28 February is commemorated as the National Science Day (NSD) every year. On this day in 1928, Sir C.V. Raman discovered the famous “Raman Effect” related to scattering of light. The theme for this year’s National Science Day 2017 is “Science and Technology for Specially Abled Persons”.

According to the World Health Organisation (WHO), over a billion people are estimated to live with some form of disability. This corresponds to about 15% of the world’s population. Between 110 million (2.2%) and 190 million (3.8%) adults have significant difficulties in functioning.

Disability prevalence is higher in developing countries. Furthermore, the rates of disability are increasing in part due to ageing populations and an increase in chronic health conditions.

The term ‘disabled’ is often associated with people diagnosed with different kinds of mental and physical conditions. Disability can be of many types, such as cognition, mobility (moving around), vision, hearing or speech, behaviour (memory, learning, and understanding), etc. and challenges the development or functioning of an individual.

Many people are born with a disability that may affect later in life. Others acquire it through an accident, chronic disease, or the ageing process. However, often people with disabilities have amazing skills and are truly motivating. They possess a unique set of abilities and perspectives and hence the special term given to them – “Specially Abled”. Their abilities are different – not superior or inferior – just different from others.

Problems of the Specially Abled
Among the issues that confront the specially abled are physical stress, emotional or mental stress, social isolation, fear of the future, educational challenges, inferiority complex, financial stress, employment gap, lack of awareness, limited access to information & services, infrastructure and many more.

Specially abled people face obstacles in accessing the health and rehabilitation services. To overcome the difficulties faced by them, it’s
important for them to become aware of technologies, facilities and policies made for them.

**How S&T Helps**

In recent decades, new technologies have had a dramatic impact on making the lives of people with disability easier. Assistive devices and technologies are providing them new opportunities to cope with their problems.

Assistive device is an equipment or product system that increases, improves or maintains the capabilities of people with disabilities and enhances overall well-being, for example, wheelchairs, hearing aids, etc. Assistive devices or technologies enable specially abled people to compensate for their impairments or problems they experience in their day to day life.

Some of the ways in which assistive technologies help the specially abled include:

a) They become self-confident, independent and more productive
b) They can work, earn and care for themselves and their families
c) They can access information or services
d) They get better aids to learn in schools or in other educational institutes
e) They feel comfortable to participate in community life.

Assistive technology devices have a wide range of solutions from pencil grip to the latest tablets for people with disabilities. There are different assistive technologies available for different categories of disabilities like text-to-speech software, hearing and visual aids, academic and learning aids, etc.

**Assistive Technology for Hearing Disability**

Hearing loss is partial or total inability to hear which may occur in one or both ears. A hearing loss above 90 decibels is generally considered deafness, hearing loss below 90 decibels is classified as hard of hearing.

There are numerous devices, technologies and frameworks available to help the hearing impaired. While some gadgets convey information visually, others improve auditory information. These devices might be used by people of all ages at varied places, including homes, workplace, school, etc. Some devices and technologies of this nature include:

**Hearing Aid:** A small electronic device that a sufferer wears in or behind the ear. It has three basic parts: a microphone, amplifier and speaker. The hearing aid receives sound through a microphone,
which converts the sound waves to electrical signals and sends them to an amplifier. The amplifier increases the power of the signals and then sends them to the ear through a speaker. Basically, a hearing aid magnifies sound vibrations that enter the ear.

**Assistive Devices to Improve Listening**

**Frequency Modulation (FM) System:** Sound is conveyed by radio waves to a personal receiver. The sound is transmitted via FM radio signals directly to an individual at a constant volume, regardless of the person’s distance from the FM microphone.

**Hearing Loop:** Sound is transmitted electromagnetically. There is a wire that circles a room and is connected to the sound system. The electromagnetic signal is then picked up by the telecoil in a hearing aid or cochlear implant.

**Infrared System:** Sound is transmitted through infrared light. A transmitter converts sound into a light signal and beams to a receiver worn by a listener. Unlike induction loop or FM systems, the infrared signal cannot pass through walls, making the information confidential.

**Alternative Communication Devices**

**Real-time Transcription:** There are systems that provide instant translation of the spoken word into text using specialised software or equipment such as computers. They typically vary based on the amount of information contained within the visual display of information ranging from summaries to words. For example, CART (Communication Access Real Time Captioning) provides a word-for-word transcription. Two other systems are C-Print and Typewell that capture the essence of a discussion, rather than translating word for word.

**Alerting Devices:** Use vibration or light to get the attention of the hard of hearing individual. Many devices have been adapted for individuals with hearing impairments, including items such as a baby monitor, watches, doorbells, etc.

**Captioning:** Televisions are equipped with the ability to provide closed captioning of programmes for individuals with hearing impairments. Logos with “cc” provided in TV guides or directly within the media programme indicate when something is closed captioned.

**Telecommunication Devices:** Individuals with hearing impairments can communicate via telephone by using Telecommunication Device for the Deaf (TDD). A TDD is a small keyboard with a display and a modem. A user either needs to connect with another person that has a TDD or use a relay service that can convert the text into voice for the hearing listener receiving the call. Text messaging has recently become a very useful avenue for individuals with hearing impairments to relay messages without using the TDD.

**Cochlear Implant:** A surgically implanted electronic device designed to make sounds audible for individuals with hearing loss. Unlike other hearing aids that amplify the sounds, cochlear implants bypass damaged portions of the ear and directly stimulate the auditory nerve.

**Assistive Devices for Visual Impairment**

Visual impairment includes ‘Low Vision’ and ‘Blindness’. Visually impaired persons most often face difficulties while travelling and reading. Some assistive devices for the visually challenged include:

**Braille Displays:** Electronic devices that can be connected to the computer by a serial or USB cable and help the blind people to read the text that is displayed visually on a computer monitor. It produces Braille characters by raising and lowering combinations of small plastic or metal pins. These are portable, cost effective and can also be connected to the Internet.

**Braille Embossers:** Also known as Braille printers, can convert electronic text into a Braille hard copy. Rather than using ink or toner, they embed raised dots onto a piece of paper to let a person using the Braille system read by using their fingers.

**Braille Paper:** A special quality of paper used for the production of Braille books or embossed sheets that comes with a specific toughness and resistance to dust/acid to ensure the long life of Braille dots.
**Braille Translation:** Software programme that translates an electronic script or document into Braille code, which can be presented in tactile format using a Braille Display or Braille Embosser.

**Electronic Note-takers:** Small portable devices that employ a Braille keyboard to enter information. The user can store the text in files that can be read and edited using the built-in speech synthesiser or Braille Display and can send it to a printer or Braille Embosser, or transfer to a computer.

**Screen Readers and Narrators:** Software programmes that work in conjunction with a speech synthesiser to provide verbalisation of everything that appears on the screen including menus, text, and punctuation. It reads aloud the content in a synthetic speech. These software programmes are available for PCs running Linux or Windows, Mac, iOS, Android, etc. Examples of screen-reading software include JAWS and WindowEyes for PC, VoiceOver for Mac and Talkback for Android. Social sites like Facebook and Twitter also provide such features to their users that generate a description of a photo through object recognition technology for someone who cannot see the photo.

**Smart Cane:** Developed at IIT Delhi, this is an electronic device that helps travelling blind people. It fits on the top fold of the white cane. Overcoming the limitations of the traditional white cane, it detects knee above and hanging obstacles such as the side of a truck, hanging cloth strings, protruding coolers or air conditioners, railing, tree branches, inclined ladders, etc.

**Smart Glasses:** An impressed version for the visually challenged. They help wearers identify shapes, determine distance, and are able to detect objects up to three metres away. They come with a transparent display such that lenses appear clear to others and allow the eyes to be seen. They have two cameras at the front of the glasses which mimic the location of your eyes to determine the distance (Stereoscopic Vision). To suit different eye conditions, they can be adjusted accordingly. Night vision smart glasses work both during the day and night.

**Calculators:** Specially designed and programmed for persons with low vision include larger display screens and accommodate large print readout. There are also calculators that provide large print displays coupled with speech output.

**Colour Assistance:** Architects and interior designers must be aware of the use of lighting, colour contrast, and the reduction of glare for effective environmental design. Placing light objects against a dark background, printing the furniture, objects, edges of the ramp and stairs with high colour contrast is an effective way to assist the visually impaired. Windows, Android and iOS also come with high contrast features including invert colour, colour correction, etc.

**Magnification:** To assist people with low vision various magnification software and devices are available. Computer magnification works similarly to a high-powered magnifying glass moving over a page. They can magnify all screen items by following the mouse cursor or keyboard. For individuals who need both types of technology, screen magnification...
Software can be used in conjunction with a screen reader.

Screen-magnification programmes include ZoomText and Magic. Computers with larger monitors and operating systems with internal features that enlarge font, increase contrast or otherwise modify computer functions benefit low-vision individuals. Desktop Video Magnifiers magnify a printed page through the use of a special television camera with a zoom lens and display the image on a monitor. Handheld Magnifiers, however, are the most familiar and the simplest to use.

**Phones:** Smartphones with large buttons, large print & talking caller’s voice, switch activated phones and vision screening are some of the easily available assistive technologies for persons with low vision that allow the users to get access without any help or support.

**Assistive Devices for Locomotor Disability**

From low- to high-tech, assistive technologies for various loco motor complexities include walking sticks, crutches, walking frames, manual and powered wheelchairs, tricycles, artificial leg or hand, leg or hand splint, clubfoot brace, corner chair, supportive seat, feeding robot, adapted cutlery and utensils, etc.

**Orthotic Devices** are externally applied devices that are designed and fitted to the body to control biomechanical alignment, correct or accommodate deformity, protect and support an injury, assist rehabilitation, increase mobility and independence. The materials used in making these devices are carbon fibres, leather, plastic polymer, rubber, etc.

There are two categories of orthotics: functional (to support abnormal biomechanics, foot deformities and functions) and accommodative (braces, splints, casts, gait plates, night bars and heel/arch support). Some of the commonly prescribed orthotic devices are: Foot orthotics, Ankle-foot orthotics, Knee-orthotics, Hip-knee-ankle-foot orthotics, Spinal orthotics, Prophylactic Braces, etc.

**Prosthetic Devices** are artificial devices applied or attached to the body to replace a missing part. It is the part of biomechatronics – the science of fusing mechanical devices with human muscle or skeleton.

An artificial limb is a prosthesis made from plastics, carbon fibre and other materials. New advancements have developed stronger and lighter artificial limbs, limiting the amount of energy expenditure in operating them. Modern technology uses Cosmesis, the creation of lifelike limbs made from silicone or PVC. Such prosthetics, such as artificial hands, can now be made to mimic the appearance of real hands, complete with freckles, veins, hair, fingerprints and even tattoos.

**Assistive Technology for Cognitive Impairment**

Cognitive impairment is a condition when a person has certain limitations in mental functioning and in skills such as communication, self-help, and social skills ranging from mild to severe.

With mild impairment, people may begin to notice changes in cognitive functions, but still be able to do their everyday activities. Severe levels of impairment can lead to losing the ability to understand the meaning or importance of something and the ability to talk or write, resulting in the inability to live independently.

A few common signs of cognitive impairment include:

1. Memory loss
2. Changes in mood or behaviour
3. Poor motor coordination
4. Difficulty in making decisions
5. Difficulty in carrying out tasks

Cognitive and psychiatric disabilities result in developmental delays that may include trouble with abstract thinking, decision-making, short and long term memory, learning skills, coordination and concentration. However, there are technologies available that can benefit such individuals.
Computer-assisted Programmes: This refers to software and applications that have been designed to provide instruction and practice opportunities for a wide range of devices (e.g., computer, laptop, iPad, mobile phones). It can help students practice spelling, writing, reading and multiplication drills. Some examples are:

- **Speech Recognition Softwares**: The user speaks into a microphone and the spoken words appear on the computer screen as text. For e.g. SpeakQ, iListen
- **Free-form Database Software**: It allows the user to create and store relevant information of any length on any subject. It may help people who have difficulty with memory. For e.g. Infoselect for micro logic, Microsoft OneNote.
- **Alternative Keyboards**: These programmable keyboards have special overlays that customise the appearance and function of a standard keyboard. For e.g. Intellikeys.

Mid-tech Devices

- **Graphic Organisers**: There are visual representations, like diagrams and mind maps of ideas and concepts. Kids can use graphic organisers to take notes while reading, which can help with comprehension. For e.g. Inspiration, Draftbuilder.
- **Optical Character Recognition (OCR)**: OCR reads aloud text from images and pictures. Persons with reading issues can use OCR by taking photos of documents and scan into a computer. OCR can read the scanned pictures on web pages (such as Google Images) as text and allow people to access information without having to read it themselves.
Often people with disabilities have amazing skills. They possess a unique set of abilities, hence the special term given to them – “Specially Abled”. Their abilities are different – not superior or inferior – just different from others.

as image files, like JPG) and text via a screen reading system. For e.g. KNFB, Kurzweil 3000TM.

Facilitating the Specially Abled
In India, many programmes, schemes, and facilities have been put forward by various institutes/organisations to provide a helping hand for the Specially Abled. Some examples are mentioned here.

1. Accessible India Campaign (Sugamya Bharat Abhiyaan) – to Make India Disabled Friendly: A nationwide campaign was launched on 3 December 2015 by the Government of India, to enable persons with disabilities to gain universal access, equal opportunity for development, independent living and participation in all aspects of life in an inclusive society. The campaign seeks to make at least 50% of all government buildings of national and state capitals fully accessible for differently abled persons by making steps and ramps, corridors, entry gates, emergency exits, parking as well as indoor and outdoor facilities including lighting, signage, alarm systems and toilets.

2. Assistance to Disabled persons for purchase/fitting of aids and appliances (ADIP) is a scheme aided by the central government and implemented by voluntary organisations to subsidise the cost of aids and appliances, and artificial limbs for people with lower income.

3. Deen Dayal Rehabilitation Scheme is a scheme by the Ministry of Social Justice & Empowerment to promote voluntary action for persons with disabilities by simplifying and facilitating procedures to support NGOs for easy access to government.

4. Rajeev Gandhi National Fellowship (RGNF) provides grants to students with disabilities for pursuing research degrees in all universities/institutions recognised by the University Grants Commission (UGC).

5. Technology Interventions for Disabled and Elderly (TIDE) is a programme by the Department of Science & Technology to promote basic research, development and adaptation of technology for improving the quality of life of the elderly population and disabled people in the country through the application of science and technology.

6. All India Council for Technical Education (AICTE) provides many facilities for admission, counselling, policies, etc. to develop awareness in the higher education system and also provide necessary guidance and counselling to differently abled persons.

7. Delhi Metro has introduced some features for the specially abled, such as extra-wide automatic flap gates for wheelchairs, tactile paths for the visually impaired, provisions of wheelchairs at stations and reserved spaces for wheelchairs in trains, lifts have been provided with access doors, handrails, call buttons in Braille, low height audio-visual indications, telephone button to communicate in emergency, etc.

8. The new Rs 500 and Rs 2000 bank notes have some features to help the visually impaired such as intaglio or raised printing of the Mahatma Gandhi portrait, Ashoka Pillar emblem, bleed lines and identity mark. The Rs 500 note has five bleed lines on the left and right in raised print and Rs 2000 note has seven angular bleed lines on the left and right side in raised print.

Organisations/Institutes
1) National Handicapped Finance and Development Corporation (NHFDC), a non profit company under the Ministry of Social Justice and Empowerment, Government of India, which provides financial assistance for widening range of income generating activities to disabled people.

2) National Institute for the Empowerment of Persons with Visual Disabilities (Divyangjan) is an institute for visual disability under the administrative control of Ministry of Social Justice and Empowerment, Government of India. It promotes research and developmental activities ensuring the emergence of disability inclusive policies, programmes and practices.

3) UDAAN is the activity centre of a non-profit trust – Foundation for Spastic and Mentally Handicapped Persons (FSMHP). Registered with the Ministry of Social Justice and Empowerment in March 2000, it works for training, rehabilitation, and medical assistance for children suffering from Autism, Cerebral Palsy, Down Syndrome, Mental retardation, traumatic brain injury and learning disabilities.

4) National Institute for the Empowerment of Persons with Intellectual Disabilities, Secunderabad, is an autonomous body under the Ministry of Social Justice and Empowerment, Govt. of India, which endeavours to excel in building capacities to empower persons with mental retardation to access the state-of-the-art rehabilitation intervention through innovative structured training courses like Early Intervention, Rehabilitation Psychology, etc.

Assistive devices reduce barriers between people with disabilities and their environments. However, according to WHO, in many low-income and middle-income countries, only 5-15% of people who require assistive devices and technologies have access to them. There is a need to encourage more innovations, awareness and reach of accessibility solutions worldwide to the over one billion specially abled in the world.

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