

**Preliminary Report on Technological Options for  
Various Disabilities  
excluding Visual Disability**

**Created By : Arun Ramachandran,  
Co-Ordinator; Insight.**

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## **Abbreviations**

ICT – Information and Communication Technologies

AT – Assistive Technology

CP – Cerebral Palsy

PC – Personal Computer

## **Executive Summary**

1. The report seeks to identify the kind of disabilities where there is a necessity as well as a possibility for Information and Communication Technologies (ICT) to intervene and bring about a positive development on the person with the disability.
2. The report is by no means an exhaustive one, but is only a preliminary report on the basis of limited online research, learnings from the National Conference on “Enabling the Differently Abled with the use of ICT”, held on the 3<sup>rd</sup> of September, 2008 and interaction with a few individuals and organisations working in the disability sector in India.
3. The intended aim of the report is to provide a direction to Insights activities in providing accessible solutions in ICT to the disabled.

## **Introduction**

The role of ICT in addressing the various concerns in the development sector has been seen to be on the rise. One of the major scope of ICT is in providing newer avenues to the disabled sections of the society. The ability of the computer to provide increased access to information for the visually challenged bears testimony to the power of assistive technology in changing the lives of the disabled. At the same time, there has been very little that has been done to bring ICT to two sections – the people with mental disabilities and the people with loco motor disabilities. Focussed efforts in the direction of developing assistive technology has to be initiated in order to bring about a change in the current scenario.

A few statistics about the disabled in Kerala is quoted here. According to the 2001 Census figures, the total number of persons with disability in Kerala is 8.6 lakhs which forms roughly 2.7 percent of Kerala's population. Among them, the target group for this study are the people with mental disabilities or intellectual impairments and people with a disability in movement or people with locomotor disabilities. The number of people with mental disabilities in Kerala is 1.41 lakhs and the number of people with a disability in movement is 2.37 lakhs. ICT can act as a medium for communcation to some one and as an employment provider to another thus bringing a perceptible change in their lives.

This report is an attempt to enlist the various Assistive Technologies available and the utility of these technologies.

## Definitions

1. Disability: "disability" means -
  - i. blindness;
  - ii. low vision;
  - iii. leprosy-cured;
  - iv. hearing impairment;
  - v. locomotor disability;
  - vi. mental retardation;
  - vii. mental illness;
  
2. "Person with disability" means a person suffering from not less than forty per cent of any disability as certified by a medical authority.
  
3. "blindness" refers to a condition where a person suffers from any of the following conditions, namely:-
  - i. total absence of sight; or
  - ii. visual acuity not exceeding 6/60 or 20/200 (snellen) in the better eye with correcting lenses; or
  - iii. Limitation of the field of vision subtending an angle of 20 degree or worse;
  
4. "person with low vision" means a person with impairment of visual functioning even after treatment or standard refractive correction but who uses or is potentially capable of using vision for the planning or execution of a task with appropriate assistive device;
  
5. "leprosy cured person" means any person who has been cured of leprosy but is suffering from -
  - i. loss of sensation in hands or feet as well as loss of sensation and paresis in the eye and eye-lid but with no manifest deformity;
  - ii. manifest deformity and paresis but having sufficient mobility in their hands and feet to enable them to engage in normal economic activity;
  - iii. extreme physical deformity as well as advanced age which prevents him from undertaking any gainful occupation, and the expression "leprosy cured" shall be construed accordingly;
  
6. "hearing impairment" means loss of sixty decibels or more in the better ear in the conversational range of frequencies;
  
7. "locomotor disability" means disability of the bones, joints or muscles leading to substantial restriction of the movement of the limbs or any form of cerebral palsy;
  
8. "mental retardation" means a condition of arrested or incomplete development of

mind of a person which is specially characterised by subnormality of intelligence;

9. "mental illness" means any mental disorder other than mental retardation;

10. "cerebral palsy" means a group of non-progressive conditions of a person characterised by abnormal motor control posture resulting from brain insult or injuries occurring in the pre-natal, peri-natal or infant period of development;

11. "rehabilitation" refers to a process aimed at enabling persons with disabilities to reach and maintain their optimal physical, sensory, intellectual, psychiatric or social functional levels;

12. "autism" is a brain development disorder that impairs social interaction and communication, and causes restricted and repetitive behavior, all starting before a child is three years old.

*Source: The definitions quoted above have either been taken from the Wikipedia or the THE PERSONS WITH DISABILITIES (Equal Opportunities, protection Of Rights And Full Participation) ACT, 1995*

## **Technological options for people with Intellectual Impairment**

Intellectual Impairment or Developmental disability is by definition :

A mental or physical disability that is present during childhood, interferes with normal physical, intellectual, or emotional development, and usually lasts throughout life. Frequently, people with mental retardation, cerebral palsy, autism spectrum disorder, various genetic and chromosomal disorders such as Down's syndrome and Fragile X syndrome, and Fetal Alcohol Spectrum Disorder are described as having developmental disabilities.

Organisations in India working for bringing ICT to people with Developmental Disabilities -

### **Media Lab Asia**

Media Lab Asia (MLAsia) has been set up by Department of Information Technology, MCIT, Government of India as a not-for-profit Research & Development organization. MLAsia carries out research and development activities for the empowerment of the disabled. They have developed software tools like the Sanyog - Indian Language based Communication Tool for children with Cerebral Palsy, Shruti - Vernacular Speech Interface for People with Visual Impairment, Screen Reading Software - SAFA (Screen Access for All), etc.. among others.

### **IICP, Kolkata**

Indian Institute of Cerebral Palsy (IICP), a leading national level Non Governmental Organisation (NGO) recognised by the Ministry of Social Justice and Empowerment, Government of India, is a specialist resource centre for cerebral palsy. It is also a national resource centre for Alternative and Augmentative Communication (AAC). IICP has 31 years of experience in service delivery, research and training and has focused on inclusion using assistive technologies to empower access, education, communication, vocational training and leisure skills.

### **C -DAC**

C-DAC Trivandrum is developing a software to aid special teachers for Mentally Retarded. This software would aid the teachers in creating a teaching programme for the mentally retarded child.

## **Assistive Technologies available for people with Intellectual Impairment**

### **For the Cerebral Palsied**

Cerebral palsy (CP) is an umbrella-like term used to describe a group of chronic disorders impairing control of movement that appear in the first few years of life and generally do not worsen over time. The disorders are caused by faulty development of or damage to motor areas in the brain that disrupts the brain's ability to control movement and posture. Symptoms of cerebral palsy include difficulty with fine motor tasks (such as writing or using scissors), difficulty maintaining balance or walking and involuntary

movements. The symptoms differ from person to person and may change over time. A common misconception about those born with Cerebral Palsy is that they are less intelligent than those born without it. Cerebral Palsy is defined as damage to the part of the brain that controls movement; areas of the brain that define a persons intelligence are not affected by CP.

It has been seen that a person with cerebral palsy due to the lack of fine motor skills is unable to use two of the most common input devices for a personal computer, viz, the keyboard and the mouse. An input device needs to be used which allows computer usage with minimal motor movement.

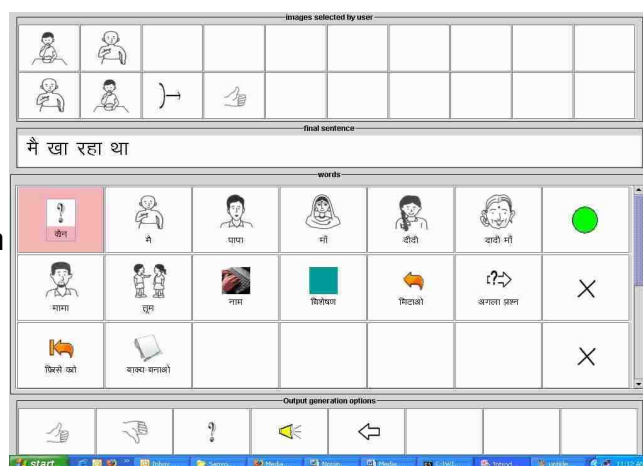
It has also been observed that cerebral palsy is associated with other developmental disorders. This makes the need for the interactive software to be simple to use and easy to understand. Assistive technologies for the cerebral palsied have seen to be providing them with new ways to communicate.

Some of the AT that have been put to use in India for the Cerebral Palsied are -

### **Sanyog - an Indian Language based Communication Tool for children with Cerebral Palsy**

Media Lab Asia in association with IIT Kharagpur has developed an Indian Language based Communication Tool for children with Cerebral Palsy called Sanyog.

"Sanyog is a multilingual Augmentative & Alternative Communication system, developed at Media Lab Asia research hub at IIT Kharagpur, to serve individuals with speech impairment and neuro-motor disorders. It allows individuals to form and vocalize their own messages. The system is comprised of a Natural Language Sentence Generator, Icon Interpretation and Disambiguation, Text-to-Speech System, a predictive virtual keyboard, facility to store and retrieve frequently used messages, and varied access switches. At present, the system supports three languages, namely Bengali, Hindi and English. The system has been deployed at IICP, Kolkata; AADI, New Delhi and Manovikas Kendra, Kolkatta, where it is being used by a number of students with special needs, facilitating improved communication with teachers and parents. A multilingual communication system with particular application to needs of the children with neuro-motor disorders has been acclaimed by the Engineering Society of Detroit, Michigan and The National Multiple Sclerosis Society, Michigan Chapter, USA by "DA Vinci" Award."



*The interface of Sanyog*

The input device in the case of Sanyog is a switch based system. The software offers the user with the option to use a dual switch interface or a single switch interface depending on the motor abilities of the user. In the dual switch interface mode, one switch

controls navigation and the other is used for selection. In the single switch interface mode, both navigation and selection is done by the same switch.

The software is structured into three different modes based on the needs of the user

- Stored Messages section allows the user to select pre-recorded messages which will be read out using a Text to Speech (TTS) system inbuilt in the software.
- The Iconic Communication Interface allows the user to form sentences using an icon based system. These sentences can then be read out using the TTS facility.
- The Keyboard Interface provides a predictive virtual keyboard and can be used to type in sentences.

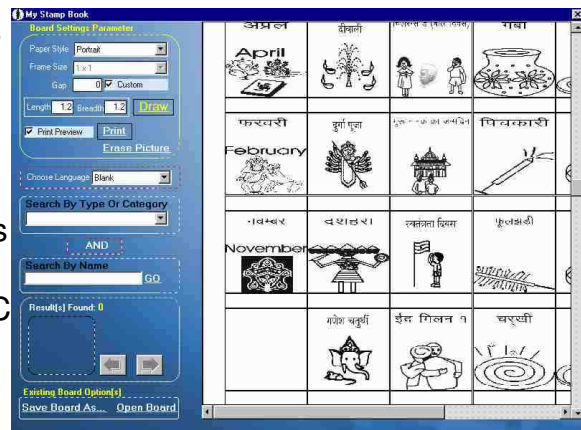
Sanyog has the following features also:

**Personalisation** – The icons used in the iconic communication or the stored messages (both icons and texts) used in the pre-stored message based communication can be personalized according to the user's likes and dislikes. A personalization interface is provided with the system for the purpose.

**Language Support** - Currently the system has support for Hindi , Bengali and English .

### IPSC – Indian Picture Symbols for Communication

Keeping the fact in mind, that many of the persons with cerebral palsy have problems in reading text the need for a picture symbol database was realised and the Indian Institute for Cerebral Palsy with the help of IIT Kharagpur created a library of culturally & linguistically appropriate picture icons called as Indian Picture Symbols for Communication. Standardised picture symbols were used. IPSC contains a database of 1936 culturally and linguistically appropriate picture symbols. The features of IPSC include -



*A snapshot of IPSC*

- Range of pre-made grids available
- Customized grids can also be made
- Easy search facility for symbols by categories and names
- Easy editing features for the display
- A single click is required to paste picture icons in the grid or to delete them
- Text can be incorporated using any font available in the system, language independent
- Easy to make picture displays by selecting picture icons and pasting them in cells
- Picture icons can be merged to form phrases
- Scope to add new categories / symbols
- Displays can be saved for later use as templates or pictures

### ITCP

ITCP is a multimedia software for writing, developed by IICP in collaboration with

Webel Multimedia Ltd. This software facilitates writing with picture symbols for students who have lower cognitive abilities. The database used by the ITCP is the Indian Picture Symbols for Communication developed by IICP. The interface is so designed that the user can operate it with the help of two access switches.

A few features of ITCP:

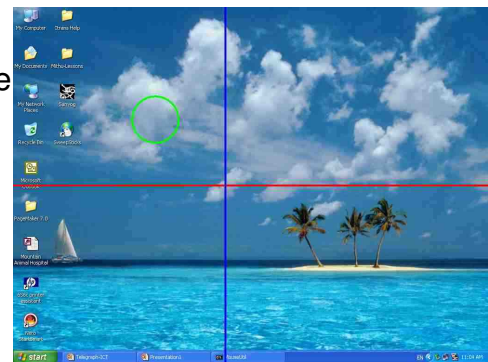
- Customised lesson grids can be made
- Attached pre-recorded speech with icons is provided (in Bengali, Hindi, English, Mizo, Nepali)
- User's work can be saved and printed

### Sweepsticks - Access Software

Sweepsticks is a software developed at IIT Kharagpur and field-tested at IICP. It is a virtual adaptive mouse and allows mouse movements, using two switches to manoeuvre the entire desktop.

Features of SweepSticks

- Can be used to achieve almost all the functionalities of a general purpose mouse.
- Can trace the patterns of the mouse actions performed by the users and adapt accordingly, so as to minimize the overall navigation effort.
- Allows the users to rectify their incorrect moves with minimal effort.

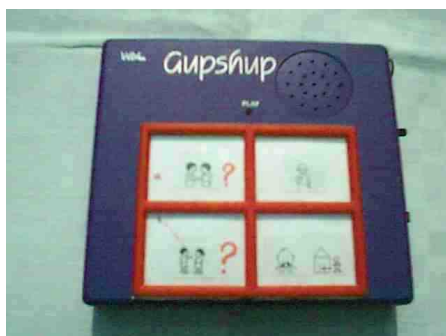


*Sweepsticks*

IICP has done an assessment of the success rate of Sweepsticks among the users in IICP. Eventhough there is an initial fumbling during the learning process, the learning curve rises considering the speed with which navigation is done using Sweepsticks.

### Low Tech Devices

The utility of Low Tech Devices is realised in instances where there are obstacles to the usage of computers and other high technology devices. These may be due to economical factors or may be due to the lack of facilities like round the clock power supply.



*Gupshup*



*Kathamala*

Low Tech Devices is of great help in remote areas, for communication for people with cerebral palsy. IICP has in association with Webel Mediatronics Ltd and Micro Solutions Ltd developed two Communication Devices named Gupshup and Kathamala. Both these devices are low cost devices and can be used to record and read out

messages. The Kathamala II version can record upto 64 messages in multiple layers.

### **For people with Autism**

Autism is a developmental disorder characterized by severe deficits in social interaction and communication and by abnormal behavior patterns, such as the repetition of specific movements or a tendency to focus on certain objects. Autism is evident in the first years of life. About a third to a half of individuals with autism do not develop enough natural speech to meet their daily communication needs.

Given the range and degree of problems that can occur with autism it is difficult to identify some computer software and resources as being "for autism". The individual's difficulty needs to be understood and an appropriate software needs to be made available to them considering the range of ICT resources available.

Some of the softwares that can be used by the autistic are -

#### **Skid**

Skid is a special online software which is designed with the intention of helping kids to communicate and learn. The software is developed by Dr. Arun Mehta, a Professor at JMIT, Radaur. Skid (<http://skid.org.in>) hosts modules written in Ruby on Rails, that work with 4 inputs: Up, Down, Yes, No . There are modules for writing, spelling, picture browsing and wikipedia browsing.

Skid is designed to be used via one of the following means of input:

- joystick or racing wheel
- arrow keys and space bar
- mouse
- touch screen

#### **Dasher**

Dasher is a software for keyboard-less typing which allows a user to type using only mouse movements (without clicking). Advanced versions of the software also allow typing through tracking of eye-ball movements. Dasher can be used by a person who has difficulty in typing.

#### **Edubuntu**

Edubuntu is a complete Linux-based operating system, (freely available with community based support) specially for children - packaged with tons of educational applications and games. A child with a developmental disability can use Edubuntu as the learning process is simplified using less of textual mode and more of pictorial modes.

### **For people with Mental Retardation**

Mental Retardation implies a significantly sub-average general intellectual functioning existing concurrently with deficits in adaptive behaviour and manifested during the developmental period that adversely affects a child's educational performance.

The following ranges, based on the Wechsler Adult Intelligence Scale (WAIS), were favored at one time, but are rarely used now:

<b>Class</b>	<b>IQ</b>
Profound mental retardation	Below 20
Severe mental retardation	20–34
Moderate mental retardation	35–49
Mild mental retardation	50–69
Borderline mental retardation	70–79

ICT has seen to have benefitted the Mentally Retarded by acting as a teaching medium. Special Teachers using computer as an aid to their teaching can simplify the learning process for the Mentally Retarded. ICT can also intervene in aiding the special teachers by providing them with assessment tools.

#### **Punarjani – Assessment tool for the Mentally Retarded**

CDAC Trivandrum is engaged in developing an assessment tool named Punarjani. The system will collect a lot of data about a particular child with Mental retardation like developmental history, school history, home environment, social environment etc.. and will be capable of suggesting a long term goal for the child.

## Technological options for people with loco-motor disabilities

The inability to access the unadapted keyboard and mouse for accessing a computer necessitates the usage of adaptive technologies for people with loco-motor disabilities. The kind of assistive technology that needs to be used depends on the type of motor disability/ability an individual has.

For ease of categorisation, a classification has been made on motor ability of a person as the technology options for people with limited hand/arm movement, people with no hand movement but with sufficient ability to control the movement feet and people with no hand and feet movement.

### Assistive technology for people with limited hand movement

#### Adaptive keyboard

In cases where a person does not have reliable muscle control in the hands for precision movements, an adaptive keyboard can be useful. Some adaptive keyboards have raised areas in between the keys, rather than lowered areas, to allow the person to first place the hand down on the keyboard, then slide the finger into the correct key. A person with tremors, or spastic movements could benefit from this type of keyboard. Keyboard overlays are also available as an adaptation to standard keyboards, which achieve the same results. In some cases, adaptive keyboards come with specialized software with word-completion technology, allowing the person to type with fewer keystrokes, since typing can be rather laborious and slow otherwise.



*An Adaptive Keyboard*

#### Single handed keyboards

Single handed keyboards have special shape and letter layout, taking into account the limited number of keys that can be accessed quickly and comfortably.



*A Single Handed Keyboard from MALTRON*

#### Dasher

Dasher is a computer accessibility tool which enables users to write without using a keyboard, by entering text on a screen using a pointing device such as a mouse, a touchpad, a touch screen, a roller ball, a joystick, a wimote, or even foot or head mice. Whatever the writer uses as a pointer, he /she selects a letter from ones displayed on a screen, whereupon the system utilizes a probabilistic predictive model to anticipate the likely character combinations for the next piece of text, and accord these higher priority by displaying them more prominently than highly unlikely letter combinations. This saves the user effort and time as they proceed to choose the next letter from those offered.



*Dasher - Screenshot*

## Trackball mouse

A trackball is a pointing device consisting of a ball housed in a socket containing sensors to detect rotation of the ball about two axes. Someone with tremors in the hands may find this kind of mouse useful because once the person moves the mouse cursor to the right location, there is less danger of accidentally moving the cursor while trying to click on the mouse button.

## Switch based access

People who have very limited mobility use this type of device. The clicking action is usually interpreted by special software on the computer, allowing the user to navigate through the operating system, web pages, and other environments.



*Single Switch Device*

## Assistive technology using feet movement

### Foot Operated Keyboard

A foot operated keyboard is specially designed (for eg. Large keys) for operation using feet.

### Foot Operated Mouse

The NoHands Mouse developed by Hunter Digital is a foot operated mouse that consists of two separate pedals. One pedal operates the pointer, while the other is used for button clicking. By default, a heel-click engages the right mouse button, while a toe-click engages the left mouse button.

The Foot Mouse (Slipper Mouse) with Programmable Pedal developed by Bili Inc is another Foot Operated Mouse available. Considering that the cost of these devices ranges from \$199 TO \$349.99, these devices can be indigenised.

## Assistive technology using head movement or movement of a part of head

### Head wand

A person moves the head to make the head wand type characters, navigate through web documents, etc. Fatigue can be an issue when a lot of keystrokes are required in order to accomplish a task.

### Sip and puff switch

Sip and puff switches are able to interpret the user's breath actions as on/off signals, and can be used for a variety of purposes, from controlling a wheelchair to navigating a computer. The hardware can be combined with software that extends the functionality of this simple device for more sophisticated applications.



*A sip and puff switch*

## **Head Mouse**

HeadMouse replaces the standard computer mouse for people who cannot use or have limited use of their hands when controlling a computer or augmentative communication device. The Head Mouse translates natural movements of a user's head into directly proportional movements of the computer mouse pointer. The HeadMouse has a wireless optical sensor which tracks a tiny disposable target that is placed on the users forehead, glasses, hat, etc. It works just like a computer mouse, with the mouse pointer being moved by the motion of the users head.

HeadMouse® Extreme developed by Origin Instruments is one such device but comes at a cost of \$995. SmartNav 4 AT another head operated pointing device developed by Natural Point comes at a cost of \$499.

## **Eye-tracking**

The device follows the movement of the eyes and allows the person to navigate through the web with only eye movements. Special software allows the person to type, and may include word-completion technology to speed up the process.

## **Conclusion**

The major challenges in providing assistive technology for people with intellectual impairments and people with loco motor disabilities lies in the fact that the nature and degree of disability varies from one person to another. A software that suits the need of one person need not be of use to a second person. This makes the need for an intervention in the field of accessibility all the more important.

The existing hardware interfaces available are very costly and will be out of reach of a common man. Indigenous hardwares need to be developed.

The greatest live example of the power of assistive technology in enabling the lives of the disabled is the case of Professor Stephen Hawking who uses a switch based device to communicate with his computer system and hence to the world. He is reason enough to highlight the need to develop assistive technologies for the disabled.