Home Automation

Universal design

People who inhabit and visit the houses we live in come in all shapes and sizes, ranging from infants to seniors, with various ever-changing abilities and skills. As we grow up, grow old and welcome new people to our homes, our housing needs change. A house that is designed and constructed to reflect the principles of universal design will be safer and more accommodating to the diverse range of ages and abilities of people who live in and visit these homes.

Universal Design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size and ability. "The Principles of Universal Design" are found on page 16.

Bolded terms throughout this fact sheet are defined in the "Glossary" on page 14.

The philosophy of universal design is that your home should be comfortable, pleasant, safe and usable by everyone in your family, be it your children, you or your spouse, aging parents or a relative with a disability. The use of technology and automation can help create living spaces that are convenient and energy-efficient, minimize the potential for accidents and result in a house that is able to adapt to life's changes—whether caused by changing family composition or the changing abilities of family members.

Effective universal design and construction can only occur when we truly appreciate how persons with disabilities engage the built environment. Universal design is only a subtle shift from what is typically done; designing for greater accessibility then is not a new way of designing, simply a more focused one. By providing flexibility in the selection of design features and incorporating adaptability into house design, the life and usability of a home is extended, which promotes the concept of **aging in place**.

This concept is increasingly popular with families and individuals who choose to stay in their homes and neighbourhoods as they grow and age. Planning for individuals' changing needs and abilities allows for periodic home customization based on changing requirements and reduces the need for future costly renovations.

Planning for future needs is good practice. Principles of universal design encourages flexibility, adaptability, safety and efficiency.

Using technology in the home

Persons with disabilities have the same needs as everyone else, for housing, health care, social interaction and employment. Nevertheless, that is not always possible without personal assistance or support. Still, persons with disabilities want choice and independence, which is about control of their lives. Home automation has been used for many years now and can enable persons with disabilities to carry out activities within a home without assistance. By means of an input device, such as a switch or a voice-controlled device, it is possible for persons with disabilities to control electronic equipment remotely (open/close doors and windows, utilize entertainment centres, telephones,

alarms and computers). Smart home technology has emerged in the last 20 years to offer extended functionalities such as monitoring and automated functions (heating, windows automatically closing in case of rain and lights automatically turning on when the occupant enters a room). With an increasing number of people with cognitive impairment and with new technological developments, the use of these technologies has been gradually increasing.

- Home entertainment (audiovisual, Internet)
- Domestic appliances (cooking, cleaning, maintenance)
- Information and communication (phone, Internet)
- Environment (programmable lighting, heating)

Devices originally designed for people with disabilities are found in every home. The remote control was originally developed to help people with limited mobility control their environment. Today remote controls are used by everyone.

Home automation now being developed for the general consumer market provides even greater benefits to people with physical, sensory and cognitive disabilities, allowing them to live more independently.

What is home automation?

Home automation systems, or smart home technologies, are systems and devices that can control elements of your home environment—lighting, appliances, telephones, as well as home security, mechanical, entry and safety systems. They can be used to improve safety, expand usability and make life easier for people of all abilities.

Home automation features located in an accessible home should be used to allow persons with disabilities to live more independently. Home automation features include but are not limited to, light-assisted doorbells, mechanically (remote control) operated windows, door openers, motion sensor lights, telephone jacks and electrical outlets for computers located in various parts of the home, extra outlets to accommodate changing technology, and security systems for fire and theft.

Home automation systems can be operated by electricity or a computer chip using a range of different types of switches. A simple device, such as a light, can be activated by a signal from a **motion sensor** or can be lit as part of a computerized home automation system.

What can home automation do?

Home automation can:

- Increase your independence and give you greater control of your home environment;
- Make it easier to communicate with your family;
- Save you time and effort;
- Improve your personal safety;
- Reduce your heating and cooling costs;
- Increase your home's energy efficiency;
- Alert you audibly and visually to emergency situations; and
- Allow you to monitor your home while you are away.

Primary elements of a home automation system

The three primary elements of a home automation system are:

1. the control system (for example, a computer, security system or telephone);
2. the device being operated (for example, a light or a furnace); and
3. the **interface**, or link, between the user and the device. An interface can be a button, a keypad, a motion sensor, a wireless tablet or a smartphone. For example, a thermostat equipped with a computer chip can be controlled by an interface, such as a push button, which sends a signal to the furnace to adjust the temperature for different times of the day and night.

The appendix on page 12 lists other examples of interfaces. Also listed in the appendix are assistive technologies. These technologies are controls that have been specifically developed to give people with disabilities greater control of their environment.

Devices automation can control

Automation can handle many simple and repetitive tasks, such as having lights come on at dusk or closing the curtains at bedtime. These tasks can be triggered by a predetermined **event**, such as a time of day, or by a preprogrammed **scene**, which groups a series of tasks under a single command.

There are currently many technologies that assist people who are blind or with limited vision, from audio announcers to identify who is calling on their telephone landline, to talking displays for kitchen appliances (for example, microwave) to audio warning systems when someone is approaching the front door, to intercom systems for communicating with a person outside or from room to room within the house, to motion detector lighting for people with partial sight. Even various apps for an iPhone can be of great assistance. There are apps that will turn an iPhone into something like a laser cane, where people can use audio beeps on phone to locate objects in their path of travel (much like enhanced shadow vision or enhanced echolocation). There are even apps that designers can download, to help simulate what an environment may appear like if designers would retain the same eye condition as their client with a visual disability.

Task automation can make everyone's life easier, particularly the lives of people with disabilities or limited agility.

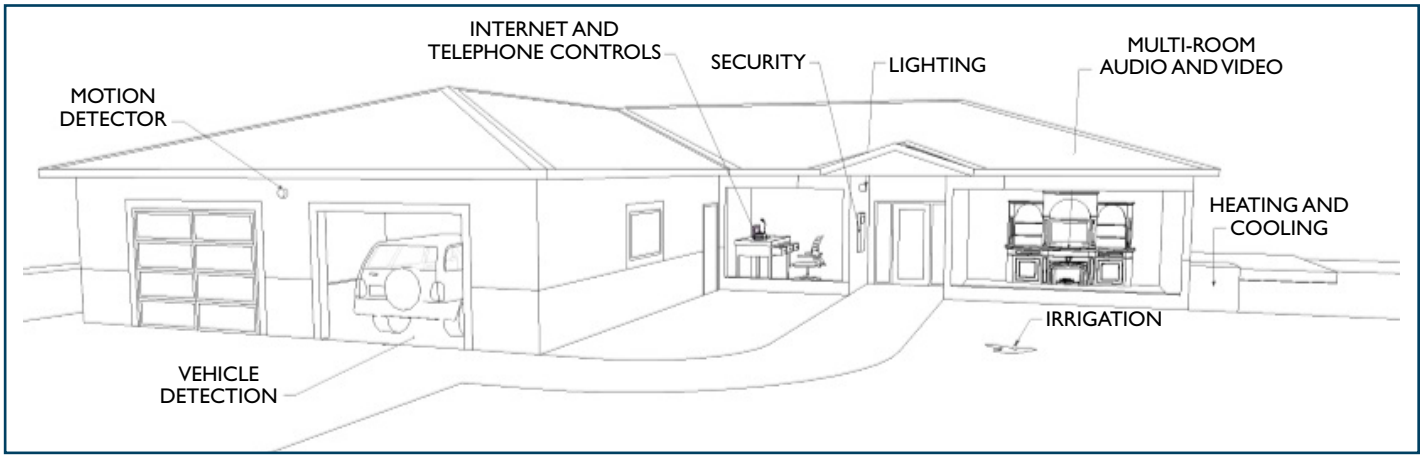

Figure 1: Automating the whole home
Diagram by Ron Wickman, Architect

Lighting

Lights on your front porch can automatically turn on when the door is opened to illuminate your path as you go outside, a benefit to everyone but especially people with limited vision. Motion sensors that activate lights can be especially beneficial to people with limited mobility and physical disabilities because they do not have to manually activate a switch.

You can even control and adjust the speed at which lights brighten as you enter a room by using a programmable dimmer switch equipped with motion sensors. This is of special importance to people with visual impairments and older people whose eyes take longer to adjust to changes in illumination. It is also a great safety feature as it eliminates the need to enter a darkened room.

Computer systems can be programmed to operate your entire home lighting system, creating different lighting zones within a room or a selection of alternate **ambient lighting** scenarios.

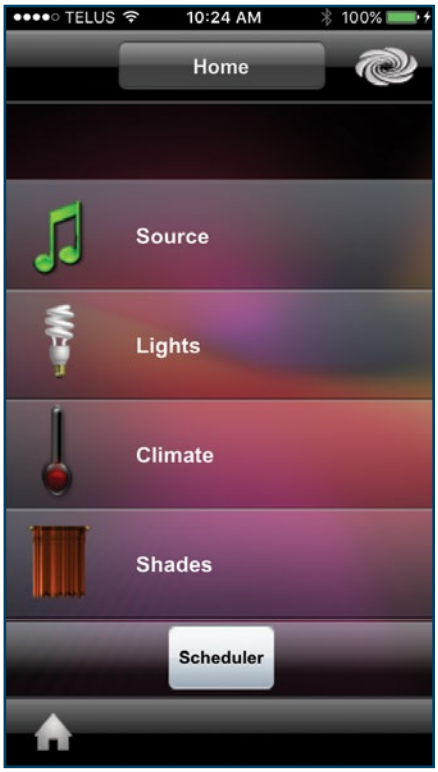

Figure 2: Keypad for programmed scenes
Photo by Ron Wickman

Television and home entertainment

Home automation enables people to control devices such as the TV, satellite dish and stereo from wherever they are, by simply using a remote control.

Security

Home security systems that charge a monthly fee have been available for many years through security companies that monitor your home. Security systems integrated with a home automation system that will notify you directly of any problems at your home are also available. This type of system needs to be set up by a professional, but it is very cost-effective as there is no monitoring fee.

A security system offers many options and enables you to control as many or as few devices as you want. A signal can be sent to the police or a security company if a window has been broken. A security system can even be set to turn off all the lights, lock the doors and turn down the thermostat when you go to bed.

If there is something wrong or unusual at your home, the security system can send a message to notify you that a pipe is leaking or someone has opened your front door, for example. If you use attendant services or are expecting a repair person, you can use your telephone to disarm the security system, unlock the door and let people in.

These systems can also be used to give your home a more lived-in look by randomly turning lights and devices such as TVs and stereos on and off.

Home automation can provide you with greater control of your environment and increase your independence. In addition, cost savings and greater energy efficiency can result.

Heating and cooling

The heating and cooling system is one of the costliest aspects of operating a home.

Programmable thermostats that use computer chips allow the heating and cooling system to be set to run only when needed. This reduces energy consumption and costs. You can program the thermostat to turn on in the morning just before you get out of bed, turn down when you leave for work and turn up again just before you come home. See CMHC's fact sheet *Setback Thermostats* for more information.

A tactile thermostat with enlarged raised numbers is designed for individuals with low vision or limited hand mobility.

- High contrast markings and low-glare design make it easier to see the current temperature settings. The temperature setting scale and switch markings are raised, for easy recognition by sight or by touch.
- The large 5, 6, 7 and 8 stand for 50, 60, 70 and 80 degrees Fahrenheit, respectively.
- Temperature adjustments are easier thanks to a large, graspable temperature-setting dial or lever. A click is heard and an indent felt to provide audible and tactile feedback for every two degrees of movement. The two degrees are for comfort adjustment during the day. A special indent is felt at the 10 degree mark for easy setback at night. There is an enlarged temperature dial and indicator arrow for aiding the user in lining up the dial with the correct temperature setting.
- The large print owner's guide is easy to read. An optional Braille owner's guide is also available.
- Easy-to-see thermostats are available for low-voltage, conventional or heat pump systems.

With programmable thermostats in different rooms of your house, you can create different zones that can be heated or cooled when occupied.

Some technologies even allow you to call your home computer system, check the temperature and change the thermostat using a wireless tablet and/or smartphone apps as a method of accessing an automation system, both from within the home and when away from home via the Internet (see figure 3).

Some cooling systems can be programmed to turn off the air-conditioning system when an open window is detected and turn the system back on when all the windows are closed.

Figure 3: Programmable thermostat
Photo by Ron Wickman

Telephones

The telephone can be more than a way of communicating with the outside world. A telephone can be used to communicate with someone at the front door and it can even be programmed to release the lock and allow a visitor to enter. This is especially helpful to people who have caregivers or attendants coming to their house. Being able to communicate with and identify the person who is at the door from anywhere in the home is a great feature for everyone, especially for people with visual impairments who may not be able to visually identify who is at the door (see figure 4).

Figure 4: Programmable telephone
Photo by Ron Wickman

Some telephones can be programmed to ring a unique tone when the doorbell or intercom button is pressed. If you are on the telephone, a unique call-waiting tone will chime. There are also a variety of amplifiers on phones that can help increase the volume of the speaker. People with hearing loss should first look for a phone that is hearing aid compatible, volume and tone controlled and has call display. Many users also like the 'speaker' ability so that they can listen to a call with both ears and no interference from their hearing aids.

A programmable telephone is invaluable because it can store the phone numbers of people you frequently call, as well as emergency telephone numbers. This is especially important for people with disabilities who find it difficult to dial the telephone quickly and accurately. Some programmable telephones even respond to voice commands. Wireless headsets provide even greater versatility.

Telephones can be programmed not to ring during specified times of the day, a benefit to parents of small children who nap or seniors who want quiet time in the afternoon or late evening.

People who are hard of hearing are used to telephones that come with both audible and visual notification systems. TTY (Teletypewriter) and computers can be used by people who are deaf or hard of hearing to transmit tones that are displayed as text, facilitating written communication. A TTY can be programmed to automatically answer and take a message.

Automated fixtures and fittings

Appliances

Computer chips are frequently installed in appliances, such as washing machines, coffee makers and water heaters. They can be programmed to operate when you want or in off-peak energy periods.

Doors

Many people use a remote control to open their garage door. An additional feature is a garage door sensor that will alert you (audibly and visually) if the door is left open.

Opening the front door while carrying a load of groceries is difficult for everyone, but can be especially awkward for people with mobility impairments or with service animals. An automatic lock release and door opener can be activated by a remote control device, similar to the device used to open garage doors (see figure 5).

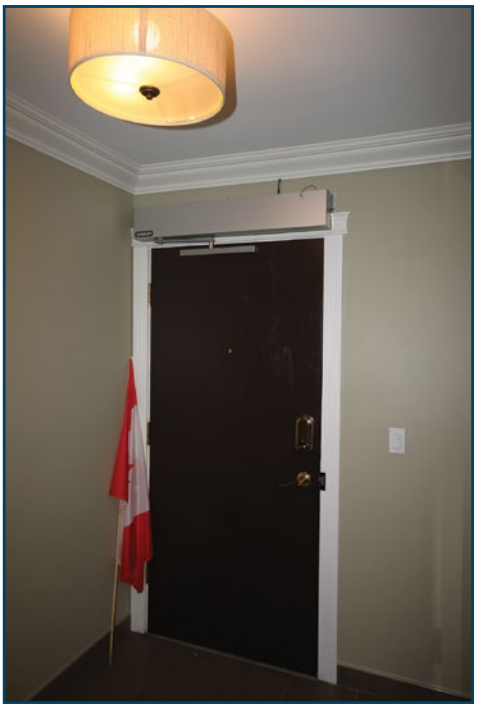

Figure 5: Remote control door opener
Photo by Ron Wickman

Motorized window shades are convenient for all people, but in particular, for people who have difficulty reaching a chain on the wall above the sink, people who have mobility or balance challenges or people with vision loss. Motorization can also benefit people of a shorter stature.

Hard wired installation needs to be considered during construction. The location and height of the wall switch and electrical outlet must meet the needs of the client.

Windows

What would you do if you were at the store when a sudden thunderstorm started and you had left your windows open? What if you had a disability and limited strength and could not close the windows yourself? Windows can be closed remotely by your home automation system and they can even be programmed to open automatically when the thermostat registers a certain temperature.

If your security system is equipped with window sensors and a window is opened when it should not be or if a window breaks, the sensor will cause the security system to automatically send you a signal or a pre-recorded message.

Blinds and curtains

For some people, opening and closing the curtains and blinds is more than an inconvenience, it is an impossibility. Many new models of curtains and blinds come pre-automated. However, it may be just as easy to modify existing installations to be able to control them using a remote control or a timer.

Water

Automated faucets are commonplace in public spaces such as washrooms. This technology is now making its way into private homes.

Getting the temperature just right for your morning shower can now be as simple as pressing a button. Electronic shower controls allow everyone in the family to personalize the water temperature and water flow. This not only saves energy—it reduces the danger of burns, which can be a concern for families with young children and people who cannot feel water temperature because of paralysis or a lack of sensation.

Some models provide audible feedback of the selection, a feature useful to people with a visual impairment.

For people who transfer onto a shower bench from a wheelchair or who require assistance entering the shower, models are available that will pause the water flow to allow the user to enter the shower area without getting sprayed.

Large hot water tanks that continuously heat and reheat water until it is needed are no longer necessary, as high-efficiency heaters produce hot water on demand, allowing a continuous flow of hot water for as long as you need it.

Fire and other safety emergencies

People with partial or total hearing loss are especially challenged in the hearing world where safety and security are concerned. Things hearing people take for granted, such as confidence in early detection and signalling systems for fire alerts, can be a real cause for anxiety.

There are several products on the market that aid people with hearing limitations to ensure their homes are safe and anxiety-free. Two of those items are:

- A fire alarm system equipped with a strobe that will flash a bright light to catch one's attention and allow sufficient time to evacuate. These products are often used in workplace, and commercial locations; and
- A wireless system that will transmit a signal, up to 30 m (100 ft), even through a closed door, to a receiver unit that activates a powerful bed vibrator to wake up a sleeping person. The vibrator will run for approximately 3 minutes or until the rest button is pressed.

Both types of system also come with audible signals for those hearing persons who live or work in the same location. The best option would be to install both systems.

Nobody likes to take chances with the safety and lives of loved ones, so it is important to be able to both detect an emergency situation and get assistance when it is needed, especially since more people with disabilities and seniors are living alone than ever before.

Automated homes can be equipped with alarms that are wired to work with several devices throughout the home. When triggered, smoke and fire alarms can activate telephones that automatically call a preprogrammed number for assistance, can turn the lights in the home on to help people find their way out and ceiling fans off to slow the spread of a fire. At the same time, the security system can be deactivated, so emergency personnel can easily get into the house.

Personal monitoring systems are used by many people as they get older, especially if they live alone. By pressing a button on a wireless pendant or bracelet, the user summons help. Monitoring companies provide the equipment and monitoring service for a monthly fee. You can select a neighbour or family member to be contacted for assistance. These services are available from most telephone companies across Canada.

If you have someone in your home, such as a senior, child or person with a developmental disability who is prone to wandering away from home, a monitoring system could also help ensure his/her safety and provide you with peace of mind. A magnetic door sensor can detect if a door has been opened. Another option is a wireless pendant or wristband that sends a continuous signal to a receiver within the home. When the person attempts to leave the area, the receiver will detect the missing signal and will sound an alarm or dial a preprogrammed number.

Instead of implementing electronic tracking systems right away, consider first a sign inside the front door reminding the person to take a phone that he or she can use in case of emergency or remove the person's jacket or walking shoes to avert wandering.

There are additional safety devices that can be of great help to people with developmental delays or seniors with Alzheimer's disease. Door alarms with magnetic contacts will register when a door is opened. For example, if a door is opened in the middle of the night, they can announce the time and relay a message such as "please return to bed."

For persons with dementia, it is a good idea to place illuminated clocks in each room indicating whether it is a.m. or p.m. and use large, clear and accurate analogue clocks.

Other considerations

Individual assessment to get the right technologies

To ensure that you get a system that meets your needs for today and tomorrow, consult with a systems integration contractor that can provide you with information. This is especially important for people with disabilities who wish to live independently to the greatest extent possible. Ask yourself the following questions to see if a home automation system meets your needs:

- Does it have an appropriate interface, switch or control that can be easily used by you and your family?
- Is it simple and intuitive to use?
- Is there enough power to run it?
- Is there a minimal time delay between control operation and feedback?
- Is there some forgiveness for error?
- Will it save time, money or energy?
- Does the system reset to default settings?

New construction and retrofit

A home automation system can be part of a new home design and construction or placed in an existing home without extensive rewiring. Some devices can simply be plugged into existing electrical outlets.

If you purchase devices and systems that simply plug into existing electrical outlets, you can install them yourself.

However, for more complex network installations and for integration of multiple hard-wired devices, it is best to have the systems installed by an electrician.

For prewiring a new building:

- Centralized lighting control systems typically need specific wiring to be installed, however, wireless lighting control systems are a great alternative—especially for retrofit applications.
- Motorized window coverings as part of a complete home automation system require a wire to be home run to a centralized location, such as an equipment room or mechanical room from each window.
- Built-in audio systems also require wire to be home run from each speaker to an equipment room.
- TV locations should each have a CAT6 cable and RG6 coaxial cable home run to the equipment room.
- Thermostat controls generally require specific wiring to the device being controlled, however, it is suggested to add an additional CAT6 cable where possible.

System requirements

Check the electrical requirements before buying a device or a system. Some systems can use existing home wiring; others will require wiring upgrades and grounding. It is best to consult an electrician.

Location of control centres

Plan the location of your computers, touch screen controls and telephones so you have easy access and full control over all of your devices. Also, plan locations for a central control panel (see figure 6), as well as a central entertainment centre (see figure 7).

Electrical panels are often installed in the basement or some out-of-the-way corner, but homeowners that cannot make it up and down the stairs may not be able to access them if a breaker trips or the power goes out. Consider moving the panel to the garage and installing it at a wheelchair-accessible height.

Figure 6: Central control panel
Photo by Ron Wickman

Figure 7: Central entertainment centre
Photo by Ron Wickman

Compatibility

There are various brands and types of home automation available, some of which will work together, and others that operate only with devices from the same company or brand. When choosing systems and devices, it is important to consider compatibility and future expansion.

Portability

Devices that are not hard-wired, such as those that plug into an electrical outlet, are portable and allow for greater flexibility in the event of changes to the home automation features or if you move to another home.

Dedicated computer system

Complex automated home systems require a separate, dedicated computer system.

In many cases, these computers can be configured to work with your regular home computer for added convenience.

Safety backup system

If you are relying on a computerized home automation system to control your alarm system, your garage door and your locks, you should invest in an alternate power source, such as a battery or a generator.

Energy efficiency

Home automation can save energy by turning off appliances when they are not needed or by programming appliances so that two do not operate simultaneously.

Cost

Devices can be simple and inexpensive or sophisticated and expensive.

Running structured wiring in an existing home may cost $1,000 to $3,000, compared to $600 to $2,000 for new homes, not including the cost of a central controller.

Wireless systems are less expensive and on average cost between $100 and $150 for each connected device and device controller. There are additional costs for the central controller as well as programming and set-up if you use a professional service provider.

Most basic home automation systems on the market cost approximately $3,500. Part of the cost of a basic system can be offset by energy savings, but the payback period is lengthy.

Controller features

A device that provides information in several different formats (text, audio, tactile) is more universally accessible to everyone.

In accessible home design, it is a good idea to consult with a professional, such as an occupational therapist. It also helps to consult with an architect, an interior designer or another design professional who is familiar with the design of accessible residences. During the design, work with the designer, occupational therapist and a systems integration contractor to determine the most positive home layout and best home automation possible.

Appendix

Interfaces

Interfaces are links between the user and the automated device. The following types of interfaces are available on the market today:

Audible sensors—Strategically located microphones that can be programmed to "listen" for sounds, such as breaking glass and other loud noises.

Biometrics—Biometrics uses physical identification marks such as fingerprints to control devices such as door locks.

Buttons and keypads—Alphanumeric keypads and push buttons are commonly used as input methods.

Magnetic door and window sensors—Magnetic contacts are applied to doors, windows, garage doors and any hinged component. If the two sides of the magnetic contact separate, a signal is transmitted.

Movement—Motion sensors send a signal to a device when they sense movement.

Pressure (air or weight)—Pressure mats register changes in pressure (like the mats at the automatic doors of grocery stores) and activate a preprogrammed control.

Switches and controls—Rocker and touch switches are the simplest form of control and can be used to activate a multitude of devices.

Voice recognition—The interface recognizes voice commands to activate devices.

Operating systems

Assistive listening device—Electronic devices installed to make communication easier in difficult listening environments. Special equipment is used to minimize the effects of noise, echoes and distortion in an unfriendly acoustic building.

Computers, wireless PDAs (for example, smartphones and wireless tablets)—These systems can be programmed to control devices.

Remote controls—Remote controls that use infrared, RF, and Wi-Fi signals are programmed to wirelessly control appliances and devices.

Assistive technologies

The following technologies have been specifically developed to assist people with disabilities.

Foot switch—A foot switch is activated by pressing with the foot on the top of a hinged surface. Foot switches are available in wired or wireless models and some provide tactile and auditory feedback.

Head mouse—A head mouse replaces a standard computer mouse for people unable to use their hands. Using wireless technology, an infrared light is used to track a small target placed on the user's forehead or glasses and measures the user's head movements.

Head switch or pillow—This switch is activated with very light pressure from the head and can control devices such as lights.

Joystick—A joystick can be used to activate various devices depending on which direction the joystick switch is moved.

Pinch switch—This switch can be operated with two fingers using very light pressure or it can be surface-mounted for one finger operation.

Sip/puff switch—Sipping on a sip/puff tube will operate one device, while puffing will operate a second device.

Touch pad switch/jelly bean—This is a single large button, activated by pressing anywhere on the top surface.

Glossary

Aging in place: The ability to remain in one's home safely, independently and comfortably, regardless of age, income or ability level throughout one's changing lifetime.

Ambient lighting: The overall illumination of an environment using lamps, overhead light fixtures, sunlight and any previously existing light.

Event: A predetermined occurrence, such as time of day, decrease in light level, change in noise level, and so on.

Interface: The link, between the user and the device, it is how the user communicates with the system. An interface can be a button, a keypad, a motion sensor, and so on.

Motion sensor: A device, also referred to as an occupancy sensor, which uses infrared signals to detect movements in a room or area.

Scene: A scene is a group of actions that are all performed in response to a single command. For example, a "Goodnight" scene can be executed from one button that causes all of the lights to turn off, the security system to arm and the TV to turn off.

Additional resources

Books

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http://www.rnib.org.uk/

NC State University: College of Design (May 2016)
http://www.design.ncsu.edu

Home for Life (May 2016)
http://www.homeforlife.ca/

Institute for Human Centered Design (May 2016)
http://humancentereddesign.org/

Livable Housing Australia (May 2016)
http://livablehousingaustralia.org.au/

The Principles of Universal Design

Principle 1: Equitable use

This principle focuses on providing equitable access for everyone in an integrated and dignified manner. It implies that the design is appealing to everyone and provides an equal level of safety for all users.

Principle 2: Flexibility in use

This principle implies that the design of the house or product has been developed considering a wide range of individual preferences and abilities throughout the life cycle of the occupants.

Principle 3: Simple and intuitive

The layout and design of the home and devices should be easy to understand, regardless of the user's experience or cognitive ability. This principle requires that design elements be simple and work intuitively.

Principle 4: Perceptible information

The provision of information using a combination of different modes, whether using visual, audible or tactile methods, will ensure that everyone is able to use the elements of the home safely and effectively. Principle 4 encourages the provision of information through some of our senses—sight, hearing and touch—when interacting with our home environment.

Principle 5: Tolerance for error

This principle incorporates a tolerance for error, minimizing the potential for unintended results. This implies design considerations that include fail-safe features and gives thought to how all users may use the space or product safely.

Principle 6: Low physical effort

This principle deals with limiting the strength, stamina and dexterity required to access spaces or use controls and products.

Principle 7: Size and space for approach and use

This principle focuses on the amount of room needed to access space, equipment and controls. This includes designing for the appropriate size and space so that all family members and visitors can safely reach, see and operate all elements of the home.

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