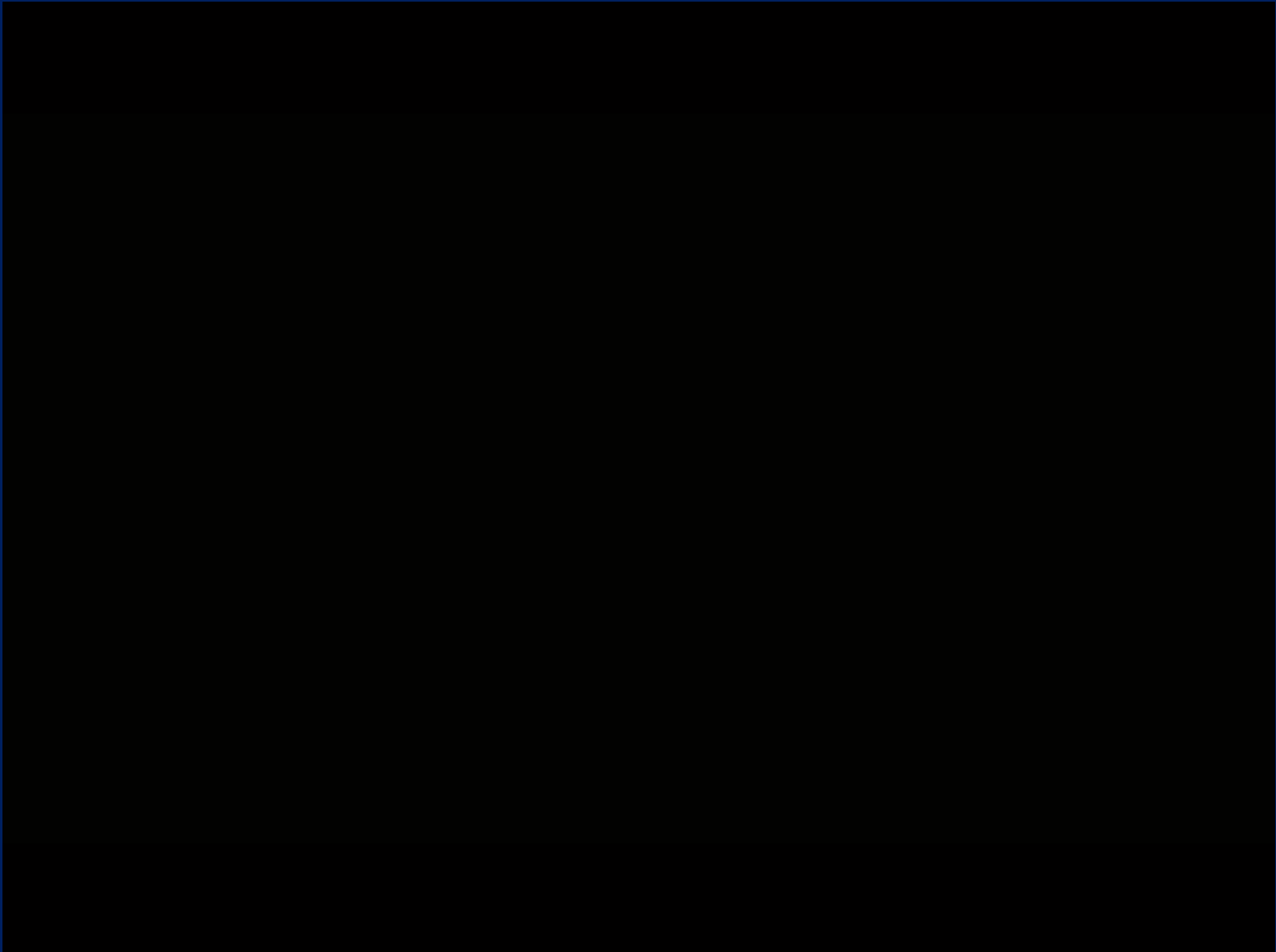
The Impact of Open Source and Maker Communities:

- Affordable Assistive tools can be created from
 - 3D-printing technology
 - Laser Cutters
 - Programmable microcontrollers
- Some examples:
 - Hand Prosthetics: [e-NABLING the future](#)
 - Accessible game controllers: [controllerproject.org](#)
 - Eyetracking and gaze based interfaces: [eyewriter](#), [opengazer](#)
 - Bioelectric interfaces: [openBCI](#), [openEEG](#)



Video: eNABLING the future

<http://enablingthefuture.org>



Thank you for your attention!

All slides and further material (software, movies)
are available on our USB stick.



[1]	World Health Organization, "Word Report on Disability," WHO Library Cataloguing-in-Publication Data, Geneva, 2011.
[2]	World Health Organization, "International Classification of Impairments, Disabilities, and Handicaps (ICIDH)," World Health Organization, Geneva, 1980.
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